Individual Consequences of Occupational Decline

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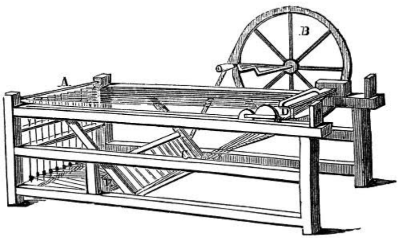
New machines enter the labor market



Research question

What are the consequences for individual workers when demand for their occupation declines?

- Study Swedish workers who in 1985 worked in occupations that subsequently ($\sim$30 years) went into (unanticipated) decline

Motivation:

- Individual welfare
- Labor market inequality
- Human capital investments
- Taxation, redistribution, retirement
- Rise of populism

Methodology: Measuring occupational decline

Information on occupations from US Occupational Outlook Handbook (OOH, published by the BLS Example) to

- Identify declining occupations
- Check for technology drivers of declines
- Distinguish between anticipated and unanticipated declines

Match this occupational information to Swedish data

- Outcomes and covariates from rich longitudinal micro data
- Good reasons not to use actual Swedish occupational growth (see below)

Regress career outcomes (1986-2013) on dummy for working in a declining occupation in 1985

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8. Mean earnings loss similarly small using US (NLSY) data

Literature: Winners & losers from technological change

Lessons from history, economic theory

- Autor (2015), Bessen (2016), Autor & Salomons (2018); Caselli & Manning (2017), Acemoglu & Restrepo (2018)

Forecasts of future job losses

- Range from pessimistic ∼50% (Frey & Osborne, 2017) to optimistic ∼10% (Arntz et al. 2016)

Evidence on individual losses from other adverse shocks

- Mass layoffs (Jacobson et al. 1993), trade (Autor et al. 2014)

But technology is trickier: how to measure individuals' exposure to tech replacement?

- Following Autor et al. (2003), the literature has focused on tasks (routine vs non-routine)
- Cortes (2016) studies this using panel data on broad task categories
- We study occupations and can compare workers in similar occupations (e.g. typists vs secretaries)

Outline

US Occupational Outlook Handbook (OOH)

Our baseline OOH in 1986-87 includes

- About 400 occupations (covering ∼80 percent of US employment) with current **employment data** and **forecasts** on employment for the decade ahead Examples
- About 200 of which (∼60 percent of US employment) also have info on **technological changes** Examples

How we use this information

- Compare OOH publication of 1986-87 to 2018-19 to identify declining occupations
  - Vanished, or employment declined by more than 25 percent
- For declining occupations, we search for technology drivers
- Use OOH forecasts from 1986-87 Details

Using OOH data to study Swedish occupations

N:N match between ∼1,400 Swedish and ∼400 US occupations

Examples of mapping

Defining occupational decline

- A Swedish occupation is coded as 'Declining' if employment growth in corresponding US occupation(s) is $<$ -25 percent
- A Swedish occupation is coded as 'Declining (technology)' if it is 'Declining' **and** there is a likely technology driver

Details

Incidence of occupational decline

- 13 percent of 1985 Swedish employment was in (329) occupations that subsequently declined

Swedish population-level micro data

Large sample

- Full sample 3,061,051 individuals
- Main sample 877,324 individuals (aged 25-36 in 1985)

Labor earnings (pre-tax), industry, education, geography

- 1970, 1975, 1980, annually 1985-2013

Unemployment, retraining, other program participation (Public Employment Service)

- 1992-2013

Occupation

- every five years 1960-1990 for population, annually (large sample) 1996-2013
- classifications change, not always easy to map
- 1985-90 classification very detailed (∼1,400 occupations)
- 1996-2013 only 3-digit level (172 occupations in harmonized classification)

Why Swedish data?

We can control for

- Rich individual characteristics
- Occupation-level life-cycle profiles, 1-digit dummies, past employment and employment changes in Sweden
- Industry dummies (to absorb trade and goods demand shocks)

Large sample means we can investigate heterogeneity

- Who bears the largest costs of occupational decline?
- Losses by occupational earnings rank and age

Why use US-based dummy for decline?

Why use *US* changes instead of *Swedish* changes?

- More information in $\sim$ 400 OOH vs 172 Swedish SSYK96
- SSYK96 defined ex-post and likely pools declining with non-declining
- Simultaneity (pick up supply changes, not demand)
- Occupational trends in Europe similar to US (Goos et al. 2014, Adermon & Gustavsson 2015)

Why report reduced form instead of using OOH decline as IV?

- Coarseness of SSYK96—worse for declining occupations; 2SLS exacerbates this problem
- Instrument becomes weak when adding relevant predictors

Why use dummy for decline instead of using full variation?

- Declines inherently interesting
- Sharp declines unlikely driven by supply

Outline

What can we learn and how?

What are the consequences of occupational decline for individual workers' careers?

- Career earnings, employment and mobility over 28 years of those aged 25-36 in 1985
- Early retirement for older workers
- Other outcomes of interest (health, family) — TBC

Econometric implementation

$$y_{i,1986-2013} = \beta D_i + \begin{bmatrix} \text{individual controls} \\ \text{occupation controls} \\ \text{industry controls} \end{bmatrix} + \varepsilon_i$$

$$D_i \equiv \mathbb{1}\{i \text{ works in an occupation in 1985 that subsequently declines}\}$$

What can we learn and how? Dealing with confounders

Non-random selection of workers into declining occupations

- Control for detailed demographics, education, prior income

Declining occupations may have different life-cycle earnings profiles, even in absence of decline

- Control for each worker's predicted life-time income, based on earnings profile (1985) in initial 3-digit occupation

Sorting in 1985 due to anticipation or ongoing decline

- Control for OOH predictions, lagged Swedish growth, 1985 employment share $\rightarrow$ surprise declines

Further (unobserved) occupation-level confounders

- Include 1-digit occupation dummies

Trade, goods demand, other industry shocks

- Include 2-digit industry dummies

Risk of over-controlling? We report a range of estimates

Outline

Occupational decline in US (OOH) predicts occupational decline in Sweden

	Change in log employment 1985-2013 (SWE)			
	(1)	(2)	(3)	(4)
Declining	-0.76			-0.44
	(0.17)			(0.18)
Employment share 1985 (SWE)		-1.23		-2.40
		(1.61)		(1.57)
Employment growth 1960-85 (SWE)		0.34		0.16
		(0.08)		(0.09)
Predicted growth index (US-OOH)			0.31	0.22
			(0.07)	(0.08)
R^2	0.12	0.15	0.21	0.29

Notes: The dependent variable is the change in the log of number of employees in each Swedish 3-digit occupation between 2013 and 1985. Regressions are weighted by 1985 Swedish employment shares. The number of observations is 172. Robust standard errors in parentheses.

Baseline (1985) characteristics for workers in subsequently declining occupations

	(1) Female	(2) Age	(3) Compuls. school	(4) High school	(5) Collg.	(6) Earnings	(7) Manuf.
A. Workers aged 16-64							
Intercept	0.52	39.5	0.33	0.56	0.11	191.3	0.25
	(0.078)	(0.41)	(0.030)	(0.033)	(0.027)	(10.8)	(0.050)
Declining	-0.25	-0.89	0.13	-0.063	-0.070	-0.23	0.38
	(0.088)	(0.63)	(0.035)	(0.034)	(0.028)	(11.0)	(0.085)
B. Workers aged 25-36							
Intercept	0.51	30.8	0.23	0.64	0.13	182.8	0.23
	(0.078)	(0.078)	(0.022)	(0.033)	(0.032)	(9.28)	(0.050)
Declining	-0.26	-0.19	0.15	-0.065	-0.082	12.0	0.38
	(0.085)	(0.091)	(0.030)	(0.034)	(0.034)	(9.40)	(0.084)

Notes: The sample includes all individuals of the indicated ages who were employed in 1985. The number of observations is 3,061,051 in panel A and 877,324 in panel B. Robust standard errors, clustered by 1985 3-digit occupation, in parentheses.

Individual-level outcomes for Swedish workers: cumulative employment and earnings

	(1)	(2)	(3)	(4)	(5)	(6)
A. Cumulative years employed 1986-2013 (mean: 23.4)						
Declining	-0.73	-0.49	-0.49	-0.30	-0.24	-0.19
	(0.26)	(0.20)	(0.20)	(0.20)	(0.18)	(0.14)
B. Cumulative real earnings ('000 2014 SEK) 1986-2013 (mean: 6,926)						
Declining	-354	-347	-241	-117	-63	-126
	(419)	(120)	(81)	(76)	(71)	(58)
C. Cumulative real earnings divided by predicted initial earnings (mean: 38.7)						
Declining	-4.29	-2.10	-2.21	-1.52	-0.98	-1.11
	(0.91)	(0.53)	(0.54)	(0.54)	(0.41)	(0.36)
Demographics & earnings		✓	✓	✓	✓	✓
Life-cycle profiles			✓	✓	✓	✓
Predictors of growth				✓	✓	✓
Occupation dummies					✓	✓
Industry dummies						✓

Notes: The sample includes all individuals who were born between 1949-1960 and who were employed in 1985. The number of observations is 877,324. Robust standard errors, clustered by 1985 3-digit occupation, in parentheses.

Individual-level outcomes for Swedish workers: probability of remaining in the initial occupation

	(1)	(2)	(3)	(4)	(5)	(6)
A. Probability of working in same 3-digit occupation in 2013 as in 1985 (mean: 0.29)						
Declining	-0.14	-0.11	-0.11	-0.065	-0.086	-0.045
	(0.043)	(0.041)	(0.042)	(0.032)	(0.035)	(0.020)
B. Probability of working in same 2-digit occupation in 2013 as in 1985 (mean: 0.35)						
Declining	-0.12	-0.088	-0.087	-0.051	-0.070	-0.037
	(0.034)	(0.034)	(0.035)	(0.030)	(0.030)	(0.019)
C. Probability of working in same 1-digit occupation in 2013 as in 1985 (mean: 0.40)						
Declining	-0.098	-0.070	-0.069	-0.039	-0.060	-0.031
	(0.030)	(0.031)	(0.032)	(0.029)	(0.027)	(0.018)
Demographics & earnings		✓	✓	✓	✓	✓
Life-cycle profiles			✓	✓	✓	✓
Predictors of growth				✓	✓	✓
Occupation dummies					✓	✓
Industry dummies						✓

Notes: The sample includes all individuals who were born between 1949 and 1960, who were employed in 1985, and who were sampled in the Wage Structure Statistics or non-employed in 2013. Sampling weights are applied. The number of observations is 553,169. Robust standard errors, clustered by 1985 3-digit occupation, in parentheses.

Robustness to alternative functional forms

Using different cutoffs for defining occupational decline Results

- Broadly, more conservative cutoff give larger losses
- Comparison group: results unchanged when dropping fast-growing occupations

Using continuous changes as regressors Graph Results

- Likely reflect supply as well as demand shifts
- Broadly similar results

Counterfactual earnings trajectories

How may workers in declining occupations have fared in the absence of occupational decline? Do workers in non-declining occupations, conditional on observable characteristics, give a plausible counterfactual?

- In short run, very small differences, if any Results
- Older workers seem largely unaffected (less exposure), see below
- No systematic differences in prior (1975 & 1980) earnings Results

Heterogeneity by occupational earnings rank

	Employment		Earnings		Earnings, normalized		Remain	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. Linear interaction								
Declining	-0.51	-0.23	-353.5	-131.0	-2.16	-1.19	-0.11	-0.045
	(0.21)	(0.15)	(110.7)	(55.8)	(0.55)	(0.37)	(0.041)	(0.020)
Declining × rank	1.17	1.17	441.5	449.2	2.63	2.63	-0.011	-0.0010
	(0.34)	(0.30)	(142.3)	(146.8)	(0.58)	(0.57)	(0.023)	(0.017)
B. Dummy interactions								
Declining	-0.32	-0.031	-323.2	-98.0	-1.94	-0.97	-0.083	-0.022
	(0.24)	(0.18)	(123.8)	(66.7)	(0.54)	(0.41)	(0.045)	(0.021)
Declining × bottom tercile	-1.12	-1.13	-341.8	-350.1	-2.10	-2.06	-0.046	-0.040
	(0.35)	(0.33)	(106.7)	(101.5)	(0.54)	(0.51)	(0.014)	(0.013)
Declining × top tercile	0.54	0.55	232.3	235.1	1.37	1.40	-0.047	-0.030
	(0.20)	(0.16)	(135.8)	(132.1)	(0.43)	(0.48)	(0.027)	(0.018)
Individual controls	✓	✓	✓	✓	✓	✓	✓	✓
Occupation & industry controls		✓		✓		✓		✓
Mean of dep. var.	23.4		6,926		38.7		0.29	
Mean of dep. var., bottom	22.3		6,001		35.6		0.27	
Observations	877,324						553,786	

Notes: Rank ranges from -1 to 1. Ranks are calculated in the full sample within each 3-digit occupation in 1985.

Unemployment & retraining

	(1)	(2)	(3)	(4)
A. Unemployment, cumulative days (mean 262, mean for bottom tercile 317)				
Declining	52.4	17.9	20.8	20.5
	(24.8)	(14.0)	(14.0)	(18.2)
Declining × rank			-63.8	
			(21.5)	
Declining × bottom tercile				42.4
				(18.3)
Declining × top tercile				-43.7
				(17.0)
B. Retraining, cumulative days (mean 29, mean for bottom tercile 35)				
Declining	11.4	4.73	5.04	5.81
	(2.68)	(1.46)	(1.48)	(2.26)
Declining × rank			-8.63	
			(1.98)	
Declining × bottom tercile				4.38
				(2.28)
Declining × top tercile				-6.96
				(2.12)
Individual controls	✓	✓	✓	✓
Occupation & industry controls		✓	✓	✓

Notes: Rank ranges from -1 to 1.

Retirement

Workers aged 37-48 in 1985

- Lose 0.32 (SE 0.11) years of employment
- 0.15 (SE 0.07) years younger when retire
- Same pattern of heterogeneity

Workers aged 49-60 in 1985

- No significant effects on employment, earnings or retirement
- Very little exposure to decline

Further results

Spillovers on similar occupations? And comparing similar occupations problematic if treatment effects heterogenous

- Worker flows from declining to similar non-declining occupations could constitute supply shocks
- Effects larger when the similar occupations also decline

Results from 'doughnut' specifications similar, though suggest slightly larger losses

Declines related to technology

- Very similar to baseline results

US Data: National Longitudinal Survey of Youth 1979

$\sim$ 6700 individuals born 1957-1964, surveyed annually 1979-1994, biennially through 2014 Details

Point estimates close to zero NLSY Results

- Imprecise on earnings (but rule out losses $>$ 7-8 percent)
- Narrower confidence intervals on employment

NLSY79 vs Swedish micro data

- Smaller sample
- Younger sample in base year (perhaps less attached)
- Employment and earnings are self-reported
- Noisier occupation measure
- Sample non-response and attrition

Outline

Looking for mechanisms in a simple Roy model

- Competitive economy with a continuum of individuals (i), two time periods, two occupations $k \in \{A, B\}$
- Earnings are consumed immediately (no savings)
- Workers' per-period log earnings are

$$y_{ikt} = \pi_{kt} + \alpha_{ik} - c_{ikt}$$

  and they choose occupation path to maximize

$$\mathbb{E}(y_{ik1} + \beta y_{ik2})$$

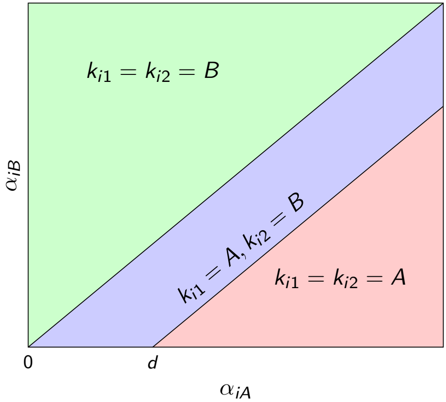
- Normalize first-period occupation prices to $\pi_{B1} - \pi_{A1} = 0$
- Negative shock to A so that $\pi_{B2} - \pi_{A2} = d$
- For simplicity, skill distribution is assumed to be jointly uniform (not necessary for key results)

Baseline: no switching cost

- Switch from A to B if

$$\alpha_{iB} > \alpha_{iA} - d$$

- Probability of staying ↑ in α_{iA}
- Earnings loss ↑ in α_{iA}
- Intuition: Low-skilled in A are also low-skilled in B, so they don't lose much from moving.

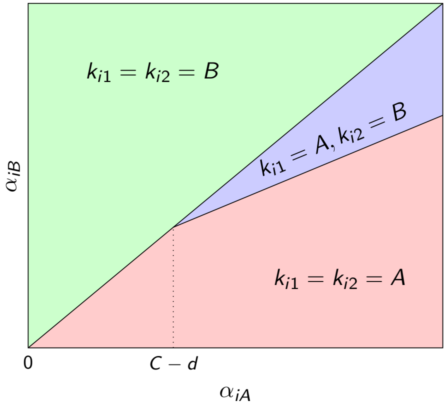


Heterogeneous switching costs

- Cost of moving $c_{iBt} = C - \alpha_{iB}$
- Switch from A to B if

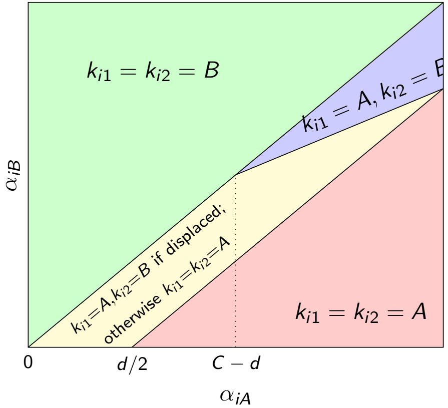
$$\alpha_{iB} - (C - \alpha_{iB}) > \alpha_{iA} - d$$

- Probability of staying $\downarrow$ in α_{iA}
- Earnings loss $\downarrow$ in α_{iA}
- Intuition: Low-skilled in A are also low-skilled in B, so it's costly to move.



Heterogeneous switching costs and involuntary switching

- Displacement of A workers
- Cost of reemployment $c_{ikt} = C - \alpha_{ik}$
- Displaced switch if $\alpha_{iB} - (C - \alpha_{iB}) > \alpha_{iA} - d - (C - \alpha_{iA})$
- Probability of staying has inverted U-shape in α_{iA}
- Earnings losses $\downarrow$ in α_{iA}
- Switchers may do worse than stayers on average



Outline

Conclusion

We aim to provide evidence of the long-run, individual consequences of occupational decline.

- Study 28-year careers of Swedish workers who in 1985 worked in an occupation that subsequently declined
- Detailed occupations allow us to measure exposure to decline
- Modest earnings and employment losses on average
- Heterogeneity — low-ranked suffered higher losses
- Those in declining occupations more likely to leave
- US data suggest similarly small mean losses
- Roy model with heterogeneity in switching costs and displacement can account for empirical findings

Policy implications

1. Mean loss from occupational decline lower than mass layoffs
   - Occupational decline is gradual (retirements)
   - Plenty of occupational switching in most occupations
   - Less risk of negative local spillovers

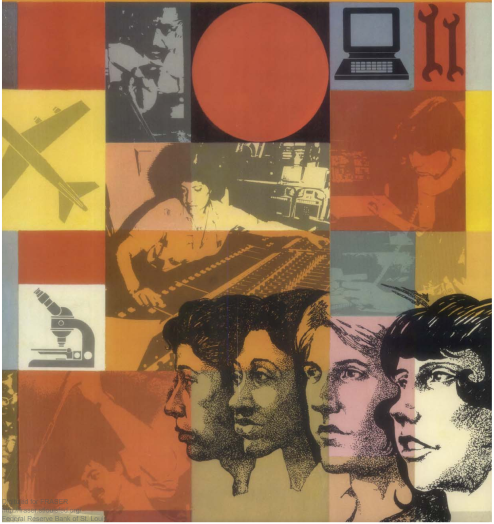
2. Governments should nevertheless be alert because
   - Losses for low earners can be high
   - Machine learning may speed up replacement process
   - In future, high-paid professionals may lose more

Occupational Outlook Handbook

1986-87 Edition

U.S. Department of Labor
Bureau of Labor Statistics
April 1986

Bulletin 2250



Related Occupations

Workers in a number of other jobs also must be good at working with figures. Among such workers are bank tellers, collection workers, insurance clerks, and statistical clerks.

Sources of Additional Information

A brochure describing a career as a bookkeeper or accounting clerk is available upon request from:

Association of Independent Colleges and Schools, 1 Dupont Circle NW., Suite 350, Washington, D.C. 20036.

State employment service offices can provide information about job openings for bookkeeping workers.

Computer and Peripheral Equipment Operators

(D.O.T. 208.685-030; 213.362, .382, .582, .682, and .685)

Nature of the Work

Since their invention in the 1940's, computers have become steadily more important in our society. At first used only for military and scientific research, today computers are essential to the operation of stores, banks, colleges and universities, government agencies, hospitals, factories, and many other organizations. Like all machines, the usefulness of computers is dependent upon the skill of the people who run them.

The duties of computer and peripheral equipment operators vary with the size of the installation, the type of equipment used, and the policies of the employer. In organizations with small computer systems, for example, computer operators may run both the computer and all the peripheral equipment such as printers, disk drives, and tape readers. In large computer installations, computer operators specialize in console operation while peripheral equipment operators run the related devices. Generally, the duties of computer operators and peripheral equipment operators involve the following tasks.

Working from operating instructions prepared by programmers or operations managers, computer operators set controls on the computer and on peripheral devices required to run a particular job. Computer operators or, in large installations, peripheral equipment operators load the equipment with tapes, disks, and paper as needed. While the computer is running—which may be 24 hours a day for large computers—computer operators monitor the computer console and respond to operating and computer messages. If an error message occurs, for example, operators must locate the problem and solve it or terminate the program.

Peripheral equipment operators may have to prepare printouts and other output for distribution to computer users. Operators also maintain log books listing events such as machine malfunctions that occurred during their shift. Computer operators also may supervise and train peripheral equipment operators and computer operator trainees. They also may help programmers and systems analysts test and debug new programs. (Detailed descriptions of these occupations are presented elsewhere in the *Handbook*.)

Working Conditions

Computer operating personnel work in well-lighted, well-ventilated, and generally comfortable rooms. When the equipment is operating, however, the computer room can be noisy. Computer and peripheral equipment operators may be required to work evening or night shifts and weekends because many organizations use their computers 24 hours a day, 7 days a week.

Employment

In 1984, computer operators and peripheral equipment operators held 241,000 and 70,000 jobs, respectively. Although some jobs for computer and peripheral equipment operators are found in almost every industry, most are in government agencies, data processing service firms, banks, insurance firms, colleges and universities, and hospitals. These organizations have data processing needs that require large computer installations.

Training, Other Qualifications, and Advancement

In many firms, clerical workers such as secretaries, typists, bookkeeping clerks, and computer tape librarians may be transferred to jobs as peripheral equipment or computer operators and trained on the job. Employers who recruit from outside their firms look for workers who already have experience or training in operating the brand and type of equipment they use. Many high schools, public and private vocational schools, business schools, and community colleges offer training in computer operations. The military services also offer training.

Employers usually require a high school education, and many prefer computer operators with some trade school or junior college training in data processing. Employers who select operators from within their organization may pay for training at such schools. Many employers test applicants to determine their aptitude for computer work, particularly their ability to reason logically.

Preparing output for distribution is the responsibility of a peripheral equipment operator.

Workers usually receive some on-the-job training to become acquainted with their employer's equipment and routines. The length of training varies with the job and the experience of the worker. New peripheral equipment operators are expected to learn their jobs in a few weeks. New computer operators, however, may require several months of training because they must become sufficiently familiar with the computer equipment to handle all problems. Operators with prior experience or training are expected to learn their employer's system within a few weeks.

Because computer technology changes often, operators must be adaptable and willing to learn. Computer and peripheral equipment operators must be able to communicate well in order to work effectively with programmers and each other. Computer operators also must be able to work independently because they may have little or no supervision on evening, night, or weekend shifts.

A few computer operators may advance to supervisory jobs. Peripheral equipment operators may become computer operators. Through on-the-job experience and additional training, some computer and peripheral equipment operators advance to jobs as programmers.

Job Outlook

Employment of computer and peripheral equipment operators is expected to rise much faster than the average for all occupations through the mid-1990's.

Advances in technology have reduced both the size and the cost of computer equipment while at the same time increasing their capacity for data storage and processing. These improvements in technology have fueled an expansion in the use of computers in such areas as factory and office automation, telecommunications, medicine, and education. As computer usage grows, so will the need for computer operators and peripheral equipment operators. Because computer and peripheral equipment operators work mainly with large computer systems—the part of the overall computer market that has slowed down—employment of operators is not expected to rise as rapidly as in previous years.

In addition to jobs resulting from growth in demand for operators, many openings will arise from the need to replace workers who transfer to other occupations or leave the labor force.

Earnings

In 1984, median weekly earnings of full-time computer operators were $300. The middle 50 percent earned between $230 and $415. The lowest 10 percent of computer operators earned $190 or less a week, and the top 10 percent earned more than $540.

Weekly earnings of beginning computer operators averaged about $340 in 1984. Experienced workers averaged about $345, and lead operators about $415. Peripheral equipment operators earned about $325 a week. In the Federal Government, computer operators without work experience started at about $245 a week in 1985.

Computer operators and peripheral equipment operators had higher earnings in the North and West than in the South. Operators employed in manufacturing, transportation and public utilities, and wholesale trade had higher earnings than those employed in retail trade, banking, insurance, and services.

Related Occupations

Other occupations involving work with computers include systems analysts, programmers, and computer service technicians. Other occupations in which workers operate electronic office equipment include data entry keyers, secretaries, typists, and printing typesetters and compositors.

Sources of Additional Information

People who want further information about work opportunities in computer operations should contact firms that use computers such as banks, manufacturing and insurance firms, colleges and universities, and data processing service organizations. The local office of the State employment service is another source of information about employment and training opportunities.

Data Entry Keyers

(D.O.T. 203.582-022, -026, -030, -054, and -070)

Nature of the Work

Vast amounts of data stored and processed by modern computer systems must be updated almost continuously. Each time an individual writes a check, for example, the amount must be entered into the bank's computer, so the correct charge can be made to his or her account. Getting data from checks, bills, invoices, and other documents into the computer system is the work of data entry keyers.

The main function of the data entry keyer is to type data from documents quickly and accurately. This is done with a variety of typewriter-like equipment. Many keyers use a machine that converts the information they type to magnetic impulses on tapes or disks. The information is then read into the computer from the tape or disk. Some keyers operate on-line terminals of the main computer system that transmit and receive data. Although brands and models of computer terminals and data entry equipment differ somewhat, their operation and keyboards are similar.

Some keyers working from terminals use data from the computer to produce business, scientific, and technical reports. In some offices, keyers also operate computer peripheral equipment such as printers and tape readers, act as tape librarians, and perform other clerical duties.

Working Conditions

Data entry keyers usually work in offices that are clean, well lighted, and generally comfortable. However, they must sit for long periods and may be subjected to high noise levels. Keyers often work with video display terminals and may experience stress and eyestrain as a result. Data entry lends itself to flexible working arrangements, and many data entry keyers have part-time or temporary jobs.

Employment

Data entry keyers held about 324,000 jobs in 1984. Although jobs for data entry keyers are found in almost every industry, the largest number are in data processing service firms, government agencies, banks, insurance firms, colleges and universities, hospitals, and department stores. These organizations use computers to keep track of accounts, billings, inventories, and other items for which large amounts of data must be frequently updated.

OOH (1986-87) on technological replacement

Bank tellers

> *The number of bank tellers is expected to increase more slowly than the average for all occupations through the mid-1990's because of the increasing use of automatic teller machines and other electronic equipment.*

Bookkeepers and accounting clerks

> *The volume of business transactions is expected to grow rapidly, with a corresponding increase in the need for financial and accounting records. However, the need for bookkeepers, who maintain these records, will not increase nearly as fast because of the increasing use of computers to record, store, and manipulate data.*

Precision assemblers

> *The effect of automation on precision assembler employment will depend on how rapidly and extensively new manufacturing technologies are adopted. Certainly, not all precision assemblers can be replaced efficiently by automated processes. Robots are expensive and a large volume of work is required to justify their purchase.*

Using OOH data to study Swedish occupations: Forecasts

US Bureau of Labor Statistics (BLS) base forecasts on

- The size and demographic composition of the labor force
- Aggregate economic growth
- Commodity final demand
- Input-output
- Industry output and employment
- Occupational employment and vacancies

For each Swedish occupation, we assign the forecast of the corresponding US occupation

- Declining [1], little or no change [2], increasing slower than average [3], increasing about as fast as average [4], increasing faster than average [5]

Mapping between NYK and OOH

OOH 86		NYK 85	
53	Dentists	121.10	Dentist
314	Custom tailors and sewers	71110	Tailor (men's clothing)
		711.20	Tailor (women's clothing)
		711.90	Other within 711 (tailoring)
313	Crushing and mixing machine operators and tenders	809.90	Other within 80 (graphical industry)
		819.10	Batch preparer (ceramics)
		819.20	Batch preparer (glass)
		819.30	Glazing preparer
		821.10	Mill operator
		821.20	Machine operator (food stuff)
		829.30	Macaroni machine operator
		829.40	Margarine preparer
		829.50	Fruit presser
		833.10	Crusher operator
		833.20	Grinder operator
		833.60	Grating machine operator (for handling color mixtures)
		839.10	Mixing machinery operator
		839.20	Soap machinery operator
		839.30	Color refraction machinery operators
		839.40	Granulator
		851.10	Mixer (building materials)

Using OOH data to study Swedish occupations: Computing changes

The growth rate of a Swedish occupation s is computed as

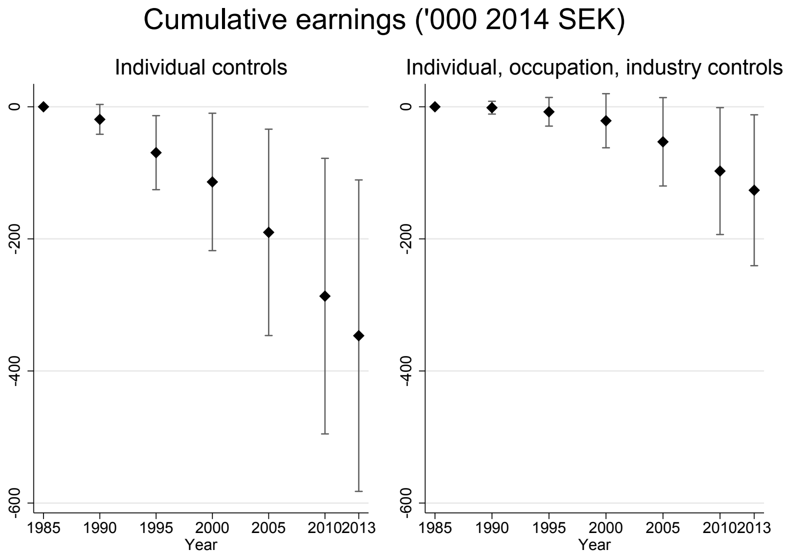
$$g_s = \underset{1\times K}{\alpha_s} \times \underset{K\times 1}{g}$$

$$= \underset{1\times K}{\alpha_s} \times \underset{K\times K}{\mathbb{1}\{\text{tech}\}} \times \underset{K\times 1}{g} \quad + \quad \underset{1\times K}{\alpha_s} \times \underset{K\times K}{\left(I - \mathbb{1}\{\text{tech}\}\right)} \times \underset{K\times 1}{g}$$

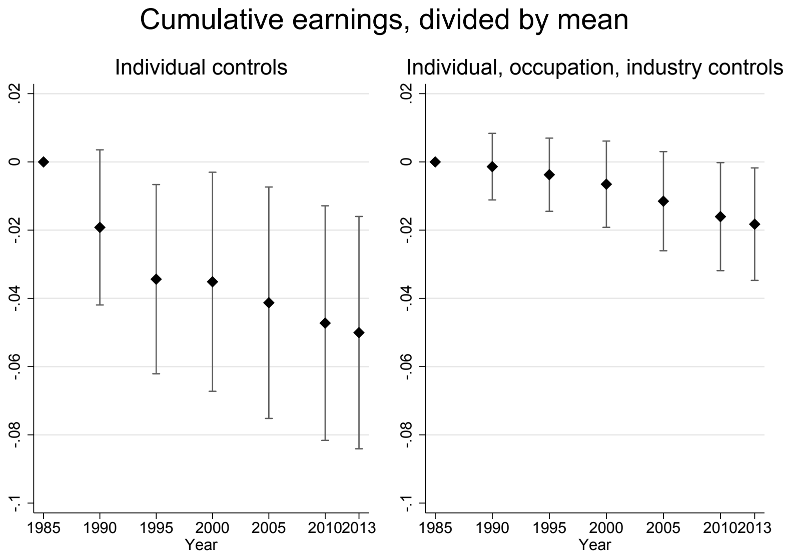
where α_s are the shares of each US occupation in Swedish occupation s, and g are the growth rates of all US occupations.

- 'Declining' if $g_s < -0.25$
- 'Declining (tech)' if 'Declining' **and** $\alpha_s \times \mathbb{1}\{\text{tech}\} \times g < -0.25$

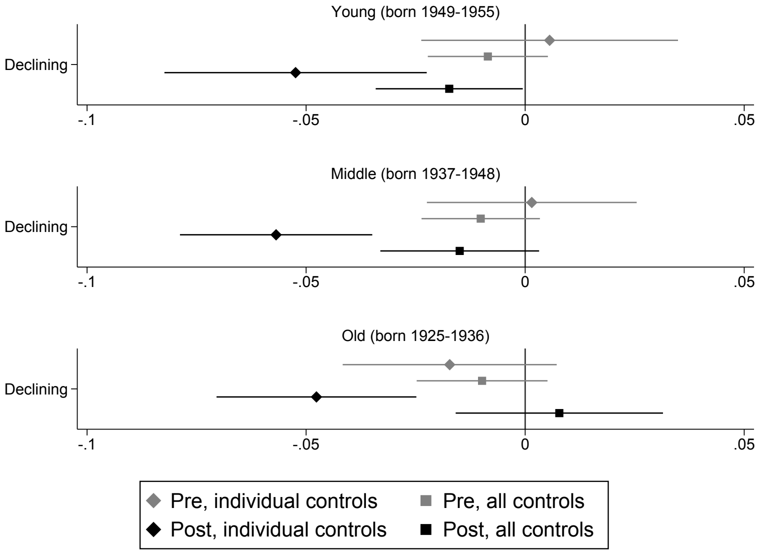
Differences in cumulative earnings over time



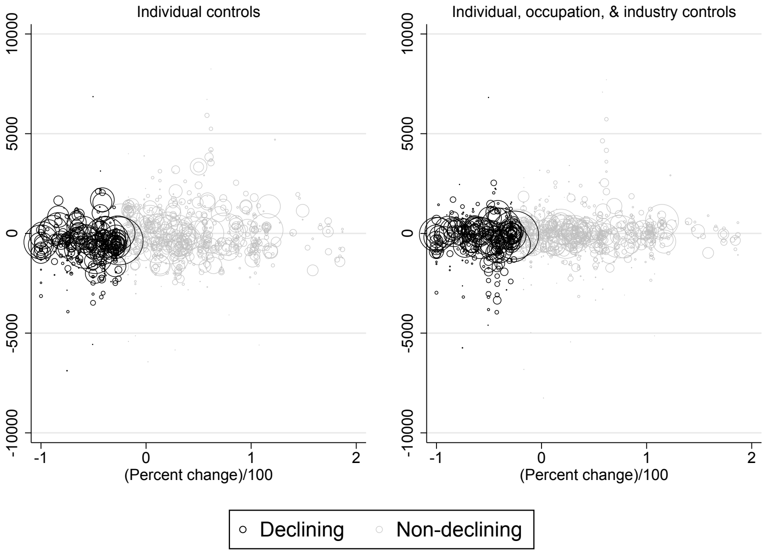
Differences in cumulative earnings (div. by mean) over time



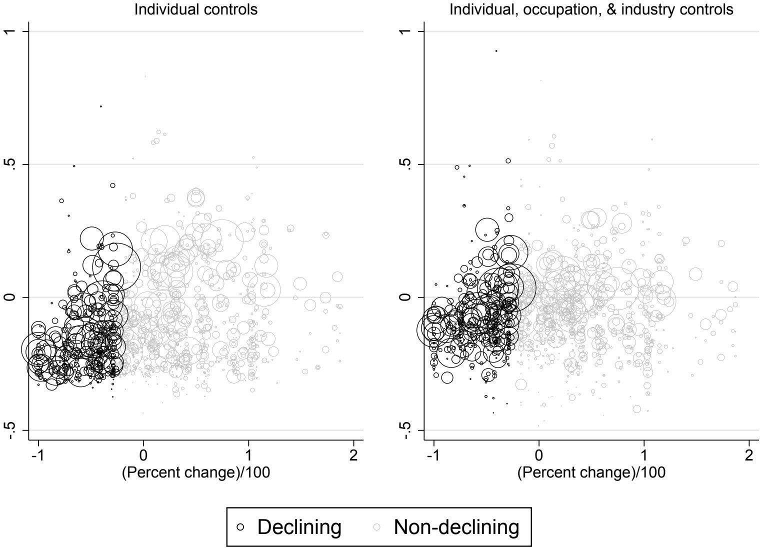
Prior earnings as outcome variable



Cumulative earnings (residualized) and employment growth



Fraction remaining (residualized) and employment growth



Alternative cutoffs for 'Declining'

	Employment		Earnings		Earnings, normalized		Remain	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Percent change $\in [-100, -50)$	-0.34	-0.18	-248.1	-90.0	-2.44	-0.98	-0.18	-0.10
	(0.20)	(0.15)	(115.6)	(75.7)	(0.62)	(0.43)	(0.040)	(0.020)
Percent change $\in [-100, -25)$ (baseline)	-0.49	-0.19	-346.6	-126.4	-2.10	-1.11	-0.11	-0.045
	(0.20)	(0.14)	(120.3)	(58.3)	(0.53)	(0.36)	(0.041)	(0.020)
Percent change $\in [-100, 0)$	-0.043	-0.0030	-35.0	-57.5	-0.70	-0.91	-0.15	-0.063
	(0.20)	(0.13)	(158.8)	(74.7)	(0.70)	(0.47)	(0.041)	(0.021)
Percent change $\in [-100, 31)$ (below median)	0.14	0.15	-46.5	-61.9	-0.55	-0.53	-0.087	-0.0094
	(0.18)	(0.13)	(150.7)	(76.1)	(0.57)	(0.50)	(0.037)	(0.022)
Baseline; control: percent change $\in (-25, 31)$	-0.72	-0.27	-460.5	-126.6	-2.40	-1.17	-0.077	-0.053
	(0.22)	(0.16)	(123.3)	(61.9)	(0.51)	(0.40)	(0.038)	(0.018)
Individual controls	✓	✓	✓	✓	✓	✓	✓	✓
Occupation & industry controls		✓		✓		✓		✓
Observations			877,324				553,786	

Notes: Each row represents a regression on a 'Declining' dummy (varying definitions) and controls. The underlying variable for 'Declining' is the percentage change in employment for the US occupation(s) corresponding to the Swedish 5-digit occupation that the individual worked in during 1985.

Continuous employment changes

	Employment		Earnings		Earnings, normalized		Remain	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Percent employment change / 100 (US)	-0.019	-0.026	103.7	64.7	0.47	0.25	0.0058	-0.0020
	(0.037)	(0.036)	(30.2)	(14.9)	(0.11)	(0.13)	(0.0068)	(0.0029)
Percent employment change / 100 (US), winsorized	0.010	0.000027	83.8	91.1	0.86	0.46	0.051	0.0035
	(0.11)	(0.080)	(112.0)	(47.5)	(0.40)	(0.25)	(0.025)	(0.014)
Log employment change (SWE)	-0.034	0.049	306.4	73.7	0.85	0.087	0.11	0.066
	(0.15)	(0.11)	(135.1)	(65.9)	(0.50)	(0.50)	(0.031)	(0.017)
Individual controls	✓	✓	✓	✓	✓	✓	✓	✓
Occupation & industry controls		✓		✓		✓		✓
Observations			877,324				553,786	

Notes: 'Percent employment change (US)' refers to the percentage change in employment 1984-2016 for the US occupation(s) corresponding to the Swedish 5-digit occupation that the individual worked in during 1985. 'Log employment change (SWE)' refers to the change in log number employed 1985-2013 in the Swedish 3-digit occupation that the individual works in during 1985.

US Data: National Longitudinal Survey of Youth 1979 (NLSY)

- Individuals born between 1957 and 1964
  - Cross-sectional & supplemental black & Hispanic samples
- Surveyed annually 1979 - 1994 and biennially through 2014 (weighted accordingly)

Methodology

- Set 1987 as base year to use the same OOH as Sweden but let the youngest NLSY reach age 22
- Control variables as in Sweden, except region (not county) dummies and no employment share or prior growth controls
- Use 1980 census to construct occupation life-cycle profiles
- Impute income for years respondents were not interviewed

NLSY Main Results

	Average Earnings (1)	(2)	(3)	Cumulative Earnings (4)	(5)	(6)	Remain (7)	(8)
A. Individual Controls								
Declining	-150.7	122.7	-91.9	-17312.8	-2.71	-0.039	0.00079	-0.048
	(1589.2)	(1901.1)	(2028.5)	(55596.1)	(2.44)	(0.017)	(0.028)	(0.042)
B. Individual Controls and Occupation Controls								
Declining	-23.8	384.3	227.0	2782.7	-2.43	-0.012	0.022	0.041
	(1536.3)	(1822.5)	(1969.2)	(56695.3)	(2.52)	(0.019)	(0.026)	(0.026)
Mean of dep. var.	44,083	46,057	46,891	1,216,117	44.2	0.09	0.20	0.36
Observations		6,679		5,817			5,750	
Odd years only		✓						
Income interpolation			✓	✓	✓	✓		
Normalized earnings					✓			
Occupation group							✓	
Major occupation group								✓

Notes: The sample for the earnings regressions includes all individuals with an occupation in 1987 and at least 8 years of reported earnings. The sample for the occupational stability regressions includes all individuals with an occupation in 1987 and who were interviewed or deceased in 2014. Sampling weights are applied. Robust standard errors, clustered by 1987 occupation, in parentheses.