# The Rise of Process Claims: **Evidence from a Century of U.S. Patents**

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### This Project in a Nutshell

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- We document an increase in the process intensity of U.S. patents over the last century and beyond
- Confirming observations by academics and practitioners
  - Steady increase in process claims since the late 1800s
  - A few ups and downs, especially around WW2 and the late 1990s
  - Decrease in process claiming starting around 2010

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  - Today:

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- Main steps of the data construction
- What do we see in the data? 10 lessons learned
- Data in use

# **Classifying Patent Claims**

### Start with Patent Claims

- Patent claims are the metes and bounds of the invention protected by a patent.
- They describe what applicants claim as their invention and seek protection for.
- Claims are of different classes and types.
  - process or method claim
  - product or apparatus claim (claiming a machine, manufacture or product)
  - product-by-process claim (claiming a product by the method used to manufacture the product)
  - ...and other (more specialized) types and formats.
- Patents typically comprise multiple independent claims
  - *Process intensity* = share of process claims over all claims
  - *Process patent* if first claim is a process claim (Kuhn and Thompson, 2019)

### **Classification Approach Makes Use of Claim Parts**

- Use information from *preamble* and *body* to classify a claim
- **Preamble** is the general description of the invention:
  - Look for keywords that indicate a process/method or a product
  - Look for phrase "by ...process" as indicator of product-by-process claim
- **Body** describes the elements, steps, or relationships the applicant claims as invention:
  - Parts-of-speech tagging
  - Steps begin with gerund form of a verb
  - Components begin with determiner, ..., and a noun
- Validation using manually classified sample of almost 10,000 claims

#### Data in Use

#### **Example: Process/Method Claim**

Claim 1 in U.S. Patent 6,635,133:

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- 1. A **method** of making a ball, comprising:
  - forming an inner sphere by forming an outer shell with a fluid mass center;
  - forming a plurality of core parts;
  - arranging and joining the core parts around the inner sphere to form an assembled core;
  - **molding** a cover around the assembled core.



FIG. 1

### Example: Product/Apparatus Claim

*Claim 1 in U.S. Patent 6,009,555:* 

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- 1. A headgear **apparatus** comprising:
  - **a headband member** having a frontal portion;
  - a visor member removably secured to said frontal portion of said headband; and
  - an eye shield member removably secured to said frontal portion of said headband.



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Preamble Body		1920-2020	Claim
Empty	Product	37.18%	Product
Product	Product	30.37%	Product
Method	Method	15.03%	Process
Method	Mixed	4.56%	Process
Method	Product	2.83%	Process
Product	Mixed	1.65%	Product
Product	Method	1.21%	Prod-by-Process
Empty	Method	1.21%	Process
Others		1.49%	
Others (no category)		4.47%	
Empty preamble	Mixed body		
Empty preamble	Empty body		
Empty preamble	No body		



#### **Data Coverage**



#### Validation (Granted Patents 1976 – 2015)

- 10,000 manually classified claims granted between 1976 and 2015
- Classification via Amazon Mechanical Turk (twice + third in case of disagreement)
- 250 claims per year; representative across NBER technology classes

	Accuracy	Coverage
Results	0.983	0.983
Simple approach (preamble only)	0.956	1
Simple approach (full claim)	0.907	1

#### How Well Does the Approach Work?



# A Century of U.S. Patents

#### **Process Claims**

**Lesson 1:** The processintensity of U.S. patents has increased by 25 percentage points, from an average of just below 10% in 1920 to more than 30% in 2020.



#### **Process Intensity Varies Across Technologies**



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#### **Diverse Patent Classes (Levels and Linear Trends)**



**Left:** Average levels of process intensity (by USPC class) **Right:** Average linear trend of process intensity (by USPC class)

#### **Decomposition: Across the Board or Just a Few?**

- We decompose the annual changes in process intensity (à la De Loecker et al. (2020)):
  - within: process intensity increases for USPC changes on average
  - between: USPC classes with higher process intensity grow faster
- Annual change in process intensity  $\Delta \mu_t$ :



- change in process claims for each class *c* weighted by the relative size of the respective class in the previous period,  $\gamma_{c,t-1}$
- change of USPC composition,  $\Delta \gamma_{ct}$  holding the share of process claims constant at the previous period's levels

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Left: Annual changes of process intensity (moving average) Right: Changes attributed to changes in process intensity (red line) and to changes in USPC composition (black line)

Time period	Change ( $\Delta \mu_t$ )	riangle within	$\Delta$ between	$\Delta$ cross term
1920–29	2.743	1.053	1.582	0.108
1930–39	3.061	0.502	2.830	-0.271
1940–49	1.234	-0.902	2.293	-0.157
1950–59	0.673	-0.122	1.072	-0.277
1960–69	5.364	2.405	3.124	-0.165
1970–79	0.980	1.661	-0.120	-0.561
1980–89	1.899	2.209	-0.731	0.415
1990–99	6.756	4.565	1.869	0.297
2000-09	2.864	1.601	1.225	0.048
2010–14	0.734	0.142	0.545	-0.031
1920-2014	26.308	13.114	13.689	-0.594

# **Some Empirical Patterns**

#### Firms vs. Individuals

**Lesson 4:** Patents granted to companies and government entities are more process-intense than those granted to individuals.



Size (Cohen and Klepper, 1996) | Life-Cycle Hypothesis (Abernathy and Utterback, 1978) | Patent-Monitoring Cost Differentials



#### Foreign vs. Domestic

**Lesson 5:** Patents granted to U.S. applicants are more process-intense than those granted to foreign applicants.



Patent-Monitoring Cost Differentials | Value Differentials (Allison and Lemley, 2000) – **No!** 

#### **Process Patents with Higher Value and Impact**

**Lesson 6:** Process-intense patents are of higher value than product-intense patents.



Patent value from Kogan et al. (2017)

#### **Process Patents with Higher Value and Impact**

**Lesson 7:** Process-intense patents are renewed and their fourth-year maintenance fees paid at higher rates, but have fallen behind in the last decade.



Did patent holders pay their 4th-year maintenance fee?

#### **Process Patents with Higher Value and Impact**

**Lesson 8:** Process-intense patents are cited more often by other patents. Patents with a mix of process and product claims have been the least cited over the last two decades.



Number of forward citations

#### Are Process-Intense Patents Really Broader in Scope?

**Lesson 10:** Process claims are shorter than product claims. Both types become longer over time.



Shorter claims indicate wider/broader patent scope (Kuhn and Thompson, 2019; Marco et al., 2019) ZEW

## Data in Use

### Data in Use: Ganglmair and Reimers (2019)



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Visibility of Technology and Cumulative Innovation: Evidence from Trade Secrets Laws

- Stronger trade secrets protection laws reduce share of process patents
- Related results with AIPA: more process than product patents are opted out of pre-grant publication

Link: https://ssrn.com/abstract=3393510

### Does Offshoring Production Reduce Innovation: Firm-Level Evidence from Taiwan

Lee G. Branstetter, Jong-Rong Chen, Britta Glennon & Nikolas Zolas

- Production offshoring by Taiwanese firms affected by policy that lifted restrictions on investment in mainland China
- Find "a shift away from product patents and towards process patents in the newly offshored categories"

#### Link: https://www.nber.org/papers/w29117



### Data in Use: Keum (2020)

#### Firing Costs and the Decoupling of Technological Invention and Post-Invention Investments

Columbia Business School Research Paper Forthcoming

64 Pages Posted: 23 Mar 2021

Daniel Keum Columbia University - Columbia Business School

Date Written: October 1, 2020

- Innovation used to lead to employment growth but labor market rigidity caused a decoupling between the two
- Process patents lead to a larger increase in CAPEX (vs. non-process patents)
- Process patents do not have a significant positive effect on employment growth (while non-process patents do)

#### Link: https://ssrn.com/abstract=3774703

Artificial Intelligence, Firm Growth, and Product Innovation\*

Tania Babina<sup>†</sup> Anastassia Fedyk<sup>‡</sup>

Alex He<sup>§</sup> James Hodson<sup>¶</sup>

November 2021

 Product patenting increases in firms that invest more in Al; process patenting does not change

Data in Use

**Empirical Patterns** 

 Conclude that firms use Al mainly for product innovation; no evidence for changes in productivity or process innovation

Link: https://ssrn.com/abstract=3651052

#### Construction

On the Rise

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#### Data in Use: de Rassenfosse et al. (2020)

#### International Patent Protection and Trade: Transaction-Level Evidence

27 Pages Posted: 14 Apr 2020 Last revised: 15 Jul 2021

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Marco Grazzi Universita' Cattolica del Sacro Cuore

#### Daniele Moschella Scuola Superiore Sant'Anna di Pisa

Gabriele Pellegrino Ecole Polytechnique Fédérale de Lausanne

Date Written: March 27, 2020

- How does trade hinge on patenting?
- Use product patent information to augment their patent-product matching algorithm
- Strong effect of patent protection on trade

#### Link https://ssrn.com/abstract=3562618



#### Data in Use: Ma (2021)

# Technological Obsolescence

Song Ma

 Examines impact of technological obsolescence on firm growth and asset returns

 Effects of product innovation are more pronounced, consistent with theories of destructions of embedded innovation being more costly for firms

Link: https://www.nber.org/papers/w29504

# Thank you! Not you, Twitter

• Paper: https://ssrn.com/abstract=4069994

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- Data: https://doi.org/10.5281/zenodo.6395307

Coming soon: EPO patents, Canadian patents, published USPTO applications, R code

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