Individual Consequences of Occupational Decline

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[Very preliminary and incomplete]

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Outline

Introduction

Data

Results

New machines enter the labor market

- In November 2017 Waymo's driverless minivans started roaming the streets of Phoenix, Arizona, with engineers in their back seats
- Meanwhile in London, an artificial intelligence program beat human lawyers in using basic information to predict whether a Financial Ombudsman would allow claims in miss-selling cases

Research question

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

- Study Swedish workers who in 1985 worked in occupations that subsequently (22 years) declined due to (unanticipated) technological change

What is at stake?

- Displaced workers' & their families' wellbeing
- Potential for further rise in inequality
- Implications for human capital investments when people expect long lives but worry about technological replacement
- Implications for the state: taxation, redistribution, retirement, design of education for young people and training for older ones
- Those who lose may not go down quietly, causing political turmoil

Literature: winners & losers from technological change

- Autor (2015) argues that technology will also create jobs; Caselli & Manning (2017) maintain that some workers will win out
  - in previous work (Graetz & Michaels 2015) we find gains from robot use
- But some jobs will be lost. Estimates for the upcoming decades range from $\sim$10% (Arntz et al. 2016) to $\sim$50% (Frey & Osborne, 2017)
- Evidence on effects of trade on individuals (Autor et al. 2014), and on mass layoffs (Jacobson et al. 1993)
- But technology is trickier. Following Autor et al. (2003), the literature has focused on tasks (routine vs non-routine)
- Cortes (2016) studies this using panel data on task categories (broad occupation groups)
- Evidence on detailed occupations is limited, not much using panel data

Methodology: measuring occupational decline due to technological change

Use understudied data from US Occupational Outlook Handbook (OOH); allows us to

- identify declining occupations
- check if decline is due to technological replacement
- distinguish b/w anticipated and unanticipated declines

For now: take all occupations declining by more than 25 percent from 1984-2017. Later: technology, anticipation.

Match US occupational info to study Swedish micro data

- Numerous advantages of longitudinal micro data
- No equivalent to OOH in Sweden—but we confirm that the OOH-based measure predicts occupational decline in Sweden

What can we learn?

- Examine effect on (22 year) career earnings and employment of those aged 25-40 in 1985
- Many more outcomes of interest (early retirement, health) — TBC
- Study heterogeneity by education (later also gender, cognitive and non-cognitive skills, geography)

Econometric implementation

$$y_{i,1985-2007} = \beta D_i + \mathbf{x}_i' \gamma + \varepsilon_i$$

$$D_i \equiv \mathbb{1}\{i \text{ works in soon-to-be-declining occupation in 1985}\}$$

- OLS for now, but will also consider matching (individuals) or synthetic controls (occupations)
- Cluster standard errors by occupation (level of variation of treatment)

Preview of what we find

1. When comparing observationally similar workers, no evidence of differential cumulative employment or earnings—can rule out income losses of more than five percent of average cumulative earnings
2. This is despite the fact that workers starting out in declining occupations are much less likely to remain in their initial occupation
3. When looking at college workers, do see meaningful income losses associated with starting in a declining occupation—this may be related to a decline in the value of occupation-specific human capital

Our measure of decline does strongly predict occupational employment growth in Sweden. We also find similar results using actual employment growth and the routine index as explanatory variables.

Results are preliminary—we need to refine our measure of decline

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Methodology: measuring occupational decline due to technological change

- Use understudied data from US Occupational Outlook Handbook (OOH) details
  - Every two years they provide detailed snapshot of occupations and predict employment change for subsequent decade
- Match data for the ∼400 occupations from 1986-1987 OOH into the 2017 OOH
  - [For timing, also use intervening editions of OOH (1996-7 & 2006-7)—TBC]
- Calculate %-change in employment by occupation
- To mitigate measurement error we focus on declines of 25% or more in employment and on occupations that vanished
- Later, restrict attention to cases where OOH predictions from 1986 (or 1996 or 2006) mention potential for technology to reduce labor demand; also distinguish anticipated/surprise declines

Use US occupational info to study Swedish individual data

- We match OOH information into Swedish occupations in 1985
- Advantages of longitudinal micro data
  - rich information on individual characteristics $\rightarrow$ controls
  - can study selection into and out of occupations
  - can look at heterogeneity (who gains, who loses)
  - can control for industry to absorb other shocks (e.g. trade shocks and change in demand)
- Can use OOH predictions to focus on unanticipated changes in occupational employment due to tech change
- No equivalent to OOH in Sweden, but
  - occupational employment trends in Europe very similar to US in general (Goos et al. 2014, Adermon & Gustavsson 2015)
  - we confirm that the OOH-based measure predicts occupational decline in Sweden

Swedish population-level micro data

Earnings, employment status, industry, education, geography

- 1970, 1975, 1980, annually 1985-2013

Wage rates

- annually 1985-2013 (sample)

Occupation

- every five years 1960-1990, annually (sample) 1996-2013
- classifications change, not always easy to map

Test scores from military enlistment exams

- males, birth cohorts 1955-1985

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

	(1)	(2)	(3)
Declining	-0.61	-0.60	-0.64
	(0.12)	(0.13)	(0.15)
Employment share 1985		-0.49	1.76
		(2.88)	(3.43)
Education controls			✓
R-squared	0.11	0.11	0.18

Notes: Regressions are weighted by Swedish 1985 employment shares. The dependent variable is the difference in the log of number of people employed in each 3-digit (SSYK) occupation between 2007 and 1985 (weighted mean: -0.01, standard deviation: 0.6). 'Declining' is the fraction of employment in a declining sub-occupation within each 3-digit occupation in 1985. Sub-occupations have been classified as declining using the Occupational Outlook Handbooks. 'Education controls' indicates that the fractions of workers with a given education level (seven categories) are controlled for. The number of observations is 273. Robust standard errors in parentheses.

Baseline (1985) characteristics for workers in subsequently declining occupations

	(1) Female	(2) Age	(3) Compuls.	(4) High school	(5) College	(6) Income
Constant	0.46	33.1	0.26	0.59	0.15	195.9
	(0.035)	(0.078)	(0.019)	(0.022)	(0.020)	(4.77)
Declining	0.081	0.024	0.046	0.037	-0.082	-13.2
	(0.10)	(0.14)	(0.028)	(0.034)	(0.031)	(9.05)
R-squared	0.00	0.00	0.00	0.00	0.01	0.00

Notes: The sample includes all individuals who were born between 1945 and 1960 and who were employed in 1985. Outcomes are measured in 1985. The number of observations is 1,336,721. Robust standard errors, clustered by occupation, in parentheses.

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

	(1)	(2)	(3)	(4)	(5)	(6)
A. Cumulative years employed 1986-2007 (mean: 18.74)						
Declining	-0.08	-0.06	0.18	0.18	-0.03	0.29
	(0.13)	(0.14)	(0.12)	(0.12)	(0.11)	(0.10)
B. Cumulative real income ('000 2014 SEK) 1986-2007 (mean: 5,267)						
Declining	-511	-357	24	19	-827	-47
	(265)	(166)	(110)	(75)	(240)	(66)
C. Percentile rank in cumulative real income (mean: 50.5)						
Declining	-3.3	-1.7	1.7	1.2	-6.7	0.5
	(3.1)	(1.7)	(1.1)	(0.6)	(2.8)	(0.5)
Female & cohort dummies		✓	✓	✓		✓
Education dummies			✓	✓		✓
Income in 1985				✓		✓
Industry dummies					✓	✓

Notes: 'Declining' is an indicator for working in an occupation in 1985 that is classified as declining subsequently. 'Income in 1985' indicates that the level of income (panels A, B) or the percentile rank (panel C) in 1985 is controlled for. The sample includes all individuals who were born between 1945 and 1960 and who were employed in 1985. The number of observations is 1,336,721. Robust standard errors, clustered by occupation, in parentheses.

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

	(1)	(2)	(3)	(4)	(5)	(6)
A. Probability of working in same 3-digit occuaption in 2007 as in 1985 (mean: 0.42)						
Declining	-0.16	-0.16	-0.16	-0.16	-0.10	-0.10
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
B. Probability of working in same 2-digit occuaption in 2007 as in 1985 (mean: 0.50)						
Declining	-0.08	-0.09	-0.08	-0.08	-0.03	-0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
C. Probability of working in same 1-digit occuaption in 2007 as in 1985 (mean: 0.55)						
Declining	-0.07	-0.08	-0.06	-0.06	-0.03	-0.03
	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)
Female & cohort dummies		✓	✓	✓		✓
Education dummies			✓	✓		✓
Income in 1985				✓		✓
Industry dummies					✓	✓

Notes: 'Declining' is an indicator for working in an occupation in 1985 that is classified as declining subsequently. The sample includes all individuals who were born between 1945 and 1960, who were employed in 1985, and who were sampled in the Wage Structure Statistics in 2007 (results for cumulative employment and income are very similar for this sample to those for the population). The number of observations is 658,429. Robust standard errors, clustered by occupation, in parentheses.

Results for income: heterogeneity by education

	(1)	(2)	(3)
A. At most compulsory schooling			
Declining	258	147	107
	(101)	(62)	(53)
Observations	353,558	353,558	353,558
B. High school			
Declining	-120	30	-51
	(139)	(61)	(49)
Observations	803,226	803,226	803,226
C. College			
Declining	-1,023	-329	-548
	(387)	(169)	(190)
Observations	179,937	179,937	179,937
Female & cohort dummies	✓	✓	✓
Education dummies & income		✓	✓
Industry dummies			✓

Notes: The dependent variable is cumulative real income 1986-2007 in thousand SEK with 2014 as base year (mean: 5,267). Robust standard errors, clustered by occupation, in parentheses.

Discussion & conclusion

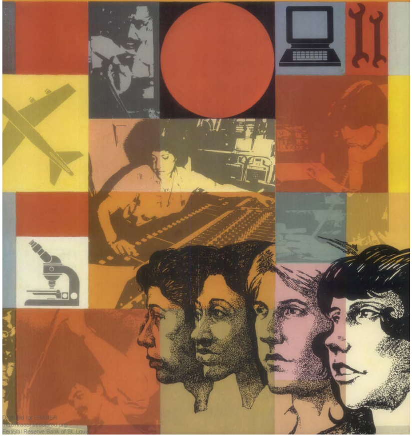
- Aim to provide first evidence on long-run effects of occupational replacement by technology at individual level
- Preliminary results show no strong evidence for adverse effects on average—can rule out losses of more than five percent of average cumulative earnings
- But occupational stability does appear to be adversely affected
- Some evidence for heterogeneity—perhaps surprisingly, high educated seem to suffer more
  - We will use military test scores to investigate if there is negative selection within the college group

Occupational Outlook Handbook

1986-87 Edition

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

Bulletin 2250



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.