

IPRs and their data analysis

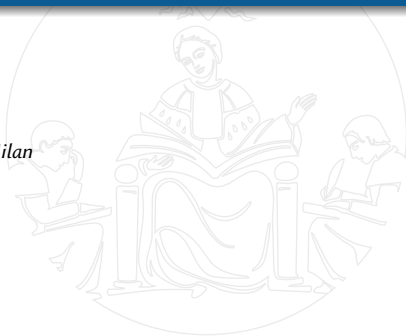
MODULE 8 – PATENT QUALITY INDICATORS

Jacopo Staccioli, PhD^{†‡}

[†] *Università Cattolica del Sacro Cuore, Milan*

[‡] *Scuola Superiore Sant'Anna, Pisa*

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1 Patent quality indicators

- What are quality indicators
- Patent scope
- Patent family size
- Grant lag
- Backward citations
- Citations to non-patent literature
- Number of claims
- Forward citations
- Breakthrough inventions
- Generality
- Originality
- Radicalness
- Patent renewal

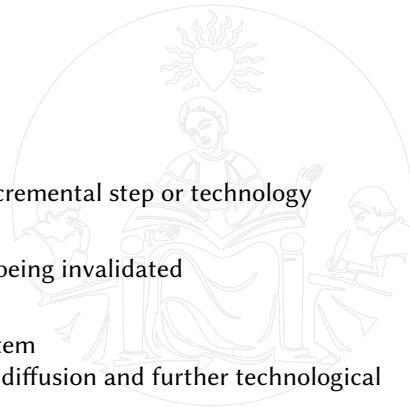


What is patent quality

- it has been long argued that the *quality* of patented inventions varies widely
 - from patent to patent
 - across firms
 - across technological fields

Q what makes a high-quality patent?

- for patent attorneys, engineers, examiners
 - a well written patent
 - a patent protecting a major invention rather than an incremental step or technology
- for legal scholars
 - the ability of a patent to stand a court dispute without being invalidated
- for economists
 - a patent that fulfils the key objectives of the patent system
 - i.e. to reward and incentivise innovation while enabling diffusion and further technological developments



Patent quality indicators

quality indicators : capture the technological and economic value of patented inventions

- useful for assessing the possible impact that inventions might have on subsequent technological developments
- low quality patents are perceived to generate uncertainty, lower incentives to innovate, stifle technology development, and trigger a number of market failures that ultimately harm innovation, entrepreneurship, employment and growth, and consumers welfare
- most stakeholders seem to agree about the necessity to “raise the bar”

example

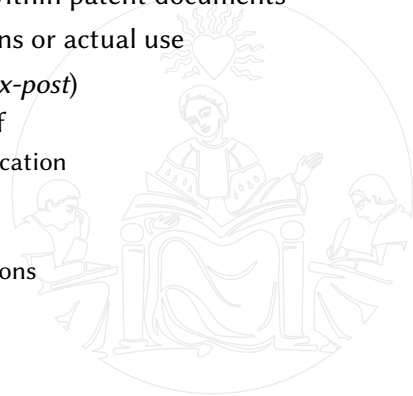
- patents increase the likelihood of obtaining venture capital
- venture capitalists would not finance firms against which patent infringement cases have been raised
- likelihood of getting challenged in court is related to patent quality (e.g. breadth of the patent claims)

Squicciarini Mariagrazia, Hélène Dernis, and Chiara Criscuolo (2013) *Measuring Patent Quality: Indicators of Technological and Economic Value*. OECD Science, Technology and Industry Working Papers 2013/03. doi: [10.1787/5k4522wkw1r8-en](https://doi.org/10.1787/5k4522wkw1r8-en)



Patent quality indicators (cont'd)

- quality indicators typically use information contained within patent documents
- they do not embed information about patent transactions or actual use
- they are retrospective in nature (can only be compiled *ex-post*)
- the period of observation depends on the indicator itself
 - *backward* citations are immediately available after publication
 - *forward* citations are subject to “truncation” effects
- comparability is best *within* patent offices
 - PTOs comply with country-specific legislations/regulations
 - common practices may differ between PTOs



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Patent scope

- the *scope* of patents is often associated with their technological and economic value¹
- technological *breadth* of patents significantly affects the valuation of the holding firm
- broad patents are more valuable when substitutes in the same product class are available
- patent scope is defined as the number of distinct 4-digit IPC subclasses
- the larger the number of distinct 4-digit IPC subclasses, the broader the scope index, and the higher the potential technological and market value of a patent

normalised index

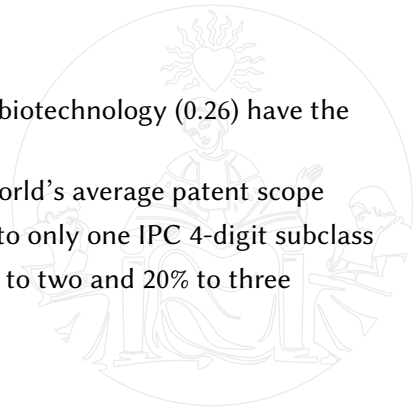
- the index is rescaled according to the maximum value of patents in the same cohort
- cohorts are defined according to filing year and WIPO technology field

¹see Lerner (1994)

Patent scope (cont'd)

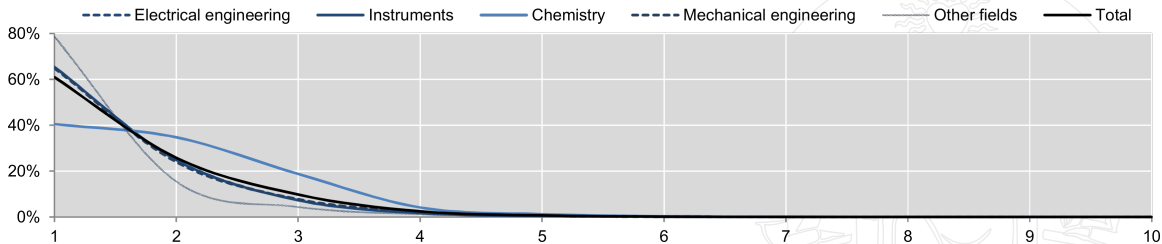
in 2009

- average (normalised) patent scope for all patents is 0.21
- pharmaceuticals (0.31), control-technologies (0.29), and biotechnology (0.26) have the largest scope values
- Australia, Canada, Japan, and Finland rank above the world's average patent scope
- in all technology fields, most patent documents belong to only one IPC 4-digit subclass
- chemistry is an exception, with 35% of patents referring to two and 20% to three



Patent scope (cont'd)

Distribution of patent scope, average values, 2009



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Patent family size

- applicants have 12 months from first filing to apply for the same invention in other jurisdictions and claim the priority date of the first application (Paris Convention, 1883)

patent family: set of patents filed to multiple PTOs, relative to the same priority filing(s)

- patent value is typically associated with the geographical scope of patent protection
 - the more jurisdictions in which patent protection has been sought, the higher the value²
 - applicants might be willing to accept additional costs and delays of extending protection to other countries only if they deem it worthwhile
- large international patent families have been found to be particularly valuable³
- family size is defined as the number of PTOs at which a given invention has been protected

²see Lanjouw et al. (1998)

³see Harhoff et al. (2003)



Patent family size (cont'd)

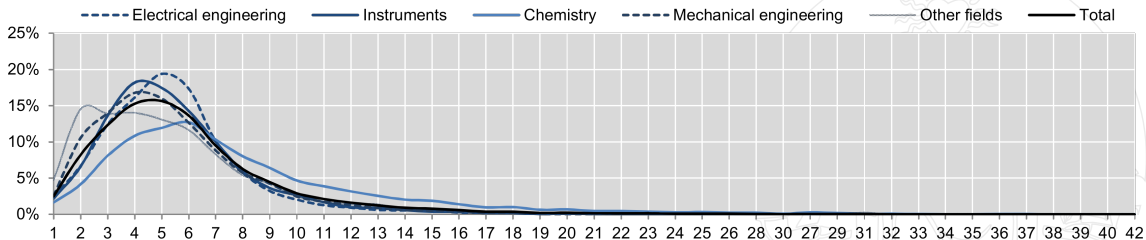
- the size of a patent family depends on the delays of publication of PTOs involved
- family indicators calculated on recent years may not provide an accurate picture of the geographical breadth (truncation effect)

in 2004

- family size of EPO patents mostly ranges between 1 and 9
- dispersion varies according to the underlying technology field
- patents in micro- and nano-technology, semiconductors, and basic communication technologies are, on average, the most broadly protected worldwide
- patents originating from Norway, Australia, Sweden, and the Netherlands tend to get the most extensive coverage worldwide



Distribution of family size, average values, 2004



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Grant lag

- empirical evidence suggests an inverse relationship between patent value and *grant lag*
 - i.e. the time elapsed between the filing date of the application and the date of the grant
- important patents are approved more quickly
- applicants try to accelerate the grant procedure for their most valuable patents
- e.g. by well documenting their applications and following closely the work of the PTO
 - the time required to reach a grant decision depends on the effort made by the filing party⁴
 - more controversial claims lead to slower grants and well-documented applications are approved faster⁵
- the grant lag index is defined as

$$\text{grant}_{P_i} = 1 - \frac{\Delta t}{\max \Delta t_i}$$

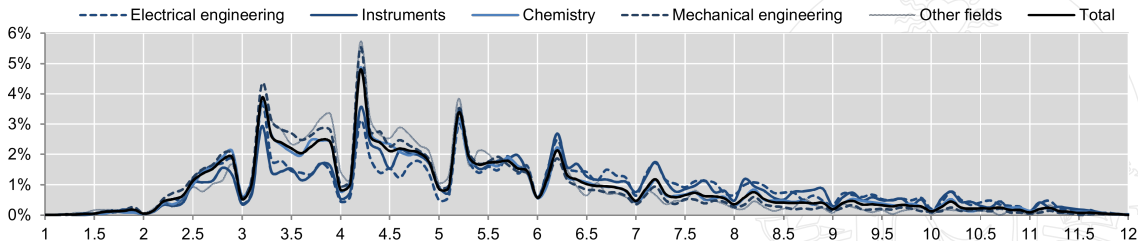
P_i : patent in cohort i
 Δt : grant lag of P_i
 $\max \Delta t_i$: maximum grant lag in cohort i

⁴see Régibeau and Rockett (2010)

⁵see Harhoff and Wagner (2009)

Grant lag (cont'd)

Distribution of grant lag, average number of years, 2000



Grant lag (cont'd)

- grant lag is subject to truncation effects
 - we do not know grant lag for applications which have not yet been granted
- peaks appearing at regular intervals suggest the existence of related administrative rules
- the vast majority of patents are granted before the 7th year after application
- sectoral variations are minimal



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Backward citations

- patent applicants are asked to disclose the prior knowledge upon which they have relied
 - either patents, scientific work, or other sources of knowledge at the basis of the invention
- backward citations are used to assess patentability and define the legitimacy of the claims
 - the number of citations can help assess the degree of novelty of an invention⁶
- backward citations either to patent and non-patent literature (NPL) are positively related to the value of a patent⁷
- however, many backward citations may signal a more *incremental* innovation⁸
- the backward citations indicator excludes references to NPL
- it generally does not suffer from truncation

⁶see Criscuolo and Verspagen (2008)

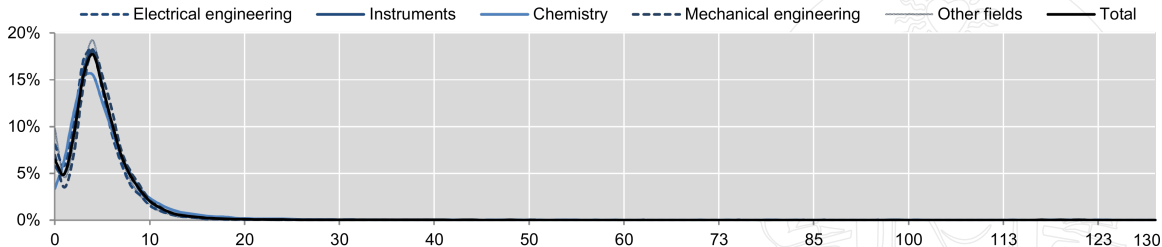
⁷see Harhoff et al. (2003)

⁸see Lanjouw and Schankerman (2001)



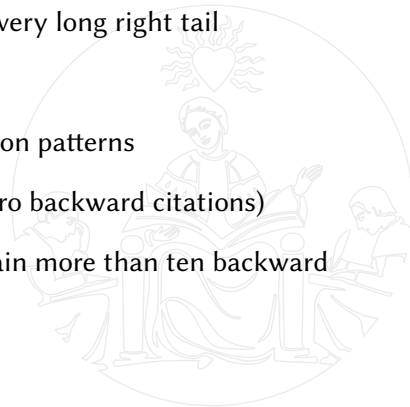
Backward citations (cont'd)

Distribution of backward citations per patents, average numbers, 2009



Backward citations (cont'd)

- backward citation index is generally left skewed with a very long right tail
- there is little time variation (not shown in the picture)
- different technology fields share similar backward citation patterns
- 5-10% of patents do not rely on prior art (i.e. features zero backward citations)
- only a very small percentage of patent documents contain more than ten backward citations



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Citations to non-patent literature

- backward citations to NPL can be considered as indicators of the contribution of public science to industrial technology⁹
- they reflect how close a patented invention is to scientific knowledge and help depict the proximity of technological and scientific developments
- patents that cite “science” may contain more complex and fundamental knowledge¹⁰
- patents citing NPL are of significantly higher quality than patents that do not¹¹
- NPL citations represent a subset of backward citations
- as such, they do not suffer from truncation
- in the 1998–2009 period very few patents cite NPL
- sectors follow very similar patterns, with most patents in all sectors not citing any NPL

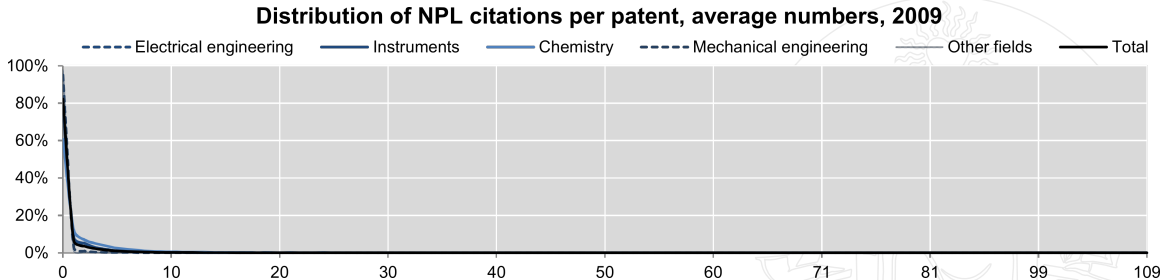
⁹see Narin et al. (1997)

¹⁰see Cassiman et al. (2008)

¹¹see Branstetter (2005)



Citations to non-patent literature (cont'd)



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Number of claims

- claims determine the boundaries of patent protection
 - only the technology or aspects covered in the claims can be legally protected and enforced
- the number (and content) of claims determine the breadth of IPRs
- also, patent fees are based on the number of claims
- hence, the number of claims not only reflects the technological breadth of a patent, but also its expected market value¹²
- the indicator is defined as the number of claims per patent
- an additional “adjusted” indicator rescales the number of claims by backward citations
 - backward citations signal that a patent belongs to a relatively well-developed technology area¹³

¹²see Tong and Davidson (1994); Lanjouw and Schankerman (2001, 2004)

¹³see Lanjouw and Schankerman (2001b)



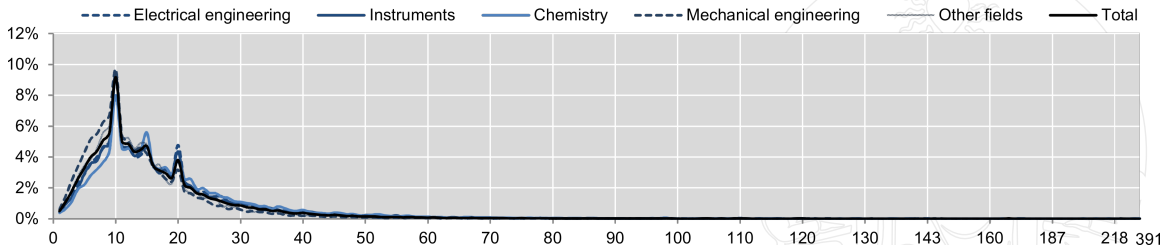
Number of claims (cont'd)

- the number of claims depends on office-specific regulations
 - e.g. in Japan there was a one-claim rule until 1975 whose influence is still visible nowadays
- the claim indicator may be sensitive to truncation, as they are reviewed during examination
 - e.g. claims may be dropped or redefined by examiners
- technology fields seem to vary in the average number of claims per patent
- but caution should be used when making intertemporal comparisons
 - different averages might reflect different underlying distributions
 - e.g. on average biotech patents feature 22 claims per patent in 1999 and 13 in 2009, while the standard deviation of the distribution of claims is above 16 in 1999 and 12 in 2009
 - micro and nano-tech patents contain on average 20 claims in 1999 and only 12 in 2009, while the standard deviation of their distributions goes from 17 in 1999 to 8 in 2009
- a very large share of the distribution has less than 30 claims per patent



Number of claims (cont'd)

Distribution of the number claims per patent, average, 2005



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Forward citations

- the number of citations a given patent receives (forward citations) mirrors the technological importance of the patent for the development of subsequent technologies
- to a certain extent, they also reflect the economic value of inventions¹⁴
- at the EPO references to prior art are classified according to their relevance
 - X: documents that are particularly important when taken alone, to the point that a claimed invention cannot be considered novel
 - I: documents that are particularly important when taken alone, to the point that a claimed invention cannot be considered to involve an inventive step
 - Y: documents that are particularly relevant if combined with one or more documents of the same category, as such a combination would be obvious to a person skilled in the art
- forward citations are counted over a period of five or seven years after publication
- the count includes self-citations
 - self-citations are generally more valuable than citations from external patents¹⁵

¹⁴see Trajtenberg (1990); Hall, et al. (2005); Harhoff et al. (2003)

¹⁵see Hall et al. (2005)



Forward citations (cont'd)

- the indicator is defined as

$$CIT_{i,T} = \sum_{t=P_i}^{P_i+T} \sum_{j \in J(t)} C_{j,i} \quad T \leq 5 \text{ or } T \leq 7$$

$CIT_{i,T}$: number of forward citations received by patent application i published in year P_i within T years from publication

$C_{j,i}$: dummy variable that gets value 1 if the patent j is citing patent i , and 0 otherwise

$J(t)$: set of all patents applications published in year t

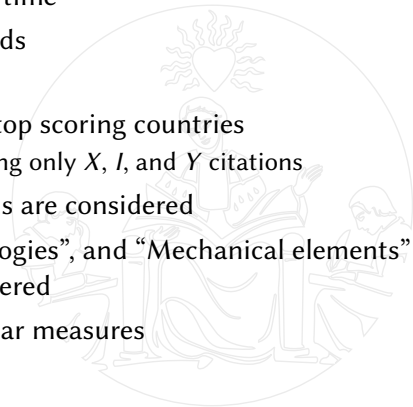


Forward citations (cont'd)

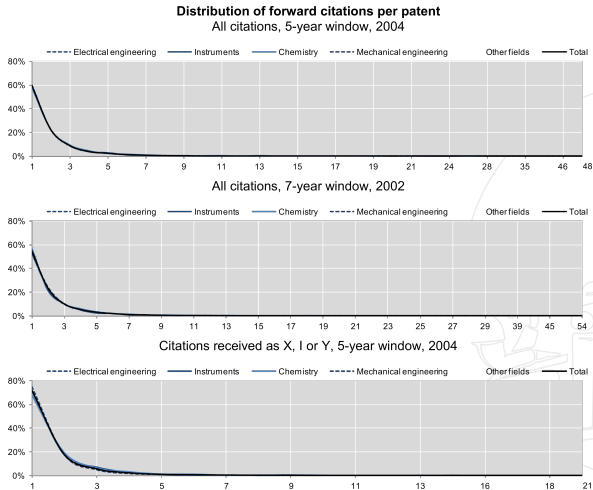
- the forward citation index has generally decreased over time
- there is substantial heterogeneity across technology fields

in 2004

- Korea, Belgium, Italy, Switzerland and Spain appear as top scoring countries
 - both when considering all citations and when considering only X , I , and Y citations
- “Computer technology” scores highest when all citations are considered
- “Surface technology, coating”, “Micro and nano-technologies”, and “Mechanical elements” score highest when only X , I , and Y citations are considered
- there is little difference between the 5-year and the 7-year measures



Forward citations (cont'd)



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Breakthrough inventions

- breakthrough inventions are high-impact innovations which serve as a basis for future technological developments, new products, or services
- quality and diversity of the technological resources of a firm are positively correlated with breakthrough innovations¹⁶
- breakthrough patents may induce subsequent innovations in certain sectors¹⁷
- breakthrough inventions are defined as the top 1% of most cited patents
 - can be restricted to relevant citations only (e.g. X, Y,...)
- truncation is an issue
 - need at least 5 or 7 years after publication to be computed
- over time a proportionally higher number of patents never get cited
- the share of breakthrough patents in the total number of patents has persistently decreased

¹⁶see Srivastava and Gnyawali (2011)

¹⁷see Popp et al. (2012)



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Generality

- forward patent citations can be used to assess the range of later generations of inventions that have benefited from a patent, by means of measuring the range of technology fields that cite the patent¹⁸
- useful for e.g. identifying general purpose technologies, investigating the role of universities as sources of commercial technologies¹⁹
- the patent generality index is defined as a variation of the Hirschman-Herfindahl Index
- it relies on the number and distribution of forward citations and the technology classes (IPC) of the patents these citations come from
- close to 1 if a patent is cited by subsequent patents belonging to a wide range of fields
 - the considered invention has been relevant for a number of later inventions, and not only in its own technology class
- the measure is close to 0 if most citations are concentrated in few fields

¹⁸see Bresnahan and Trajtenberg (1995)

¹⁹see Hall and Trajtenberg (2004); Henderson et al. (1998)

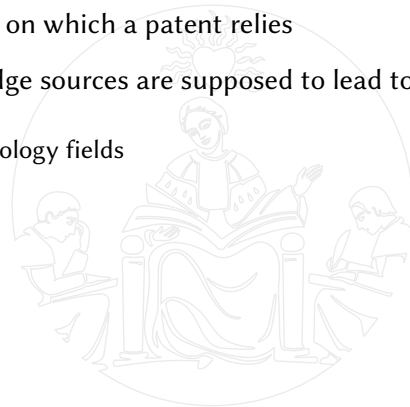


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- **originality** refers to the breadth of the technology fields on which a patent relies
- inventions relying on a large number of diverse knowledge sources are supposed to lead to original results
 - i.e. citing patents which belong to a wide array of technology fields
- similar to the generality index
 - generality leverages forward citations
 - originality leverages backward citations

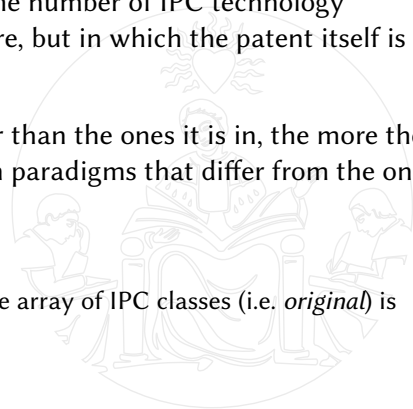


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- the *radicalness* of a patent is a time invariant count of the number of IPC technology classes in which the patents cited by the given patent are, but in which the patent itself is not classified
- the more a patent cites previous patents in classes other than the ones it is in, the more the invention should be considered radical, as it builds upon paradigms that differ from the one to which it is applied
- there is correlation with generality
 - it is reasonable to expect that a patent combining a wide array of IPC classes (i.e. *original*) is also a more radical invention



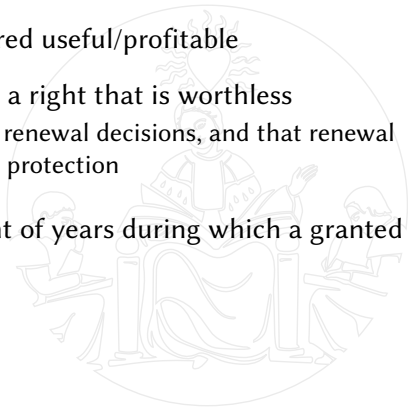
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Patent renewal

- patent renewal signals that the invention is still considered useful/profitable
- i.e. it has some value, as no rational agent would pay for a right that is worthless
 - assumption that patent owners make profit-maximising renewal decisions, and that renewal rates can be used to estimate the private value of patent protection
- patent renewal indicator corresponds to the simple count of years during which a granted patent has been kept alive



Housekeeping

- you have access to the `oecd_quality_202408` database alongside the usual `PATSTAT`²⁰
 - `uspto table`: contains quality indicators for US patents
 - `epo table`: contains quality indicators for European patents
- use JOIN statements ON patents' `appln_id` as usual

```
SELECT *  
FROM patstat2023b.tls201_appln ta  
JOIN oecd_quality_202408.epo e  
ON ta.appln_id = e.appln_id  
...
```

²⁰ courtesy of OECD Directorate for Science, Technology, and Innovation

Housekeeping (cont'd)

attribute	description
appln_id	patent application identifier
[app/pub]_nbr	application/publication number (e.g. EPYYYYNNNNNNN)
filing	filing year
tech_field	WIPO technology field, based on Schmoch (2008), 2011 rev.
many_field	= 1 if the patent is allocated to other fields
patent_scope	patent scope
family_size	family size
grant_lag	days between filing and grant dates
bwd_cits	number of backward patent citations
npl_cits	number of NPL citations
claims	number of claims
...	...

see the full table in Squicciarini, Dernis, Criscuolo (2013, p. 64)

