DECLINING OCCUPATIONS AND CAREER OUTCOMES IN NORWAY

Supplemental Appendix

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Data and variable definitions

From administrative linked employer-employee register data for the full population from 2007–2024 from Statistics Norway, we select a sample of employees from 2007 and follow them annually to 2024.

The 2007 sample of employees

Our sample includes all 22–45-year-old employees in 2007 who were residents in Norway. For each employee we keep main occupation defined as the occupation with largest wage earnings, summing over all jobs (employers) in 2007. We require that annual earnings from main occupation must exceed 0.5 basic amounts of the Norwegian pension system (33,400 2007-NOK), roughly equal to 4,800 2022-USD (inflation and exchange-rate adjusted). Students are included (9.6% are students in 2007, of which 40% are 22–25 years old). The data do not include self-employed workers, and we drop military occupations.

Occupational classification

Occupation is reported for each annual observation by statistics Norway, using the Norwegian Styrk-98 classification, based on ISCO-88. We measure occupations at the three-digit level. Because public sector classifications were reported using position codes (stillingskoder) rather than occupation codes in the earlier years of our data, with a gradual and lumpy transfer to Styrk-codes, we lump together white-collar public-sector administrative jobs (including managers) into one occupation (Public sector administration) every year before calculating growth in annual employment shares, etc. Three digit-occupations with less than 250 observations in 2007 are lumped together with similar occupations (521 into 522, 912 into 913, 611 & 612 into 613, 631 into 641, 732 & 733 into 731, and 743 into 744). Observations with missing occupation are excluded but included in the denominator when calculating annual occupation shares. A full list of occupations, including employment growth between 2007 and 2024, is provided in Appendix Table 1.

We create an indicator of *declining occupations* for occupations where the employment share, that is, the count in 2024 minus the count in 2007 divided by the count in 2007, declines by at least 25% from 2007 to 2024.

We calculate *growth quartiles* based on relative change in occupation shares, correcting for overall employment growth, equal to the share in 2024 minus the share in 2007, divided by the share in 2007.

Variable definitions and data series 2007–2024

We measure outcomes in terms of employment and earnings series for every year from 2007 to 2024 for the entire 2007-sample of employees.

Employment series are defined from the observed *annual labor earnings from main occupation* that year being above a certain threshold as defined above. Non-employment status includes dead persons and emigrants. By 2022 (the last year with demographic data) 1.68% had emigrated and 1.19% were dead. There is a break in the series between 2014 and 2015 due to an administrative change in the reporting routines for the Employer-Employee register, from physical and annual reporting to monthly reporting mainly directly from digital payroll systems that include slightly more reported job-spells.

Earnings series include *total pre-tax wage earnings* from all jobs (employment spells) each year, conditional on employment. Income from self-employment is not included. Earnings are measured in real (inflation adjusted) 2022-NOK and winsorized at 0.1% and 99.9%. *Earnings ratio* is calculated as cumulative real earnings over 2007–2024 relative to the 2007-level (capped at 500 before winsorizing).

Covariates and group definitions measured in 2007

Education and student status by October 2007 is obtained from the Norwegian National Data Base managed by Statistics Norway.

An immigrant is defined as a worker born outside of Norway by two foreign-born parents. High-income countries include EU, EFTA (minus Norway), Great Britain, US, Canada, Australia, and New Zealand.

Control variables in regressions and group classifications in the heterogeneity analyses include sex, age (three groups), education (no/low, middle, and high), immigrant status (natives, high-income countries, and rest of the world), industry dummies (two-digit NAICS codes), five dummies for centrality of residential municipality (measured relative to the most central: Asker, Bærum, Drammen, Lørenskog, Moss, Oslo, Rælingen, Skedsmo), log annual wage earnings in 2007, rural vs. urban residential municipality according to classification by Statistics Norway (Urban: Asker, Askim, Bergen, Bærum, Drammen, Fet, Fredrikstad, Frogn, Gjerdrum, Hamar, Horten, Lier, Lørenskog, Moss, Nedre Eiker, Nittedal, Oppegård, Oslo, Randaberg, Rygge, Rælingen, Røyken, Sandefjord, Sandnes, Sarpsborg, Skedsmo, Ski, Sola, Stavanger, Trondheim, Tønsberg, Ullensaker, Vestby, Ås), log number of employees in 2007-establishment and -firm (count set to 1 if missing or 0/negative before taking logs), and six dummies for the change in firm employment from 2007–2016 and 2016–2024, respectively: grew, shrank or closed (relative to stayed constant and firms with missing employment info), private sector worker according to sectoral definition by Statistics Norway.

Occupational changes

Appendix Table 1 provides data on employment growth for three-digit occupations from 2007 to 2024. Column 2 shows employment growth as a share of the workforce, while Column 3 shows employment growth relative to the occupation's employment in 2007. Occupations with the largest relative growth (Q4) include STEM professionals such as Mathematicians, Statisticians and Computer system designers and computer programmers, Health and Life science professionals, Legal and Business professionals, Nurses and Health professionals, as well as Restaurant service workers. The most stagnant occupations (Q1) include Library, Mail and Related clerks, Secretaries and Keyboard-operating clerks, Metal- and Mineral-products Machine operators, Laborers in Manufacturing, Cashiers, Tellers and Related clerks, and Shop Salespersons. Column 1 shows the share of private-sector workers in each occupation, and Column 4 the respective growth quartile.

Correlations of growth and occupation traits

Table 2 provides correlations of occupation growth from 2007 to 2024 with skill features of the occupation and traits of individuals employed in the occupation in 2007. Correlations are weighted by counts of individuals in occupations in 2007. Columns 2–5 provide the mean values of each trait by growth quartile. In line with previous work, we find that occupations with a high degree of routine tasks decline, whereas occupations requiring service and abstract/cognitive tasks grow. Likewise, occupations with college educated workers grow, and those with less education decline. There is further a positive correlation between growth and the wage level in 2007.

Regression tables

Appendix Tables 3–5 reports the full sequence of controls from Table 2 in the paper. Table A3 reports the results for cumulative earnings relative to 2007 level. Column 1 shows the results from the base analysis without controls, replicating the results from Table 2, and then 2 adds demographics, 3 industry, 4 geography, and finally establishment and firm size and growth are added in Column 5, replicating the numbers from the analysis with full controls from Table 2. We note from Panel A that the coefficient for declining occupations starts out insignificant and unstable but becomes negative below -1 after adding industry fixed effects and ends up with at -1.2 with a t-value of 1.72 with the full set of controls. In Panel B the most stagnant group shows up with a positive coefficient, not significant, without controls, that declines with the addition of demographic controls and turns negative once industry fixed effects are added, down to the same level, still insignificant, as in the model with full controls. Declining occupations appear to be positively correlated with industries that display higher earnings growth for individuals who start out there. For accumulated earnings, reported

in Table A4, the baseline results are more negative, which reflects the fact that declining occupations display lower earnings at the initial level, as shown in Figure A1.

The results for cumulative years employed in Table A5 also show a similar development, where the results stabilize after adding industry fixed effects, and remain small and insignificant thereafter.

Appendix Table 1: Occupations and growth from 2007 to 2024

Occupation	Private sector share	Relative Growth in share of workforce	Relative Growth in count of workers	Quartile
	(1)	(2)	(3)	(4)
Library, mail and related clerks	0.80	-0.77	-0.74	1
Printing-, binding- and paper-products machine operators	1.00	-0.66	-0.61	1
Legislators	0.49	-0.66	-0.60	1
Graphic artists, photographers, and related trades workers	0.98	-0.59	-0.53	1
Wood-processing and papermaking-plant operators	0.99	-0.53	-0.46	1
Secretaries and keyboard-operating clerks	0.78	-0.52	-0.45	1
Technical illustrators	0.99	-0.45	-0.37	1
Metal- and mineral-products machine operators	0.98	-0.43	-0.35	1
Chemical-products machine operators	1.00	-0.40	-0.32	1
Chemical-processing-plant operators	0.99	-0.37	-0.27	1
Assemblers	0.99	-0.35	-0.25	1
Labourers in manufacturing	1.00	-0.35	-0.25	1
Precision workers in metal and related materials	0.96	-0.34	-0.24	1
Textile-, fur- and leather-products machine operators	0.93	-0.33	-0.24	1
Messengers, porters, doorkeepers and related workers	0.79	-0.33	-0.23	1
Cashiers, tellers and related clerks	0.97	-0.30	-0.20	1
Numerical clerks	0.97	-0.29	-0.18	1
Metal-processing-plant operators	1.00	-0.28	-0.17	1
Glass, ceramics and related plant operators	1.00	-0.27	-0.16	1
Stone cutters and related workers	0.99	-0.26	-0.15	1
Butchers, bakers and other related food preparers	1.00	-0.22	-0.11	1
Religious professionals	0.38	-0.21	-0.10	1
Ship and aircraft controllers and technicians	0.96	-0.20	-0.08	1
Shop salespersons and demonstrators	1.00	-0.19	-0.07	1
Wood treaters, cabinet-makers, and related trades workers	0.98	-0.18	-0.06	2
Other teaching professionals	0.51	-0.17	-0.05	2
Senior officials of interest organisations	0.94	-0.16	-0.04	2
Laboratory assistants	0.80	-0.16	-0.04	2
Business services agents and employment agents	0.98	-0.14	-0.02	2
Textile, garment and related trades workers	0.85	-0.14	-0.01	2
Directors and chief executives	0.96	-0.12	0.01	2
Founders, welders, sheet-metal workers, etc.	1.00	-0.12	0.01	2
Other department managers	0.95	-0.11	0.02	2
Journalists, librarians and information associate professionals	0.63	-0.11	0.02	2
Technical and subject teaching and other teaching associate and pedagogical professionals	0.51	-0.07	0.07	2
Finance and sales associate professionals	0.99	-0.07	0.07	2

Production and operations department managers	0.70	-0.07	0.07	2
Domestic and related helpers and cleaners	0.74	-0.06	0.07	2
Primary education teaching associate professionals	0.06	-0.06	0.08	2
Power-production and related plant operators	0.69	-0.05	0.09	2
Computer associate professionals	0.78	-0.03	0.11	2
Mobile-plant operators	0.97	-0.02	0.12	2
Machinery mechanics and fitters	0.96	-0.02	0.13	2
Other personal services workers	0.98	0.00	0.14	2
Material-recording and transport clerks	0.96	0.00	0.14	2
Life science technicians and related associate professionals	0.31	0.01	0.15	2
Public admin.	0.11	0.01	0.16	2
Building finishers and related trades workers	0.98	0.02	0.17	2
Painters, building structure cleaners and related workers	0.94	0.02	0.17	3
Electricians, electrical and electronic equipment mechanics and fitters	0.96	0.02	0.17	3
Writers and creative or performing artists	0.54	0.02	0.17	3
Oil, gas, mining- and mineral-processing-plant operators	1.00	0.03	0.18	3
Nursing and midwifery professionals	0.06	0.03	0.19	3
Secondary education teaching professionals	0.10	0.03	0.19	3
Food and related products machine operators	1.00	0.04	0.19	3
Building, vehicle and related cleaners	1.00	0.04	0.19	3
Police officers	0.00	0.05	0.21	3
Administrative and economic associate professionals	0.70	0.06	0.21	3
Crop and animal producers	0.99	0.08	0.23	3
Motor-vehicle drivers	0.99	0.08	0.24	3
Building frame and related trades workers	0.93	0.08	0.24	3
Physicists, chemists and related professionals	0.82	0.08	0.24	3
Client information clerks	0.98	0.09	0.25	3
Social science and related professionals	0.64	0.12	0.29	3
Engineering science technicians	0.88	0.13	0.29	3
Protective services workers	0.51	0.13	0.29	3
Personal care and related workers	0.24	0.14	0.31	3
Locomotive-engine drivers and related workers	0.99	0.15	0.31	3
Labourers in construction and maintenance, etc.	0.95	0.15	0.32	3
Garbage collectors and related labourers	0.75	0.16	0.34	3
Religious associate professionals	0.49	0.17	0.34	3
Travel attendants	0.93	0.18	0.36	3
Optical and electronic equipment operators	0.73	0.19	0.37	3
Pre-primary education teaching associate professionals	0.42	0.20	0.38	4
General managers of small enterprises	0.99	0.21	0.38	4
Nursery and Registered Nurses for the Mentally Subnormal (RNMS)	0.12	0.24	0.42	4
Modern health associate professionals (except nursing)	0.45	0.25	0.44	4
Blacksmiths, gunsmiths, locksmiths and related trades workers	0.99	0.28	0.47	4
Architects, engineers and related professionals	0.86	0.29	0.48	4

Forestry workers, etc.	1.00	0.33	0.53	4
College, university and higher education teaching professionals	0.10	0.34	0.53	4
Housekeeping and restaurant services workers	0.94	0.34	0.54	4
Special education teaching professionals	0.12	0.39	0.60	4
Ships/deck crews and related workers	0.98	0.40	0.60	4
Life science professionals	0.64	0.44	0.66	4
Health professionals	0.27	0.56	0.80	4
Fire and safety inspectors	0.82	0.57	0.80	4
Storing and goods handling labourers	0.99	0.58	0.81	4
Business professionals	0.81	0.74	1.00	4
Social workers (college-trained), child care officers, etc.	0.26	0.76	1.02	4
Computer systems designers and computer programmers	0.88	0.81	1.08	4
Legal professionals	0.73	0.85	1.12	4
Curators, librarians and related professionals	0.28	0.97	1.26	4
Agricultural, fishery and related labourers	0.98	1.03	1.33	4
Artistic, entertainment and sports associate professionals	0.97	1.21	1.54	4
Fish farmers, etc.	0.99	1.22	1.55	4
Mathematicians, statisticians and related professionals	0.47	3.55	4.22	4

Notes: Table provides occupational categories and occupation growth from 2007 to 2024.

Appendix Table 2: Correlations of occupation traits

	Correlation of trait with occupation growth 2007–24	Mean value in quartile [4=fastest growth]			
		Q1	Q2	Q3	Q4
	(1)	(2)	(3)	(4)	(5)
Task/skill traits:					
Autor-Dorn: Routine tasks	-0.236*	6.165	3.800	4.137	3.909
Autor-Dorn: Abstract tasks	0.353*	1.632	3.214	2.089	4.649
Autor-Dorn: Manual tasks	0.197*	0.396	1.124	1.962	1.426
Deming: Social tasks	0.271*	2.306	4.000	2.766	4.723
Deming: Math tasks	0.079*	3.938	4.057	3.361	4.568
Deming: Routine tasks	-0.260*	5.646	4.166	4.158	3.913
Deming: Service tasks	0.288*	2.944	3.751	4.224	5.573
Traits of workers in occupation in 2007:					
Share male	-0.014*	0.477	0.572	0.542	0.430
Share immigrants	-0.004*	0.093	0.098	0.103	0.097
Share with less than high school education	-0.107*	0.258	0.164	0.197	0.077
Share with completed high school education	-0.145*	0.556	0.396	0.527	0.202
Share with college education or more	0.230*	0.185	0.440	0.276	0.721
Average age	-0.009*	33.50	35.184	34.191	34.207
Average real income (2022-NOK)	0.072*	kr 377 237	kr 524 611	kr 429 671	kr 500 646
Share lives in rural area	-0.064*	0.570	0.492	0.577	0.459
Share private sector	-0.170*	0.830	0.618	0.535	0.463

Notes: Table provides descriptive statistics on occupations. Column 1 provides correlations of occupation growth from 2007 to 2024 with skill features of the occupation and traits of individuals employed in the occupation in 2007. Correlations are weighted by counts of individuals in occupations in 2007. * signifies statistically significant at a 5% level. Columns 2-5 provide mean values by quartile.

Appendix Table 3: Individual-level regressions of cumulative earnings 2007-24 relative to 2007 level

	Base analysis without controls	Col. 1 plus demographic controls	Col. 2 plus industry fixed effects	Col. 3 plus centrality of municipality	Col. 4 plus size and growth controls for establishment and firms and private sector dummy
	(1)	(2)	(3)	(4)	(5)
	A. Models with occupation decline as single indicator variable for declines exceeding 25%				
(0/1) declining occupation	-0.224	0.073	-1.041	-1.021	-1.207
	(1.899)	(0.854)	(0.747)	(0.707)	(0.699)
	B. Models with occupation decline/growth as quartile indicators relative to the top two quartiles				
(0/1) most stagnant	1.617	0.485	-0.998	-0.968	-0.997
	(1.641)	(0.771)	(0.630)	(0.618)	(0.612)
(0/1) second-most stagnant	-2.131	0.681	0.014	-0.005	0.018
	(0.970)	(1.161)	(0.840)	(0.823)	(0.858)

Notes: See Table 2. This table reports individual-level regressions of cumulative 2007-24 earnings relative to 2007 earnings. Earnings ratios are capped at a value of 500. In Panel A, a single indicator variable models the individual being in an occupation in 2007 that will decline in size by 25% or more in employment counts by 2024. Panel B models quartiles of relative occupation growth. Column header describes the control variables added in each column. Column 2 adds fixed effects to model sex, age (3 groups), education (3 groups), and immigrant background (3 groups) and includes the log initial earnings of the individual in 2007. Column 3 adds NAICS2 fixed effects. Column 4 adds fixed effects for six centrality levels of the individual's municipality in 2007. Column 5 adds controls the log initial employment sizes of an individual's establishment and firm in 2007, indicators for whether the 2007 firm closed, shrank, or grew in employment by 2016 and by 2024, respectively, and an indicator the individual being a private sector worker in 2007. Regressions are unweighted, have 1,111,041 observations, and cluster standard errors by occupation.

Appendix Table 4: Individual-level regressions of cumulative earnings 2007–24 (in 2022-NOK)

	Base analysis without controls	Col. 1 plus demographic controls	Col. 2 plus industry fixed effects	Col. 3 plus centrality of municipality	Col. 4 plus size and growth controls for establishment and firms and private sector dummy
	(1)	(2)	(3)	(4)	(5)
	A. Models with occupation decline as single indicator variable for declines exceeding 25%				
(0/1) declining occupation	kr -1 858 998	kr -655 649	kr -977 359	kr -968 390	kr -1 002 421
	(668 343)	(370 291)	(331 927)	(316 367)	(308 304)
	B. Models with occupation decline/growth as quartile indicators relative to the top two quartiles				
(0/1) most stagnant	kr -1 919 584	kr -257 182	kr -610 308	kr -598 503	kr -588 811
	(1 010 222)	(301 227)	(281 302)	(279 739)	(280 371)
(0/1) second-most stagnant	kr 891 351	kr 168 016	kr 44 552	kr 36 409	kr 45 137
	(1 193 724)	(463 928)	(353 004)	(347 845)	(354 426)

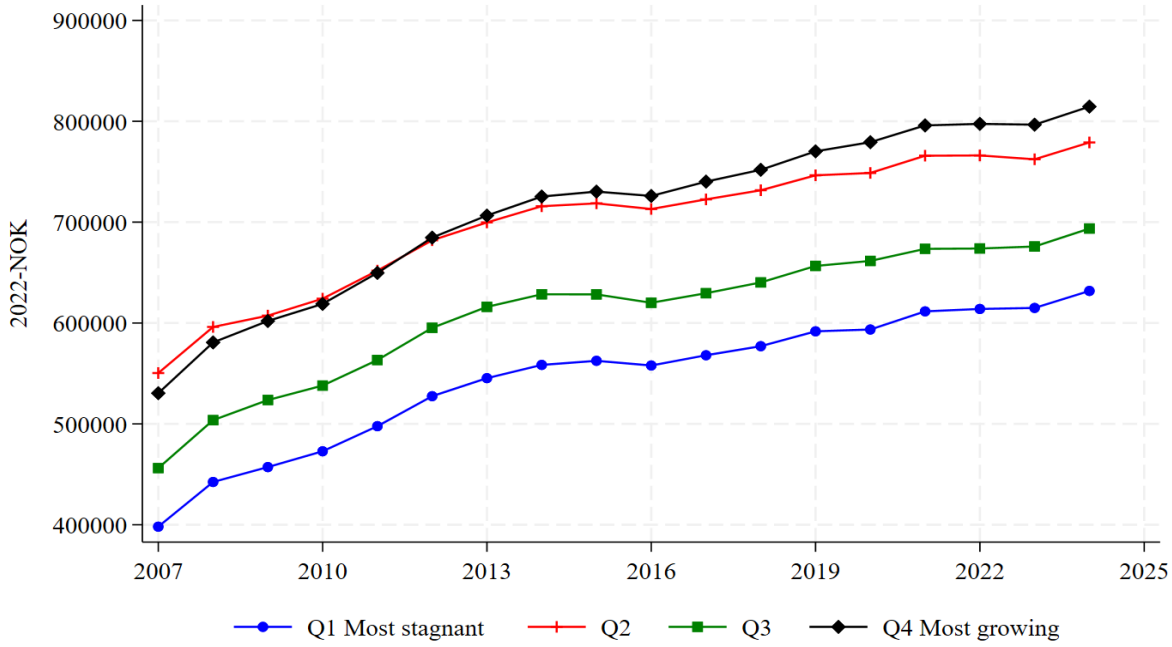
Notes: See Table 2 and Appendix Table 3. This table reports regressions with cumulative earnings during 2007-24 as the outcome variable. Earnings are expressed in constant 2022 Norwegian Kroner and winsorized at 0.1% and 99.9% levels.

Appendix Table 5: Individual-level regressions of cumulative years employed 2007–2024

	Base analysis without controls	Col. 1 plus demographic controls	Col. 2 plus industry fixed effects	Col. 3 plus centrality of municipality	Col. 4 plus size and growth controls for establishment and firms and private sector dummy
	(1)	(2)	(3)	(4)	(5)
	A. Models with occupation decline as single indicator variable for declines exceeding 25%				
(0/1) declining occupation	-0.430	-0.027	0.058	0.054	0.046
	(0.189)	(0.104)	(0.127)	(0.136)	(0.132)
	B. Models with occupation decline/growth as quartile indicators relative to the top two quartiles				
(0/1) most stagnant	-0.537	-0.036	0.040	0.033	0.045
	(0.214)	(0.121)	(0.107)	(0.112)	(0.105)
(0/1) second-most stagnant	0.180	0.029	0.005	0.011	0.008
	(0.329)	(0.122)	(0.072)	(0.074)	(0.072)

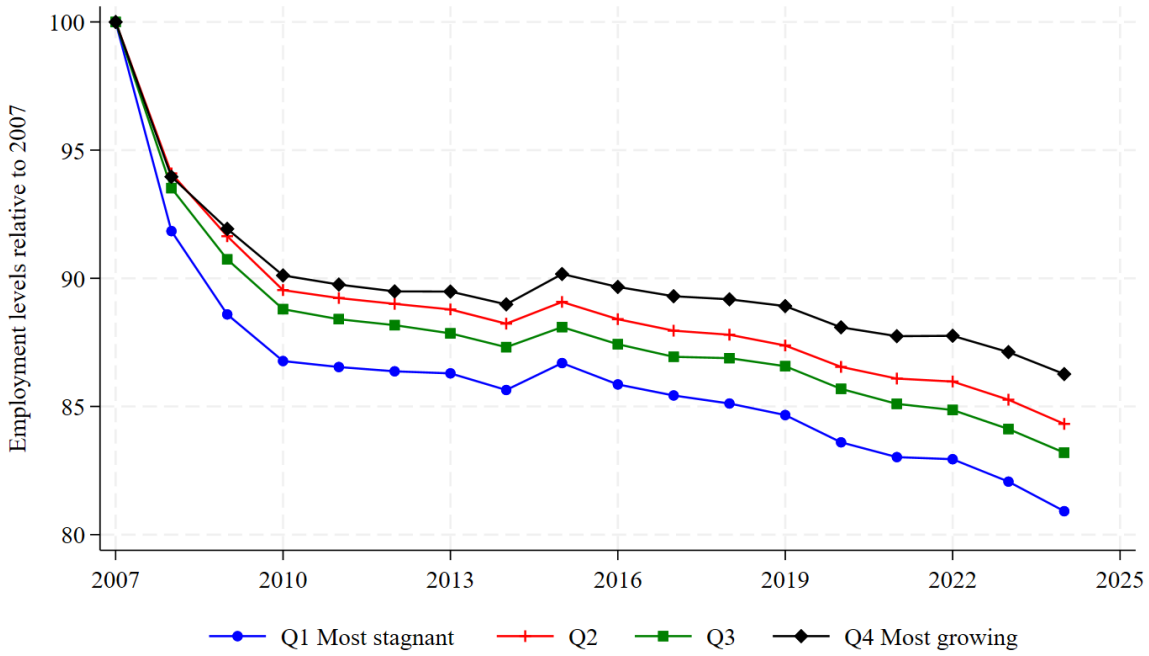
Notes: See Table 2 and Appendix Table 3. This table reports regressions with cumulative years employed 2007-2024 as the outcome variables.

Appendix Figure 1: Earnings Levels (NOK) by Occupational Growth Rate of Workers Initial Occupation, 2007–2024. All workers



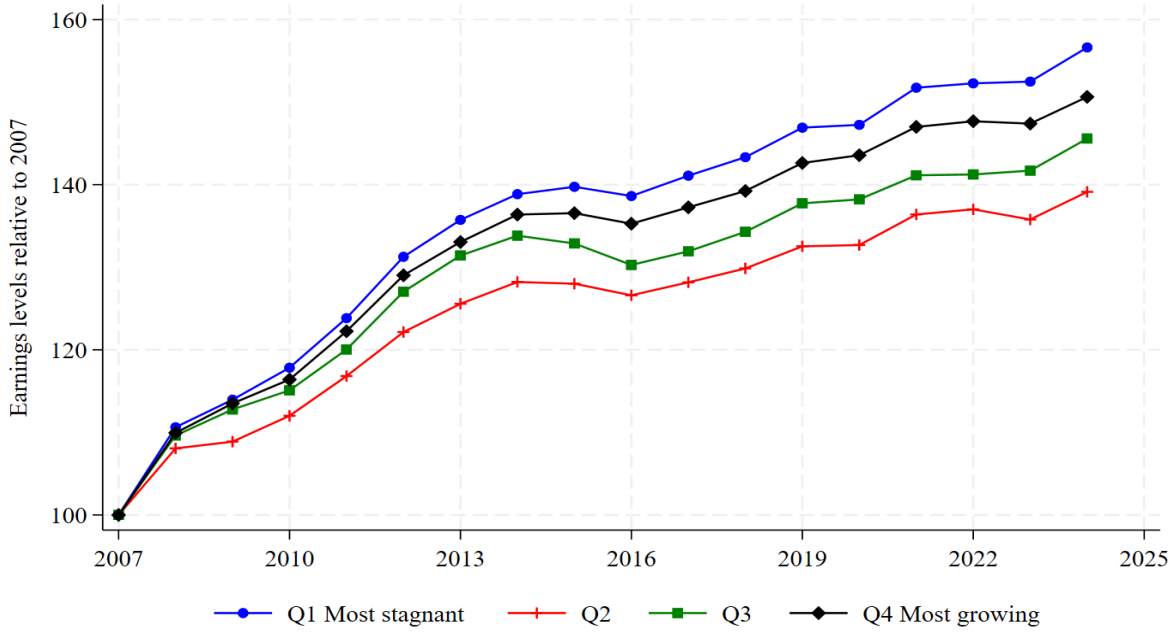
Notes: See Figure 2. This figure provides the base levels for earnings.

Appendix Figure 2: Employment levels by occupational growth rate of worker's initial occupation. Private sector workers



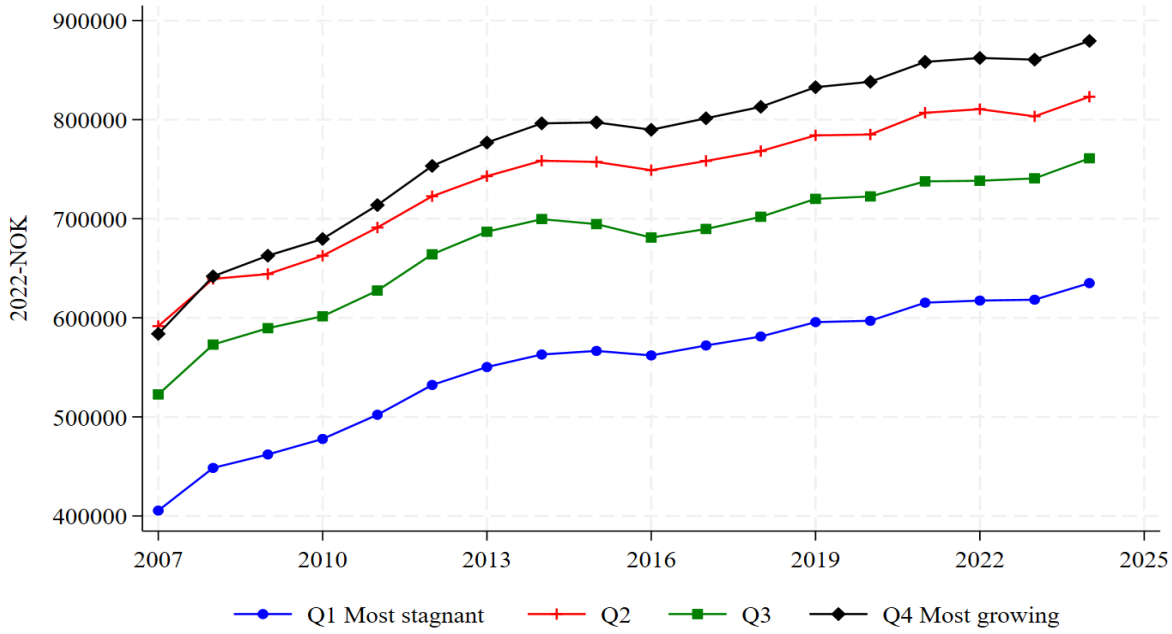
Notes: See Figure 1.

Appendix Figure 3: Earnings levels by occupational growth rate of worker's initial occupation. Private sector workers



Notes: See Figure 2.

Appendix Figure 4: Earnings Levels (NOK) by Occupational Growth Rate of Workers Initial Occupation, 2007–2024. Private sector workers



Notes: See Figure 2. This figure provides the base levels for earnings for workers in the private sector in 2007.