

# Aeronautical patents and aviation history from 1880-1916

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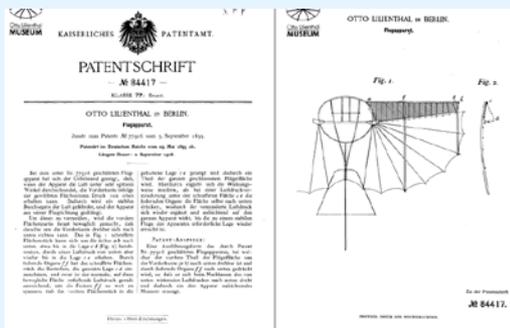
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Society for Government Economists session: It's All about Technology

ASSA conference, San Francisco

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# Goals and questions

Airplanes have a long pre-history.

There is vast documentation – bibliography, letters, exhibitions, clubs, patents.

We know eventually airplanes will be valuable.

What processes led to their invention and the startup industry?

What does the patent stream look like?

New here: combined aeronautics patent data set from many sources

# Aeronautics and aviation from 1880

1880: aeronautics/aviation is a niche activity –  
maybe hopeless, useless, dangerous

Clubs and journals and exhibitions associated with ballooning exist especially in Paris, London, and Berlin

Interest in “aerial navigation,” wings, and “flying machines” gathers there

1890s Public glider flights ; survey book defines field

Many designs were shared and discussed - **open source practices**

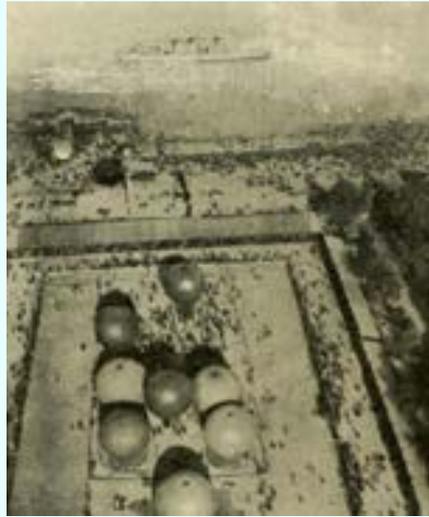
1903 Wright brothers’ powered-glider flight, 1906 major patent

1908-11 Big exhibitions. Industry arises

1914 World War I begins

# Balloons and bird-like designs

Balloons,  
since 1783



Balloon contest 1895

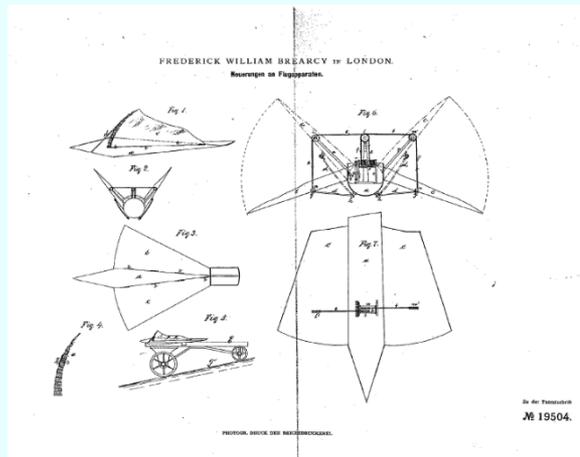


Santos-Dumont

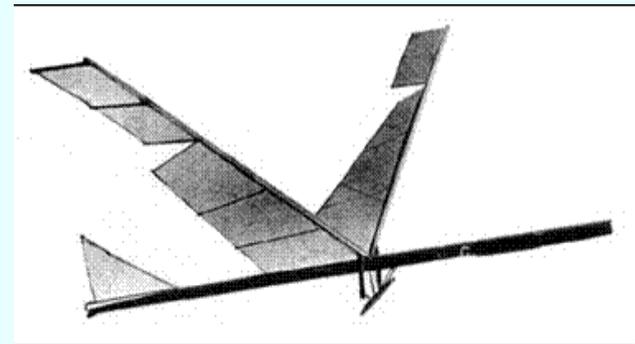
1901

Dirigible flew  
around Eiffel  
Tower and  
returned to  
starting place

Ornithopters  
have flapping  
wings



Brearey's 1882 patent



Hargrave 1891 model ornithopter

# Fixed wing shapes



Le Bris 1868 *Albatross* was pulled by a horse and lifted off from the cart.

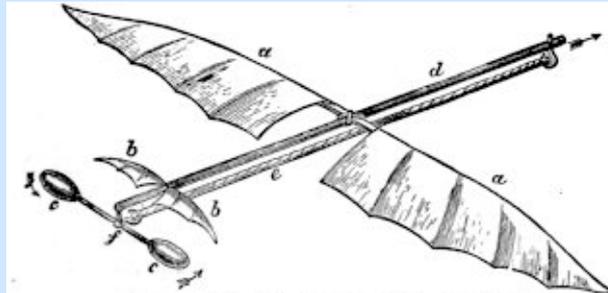
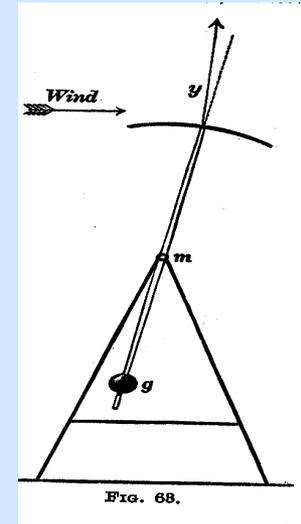
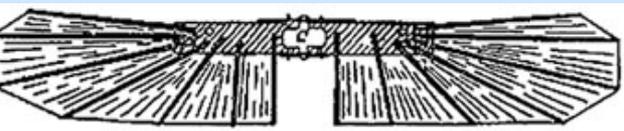


FIG. 59.—Aero-plane model with automatic rudder. *a a*, elastic aero-plane; *b b*, automatic rudder; *c c*, serial screw centred at *f*; *d*, frame supporting aero-plane, rudder, and screw; *e*, india-rubber, in a state of torsion, attached to hook or crank at *f*. By holding the aero-plane (*a a*) and turning the screw (*c c*) the necessary power is obtained by torsion. (M. Pénaud, 1872.)

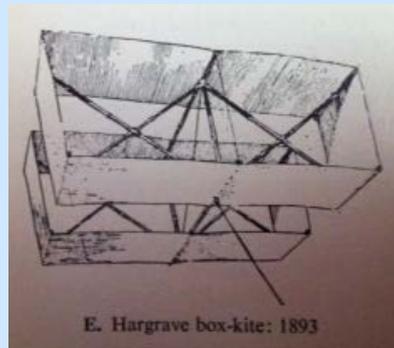
Penaud, ~1872  
Wind-up model  
with tail



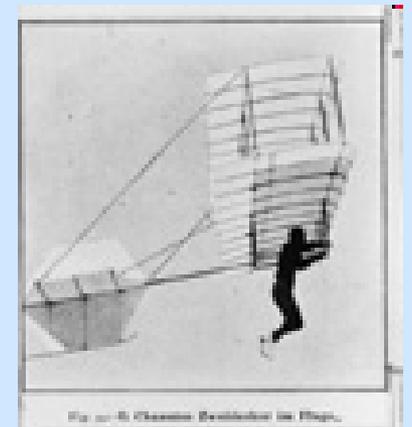
Lilienthal 1870s-1880s



Mouillard  
1881



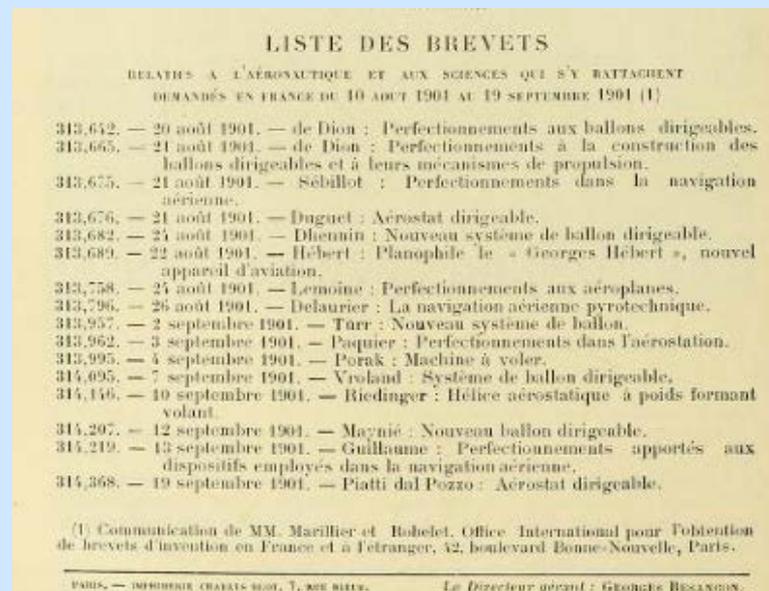
Hargrave box kites 1893



Chanute-Herring glider, 1896

# Data on aero patents

- EPO's Patstat / Espacenet data
  - Coverage back to 1910 or earlier, varying by country
- Data before 1910 is eclectic, from a dozen sources, aero-focused, classified variously
  - INPI: French vintage patent database online; *L'Aerophile*; *AÉRO-MANUEL 1914*; *Catalogue des brevets d'invention*, 1880s; SUBJECT-MATTER INDEX OF PATENTS FOR INVENTION (1883)
  - google patents & USPTO
  - Brewer and Alexander, 1893, *Aeronautics*
  - *Aeronautical Journal*
  - coverage of German patents is incomplete
  - Some duplication too
- 13,500 patents here total



# Example: Lilienthal patent



KAISERLICHES



PATENTAMT.

## PATENTSCHRIFT

— № 84417 —

KLASSE 77: SPORT.

OTTO LILIENTHAL IN BERLIN.

Flugapparat.

Zusatz zum Patente № 77916 vom 3. September 1893.

Patentiert im Deutschen Reiche vom 29. Mai 1895 ab.

Längste Dauer: 2. September 1908.

Bei dem unter Nr. 77916 geschützten Flugapparat hat sich der Uebelstand gezeigt, daß, wenn der Apparat die Luft unter sehr spitzem Winkel durchschneidet, die Vorderkante infolge der gewölbten Flächenform Druck von oben erhalten kann. Dadurch wird ein stabiles Durchsegeln der Luft gefährdet, und der Apparat aus seiner Flugrichtung gedrängt.

Um dieses zu vermeiden, wird die vordere Flächenpartie derart beweglich gemacht, daß dieselbe um die Vorderkante drehbar sich nach unten richten kann. Das in Fig. 1 schrägflächige Flächenstück kann sich um die Achse *a b* nach unten, etwa bis in die Lage *c d* (Fig. 2) herabsenken, durch einen Luftdruck von unten aber wieder bis in die Lage *c e* erheben. Durch federnde Organe *ff* hat das schrägflächige Flächenstück das Bestreben, die gesenkte Lage *c d* einzunehmen, und zwar ist der normale, auf diese bewegliche Fläche entfallende Luftdruck gerade ausreichend, um die Federn *ff* so weit zu spannen, daß das vordere Flächenstück in die

gehobene Lage *c e* gelangt und dadurch ein Theil der ganzen geschlossenen Flügelfläche wird. Hierdurch ergibt sich die Wirkungsweise insofern, als bei einer Luftdruckverminderung unter der schrägflächigen Fläche *c e* die federnden Organe die Fläche selbst nach unten drücken, wodurch der verminderte Luftdruck sich wieder ergänzt und aufrichtend auf den ganzen Apparat wirkt, bis die zu einem stabilen Fluge des Apparates erforderliche Lage wieder erreicht ist.

### PATENT-ANSPRUCH:

Eine Ausführungsform des durch Patent Nr. 77916 geschützten Flugapparates, bei welcher der vordere Theil der Flügelfläche um die Vorderkante (*a b*) nach unten drehbar ist und durch federnde Organe *ff* nach unten gedrückt wird, so daß er sich beim Nachlassen des von unten wirkenden Luftdruckes nach unten dreht und dadurch ein den Apparat aufrichtendes Moment erzeugt.

Hierzu 1 Blatt Zeichnungen.



OTTO LILIENTHAL IN BERLIN.

Flugapparat.

Fig. 1.

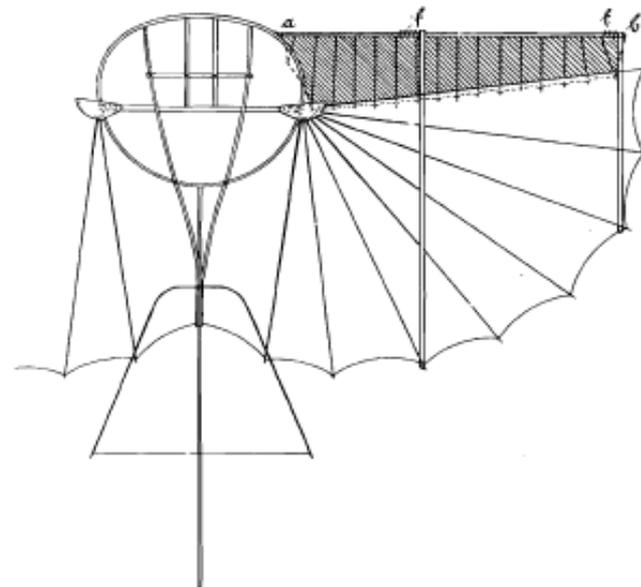


Fig. 2.



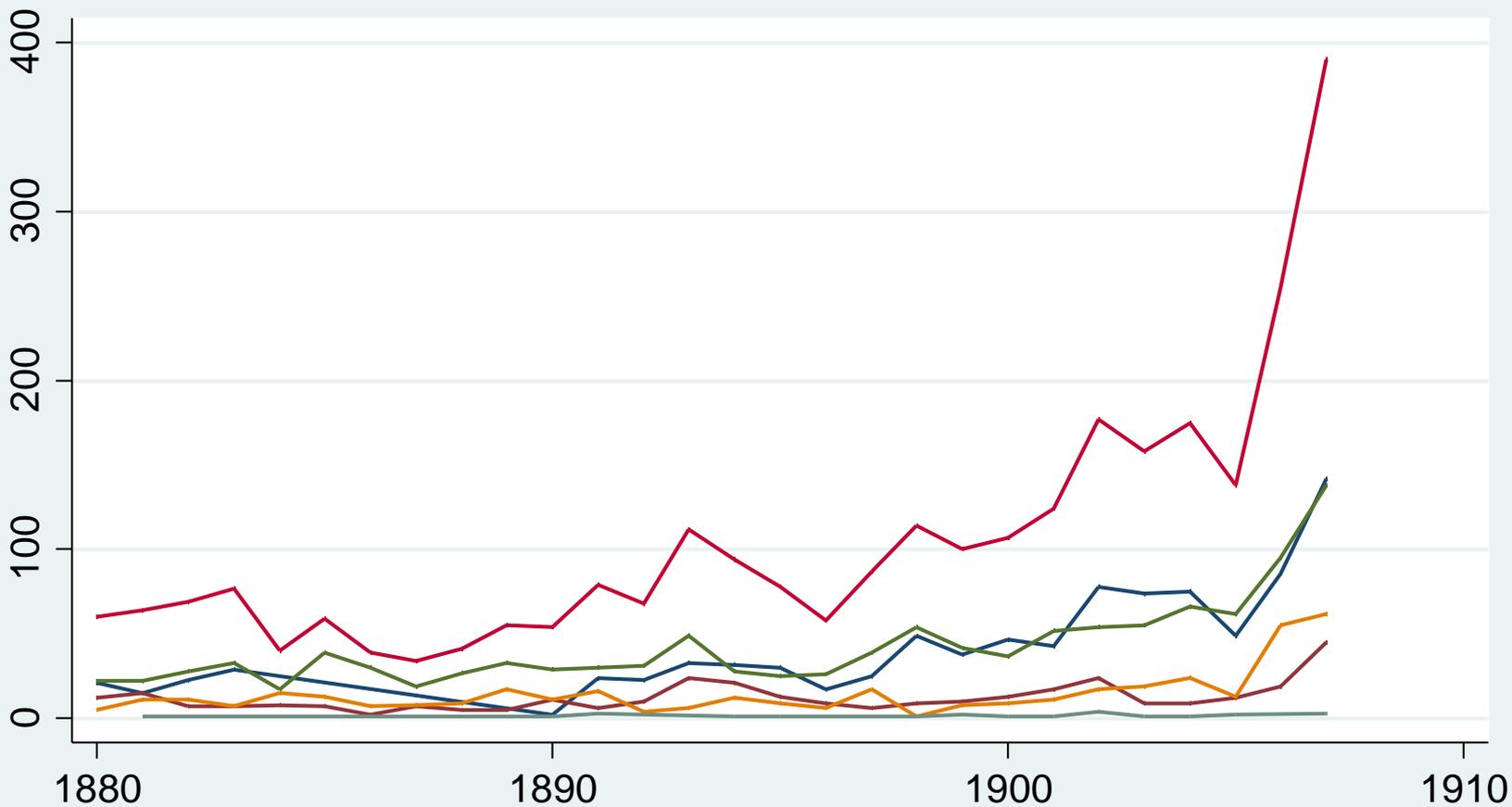
Zu der Patentschrift

№ 84417.

# Patent differences across countries

- Core: France, Britain, Germany, and US
- Patent docs per se look similar in terms of length, claims, description, diagrams, definition of inventor and agent, time to approve
- Many rules similar along lines of 1883 Paris Convention
- German and US systems require more “examination”
  - Novel, non-obvious, useful
- France and Britain sometimes just “register” an application
- “Patent controversy” – some countries didn’t have patent systems ; some inventors avoided patenting
- Aeronautics classified differently
  - In France: “marine/aerostation” category
  - In Germany: “Sport”

# Aero patents grew to 1906, then spike



# Counting patents, early period

Year is from grant date (not application date)

Supplementary patents are counted like first patents here – “additions”, foreign filings

These patents cover aeronautics, but not engines

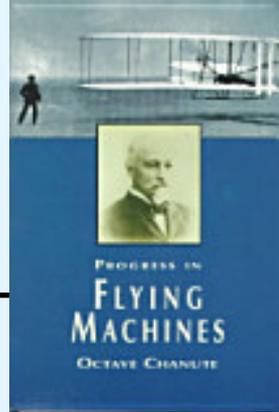
Maybe 75% coverage of those

## **Why do they patent before 1900?**

Uncertain. Most of these seem to expire quickly

Professional identity / activity, tradition, to get the word out, to be remembered and credited

# Most-cited early experimenters published and patented

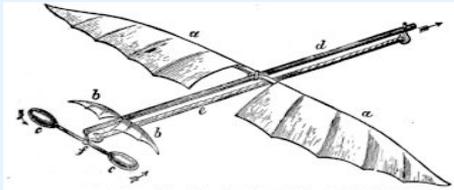


<b>Experimenter</b>	<b>Location (home)</b>	<b>Page counts, Chanute (1894)</b>	<b>Publication counts, Brockett (1910)</b>	<b>Patent counts</b>
Maxim	Britain (US)	33	25+	11
Lilienthal	Germany	31	50+	15
Pénaud	France	22	12	2
Mouillard	Algeria, Egypt (Fr)	21	6	1
Hargrave	Australia (Br)	19	25+	0
Moy	Britain	19	10	9
Le Bris	France	17	0	1
Langley	U.S.	16	40+	0
Wenham	Britain	15	10+	1
Phillips	Britain	14	3	4
Chanute	U.S. (France)	*	50+	5

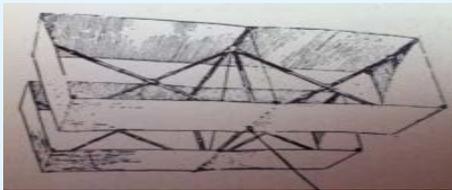
# Copying from previous designs – so not really intellectual property



Lilienthal's glider



Penaud's tail



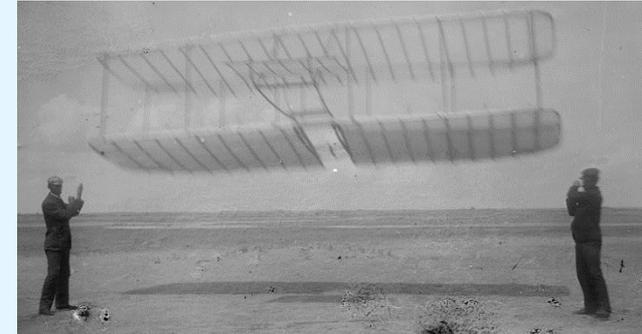
Hargrave's box kites



Chanute-Herring  
glider, 1896



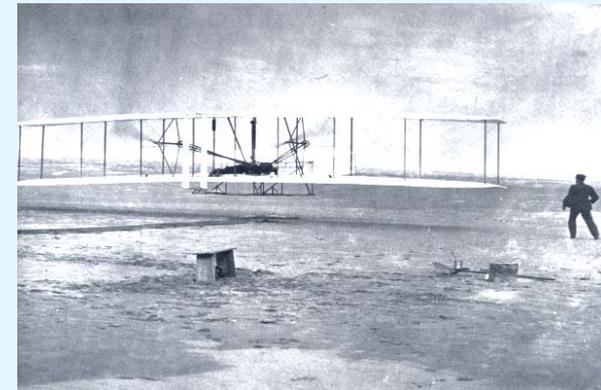
Pratt truss for bridges

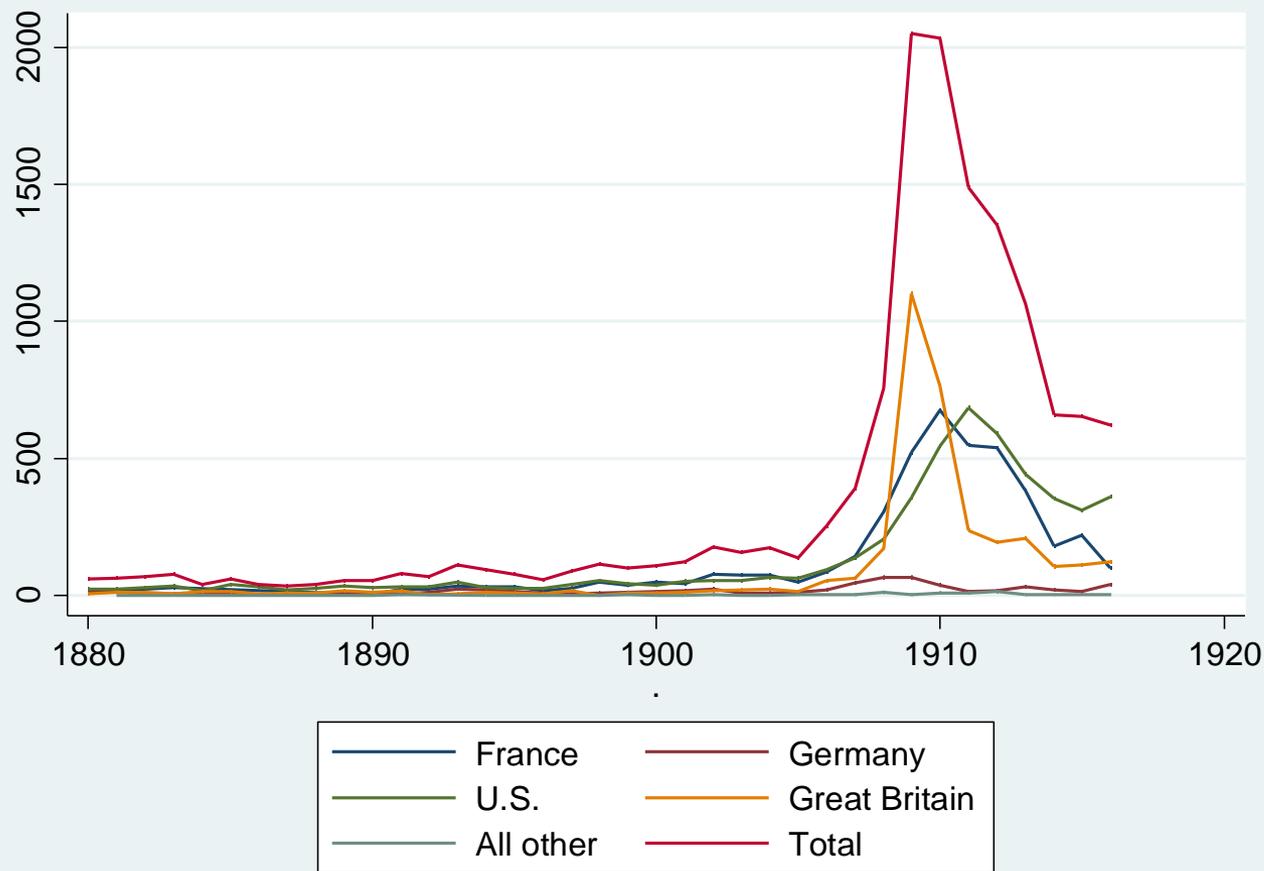


Wright brothers 1901-2 kites  
and gliders



Wright 1903 powered glider





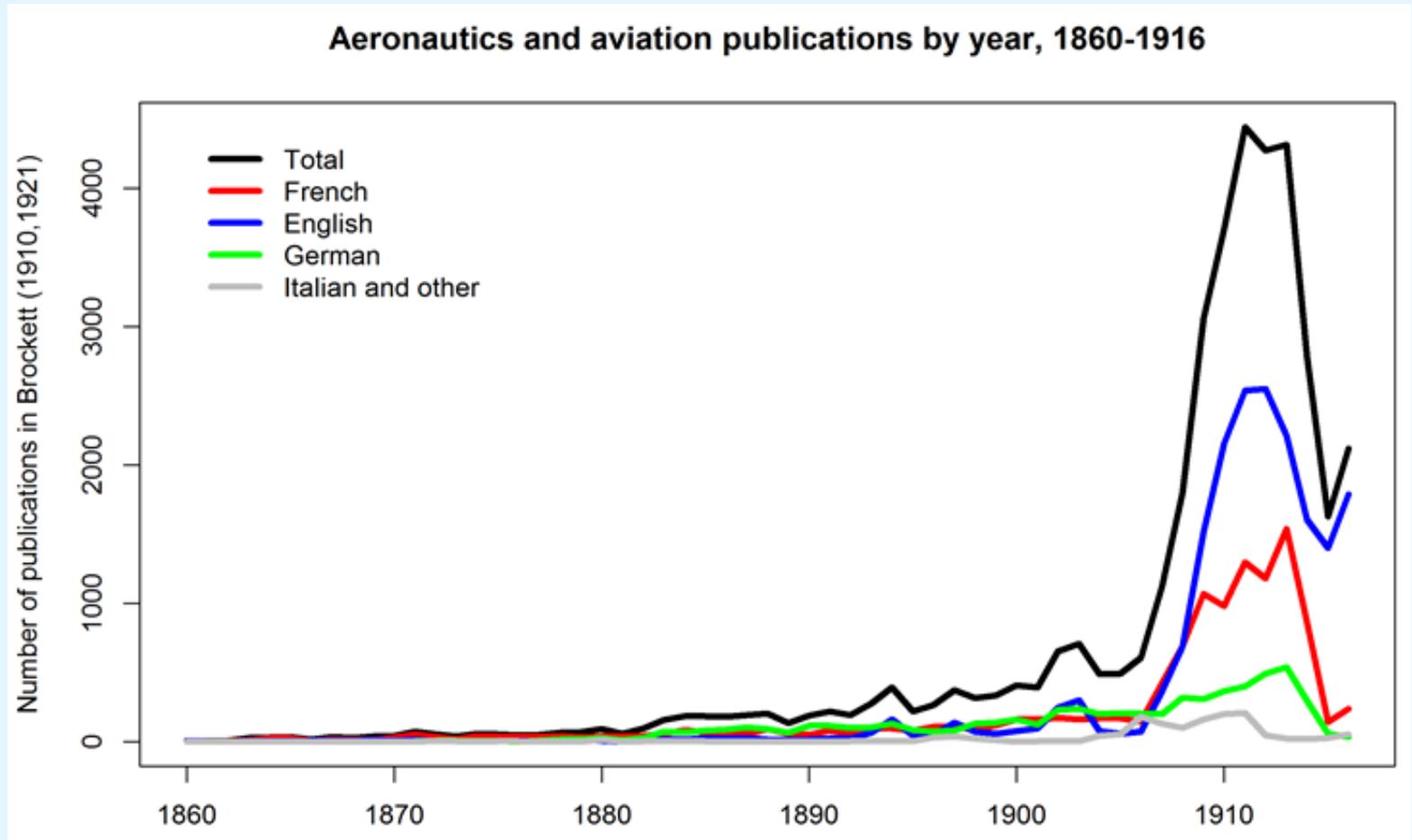
## Aeronautical patents decline after 1912 especially in war

Companies are increasingly funding development and applying for patents.

No obvious effect of Wright lawsuits in U.S. circa 1911

In World War I: aviation technology is dangerous to share

# Aero publications show similar trends



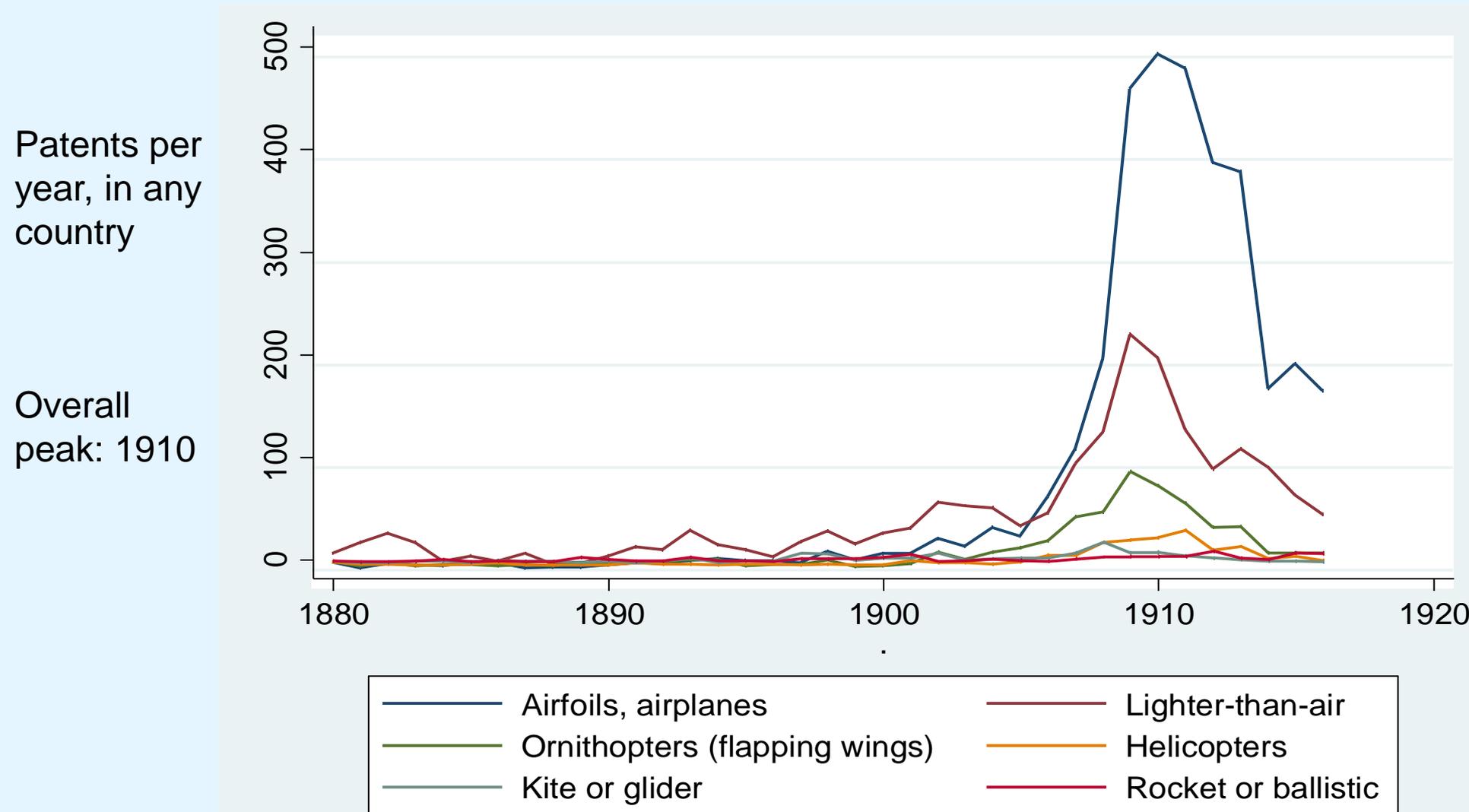
Source: Brockett's *Bibliography of Aeronautics* (1910, 1921)

1907 – Interest in new industry ; 1914 – notable drop during the war, especially in French, German and Italian. *L'Aerophile* explicitly reduced frequency of publication.

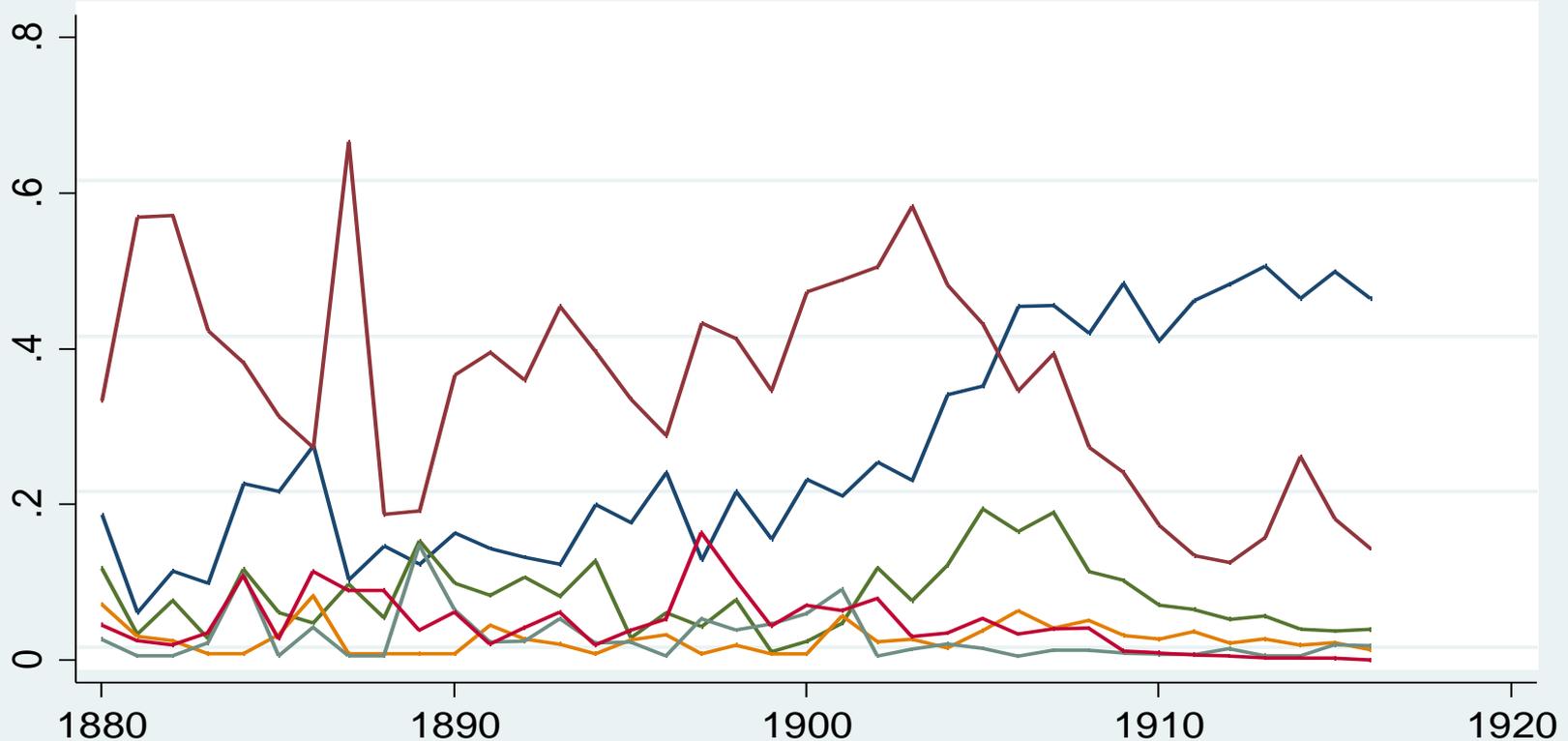
# Classifying technology in a patent

- Patstat / Espacenet patents usually have standard CPC categories
- Colleagues and I have read and categorized many earlier ones
- Many here are classified by finding key words in title (for now)
- About half have been categorized

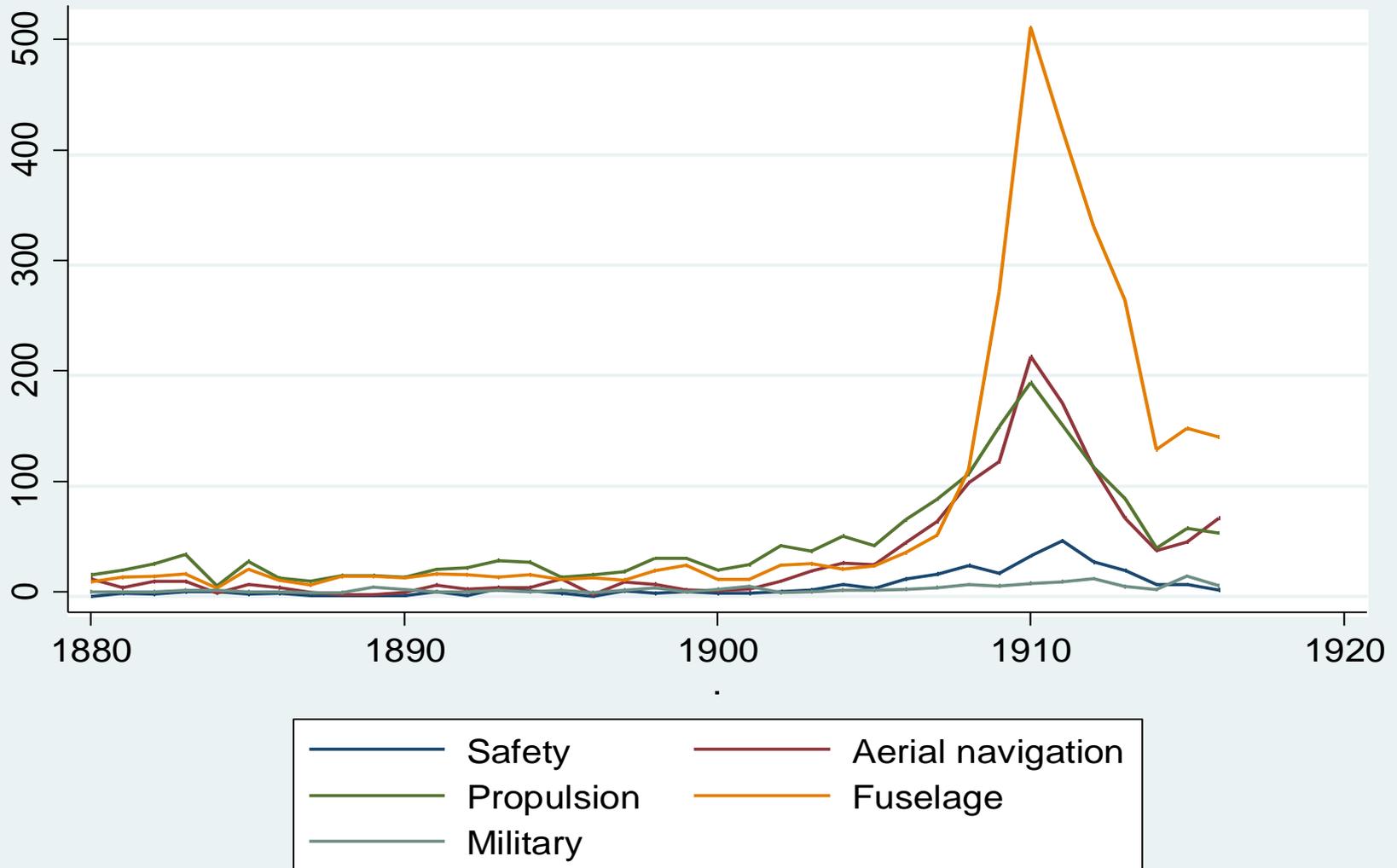
# Spike in several flight technology topics



# As proportion of aero patents, wings/airfoils/airplanes take over from other ways of lift and flight



# Other themes and topics of patents

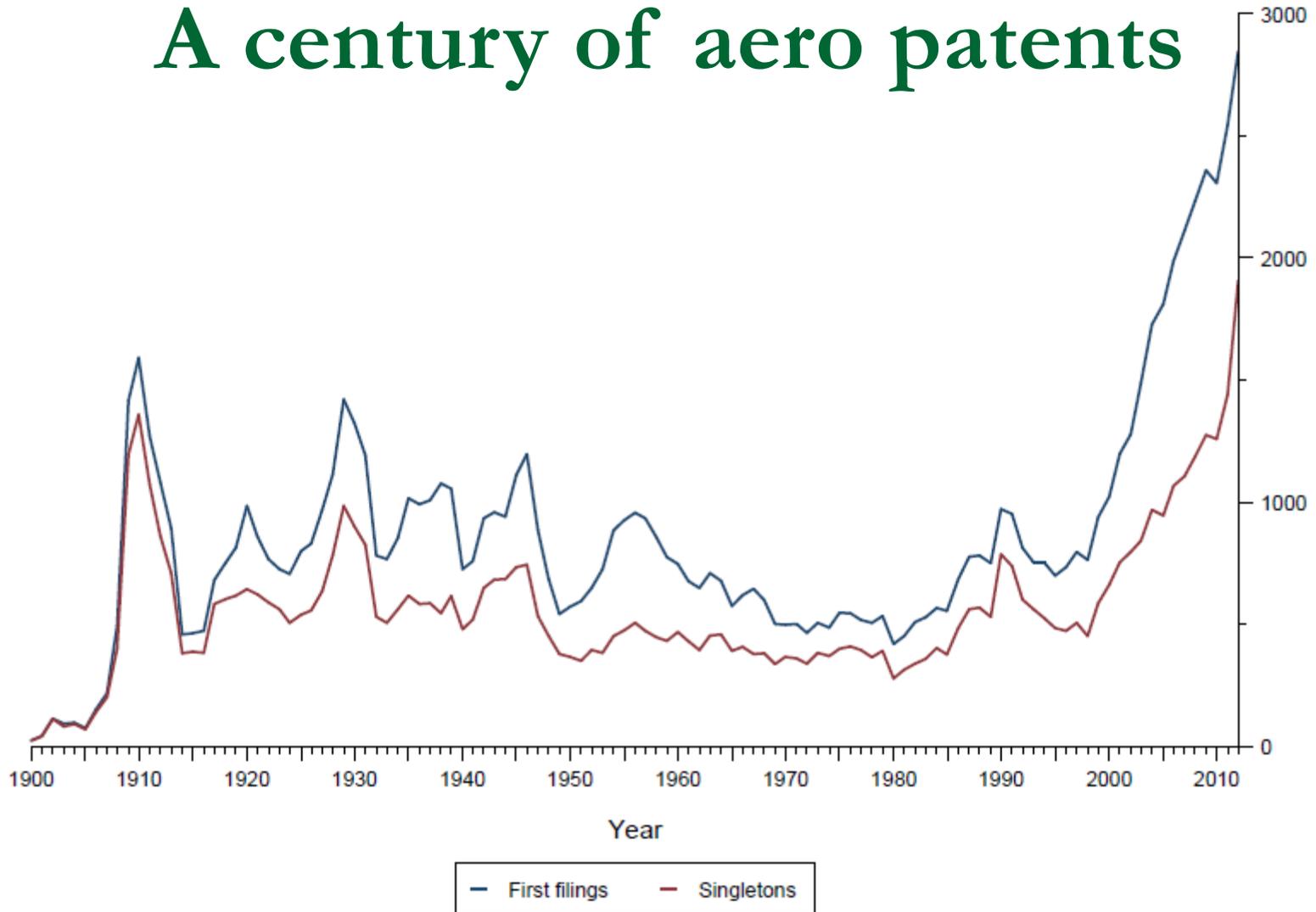


Military low: not clearly distinguished, not mainly aeronautic, and furthermore patents make information public which is not helpful for military intent <sup>28</sup>

# Long trends in aero patents to the present

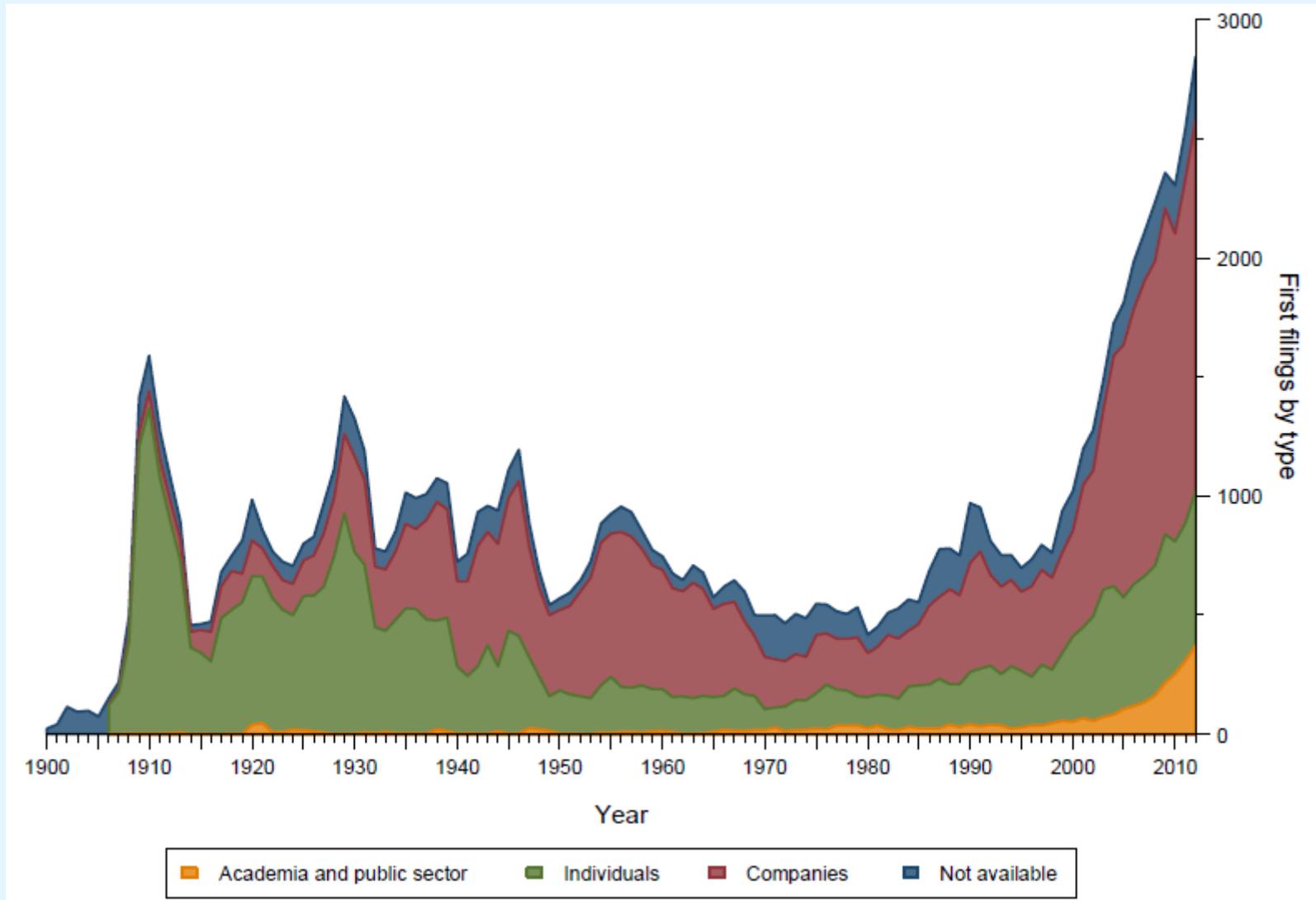
WIPO, World Intellectual Property Report: Breakthrough Innovation and Economic Growth, 2015

# A century of aero patents

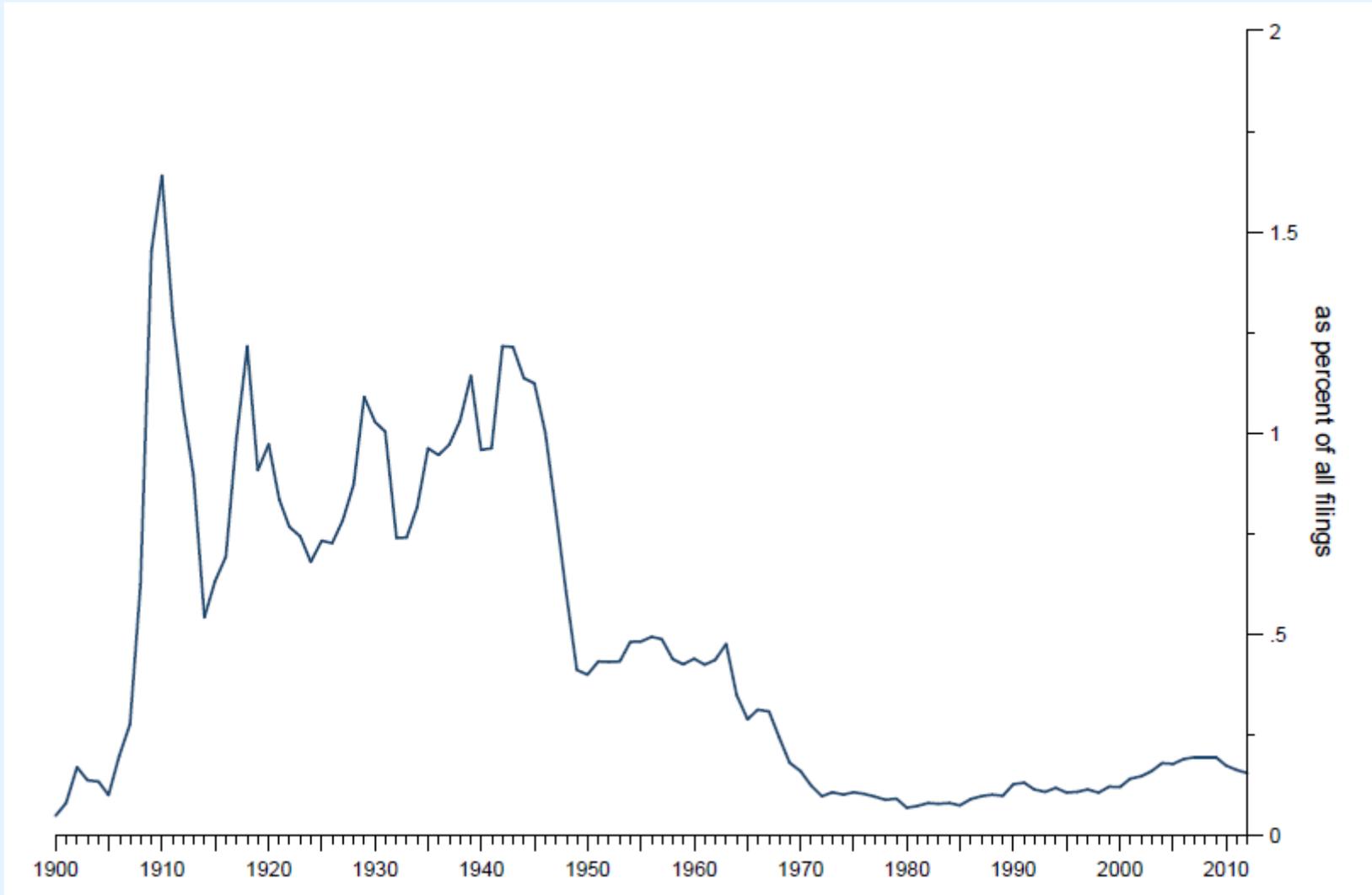


The 1910 peak in aeronautical patent filings globally was not reached again until 2000. It was a kind of frenzy of opportunity.

# Long term transition from individual applicants to companies



# Aero patents as % of all patents



By this measure, the 1910 peak was never exceeded.

# Conclusions

## Three big phases of patenting

- ❑ Scientific / hobbyist “open source” period to 1906 -- growth
- ❑ Startup industry period to 1914 -- boom
- ❑ Decline into World War I period

Burst of patents across aeronautic/aviation topics starting in 1907

Publications, clubs, and exhibitions boom then too

Technology topics focuses on airfoil/fixed-wings especially

Inflow of companies and interest in that topic, not mainly change in focus

Military interest important for business but not as visible in patents