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Dependent Invention and Dependent Inventors

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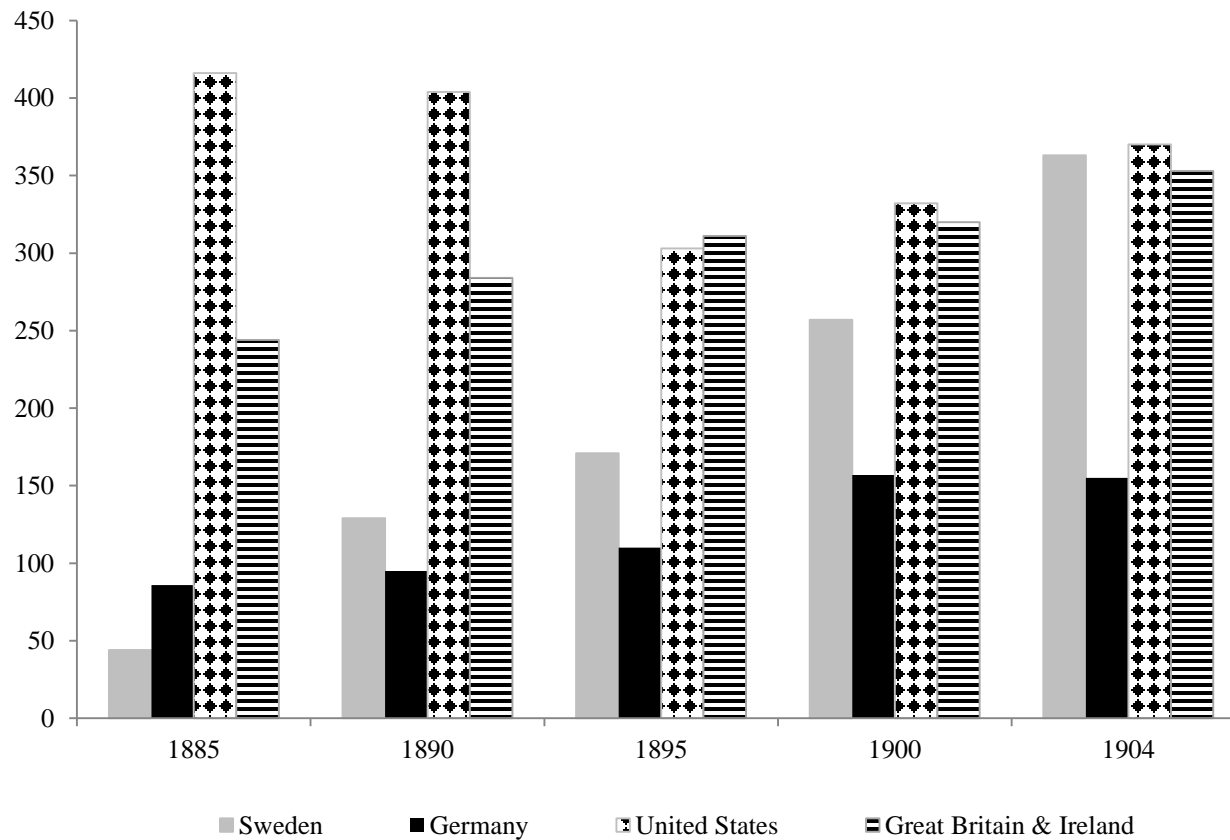


Introduction and motivation

- Understanding the sources for new inventions is crucial for research in economic history and for policy makers working with research policy
 - Still not clear. Universities, independent inventors or firms?
 - Historically, the story about the "Schumpeterian inventor" (and the decline there of)
- In which organizational settings do inventions emerge?
- To what extent does a patent granted to an individual represent an invention made by an independent inventor?



Historical perspective



Patents per million inhabitants, 1885-1904

Note: Sweden, Germany and the US all had examination systems while the UK still used a registration system throughout the period.

Source: Tisell (1907)



Introduction and motivation

- The story about the "Schumpeterian inventor" (and the decline there of)
 - Independent inventors were the main source of of new inventions during late 19th century (e.g. Schumpeter 1942, Hughes 1988, Lamoreaux & Sokoloff 2005)
 - Independent inventors have been qualitatively and quantitatively underestimated (e.g. Jewkes et al 1969, Nicholas 2010; 2011)
 - Approx. 85% of all patents ~1880-1914 come from independent inventors (e.g. Sáiz 2012, Nuvolari & Vasta 2015, Nicholas 2010; 2011, Basberg 2015)
- Market coordination argument, e.g. markets for technology



Introduction and motivation

- Individual patentees were strongly associated with industry (Basberg, 2015 p. 38)
- “[I]t is also possible that patents formally granted to individuals actually cover the formalized inventive activities taking place inside companies. This is probably a more serious source of error for the period considered here.” (Nuvolari & Vasta, 2015 p. 12)



Introduction and motivation

- The myth of the lone inventor
 - Commercial success low for independent inventors (Åstebro 1998; 2003, Dahlin et al 2004)
 - Individuals without affiliation to organizations, are less likely to achieve breakthroughs and more likely to invent particularly poor outcomes (Singh and Flemming 2010)
 - Invention is a social phenomenon (e.g. Gilfillan 1935, Nuvolari 2004, Lemley 2012)
- Argument for organized invention is due to resource dependencies, complementarities, and social interaction



Introduction and motivation

We study to what extent inventive activity was (in)dependent in Sweden during the second industrial revolution.

- We code 1,500 occupational titles for more than 20,000 individuals according to the Historical International Standard Classification of Occupations (HISCO) (Van Leeuwen et al, 2002)
- We reconstruct the inventive careers for a sample of 110 Swedish "Great Patentees" to pin-point their place of work at the time of their patent applications



Preview of results

- Engineers and general managers highly over represented
- Individuals with occupations most associated with firms produce higher (economic) quality patents (measured as patent fees paid)
- Most "Great patentees" apply for patents in their own name while being employed by firms
- Only 8% can be categorized as truly independent
- 44% are employed by firms
- Individuals move in and out of roles



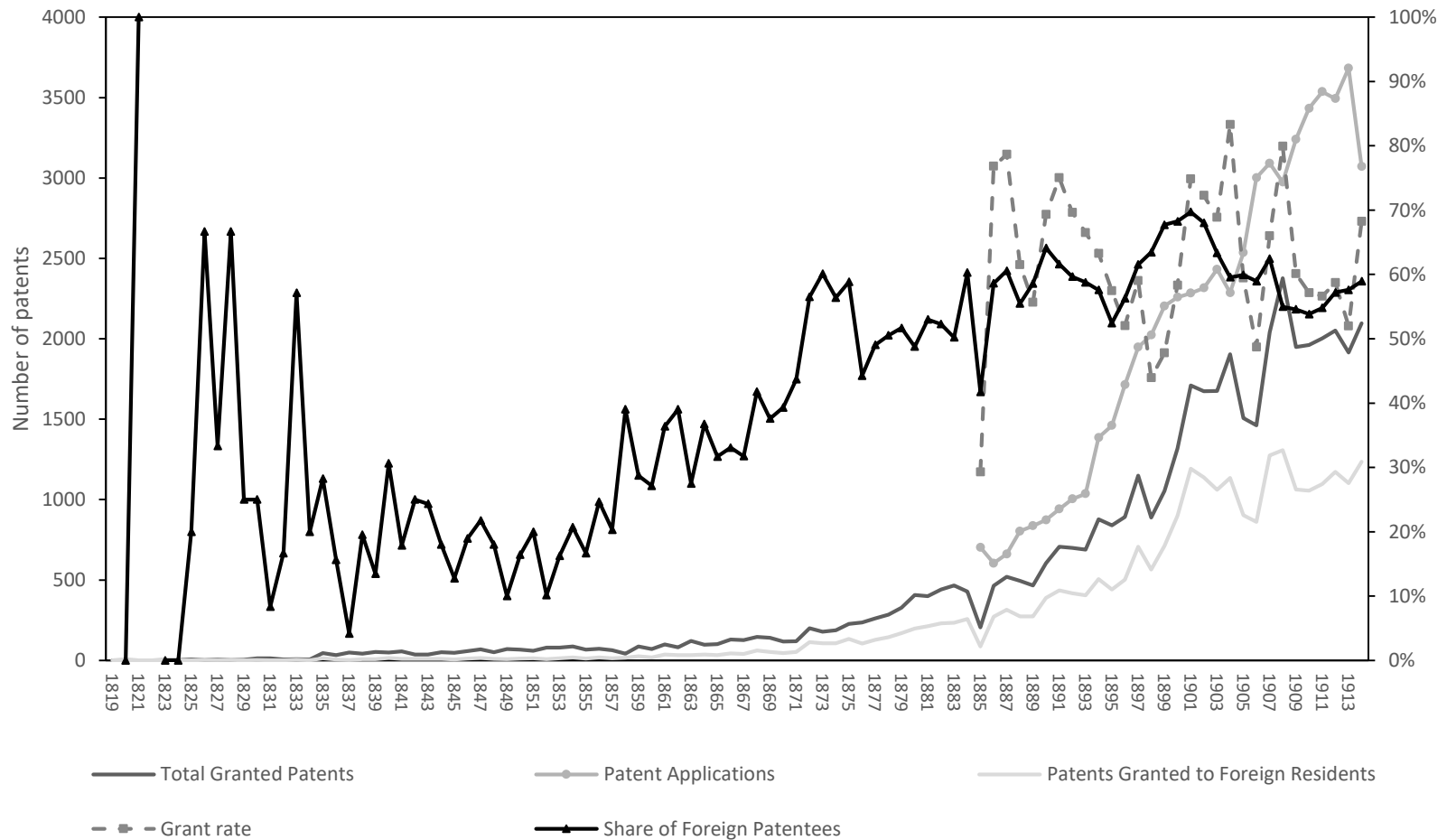
Background: Proprietary capitalism

The main period of study (1880-1914) characterized by a "technological revolution" and proprietary capitalism

- Patents increase rapidly
- Increase of patents granted to firms
- Factories are owned by individuals not corporations



Patents

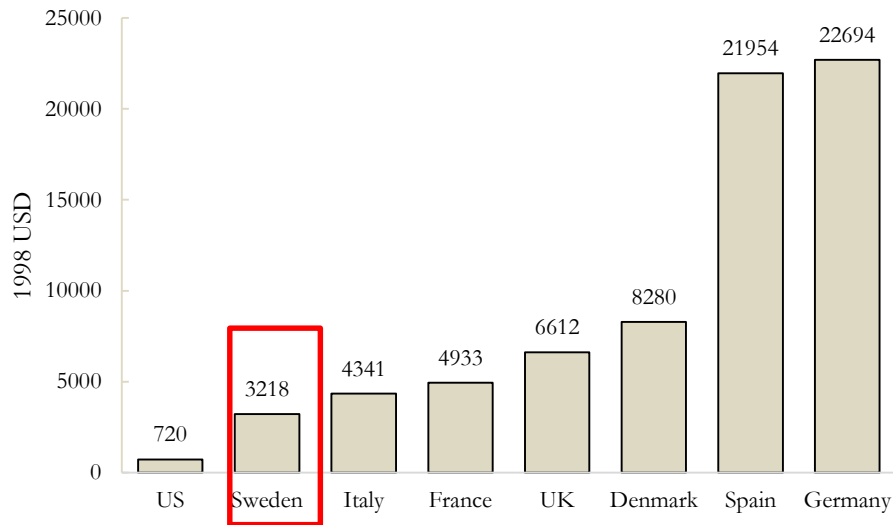


Patenting in Sweden 1819-1914

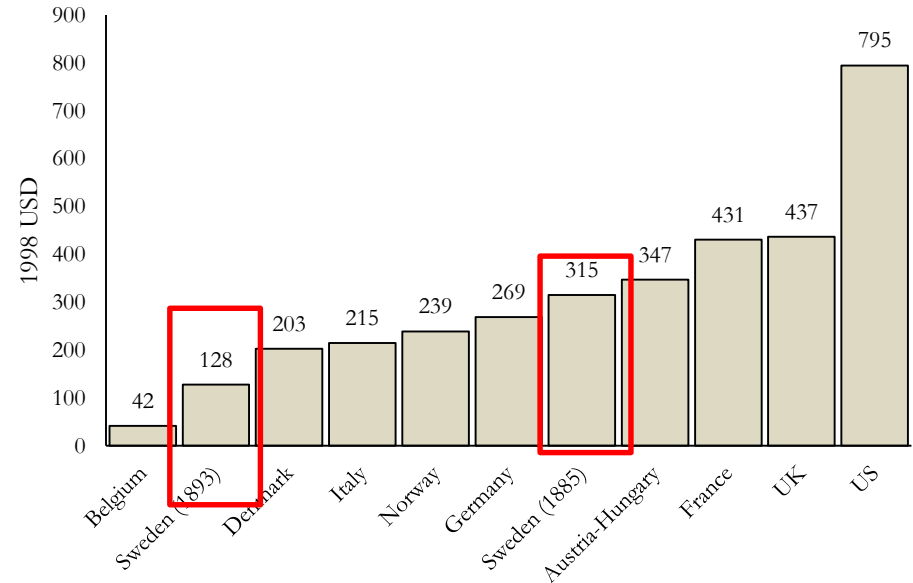
Source: Authors' database and Sáiz 1999. Note: Total granted patents, patent applications and foreign patents (right axis), grant rate and foreign share (left axis). Grant rate is calculated as $\text{grants}_{\text{YEAR}} / \text{applications}_{\text{YEAR}}$ and should thus be taken as an approximation.



Cheap patent system



Patenting costs in different countries in 1900
Source: Lerner (2002)

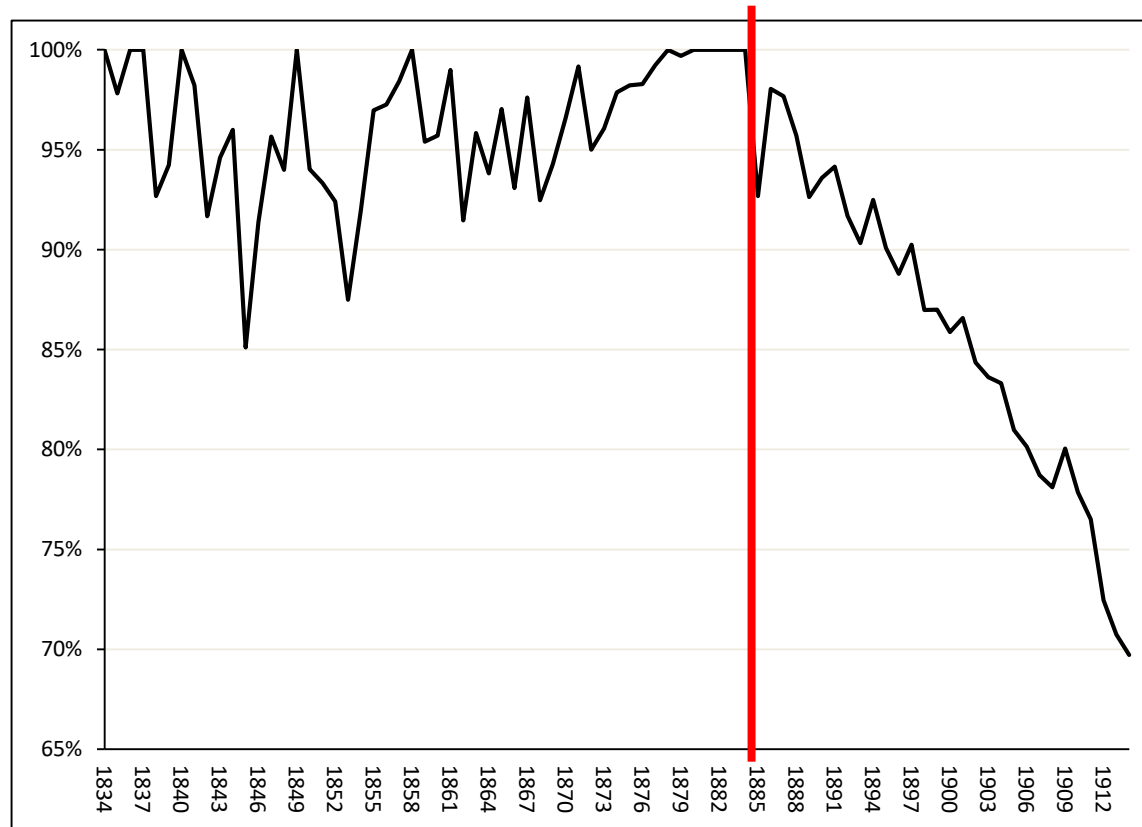


Patent application costs in different countries in 1884.

Source: Andrée, S.A., 1888. Uppfinningarna i Sverige åren 1870–84, Stockholm



Individuals vs firms

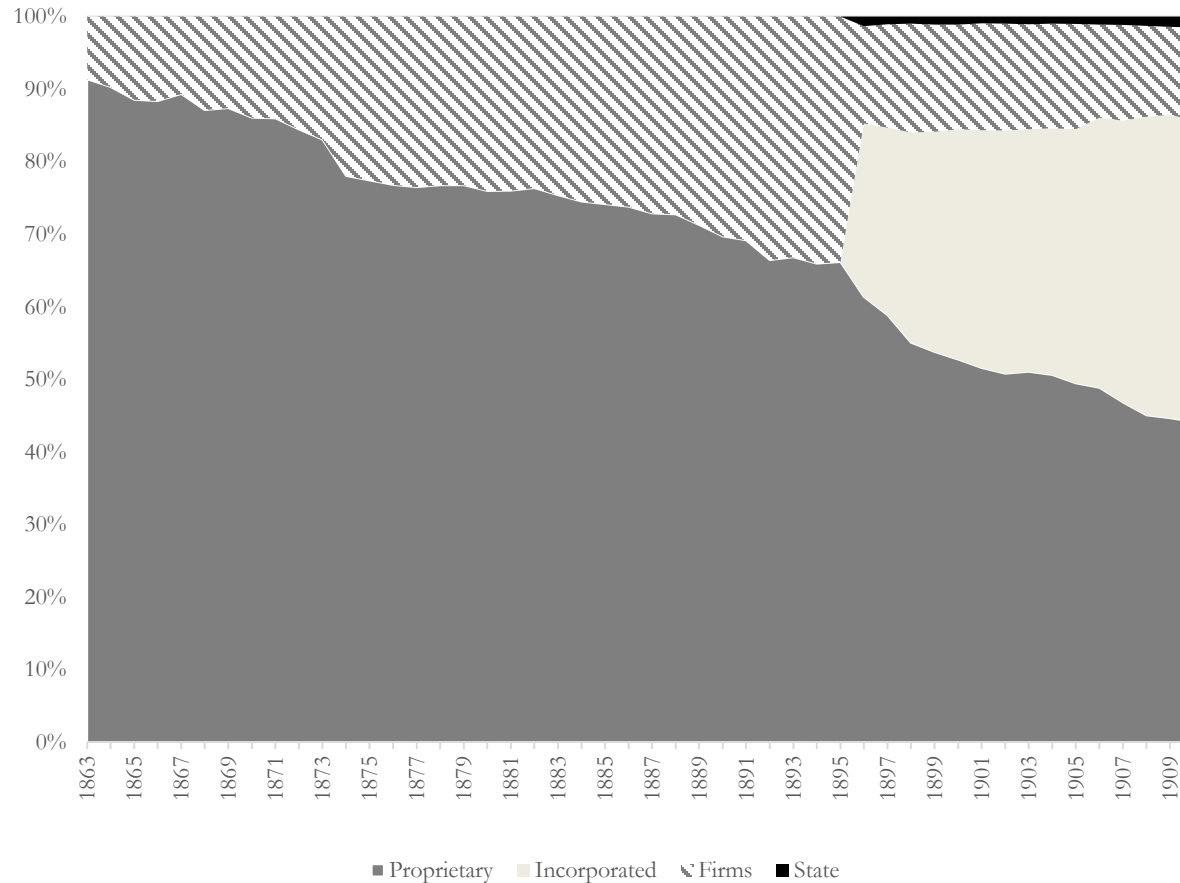


Share of patents granted to individuals in Sweden, 1834-1914

Source: Authors' database



Factory ownership



Factory ownership in Sweden 1863-1910.

Source: Swedish Official Statistics, BISOS D) Fabriker och manufaktur 1863-1910



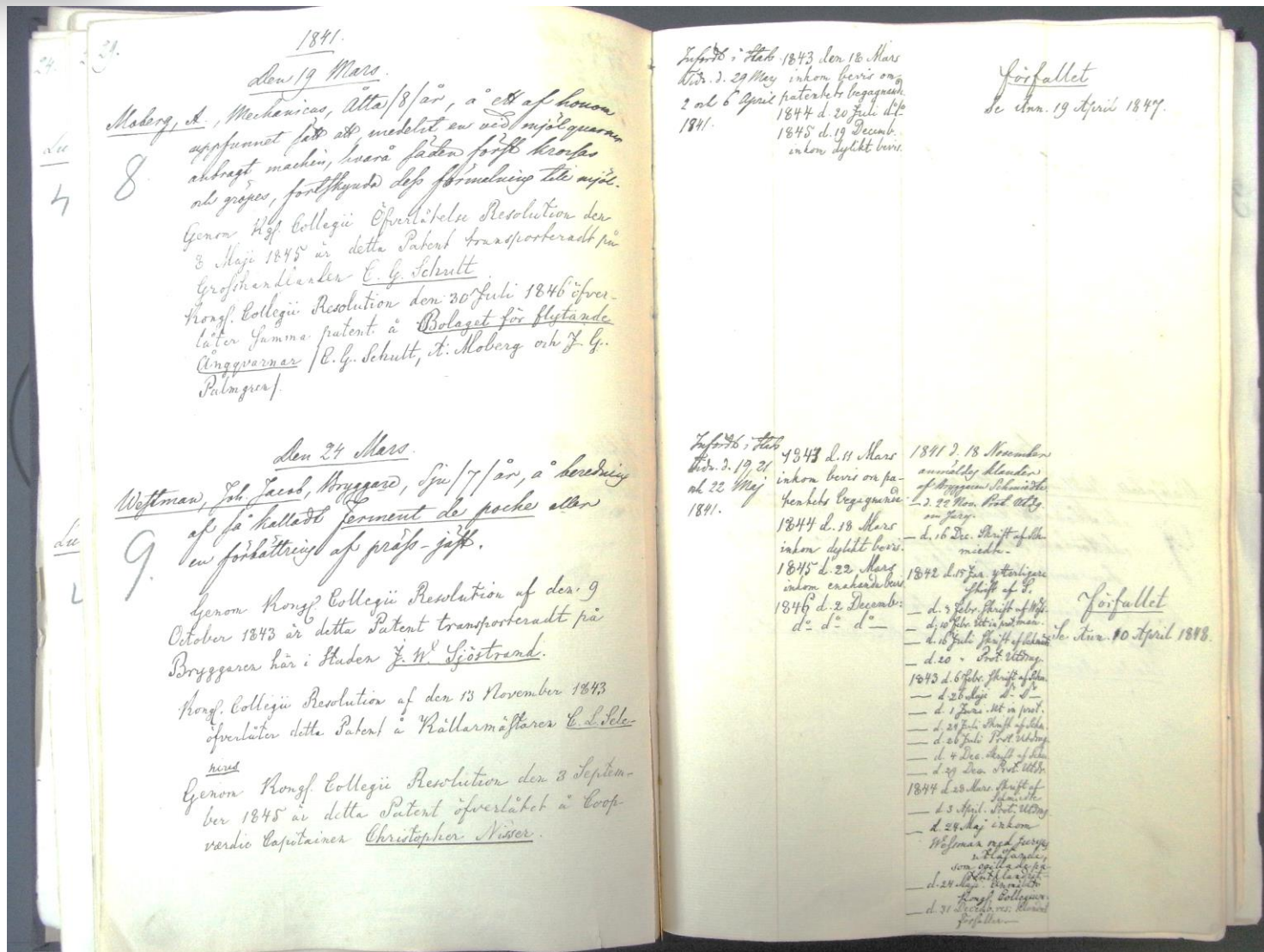
Our data

Two data sets:

- Patents: Universe of Swedish patents 1819-1914, approx. 45,000 patents (38,190 for the period 1885-1914). Includes names, address, occupation of inventors and patentees, patent fees etc.
- "Great Patentees": The 110 Swedish patentees with the most granted patents in their name. Reconstructed careers for 79 of them using biographical dictionaries such as *Svenskt biografiskt lexikon* (SBL) and *Svenska teknologföreningen 1861-1936* (STF)

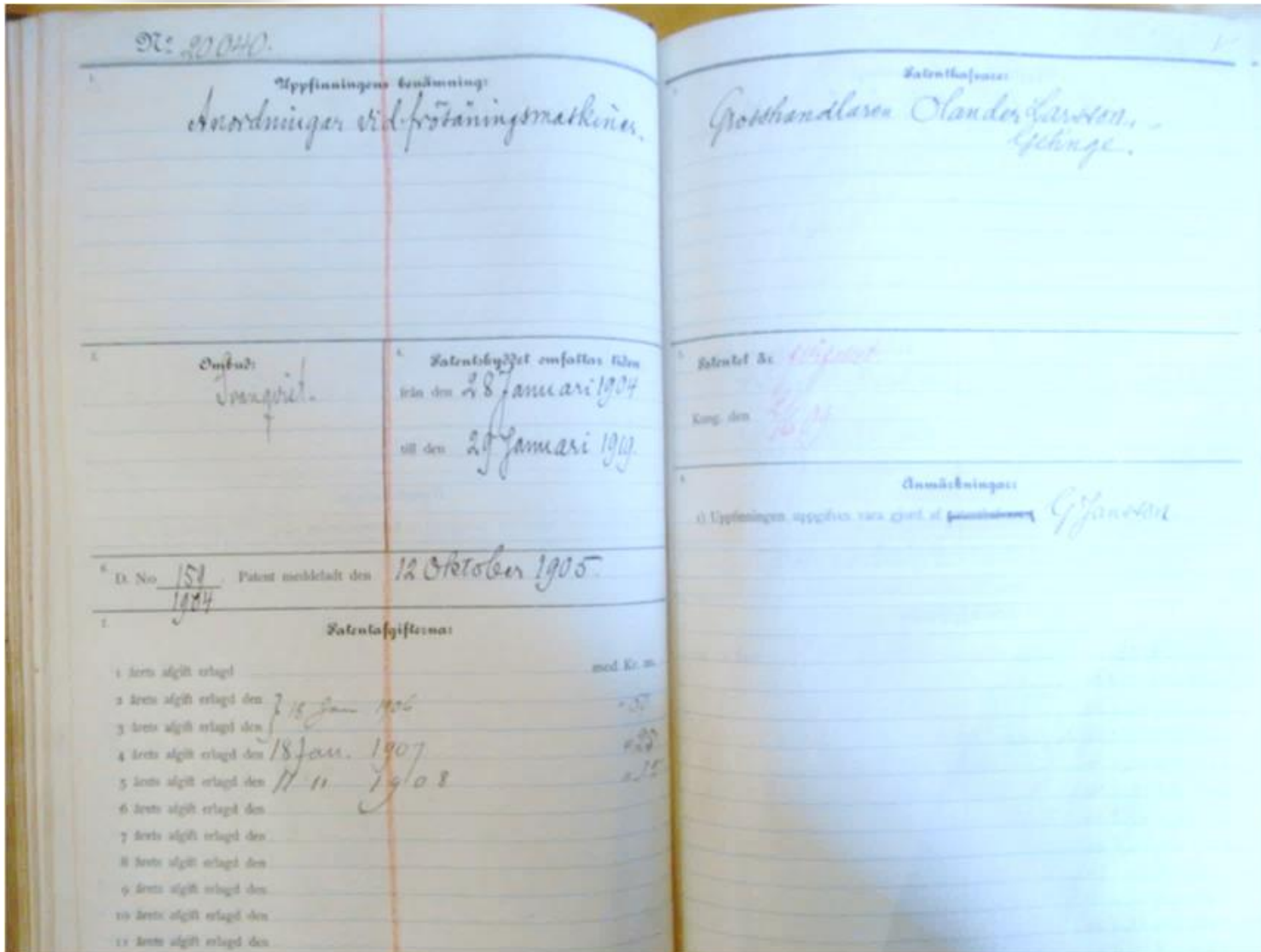


From the archives



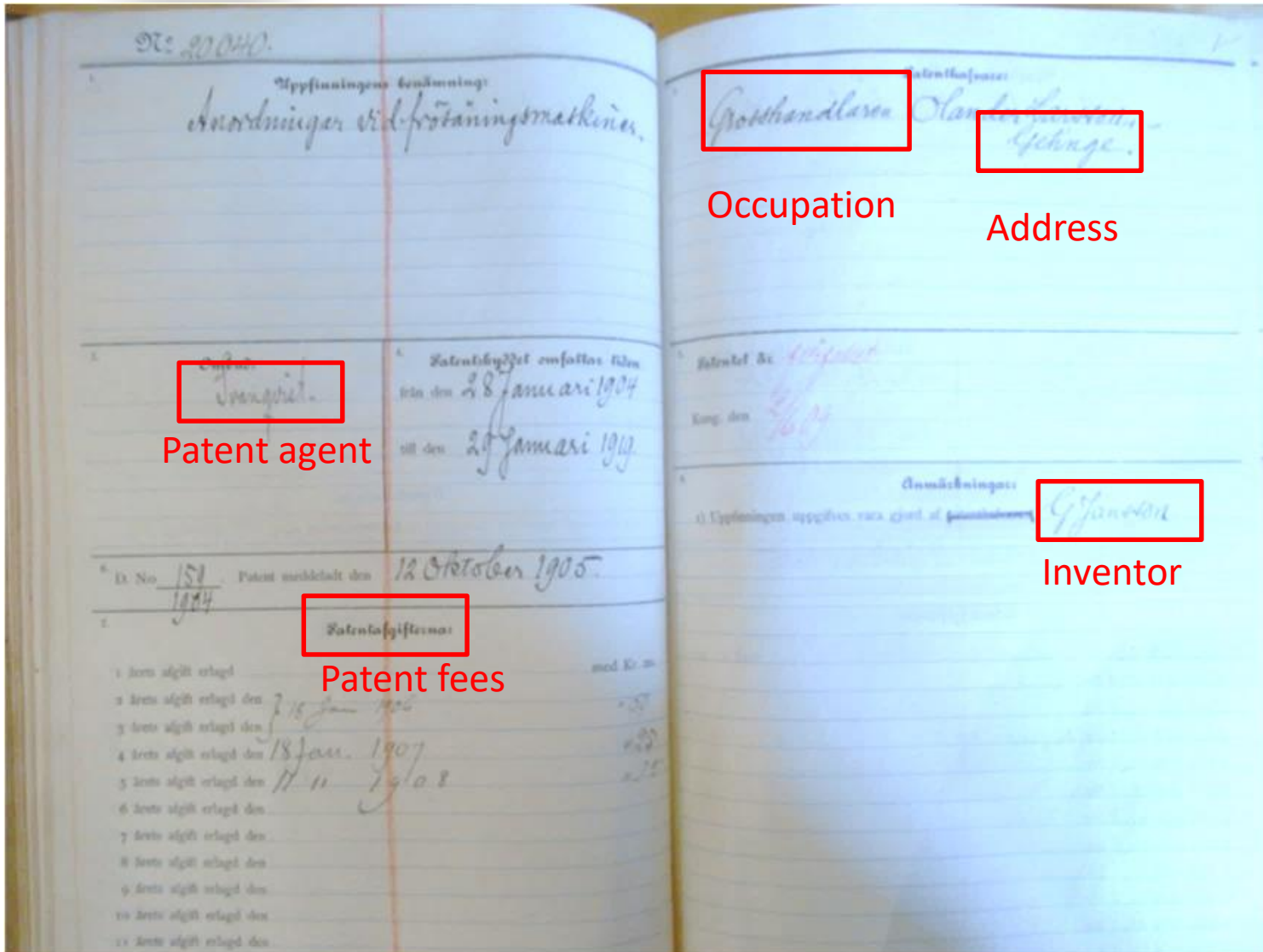


From the archives





From the archives





Biographical dictionaries



Johan August Brinell.

F. i Bringetofta, Jönk. län, 1849^{19/6}. Ex. fr. Tekn. elem.-skolan i Borås 71. Ritare hos ingenjör W. Wenström m. fl. 71—75; ingenjör vid Lesjöfors aktiebolag 75—78 o. 79—82 o. vid Borås mekan. verkstad 78—79; öfveringenjör vid Fagersta bruks aktiebolag 82—1903; öfveringenjör vid Järnkontoret fr. 03. L. V. A. 02.

- Inventor of the Brinell scale in 1900 measuring indentation hardness of materials
- Research in 1880s laid foundation to metallography, the study of the physical structure and components of metall



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- Cross check these years with application dates in the patent database

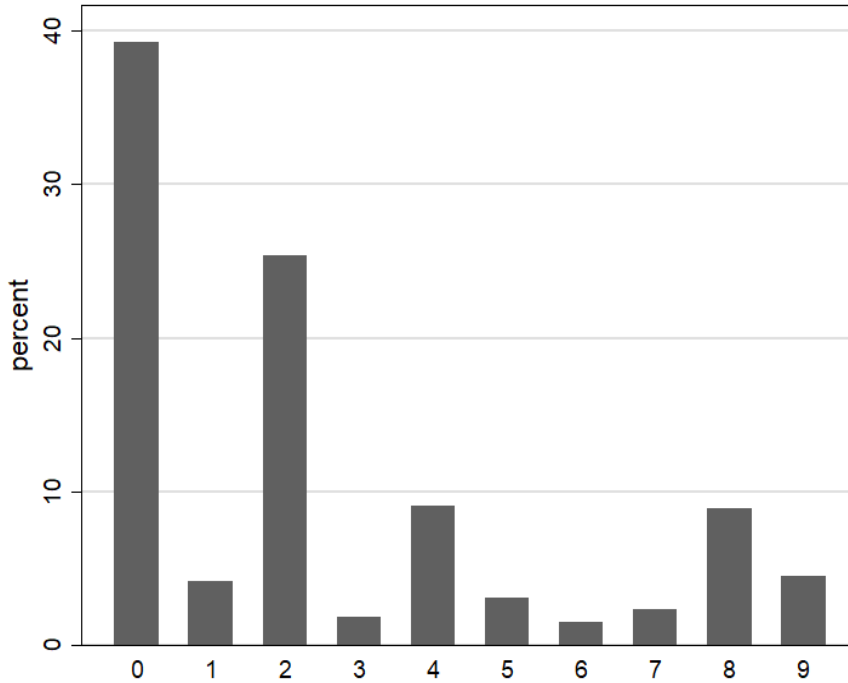


Empirical framework

- Classification of all occupations according to HISCO groups
- Probit (marginal effects) and censored poisson regressions to test the Swedish data
- Classification of "Great Patentees"
- Extended cpoisson to include occupations



Occupations



HISCO distribution, major classes

HISCO-minor	Description	%
02	Architects, Engineers and Related Technicians	32.75
21	Managers	21.74
41	Working Proprietors (Wholesale and Retail Trade)	8.10
84	Machinery Fitters, Machine Assemblers and Precision-Instrument Makers (Except Electrical)	4.63
22	Supervisors, Foremen and Inspectors	2.98
58	Protective Service Workers	2.66
01	Physical Scientists and Related Technicians	2.27
06	Medical, Dental, Veterinary and Related Workers	1.99
13	Teachers	1.77
83	Blacksmiths, Toolmakers and Machine-Tool Operators	1.70

Distribution of HISCO Occupational Groups across individuals



Occupations

HISCO -code	Description	%	Occupation (Swedish)	Occupation (English)	%
02000					
	Engineers, Specialization Unknown	28.98			
21110			Ingenjör	Engineer	28.4
	General Manager	17.70			
41025			Fabriksidkare	Manufacturer (factory owner, proprietor)	12.4
	Working Proprietor (Wholesale or Retail Trade)	5.61			
84100			Handlande	Merchant	5.4
	Machinery Fitter or Machine Assembler, Type of Machine Unknown	3.44			
-1			Mekaniker	Mechanic	3.0
	Noble men/women	2.47			
22610			Direktör	General Manager	2.4
	Production Supervisor or Foreman, General	2.26			
58320			Kemist	Chemist	2.1
	Officer	2.20			
01110			Grosshandlare	Wholesale merchant	1.9
	Chemist, General	2.11			
41020			Verkmästare	Foreman	1.7
	Working Proprietor (Wholesale Trade)	2.01			
21220			Disponent	Technical manager	1.0
	Production Manager (except Farm)	1.38			
			Elektriker	Electrician	1.0



Probit and cpoisson regressions

	(3)	(4)
indep	-0.274*** (0.0155)	-0.271*** (0.0156)
foreign	-0.0372* (0.0145)	-0.0400** (0.0145)
stockholm	-0.0151 (0.0181)	-0.0153 (0.0181)
indepXforeign	0.0496** (0.0156)	0.0472** (0.0156)
indepXstockholm	0.0384 (0.0203)	0.0428* (0.0203)
agent		-0.0591*** (0.0114)
Year Dummies	Yes	Yes
N	38190	38190

Probit regressions, 6-year renewal, marginal effects, depvar: dummy where 1 = payment for the sixth year was made

	(3)	(4)	(5)
indep	-0.570*** (0.0211)	-0.559*** (0.0214)	-0.560*** (0.0213)
foreign	-0.0811*** (0.0240)	-0.0828*** (0.0239)	-0.0839*** (0.0241)
indepXforeign	0.0758** (0.0257)	0.0644* (0.0260)	0.0655* (0.0259)
urban	0.0121 (0.0184)		0.0172 (0.0184)
stockholm		0.0210 (0.0192)	
agent		-0.148*** (0.0340)	-0.147*** (0.0339)
Year Dummies	Yes	Yes	Yes
Constant	1.784*** (0.0787)	1.840*** (0.0803)	1.841*** (0.0803)
Observations	38190	38190	38190

Censored Poisson regressions, individual vs firm, depvar: patent length in years (0-14).



”Great Patentees”

- Follow classification of Sandström (2014)
 - You do not classify as an “independent inventor” if you work for or get your main source of income from a firm.
- Similar to Jewkes et al:
 - “[T]he distinction between individual inventors and others can be taken as that between who work on their own and those who are employed in an institution of some kind set up for the purpose of invention” (Jewkes et al, 1969 p. 82)



"Great Patentees"

Entrepreneur: Individuals that patent in their own name but own or have founded their own firms

Spin-off: Individuals that have been employed in a firm previous to starting their enterprise but do so in the same or industry area as their previous employer

Manager: Individuals that have prominent positions, such as general manager, in a firm but still patent in their own name

State: Individuals that are employed at government agencies at the time of their patent application

Academic: Individuals employed at universities

Employee: Individuals employed by firms in non-managerial positions



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fr. 03. L. V. A. 02.



"Great Patentees"

Occupation	All occupations during career	Main occupation
Independent	10%	8%
Entrepreneur	38%	29%
Spin-off	10%	8%
Manager	35%	19%
State	10%	4%
Academic	8%	6%
Employee	39%	25%

Source: Authors' database



Extended cpoisson

	(1)	(2)	(3)	(4)	(5)
indep	-0.733*** (0.0159)	-0.758*** (0.0224)	-0.448*** (0.0214)	-0.618*** (0.0347)	-0.605*** (0.0348)
foreign	-0.0576*** (0.0115)	-0.0875*** (0.0217)	-0.0880*** (0.0217)	-0.0946*** (0.0239)	-0.0971*** (0.0237)
TechProfessionals	0.368*** (0.0154)	0.367*** (0.0155)		0.230*** (0.0298)	0.231*** (0.0298)
AdminManagers	0.239*** (0.0177)	0.237*** (0.0177)		0.0996** (0.0310)	0.0968** (0.0310)
Year dummies	Yes	Yes	Yes	Yes	Yes
indepXforeign		0.0400 (0.0255)	0.0344 (0.0256)	0.0358 (0.0257)	0.0227 (0.0260)
ProfWorkers			-0.189*** (0.0362)	-0.0223 (0.0452)	-0.0204 (0.0452)
ClericalWork			-0.456*** (0.0581)	-0.290*** (0.0641)	-0.292*** (0.0640)



Conclusions

- By using place of work as an indicator as few as 10% of all inventions patented by individuals can be considered to be truly independent, while as much as 10% originate inside universities or state-owned enterprises.
- Individuals that most likely were employed by firms, but applied for patents in their own name, have patents of a higher quality (measured as patent fees paid).
- Lends support to the theory emphasizing resource dependencies and complementarities that organizational settings such as the factory floor are better situated to provide
- Previous research suggests that the decline of the “Schumpeterian inventor” has been exaggerated.
 - We instead posit that it is the “era of independent inventors” that has been exaggerated
 - Factories and firms were always crucial to inventive activity also during the end of the 19th century and the second industrial revolution.



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THANK YOU!!