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In the footsteps of Chalmers and Ørsted

The expansion of higher technical education in Sweden and Denmark, 1829–1929

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Key points

1829: two polytechnic institutes open

- Chalmers University of Technology
- Technical University of Denmark (DTU)

To what extent did the socioeconomic backgrounds of the students of Chalmers and DTU differ (if at all)?

- Did changes in entry requirements and course offerings affect cohort composition?

Sources: graduate biographies (1829–1929)

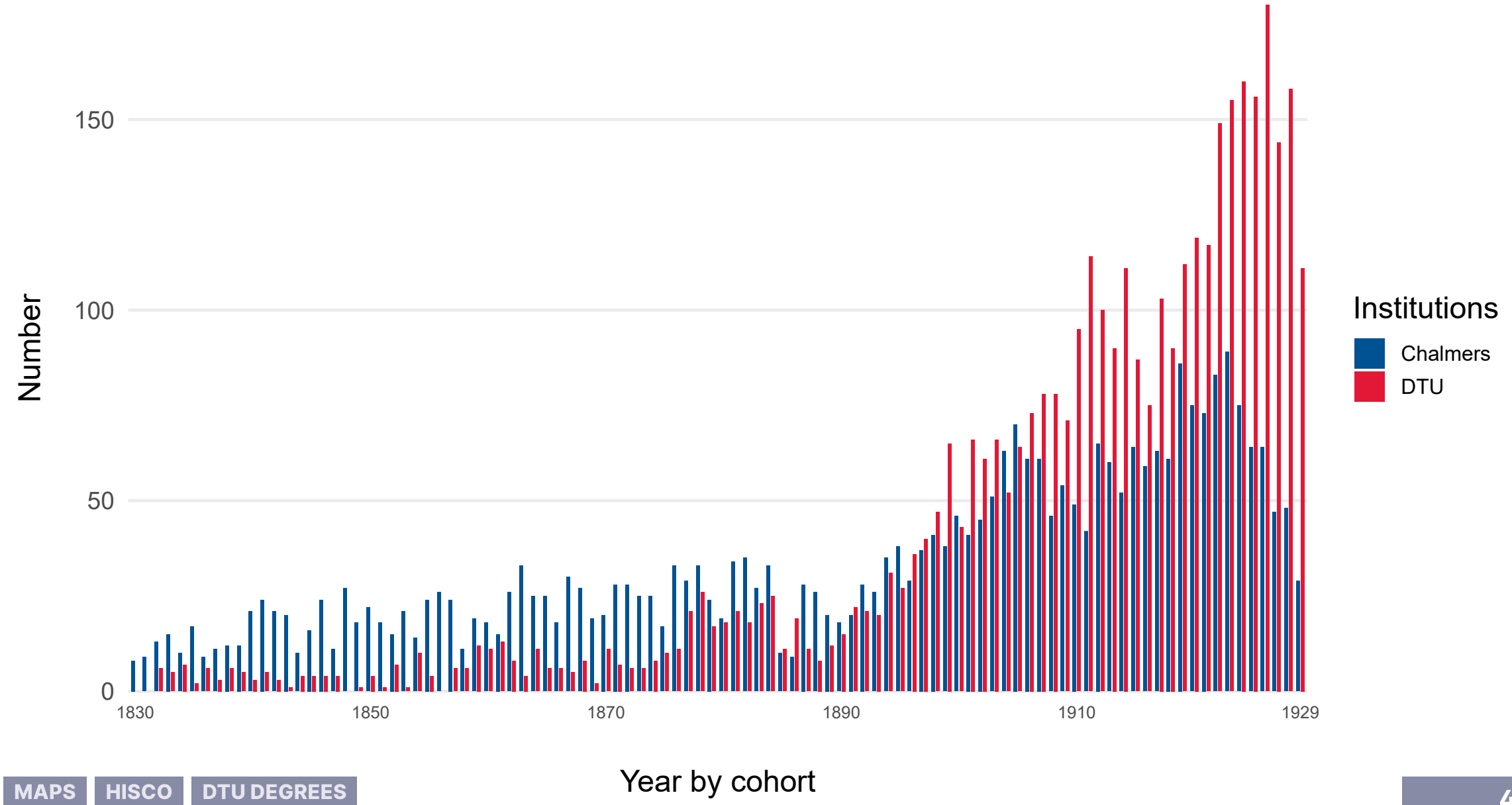
THE TWO INSTITUTES

Chalmers

- Endowment from the estate of William Chalmers († 1811)
  - An industry school for poor children who could read and write
- Emphasis on scientific education as necessary for new technology
- Evolved into an institute of higher education during 1800's
  - Granted university status in 1937

DTU

- A spin-off from the University of Copenhagen
  - Shared staff and resources
  - First director: physicist HC Ørsted
- Anchored in academic traditions
  - Theoretical rather than practical
  - High school exam as prerequisite
- Significant changes in 1890's: new campus, new courses



MAPS HISCO DTU DEGREES

RESEARCH QUESTION

To what extent did the socioeconomic backgrounds of the students of Chalmers and DTU differ (if at all)?

Institutional differences

Did DTU attract relatively more students from 'elite' backgrounds than Chalmers?

Barriers to education

To what extent did capacity constraints and entry requirements influence who pursued technical education?

Quality of education

To what extent did changes in courses and investment in teaching and facilities shape student cohorts?

MOTIVATION

The relevance of student backgrounds

A standard story

- Estimating the returns to education is often complicated by 'unobserved' individual characteristics
- Where education is an elite pursuit, we risk conflating effects of social status and effects of education

An elite problem

- If changes in access to and/or quality of education influence the socioeconomic composition of cohorts, this might bias (overstate) estimates of the gains to education

EDUCATIONAL CHANGES

Chalmers

- Preparatory 'lower' school established

DTU

- Civil engineering programme introduced
- UCph opens Faculty of Natural Sciences

1850 →

Chalmers

- 1882: Chalmers Institute of Technology
- 1887: Shipbuilding school incorporated into Chalmers

DTU

- 1890: New campus
- 1894: Reorganisation of course: engineering
- 1897: First female graduates

1880 →

Chalmers

- 1911: First professors
- 1917: First female graduates
- 1917: High school exam as prerequisite

DTU

- 1916: Doctorate in engineering (*Doctor technices*) introduced

1910 →

SOURCE MATERIAL

vid Gbgs Nya Verkstads AB. 1906—08; ombord S/S. »Australic» 1908—09; Gbgs Nya Verkstads AB. 1909; Lindholmens Mek. Verkstads AB. 1910; Fore River Shipbuilding Co., Quincy, U. S. A., 1910—12; Gbgs

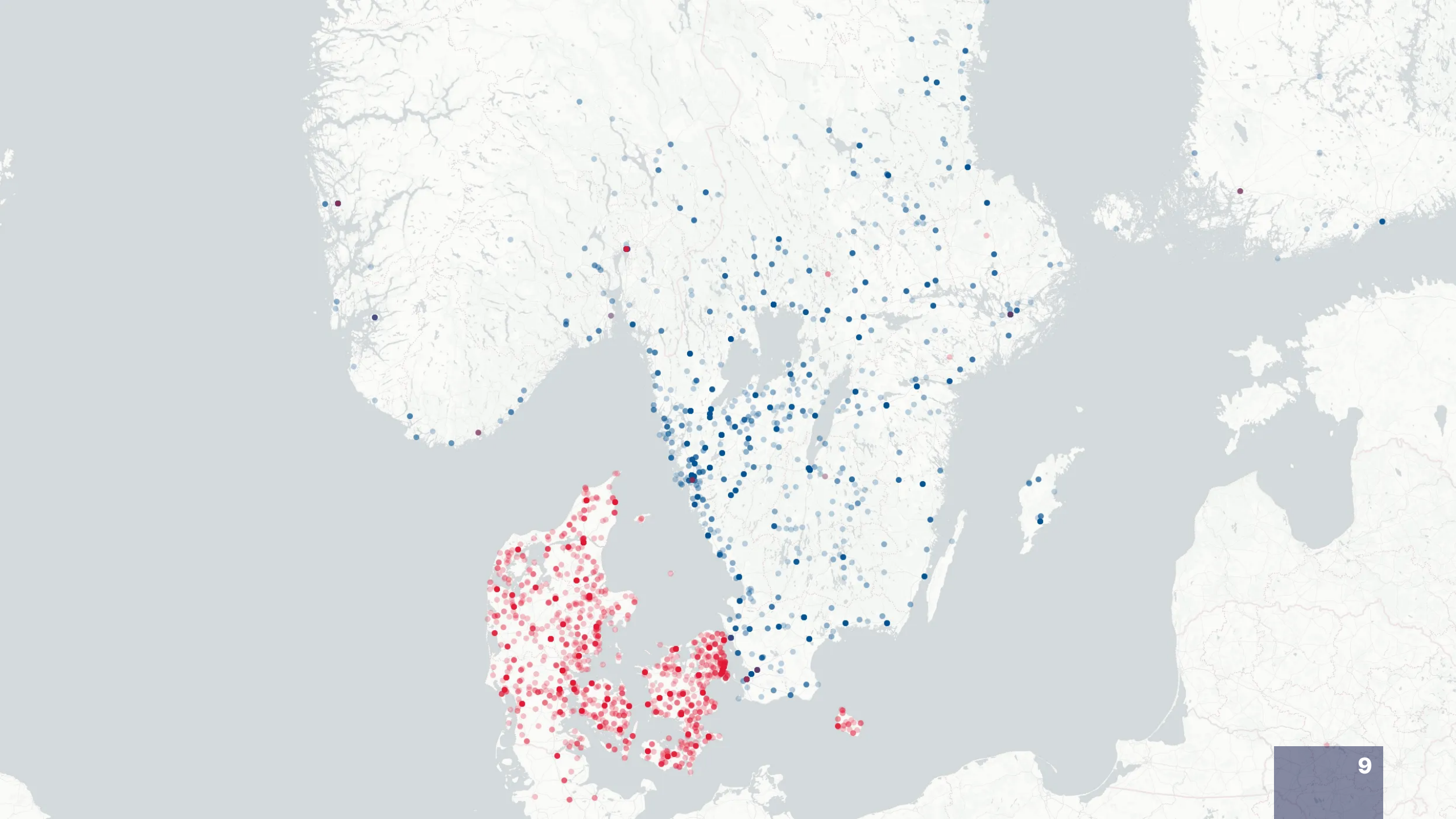
Nilsson Petrus Valdus [1910], f. i Hälsingborg d. 29 okt. 1886 av grosshandlare Per N. och Elna Persson; † d. 18 juni 1928. — Efter några års verksamhet i Norge, anst. i Svenska AB. »Naxos», Väs-

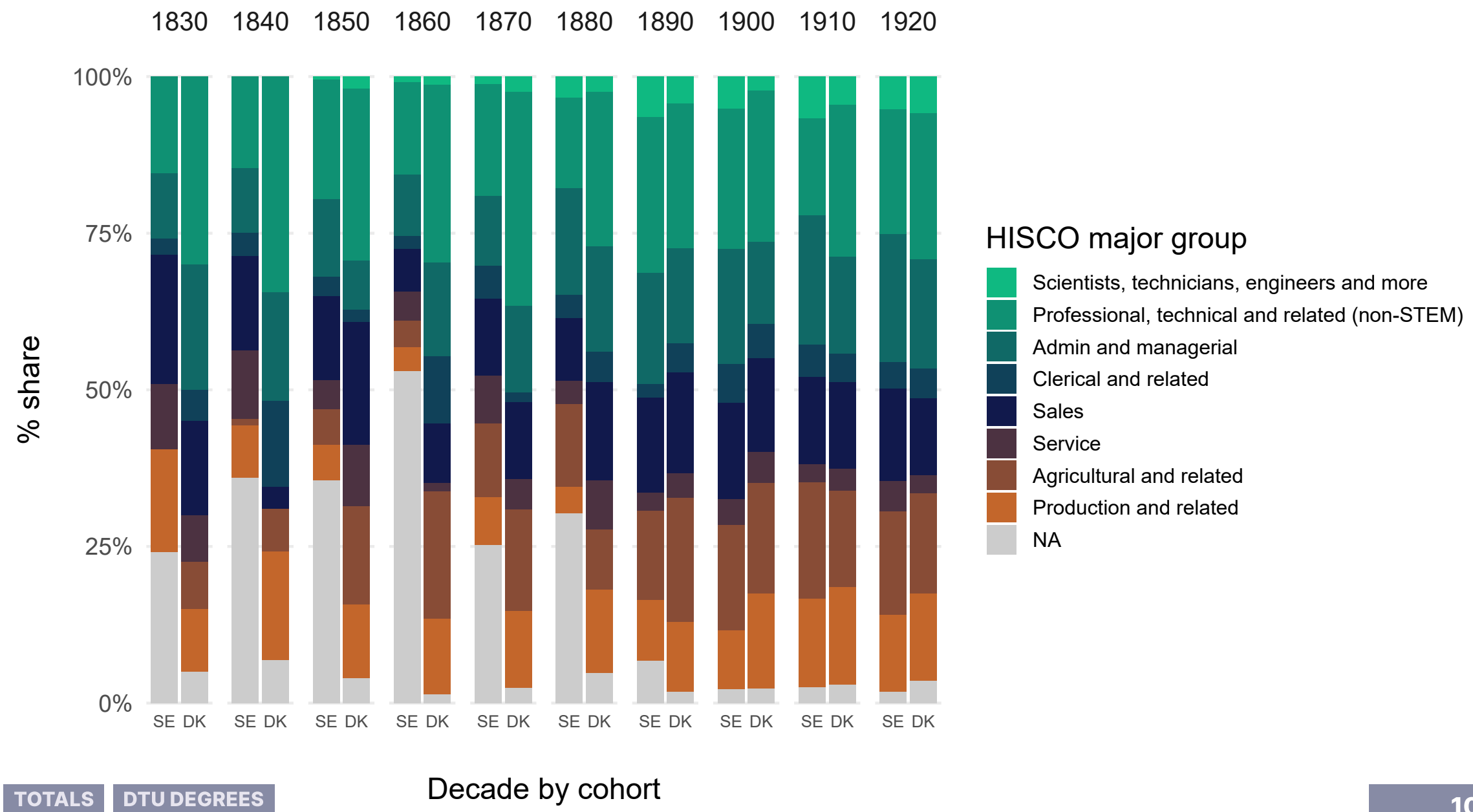
Nilsson Rudolf. Graduated 1920. Born in Åryd, Kronoberg county, 15 Aug. 1892, to landholder Karl August N. and Ingrid Olsson. — Employed at the tramways in Gothenburg; moved to the USA after a few years, where he worked as an architect in Chicago.

havan, sedan 1923.

Nilsson Nils Verner ex. 1923, f. i Bilbao, Spanien, d. 9 sept. 1901, av ingeniör Per N. och Olga Svea Jansson; † d. 4 mars 1925. — Förolyckad vid flygolycka i militärtjänst. Till hans minne donerade hans föräldrar 10 000 kr. till ett studiestipendium vid

1907—08; ASEA, Västerås, 1911—12; Kungl. Vattenfallsstyrelsen, Trollhätte Kraftverk, byråingeniör, 1913—16; Norrköpings kommunala affärsverk, drifts- & byråingeniör för elektricitetsverk och spårvägar 1916—27; egen konsulterande verksamhet 1923 och 1924. Mellersta och Norra Sveriges Ångpanneföre-




1830
1840
1850
1860
1870
1880
1890
1900
1910
1920
100%
75%
50%
25%
0%
% share
SE DK
Decade by cohort
HISCO major group
Scientists, technicians, engineers and more
Professional, technical and related (non-STEM)
Admin and managerial
Clerical and related
Sales
Service
Agricultural and related
Production and related
NA

Results

In the footsteps of Chalmers and Ørsted

The expansion of higher technical education in Sweden and Denmark, 1829–1929

RESULTS

Probit results by HISCO major group (relative to Chalmers, 1890–1929)

	HISCO first digit =							
	STEM	0-1	2	3	4	5	6	7-9
DTU	-0.20*** (0.06)	0.10** (0.04)	-0.18*** (0.04)	-0.08 (0.07)	-0.16*** (0.05)	-0.15** (0.07)	0.20*** (0.05)	0.03 (0.05)
Distance to inst. (km, log)	-0.03** (0.01)	0.01 (0.01)	-0.01 (0.01)	-0.05*** (0.01)	-0.06*** (0.01)	-0.06*** (0.01)	0.17*** (0.01)	-0.05*** (0.01)
Born outside Nordics	0.93*** (0.16)	0.43*** (0.13)	0.36** (0.14)	0.17 (0.24)	0.16 (0.17)	0.16 (0.26)	-1.43*** (0.22)	-0.35 (0.22)
Constant	-1.79*** (0.49)	-0.50** (0.24)	-0.58** (0.26)	-1.26*** (0.36)	-0.81*** (0.29)	-5.17 (111.11)	-2.28*** (0.38)	-0.93*** (0.29)
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Num. obs.	5333	5333	5333	5333	5333	5333	5333	5333

Dependent variable: Probability of graduate coming from household in each HISCO major group (columns). DTU evaluated relative to Chalmers. Robust standard errors reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

OLS INVERTED

RESULTS

Chalmers: Entry requirements and HISCO (probit, 1910–1929)

	STEM	0-1	2	3	4	5	6	7-9
Chalmers	0.33** (0.14)	-0.22** (0.09)	0.19* (0.10)	0.23* (0.14)	0.09 (0.10)	0.00 (0.17)	-0.01 (0.10)	-0.03 (0.10)
1917-1919	0.15 (0.15)	-0.13 (0.09)	0.10 (0.10)	0.11 (0.15)	-0.01 (0.11)	0.09 (0.16)	0.01 (0.11)	0.01 (0.11)
1920-1929	0.16 (0.10)	-0.03 (0.06)	0.12 (0.07)	0.06 (0.10)	-0.08 (0.07)	-0.05 (0.12)	0.03 (0.08)	-0.06 (0.07)
Chalmers × 1917-1919	-0.20 (0.22)	0.02 (0.15)	0.01 (0.16)	-0.16 (0.24)	-0.00 (0.17)	0.13 (0.27)	-0.17 (0.17)	0.14 (0.17)
Chalmers × 1920-1929	-0.29* (0.17)	0.09 (0.11)	-0.08 (0.12)	-0.18 (0.17)	0.10 (0.13)	0.37* (0.20)	-0.19 (0.12)	0.01 (0.13)
Distance to inst. (km, log)	-0.05*** (0.01)	-0.00 (0.01)	-0.00 (0.01)	-0.06*** (0.01)	-0.05*** (0.01)	-0.07*** (0.02)	0.16*** (0.01)	-0.04*** (0.01)
Born outside Nordics	1.10*** (0.18)	0.52*** (0.16)	0.31* (0.17)	0.25 (0.28)	-0.03 (0.22)	0.32 (0.32)	-1.23*** (0.24)	-0.66** (0.31)
Constant	-1.63*** (0.09)	-0.50*** (0.06)	-1.03*** (0.07)	-1.57*** (0.09)	-0.94*** (0.07)	-1.68*** (0.10)	-1.54*** (0.08)	-0.89*** (0.06)
Pseudo R^2	0.03	0.01	0.00	0.01	0.01	0.02	0.06	0.01
Num. obs.	3564	3564	3564	3564	3564	3564	3564	3564

Dependent variable: Probability of graduate coming from household in each HISCO major group (columns). Chalmers evaluated relative to DTU. Robust standard errors reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

OLS 1890-1929

RESULTS

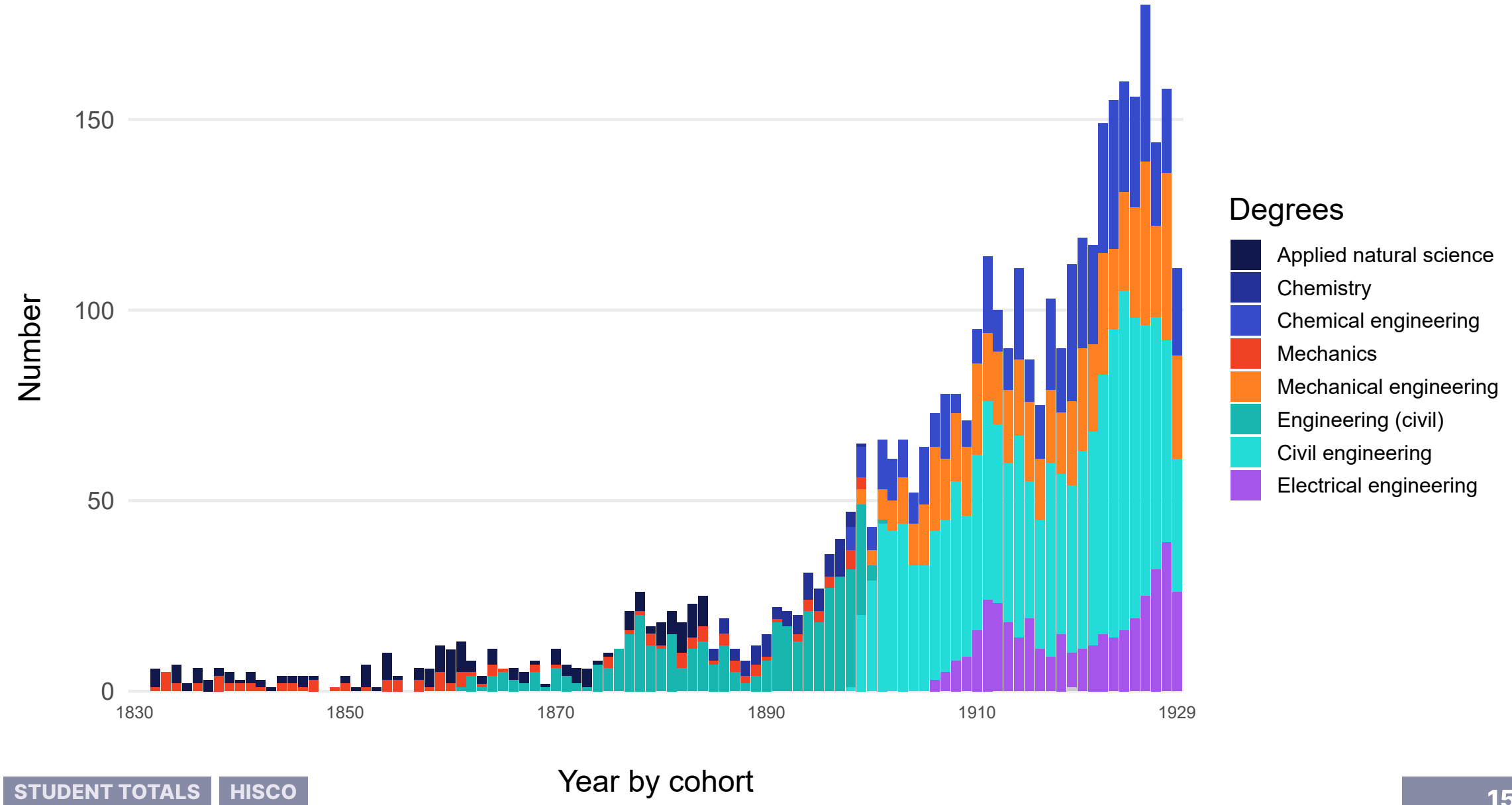
DTU: Course reorganisation and HISCO

(probit, 1890–1910)

	STEM	0-1	2	3	4	5	6	7-9
DTU	-0.62** (0.24)	-0.14 (0.13)	-0.15 (0.15)	0.24 (0.23)	-0.17 (0.15)	0.12 (0.23)	0.39*** (0.15)	-0.14 (0.16)
1898-1900	-0.20 (0.23)	0.12 (0.15)	0.27* (0.16)	-0.48 (0.41)	0.03 (0.17)	0.14 (0.26)	-0.31 (0.19)	-0.38* (0.22)
1901-1910	-0.20 (0.15)	-0.16 (0.11)	0.02 (0.12)	0.40** (0.19)	0.02 (0.12)	0.05 (0.19)	0.04 (0.12)	-0.08 (0.13)
DTU × 1898-1900	0.78** (0.35)	-0.01 (0.21)	-0.34 (0.23)	0.37 (0.47)	0.00 (0.24)	-0.22 (0.36)	0.20 (0.25)	0.52* (0.28)
DTU × 1901-1910	0.27 (0.28)	0.21 (0.15)	-0.09 (0.17)	-0.45* (0.25)	-0.03 (0.17)	-0.05 (0.26)	-0.15 (0.17)	0.29 (0.18)
Distance to inst. (km, log)	0.02 (0.02)	0.04*** (0.01)	-0.03** (0.01)	-0.05** (0.02)	-0.08*** (0.01)	-0.03* (0.02)	0.17*** (0.02)	-0.06*** (0.01)
Born outside Nordics	0.47 (0.31)	0.20 (0.23)	0.44* (0.25)	-0.02 (0.44)	0.42 (0.26)	-0.00 (0.45)	-1.72*** (0.46)	0.05 (0.32)
Constant	-1.51*** (0.16)	-0.62*** (0.10)	-0.80*** (0.12)	-1.71*** (0.19)	-0.68*** (0.12)	-1.70*** (0.19)	-1.75*** (0.13)	-0.90*** (0.13)
Pseudo R^2	0.03	0.01	0.01	0.02	0.02	0.01	0.08	0.02
Num. obs.	1908	1908	1908	1908	1908	1908	1908	1908

Dependent variable: Probability of graduate coming from household in each HISCO major group (columns). DTU evaluated relative to Chalmers. Robust standard errors reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

OLS 1890-1929


Number
150
100
50
0
1830
1850
1870
1890
1910
1929
Year by cohort
Degrees
Applied natural science
Chemistry
Chemical engineering
Mechanics
Mechanical engineering
Engineering (civil)
Civil engineering
Electrical engineering

RESULTS

Degree differences and HISCO major groups (DTU, probit, 1829–1929)

	STEM	0-1	2	3	4	5	6	7-9
Chemical	-0.50** (0.25)	0.13 (0.11)	0.16 (0.12)	-0.11 (0.18)	-0.12 (0.13)	-0.31 (0.19)	-0.18 (0.13)	0.12 (0.13)
Mechnical	-0.37 (0.30)	0.10 (0.14)	0.08 (0.16)	0.14 (0.21)	-0.22 (0.17)	0.09 (0.21)	-0.28 (0.18)	0.14 (0.17)
New degree	0.17 (0.13)	0.05 (0.07)	0.02 (0.09)	0.04 (0.12)	-0.12 (0.09)	-0.26** (0.12)	-0.04 (0.09)	0.18* (0.09)
Chemical × New	0.38 (0.27)	-0.08 (0.13)	0.06 (0.14)	0.08 (0.21)	0.16 (0.15)	0.35 (0.22)	-0.03 (0.16)	-0.31** (0.15)
Mechnical × New	0.16 (0.32)	-0.21 (0.15)	0.05 (0.18)	-0.40* (0.24)	0.30 (0.19)	-0.01 (0.24)	0.13 (0.20)	-0.00 (0.19)
Electrical (New)	-0.15 (0.13)	-0.02 (0.08)	0.15* (0.09)	-0.15 (0.13)	-0.01 (0.09)	0.03 (0.14)	0.00 (0.09)	-0.05 (0.09)
Distance to inst. (km, log)	-0.03*** (0.01)	0.02** (0.01)	-0.02** (0.01)	-0.05*** (0.01)	-0.06*** (0.01)	-0.09*** (0.01)	0.18*** (0.01)	-0.05*** (0.01)
Born outside Nordics	0.60*** (0.21)	0.31** (0.14)	0.21 (0.16)	0.28 (0.23)	0.36** (0.17)	0.78*** (0.22)	-1.46*** (0.24)	-0.69** (0.30)
Constant	-1.69*** (0.12)	-0.64*** (0.07)	-1.04*** (0.08)	-1.52*** (0.11)	-0.86*** (0.08)	-1.39*** (0.11)	-1.46*** (0.09)	-1.07*** (0.09)
Pseudo R^2	0.02	0.00	0.01	0.01	0.02	0.05	0.11	0.02
Num. obs.	3765	3765	3765	3765	3765	3765	3765	3765

Dependent variable: Probability of graduate coming from household in each HISCO major group (columns). Baseline degree is civil engineering. Robust standard errors reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Headlines

Results

Similar mix of student backgrounds by 1929

Reforms at DTU coincided with growth in graduate numbers

Implications

Larger student cohorts no less elite!

No effect (?) of access and quality on cohort composition

Future work

To what extent can differences in employment outcomes be observed between Chalmers and DTU?

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Extra slides

EXTRA

Comparing measures of household status

OLS results, 1890–1929

	HISCO (major)	HISCO (minor)	HISCLASS
Chalmers	3.05*** (0.51)	33.09*** (5.05)	3.07*** (0.49)
DTU	3.18*** (0.50)	34.68*** (5.01)	3.34*** (0.49)
Distance to inst. (km, log)	0.01 (0.02)	0.06 (0.16)	0.09*** (0.02)
Born outside Nordics	-1.59*** (0.24)	-15.71*** (2.38)	-2.05*** (0.22)
Cohort fixed effects	Yes	Yes	Yes
RMSE	2.71	27.40	2.86

Dependent variable: HISCO/HISCLASS value of household. Robust standard errors reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

BASELINE

EXTRA

Probability of being a student of DTU given household

Probit results, 1890–1929

Dependent variable: Probability of graduate being a student of DTU (relative to Chalmers). Baseline HISCO major group is Production and related workers. Robust SE's reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1)	(2)
HISCO major group		
Professional, technical and related	0.04 (0.06)	-0.04 (0.19)
Admin and managerial	-0.18*** (0.07)	-0.14 (0.21)
Clerical and related	-0.13 (0.10)	0.34 (0.34)
Sales	-0.18** (0.07)	-0.14 (0.21)
Services	-0.19* (0.11)	0.16 (0.33)
Agricultural and related	0.15** (0.07)	0.42** (0.20)
Decade		
1900-09		0.27 (0.20)
1910-19		0.27 (0.18)
1920-29		0.55*** (0.18)
Distance to inst. (km, log)	-0.19*** (0.01)	-0.20*** (0.01)
Born outside Nordics	0.85*** (0.14)	0.87*** (0.13)
Constant	0.77*** (0.25)	0.70*** (0.16)
Cohort fixed effects	Yes	
Num. obs.	5333	5333

BASELINE

EXTRA

Chalmers: High-school exam and HISCO minor group

OLS results, 1890–1929

	Chalmers only		Chalmers relative to DTU	
	(1)	(2)	(3)	(4)
Chalmers			-2.80*** (0.99)	-3.31*** (1.06)
1920-1929	1.03 (1.29)		-1.91* (0.98)	
1917-1929		2.32* (1.22)		-1.37 (0.96)
Chalmers × 1920-1929			2.90* (1.62)	
Chalmers × 1917-1929				3.63** (1.55)
Distance to inst. (km, log)	-0.16 (0.35)	-0.19 (0.35)	0.08 (0.16)	0.08 (0.16)
Born outside Nordics	-12.20*** (4.46)	-12.09*** (4.46)	-15.39*** (2.35)	-15.40*** (2.35)
Constant	38.44*** (1.75)	37.92*** (1.76)	40.21*** (0.77)	40.12*** (0.81)
R^2	0.00	0.01	0.01	0.01
RMSE	26.94	26.92	27.40	27.40

Dependent variable: HISCO minor group value (two-digit code). Robust standard errors reported in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

PROBIT | PROBIT 1890-1929

EXTRA

DTU: Course changes and HISCO minor group

OLS results, 1890–1910

	DTU only		DTU relative to Chalmers	
	(1)	(2)	(3)	(4)
DTU			4.05 (2.61)	5.79*** (2.05)
1898-1910	0.75 (2.01)		0.01 (2.14)	
1901-1910		1.68 (1.74)		3.69** (1.84)
DTU × 1898-1910			0.76 (2.93)	
DTU × 1901-1910				-2.00 (2.53)
Distance to inst. (km, log)	-0.26 (0.30)	-0.27 (0.30)	-0.24 (0.26)	-0.25 (0.26)
Born outside Nordics	-8.47 (5.24)	-8.50 (5.24)	-10.20** (4.27)	-10.30** (4.37)
Constant	41.11*** (1.96)	40.62*** (1.58)	37.03*** (2.19)	34.81*** (1.84)
R^2	0.00	0.00	0.01	0.01
RMSE	27.11	27.10	26.73	26.69

Dependent variable: HISCO minor group value (two-digit code). Robust standard errors reported in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

PROBIT | PROBIT 1890-1929

EXTRA

Chalmers: Entry requirements and HISCO (probit, 1890–1929)

	STEM	0-1	2	3	4	7-9
Chalmers	0.33*** (0.09)	-0.04 (0.05)	0.21*** (0.06)	0.13 (0.08)	0.12** (0.06)	-0.10 (0.06)
1917-1919	0.23* (0.13)	-0.07 (0.08)	0.13 (0.09)	0.05 (0.13)	-0.04 (0.10)	0.06 (0.10)
1920-1929	0.25*** (0.08)	0.04 (0.05)	0.15*** (0.05)	0.01 (0.08)	-0.11* (0.06)	-0.01 (0.06)
Chalmers × 1917-1919	-0.23 (0.20)	-0.18 (0.14)	0.00 (0.14)	-0.07 (0.21)	-0.01 (0.15)	0.22 (0.15)
Chalmers × 1920-1929	-0.32** (0.13)	-0.11 (0.08)	-0.08 (0.09)	-0.09 (0.13)	0.09 (0.09)	0.09 (0.10)
Distance to inst. (km, log)	-0.03*** (0.01)	0.01 (0.01)	-0.01 (0.01)	-0.05*** (0.01)	-0.06*** (0.01)	-0.05*** (0.01)
Born outside Nordics	0.93*** (0.16)	0.42*** (0.13)	0.36** (0.14)	0.15 (0.24)	0.15 (0.17)	-0.34 (0.22)
Constant	-1.75*** (0.07)	-0.59*** (0.04)	-1.03*** (0.04)	-1.54*** (0.06)	-0.89*** (0.04)	-0.92*** (0.04)
Pseudo R^2	0.02	0.00	0.01	0.01	0.01	0.01
Num. obs.	5333	5333	5333	5333	5333	5333

Dependent variable: Probability of graduate coming from household in each HISCO major group (columns). Chalmers evaluated relative to DTU. Robust standard errors reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

PRIMARY

EXTRA

DTU: Course reorganisation and HISCO (probit, 1890–1929)

	STEM	0-1	2	3	4	7-9
DTU	-0.70*** (0.24)	-0.18 (0.13)	-0.11 (0.15)	0.24 (0.23)	-0.13 (0.15)	-0.11 (0.16)
1898-1900	-0.19 (0.23)	0.12 (0.15)	0.27* (0.16)	-0.48 (0.41)	0.02 (0.17)	-0.38* (0.22)
1901-1929	-0.16 (0.13)	-0.22** (0.09)	0.10 (0.11)	0.31* (0.18)	-0.03 (0.11)	0.03 (0.12)
DTU × 1898-1900	0.74** (0.35)	-0.02 (0.21)	-0.33 (0.23)	0.36 (0.47)	0.02 (0.24)	0.53* (0.28)
DTU × 1901-1929	0.56** (0.25)	0.33** (0.14)	-0.05 (0.15)	-0.38 (0.23)	-0.03 (0.15)	0.15 (0.17)
Distance to inst. (km, log)	-0.03*** (0.01)	0.01 (0.01)	-0.01 (0.01)	-0.05*** (0.01)	-0.06*** (0.01)	-0.05*** (0.01)
Born outside Nordics	0.94*** (0.16)	0.42*** (0.13)	0.36** (0.14)	0.15 (0.24)	0.15 (0.17)	-0.35 (0.22)
Constant	-1.31*** (0.13)	-0.50*** (0.09)	-0.89*** (0.11)	-1.69*** (0.18)	-0.75*** (0.11)	-0.97*** (0.12)
Pseudo R^2	0.02	0.01	0.00	0.01	0.01	0.01
Num. obs.	5333	5333	5333	5333	5333	5333

Dependent variable: Probability of graduate coming from household in each HISCO major group (columns). DTU evaluated relative to Chalmers. Robust standard errors reported in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

PRIMARY