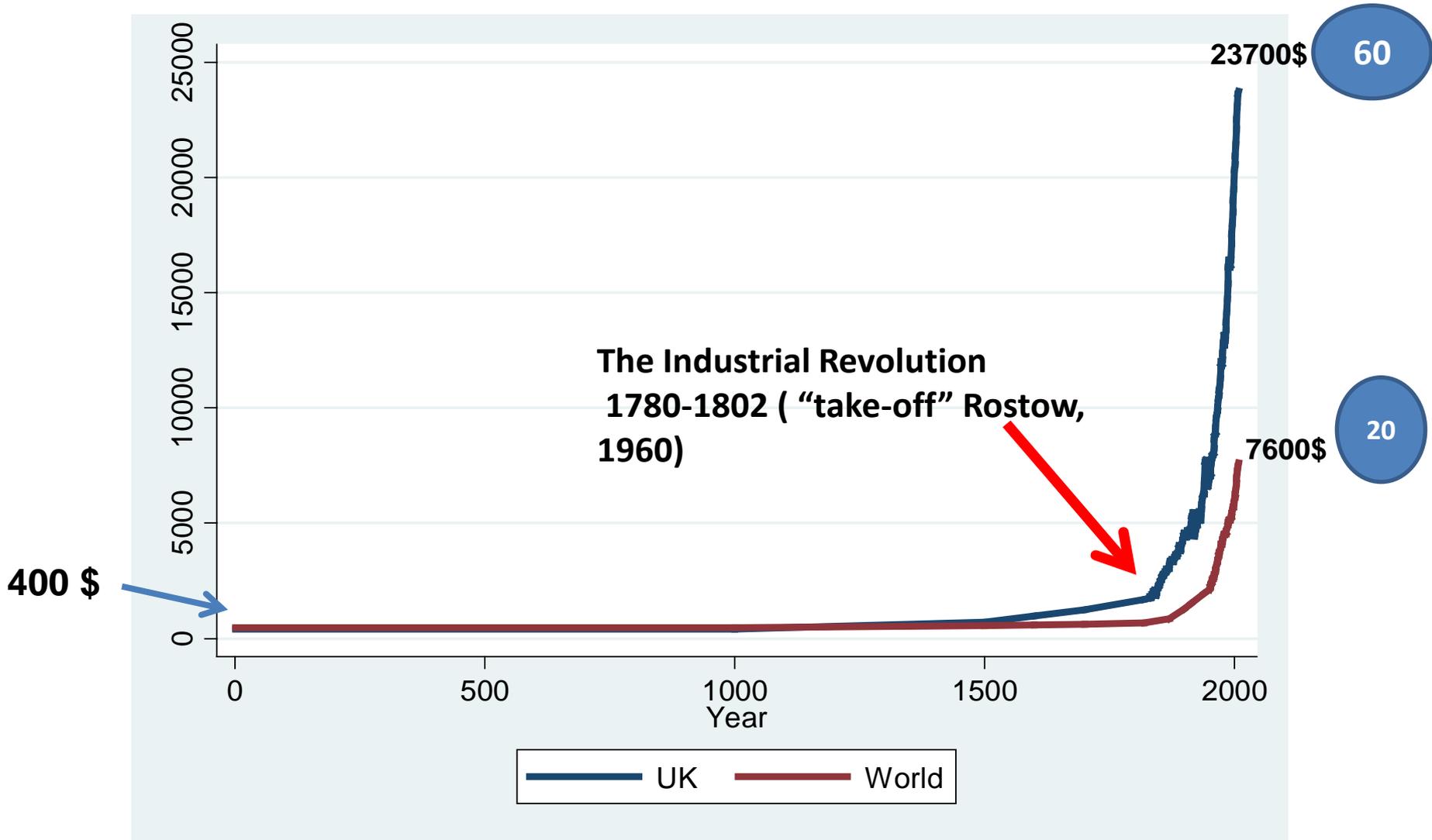


**Not so patently obvious:
Reappraising patents and innovation
during the British Industrial Revolution**

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World Economic Performance (GDP per capita 1990 \$)



Source: Maddison (2008)

“That reminds me to remark, in passing, that the very first official thing I did, in my administration -- and it was on the very first day of it, too – was to start a patent office; for **I knew that a country without a patent office and good patent laws was just a crab, and couldn't travel any way but sideways or backwards**”

Mark Twain, *A Connecticut Yankee in King Arthur's Court*, 1889



Patents and the Industrial Revolution: The viewpoint of modern growth theory

"It is the presence of patents and copyrights that enables inventors to earn profits to cover the initial costs of developing new ideas. In the last century (or two), the world economy has witnessed sustained, rapid growth in population, technology and per capita income never seen before in history.

Consider how the model economy would behave in absence of property rights. In this case, innovators would be unable to earn the profits that encourage them to undertake research in the first place, so that no research would take place. With no research, no new ideas would be created, technology would be constant, and there would be no per capita growth in the economy. Broadly speaking, just such a situation prevailed in the world prior to the Industrial Revolution"

C. I. Jones (2002), *Introduction to Economic Growth*, p. 121

Map of the literature (I)

Optimists:

Patent system by creating property rights on new technological knowledge provided a key incentive to inventive activities. Patent system was a **fundamental institutional foundation of the industrial revolution.**

Patents also promoted the diffusion of ideas.

Pessimists:

Incentive effect of patents was limited. Patents in some cases had a negative impact on inventive activities (“blocking effect”)

Map of the literature (II)

	OPTIMISTS	PESSIMISTS
First wave: 1970s	North (1973); North (1981)	Landes (1969): Landes (1986)
Second wave: 1980s-1990s	Dutton (1984); Sullivan (1989; 1990) Sullivan (1995)	MacLeod (1988) O'Brien et al. (1992); O'Brien et al. (1995)
Third wave: 2000s	Broadberry & Gupta (2009)	Nuvolari (2004); Moser (2005); Creasley & Oxley (2007) Clark (2007)
		Allen (2009); Mokyr (2009) Bottomley (2014)



The origins of the English Patent System: the Statute of Monopolies



James I, in 1621

Conflict between king and Parliament led to the enactment of the Statute of Monopolies:

Section 1:

“...all Monopolies..are altogether contrary to the Laws of this Realm, and so are and shall be utterly void and of none Effect, and in no wise to be put in Use or Execution”

Section 6: “...any declaration before mentioned shall not extend to any letters patent and grants of privilege for the term of fourteen years or under, hereafter to be made, **of the sole working or making of any manner of new manufactures within this realm, to the true and first inventor and inventors of such manufactures....**”

English patent system

- Patent system is based on the clause of exemption of section 6 of the Statute of Monopolies.
- Patent is granted to “the first and true inventor” (novelty requirement: new “within this Realme”, importation of technology from abroad is still protected (eg, patent to T.Lombe for importing silk mill technology from Italy))
- Patent is of limited duration: 14 years (7 years is the normal term of apprenticeship of an English craftsman)
- Laissez-faire approach: no examination, but only registration
- Issue of specification: *Liardet vs. Johnson* (1778) establishes that the specification should allow anyone skilled in the art to construct the invention (practice of specifications was established around 1720s)

D. North and the patent system

"..Innovation will be encouraged by modifying the institutional environment, so that the private rate of return approaches the social rate of return...The development of patent laws provides such protection....**By 1700...England had begun to protect private property in knowledge with its patent law. The stage was now set for the industrial revolution.**"

[D. North and R. Thomas (1973), *The Rise of the Western World*]

"..The failure to develop systematic property rights in innovation until fairly modern times was a major source of the slow pace of technological change...**[A] systematic set of incentives to encourage technical change and raise the private rate of return of innovation close to the social rate of return was established only with the patent system.**"

[D.North (1981), *Structure and Change in Economic History*]

Conflict between king and Parliament over patents is also mentioned in North & Weingast (1988) but without major emphasis.

David Landes and the patent system

"A number of writers have laid stress on the incentive effect of patent legislation. I am inclined to doubt its significance..."

[D. Landes (1969), *The Unbound Prometheus*]

"On balance, patents were not the major incentive to innovation. The biggest and surest source of gain was the application of invention in one's own enterprise – a Schumpeterian headstart...."

D. Landes, (1986), "What do bosses really do?"

Innovation without patents: Evidence from Crystal Palace (1851)

TABLE 3 –PATENTING RATES ACROSS INDUSTRIES, BRITISH EXHIBITS IN 1851

Industry	Britain				United States	
	All Exhibits		Award-winners		All Exhibits	
	Total	% Pat.	Total	% Pat.	Total	% Pat.
Mining and metallurgy	418	5.0%	74	5.4%	52	7.7%
Chemicals	136	5.1%	75	8.0%	32	0.0%
Food processing	140	7.9%	73	9.6%	70	7.1%
Engines	406	24.6%	80	38.8%	31	42.0%
Manufacturing machinery	242	29.8%	70	47.1%	32	43.8%
Civil, mil., naval engineering	559	13.4%	88	15.9%	17	23.5%
Agricultural machinery	261	19.9%	37	40.5%	27	37.0%
Scientific instruments	581	9.6%	139	15.8%	74	16.2%
Manufactures	1,955	10.2%	601	16.3%	98	15.3%
Textiles	1,679	6.8%	522	8.6%	117	6.0%
All industries	6,377	11.1%	1,759	15.6%	550	15.3%

Source: Moser (2005 and 2010)

Innovation without patents: Evidence from the “Great” Inventors

Use of the evidence from the “great” inventors to assess the evidence from patenting (Khan and Sokoloff, 1993)

Dictionary of National Biography: 63 volumes, published in 1882 – 1900. It was meant to provide “full, accurate and concise biographies of all noteworthy inhabitants of the British Islands”. 29,120 entries comprising “all men and women of British or Irish race who have achieved any reasonable measure of distinction in any walk of life”.

We identified all individuals (383) in the original DNB (born 1650-1850) who are credited with at least 1 invention, 40% of these did not take patents (MacLeod and Nuvolari, 2006). Entries of many of these inventors were written by R. Prosser and H. Wood, senior clerks at the Patent Office.

Patenting behaviour of Bob Allen (2009)’s “great inventors”, compilation based on Singer (1954-84) and Mokyr (1990), 79, 32% of these did not take patents.

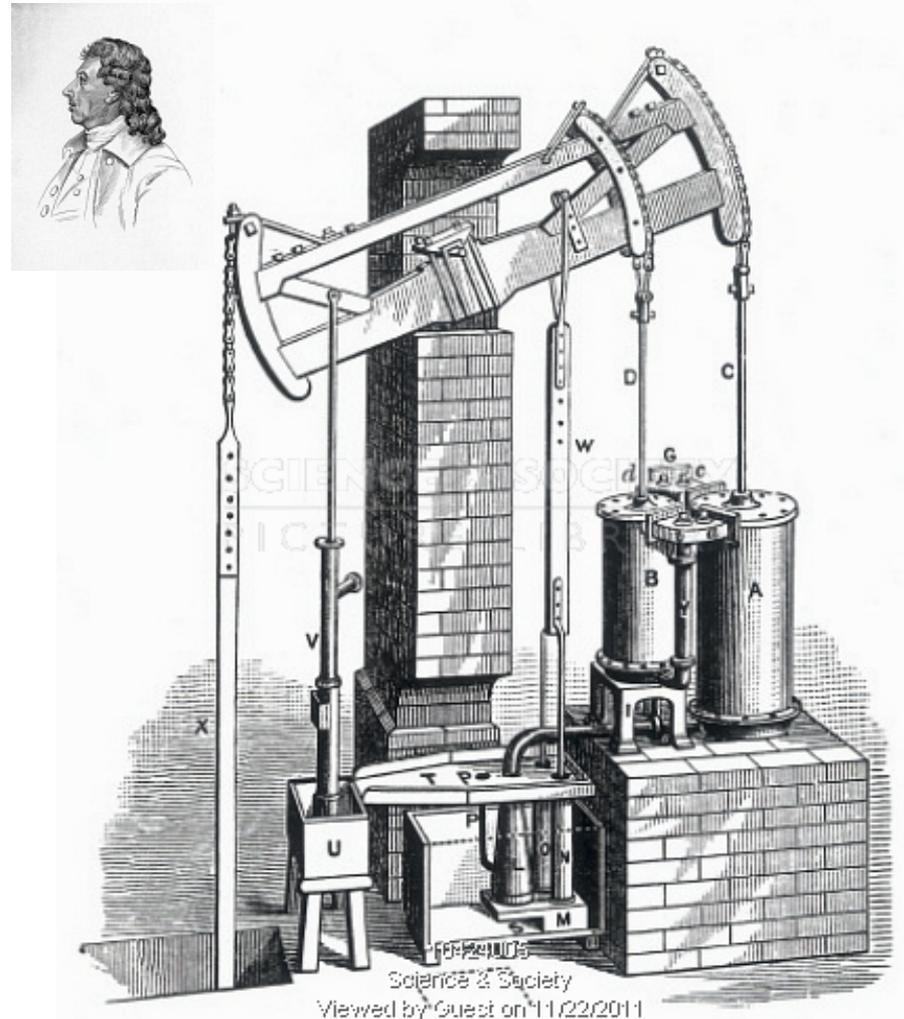
Patenting behavior of Meisenzhall and Mokyr (2011)’s (visible) “tweakers”: they identified 759 individuals, 40% of these did not take patents.

Blocking patents: Watt vs. Hornblower

James Watt's patent for the separate condenser (prolonged by Parliament in 1775 for 25 years) covered 6 broad design features (specification with no drawings):

- 1) cylinder with closed top,
- 2) piston pressed down by steam,
- 3) steam case,
- 4) separate condenser
- 5) air-pump
- 6) piston kept tight by oil or grease.

Boulton & Watt succeed in blocking the development of the Hornblower compound engine (see however revisionist paper by Selgin & Turner, 2011)



Patents abolished: Arkwright

- Arkwright adopts a similar patent strategy to Watt
- Arkwright's patent (again with a very dubious specification comprising many possible roller spinning design) is declared void in 1785.
- In 1795 there are 438 cotton mills in England.
- Arkwright dies in 1795 with a wealth of 500,000 pounds.

Collective invention (Allen, 1983)

Particular type of innovation process

- Innovation based on voluntary knowledge sharing among competing actors
- Innovation without patent protection (or very liberal use of patents)

Two additional features:

- Knowledge sharing seems to be based on self-organization (rather than design)
- Remarkable innovative performance

Collective Invention

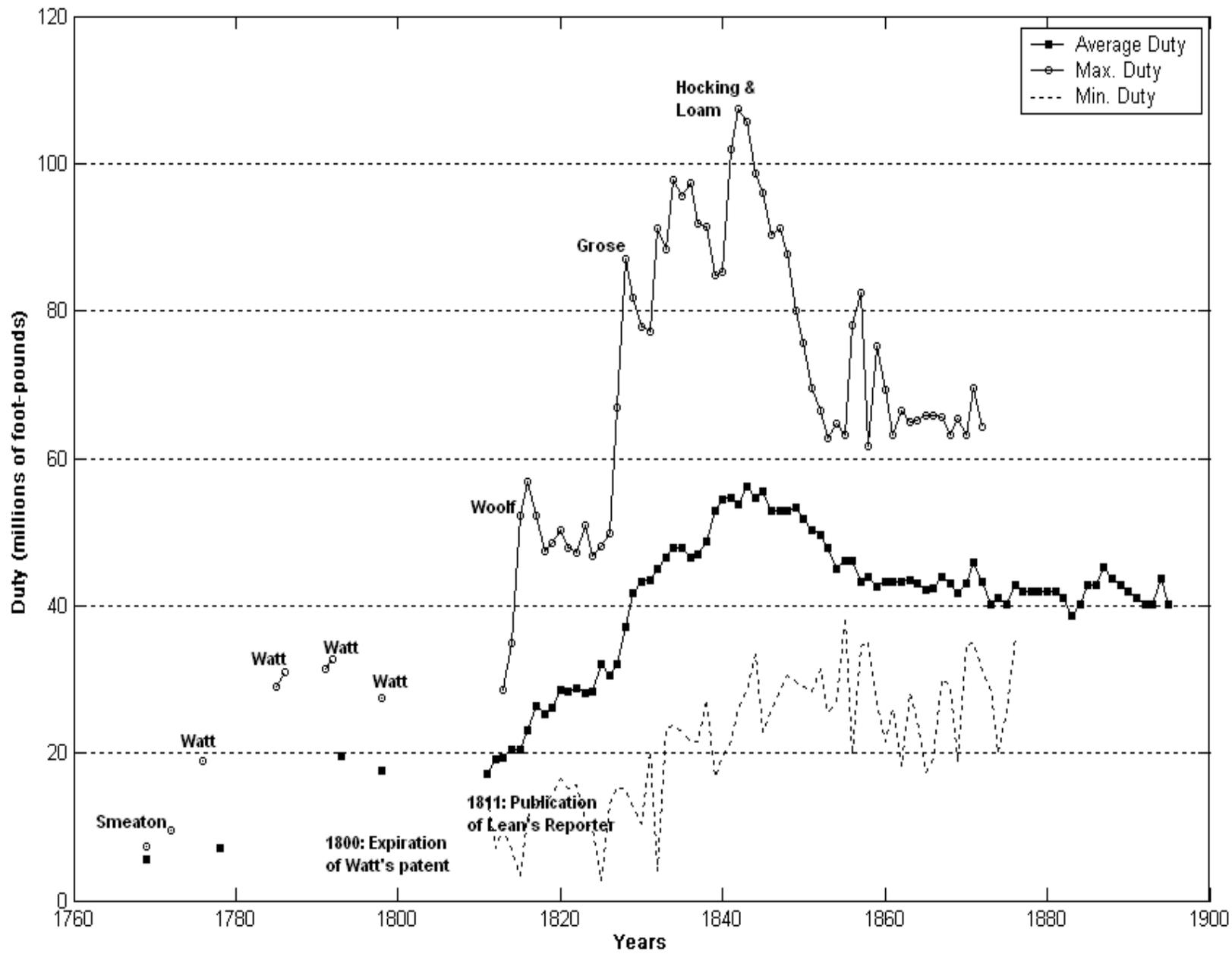
(Allen, 1983 or Schneider, 1871 ?)

“Certain localities have had very restrictive habits in their industries; that is habits of secrecy. In those localities, every one hides what is doing, or takes out a patent. The localities in which this spirit prevails very seldom advance with great speed. They remain almost always at a very low industrial level. The localities, on the other hand, which have a very liberal spirit in matters of invention and in matters of patents, advance very rapidly. The entire locality profits greatly by it, and every one gets his share of the advantage...[O]ne of the most remarkable facts in the world is the immense progress which has been made by the locality of Middlesboro’ ...; 15 years ago, there was scarcely anything done there in the iron manufacture. At present it is the first district of the world for that manufacture, and I have found there is a most liberal spirit, everybody telling his neighbour, everybody telling any stranger who has had the honour of being admitted to those great manufacturers “This is what we do”, “This is what succeeds with us”, “This our invention”. I have told you the result...”

Eugene Schneider, *Select Parliament Committee on patent law*, 1871, p. 133

The Case of the Cornish steam engine (Nuvolari, 2004)

- Importance of fuel efficiency (“duty” of the engine)
- Boulton & Watt in Cornwall
- The patent dispute (Watt vs. Hornblower)
- The publication of *Lean’s Engine Reporter* (1811)
- Richard Trevithick’s Wheal Prosper engine (1812) (first successful high pressure expansive design)
- Throughout the first half of the nineteenth century the Cornish Engine is the peak of steam engineering



Geographical Distribution of British steam patents, 1698-1852

County	N. of Patents 1698-1852	(%) 1698- 1852	N. of Patents 1698-1812	(%) 1698- 1812	N. of Patents 1813-1852	(%) 1813- 1852
Cornwall	17	1.50	8	6.25	9	0.89
Cornwall*	21	1.85	12	9.38	9	0.89
Derby	11	0.97	1	0.78	10	0.99
Durham	13	1.15	0	0.00	13	1.29
Gloucester	20	1.76	8	6.25	12	1.19
Kent	31	2.73	1	0.78	30	2.98
Lancashire	145	12.78	5	3.91	140	13.90
London	395	34.80	40	31.25	355	35.25
Northumberland	22	1.94	2	1.56	20	1.99
Nottingham	13	1.15	1	0.78	12	1.19
Scotland	47	4.14	6	4.69	41	4.07
Stafford	27	2.38	5	3.91	22	2.18
Surrey	88	7.75	10	7.81	78	7.75
Wales	12	1.06	1	0.78	11	1.09
Warwick	58	5.11	8	6.25	50	4.97
York	63	5.55	11	8.59	52	5.16
Others	152	13.39	9	7.03	143	14.20
Total	1135	100	128	100	1007	100

Source: Nuvolari (2004)

Cornish Inventions in Steam engineering (not patented)

- Richard Trevithick high pressure expansive engine design
- Arthur Woolf double beat valve
- Samuel Grose thermal lagging
- Richard Hosking boiler water gauge
- Hocking & Loam “cylinder cushion”

Source: Pole (1844)

These are all **patentable** inventions!

The Historical Significance of Collective Invention

“Under the conditions prevailing during the nineteenth century [collective invention].. was probably **the most important source of inventions**” (Allen, 1983, p. 21)

“ There are three reasonably well documented cases of successful collective invention: the case documented by Allen (1983) of the Cleveland (UK) iron industry between 1850 and 1875; the case documented by MacLeod (1988) of the English clock and instrument makers, and the case documented by Nuvolari (2004) of the Cornish steam engine makers after 1800. Examples of such cases are not many and they required rather special circumstances that were not common and **collective invention in its most extreme form, to judge from its short lifespans, was vulnerable and ephemeral**” (Mokyr, 2008, p.22)

Still, some critical technologies (high-pressure steam, iron smelting) were developed by means of collective invention . **This means that inventive activities could be organized effectively also without patent protection.**

The historical significance of collective invention (II)

- Cleveland blast furnaces (Allen, 1983)
- **Cornish steam engines (Nuvolari, 2004)**
- **London clock-makers (MacLeod, 1988): collective ownership of knowledge + lobbying for revoking specific patents**
- Lyon silk industry (Perez, 2002): collective ownership of knowledge
- Zaankstreek Windmills (Davids, 2009)
- Berkshire paper-making (McGaw, 1987)
- Western steam-boat (Hunter, 1949)
- Viennese chairs (Kyriazidou & Pesendorfer, 1999)
- Japanese cotton spinning (Saxonhouse, 1974)
- **Coal-burning stove (Allen, 2009)**
- **Introduction of clover in agriculture rotations (Allen, 2009)**

Alternative to patents: procurement and patronage (David, 1993)

Procurement:

- Longitude Act (1714): prize assigned in 1774 to John Harrison for his “perfect watch
- Rainhill Locomotive Trials, prize of £ 500 won by George and Robert Stephenson with the “Rocket”
- Mining Safety Lamp: prize of £1,000 assigned to Sir H. Davy (1815)
- Block-making machinery (Royal dockyards)
- Cannon boring machine (John Wilkinson)

Patronage

- Charles Babbage’s “difference engine” (1821-1834)

Conclusions

Big counterfactual question: “Would there have been the Industrial Revolution without the patent system?”

Probably yes! Despite the “optimist” discussion of patents in some “popular” books (eg, Acemoglu & Robinson, Ferguson, Rosen, etc.), there seems a new sceptical view of the English patent system emerging.

Roots of Western industrialization were wider and deeper. In our judgement patent system was not a fundamental institutional foundation of the industrial revolution.

Why patents not so important ? Diffusion of technology did not dissipate innovators’ rents (constrained capacity due to shortages of “implementation skills”) in such context it can even be convenient not patent, but share knowledge (Bessen and Nuvolari, 2014)