Using Patent Data to Measure the Impact of Publicly-Funded Research

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ASU, CSPO, and NBER

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New Tools for Science Policy Seminar

Context

- Assessing the impact of publicly-funded S&T is once again high on the policy agenda
- Agencies and analysts need systematic measures of “real world” impact
- Linking patented inventions to federally-funded R&D increasingly common approach (used by scholars and policymakers alike)
- Today: *How are patent data used in research assessment? What are best practices, major data sources, tricks of the trade? What is the data frontier? How can they be made more useful in assessment of public research funding?*

Perils

Patent Data as Economic Indicators

Griliches 1990

Journal of Economic Literature
Vol. XXVIII (December 1990), pp. 1661–1707

Patent Statistics as Economic Indicators: A Survey

By Zvi Griliches
Harvard University

I am indebted to my friends and collaborators for many ideas and comments. Parts of this survey borrow heavily (often verbatim) from our earlier work on this topic, especially from Griliches, Ariel Pakes, and Bronwyn Hall (1987), Griliches, Hall, and Pakes (1988), and Griliches (1989). I am indebted to the National Science Foundation (PRA85–12758 and SES 82–08006) and the National Bureau of Economic Research Productivity Program for financial support of this work and to B. Hall, A. Pakes, K. Pavitt, M. Schankerman, and F. M. Scherer for their comments on an earlier draft. The first draft of this survey was begun while I was a guest of the Rockefeller Foundation at the Bellagio Study and Conference Center in Italy. An earlier version of this paper was presented as the W. S. Woytinsky Lecture of 1989 at the University of Michigan.

Overheard at a Catskills Resort (one guest to another):
—The food is so terrible here.
—Yes. And the portions are so small.

Background

Patented Dec. 31, 1935   2,026,082

UNITED STATES PATENT OFFICE

2,026,082

BOARD GAME APPARATUS

Charles B. Darrow, Philadelphia, Pa., assignor to Parker Brothers, Inc., Salem, Mass., a corporation of Maine

Application August 31, 1935, Serial No. 38,757

9 Claims. (Cl. 273—134)

This invention relates to board game apparatus and is intended primarily to provide a game of barter, thus involving trading and bargaining.

In order that the principle of the invention may be readily understood, I have disclosed a single embodiment thereof in the accompanying drawings, wherein—

Fig. 1 is a plan view of one form or arrangement of board or playing field for the game, the lettering on the respective spaces or areas being clearly represented and the distinctive colors being indicated thereon according to the chart for draftsmen in the Patent Office Rules of Practice;

Fig. 2 is a view in elevation of symbols or tokens that are used by the several players respectively and which are shaped in representation of diversified objects;

Fig. 3 is a perspective view of some of the Houses that are used by the players who acquire Real Estate locations as designated by many of the spaces or areas;

Fig. 4 is a similar view of certain of the Hotels that are similarly used;

Fig. 5 represents in perspective the dice used to determine the extent or length of the moves of the players along the path or course;

Figs. 6 and 7 represent twenty-two cards which constitute the Title cards of the respective Real Estate holdings, spaces or areas indicated on the board of Fig. 1;

Fig. 8 represents a set of six cards, four of which give the rental and mortgage values of the four Railroads indicated by four certain spaces or areas on the board, and the other two of which indicate the rental and mortgage values of certain Utilities represented at two of the spaces or areas of the board;

Fig. 9 represents sixteen so-called Chance cards which are to be drawn from individually by every player who moves onto a Chance space or area of the board;

Fig. 10 is a similar view of sixteen Community Chest cards which are drawn from by each player who moves onto a Community Chest area or space indicated on the board; and

Fig. 11 is a view of the play or scrip money used in denominations of 1, 5, 10, 20, 50, 100 and 500 dollars.

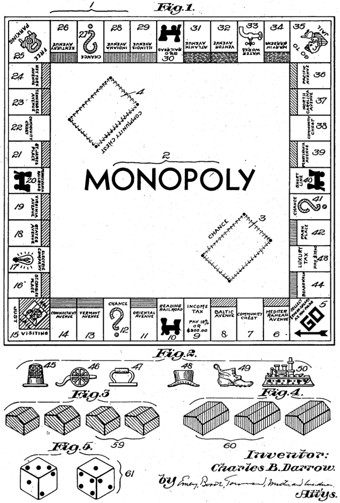
Before describing the game in detail, I will set forth certain of the salient features thereof and the general purpose of the game which is primarily one of barter. Much of the interest in the game lies in trading and in striking shrewd bargains. While I have illustrated and will now describe in detail that specific embodiment of my invention involving real estate areas or locations, it is to be understood that in its broader aspect my invention is not limited to the representation or simulation (among other features) of real estate areas or locations, with or without building improvements thereon, inasmuch as other types of properties are comprehended within the scope thereof, and other privileges or benefits than rentals would in such cases be provided for in such other forms of my invention. As will be hereinafter set forth, there are, in the represented embodiment of the invention, twenty-two Real Estate areas or locations designated upon the board, and according to the throw of the dice or other chance-determining element, the players may move onto some one or another of the Real Estate locations which they then acquire or may acquire through purchase from the Banker, who is preferably one of the players. The players then seek to develop their said Real Estate locations by erecting buildings thereon which are, in this embodiment of the invention, Houses and Hotels. Each of the players at the commencement of the game is furnished with a certain amount of game or scrip money, say, $1500 per player, and each player, as his symbol or token is moved, according to the throw of the dice, about the path or course repeatedly so long as the game continues, will, in accordance with the throw of the dice, land at times upon one of the Chance areas or one of the Community Chest areas, instead of upon a Real Estate area, whereupon he must draw a card from the appropriate one of the two piles of Chance and Community Chest cards, which cards indicate some financial or other penalty or benefit whereby his capital is augmented or diminished. Or he may land upon one of the four Railroad properties which, if not already controlled (acquired) by some other player, he may himself acquire; or he may land upon the space marked Income Tax, whereupon he will have to pay to the Bank a substantial portion of his capital, or upon the space marked Luxury Tax. Other financial benefits and penalties will be fully set forth in the ensuing specific description of the selected embodiment of the invention, to which, however, my invention is not limited excepting as hereinafter set forth in the claims.

The board as a whole is indicated at 1 in Fig. 1. Inasmuch as the game is known upon the market as Monopoly, that name is indicated at 2 on the board in the central space, whereon at 3 and 4 are indicated the places where the set of Chance cards and the set of Community Chest cards are

Dec. 31, 1935.   C. B. DARROW   2,026,082

BOARD GAME APPARATUS

Filed Aug. 31, 1935   7 Sheets-Sheet 1



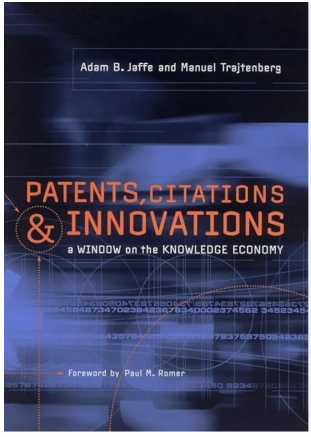
Promise

- “They are available; they are by definition related to inventiveness; and they are based on what appears to be a slowly changing standard” (Griliches 1990, p. 1663)
- Rich information: Inventor, firm names, location
- Technology class
- Long time series
- “One can actually read the detailed text of a series of patents in a particular field as raw material for an economic-technological history of it”*

Perils

- In most sectors patents not as important as other means of appropriating returns to R&D investments (most recently, Mezzanoti and Simcoe 2023)
- Not all important innovations are patented (differences across firms, sectors in propensity to patent; trade secrecy and tacit knowledge)
- Not all patents are innovation: the leniency of a patent granting examiner/agency influences patent grant counts; as does applicant effort
- *Implication: Hard to compare patent counts across fields; countries; maybe institutions (with different patent strategies)*
- Not all patents are important inventions: skew-distributed value (private/social) of underlying inventions (compare 8,697,359 to 8,696,487, each issued 4/15/2014)

The Citation Revolution



(12) **United States Patent**
Dart et al.

(10) **Patent No.: US 8,969,325 B2**
(45) **Date of Patent: Mar. 3, 2015**

(54) **TRPV1 ANTAGONISTS**

(71) Applicant: **AbbVie Inc.**, North Chicago, IL (US)

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(73) Assignee: **AbbVie Inc.**, North Chicago, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 72 days.

(21) Appl. No.: **13/716,862**

(22) Filed: **Dec. 17, 2012**

(65) **Prior Publication Data**

US 2013/0172334 A1 Jul. 4, 2013

Related U.S. Application Data

(60) Provisional application No. 61/577,394, filed on Dec. 19, 2011, provisional application No. 61/704,823, filed on Sep. 24, 2012.

(51) **Int. Cl.**

C07D 405/12	(2006.01)
C07D 215/38	(2006.01)
C07D 239/80	(2006.01)
C07D 413/12	(2006.01)

USPC **514/105**; 544/230; 544/284; 544/286; 544/70; 546/15; 546/157; 514/230.5; 514/266.21; 514/266.24; 514/266.3; 514/278; 514/312

(58) **Field of Classification Search**

None

See application file for complete search history.

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Citations to the rescue?

- One common way to account for differences in value is citation-weighting
  - Some evidence that citation-weighted patents correlate between with value than patent counts alone
  - More validation needed; best-practice is to use other value indicators as well

- Forward and backward citations also used to trace spillovers from one research field to another. But ...
  - Front-page citations are made for legal purposes (prior art) not quite the same as research impact
  - Examiners account for a substantial share of citations
  - Patent citation strategy varies by field, firm, invention
  - Changes in citation patterns over time (citation inflation)

Standard approaches to linking patents to public funding, some applications, known limitations

Standard approaches to linking patents to public funding: front-page citations to publicly-funded publications and patents

US005681814A

United States Patent [19]

Clark et al.

[11] **Patent Number: 5,681,814**

[45] **Date of Patent: Oct. 28, 1997**

[54] **FORMULATED IGF-I COMPOSITION**

[75] Inventors: **Ross G. Clark**, Pacifica; **Douglas A. Yeung**, Fremont; **James Q. Oeswein**, Moss Beach, all of Calif.

[73] Assignee: **Genentech, Inc.**, South San Francisco, Calif.

[21] Appl. No.: **71,819**

[22] Filed: **Jun. 4, 1993**

Related U.S. Application Data

[60] Continuation-in-part of Ser. No. 806,748, Dec. 13, 1991, abandoned, which is a division of Ser. No. 535,005, Jun. 7, 1990, Pat. No. 5,126,324.

[51] **Int. Cl.**[6] **A61K 38/00**; A01N 37/18

[52] **U.S. Cl.** **514/12**; 514/2; 514/21

[58] **Field of Search** 514/2, 12, 21

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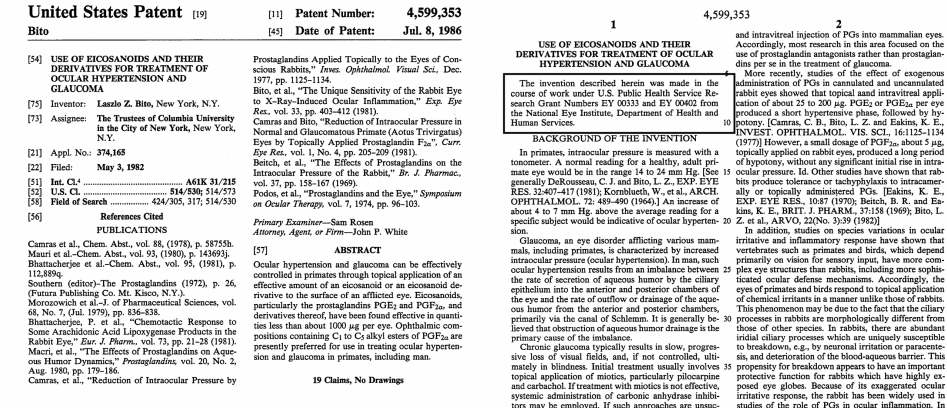
Standard approaches to linking patents to public funding: government-interest



United States Patent [19]

Bito

[11] **Patent Number: 4,599,353**

[45] **Date of Patent: Jul. 8, 1986**

[54] **USE OF EICOSANOIDS AND THEIR DERIVATIVES FOR TREATMENT OF OCULAR HYPERTENSION AND GLAUCOMA**

[75] Inventor: **Laszlo Z. Bito**, New York, N.Y.

[73] Assignee: **The Trustees of Columbia University in the City of New York**, New York, N.Y.

[21] Appl. No.: **374,165**

[22] Filed: **May 3, 1982**

[51] **Int. Cl.**⁴ **A61K 31/215**

[52] **U.S. Cl.** **514/530**; 514/573

[58] **Field of Search** 424/305, 317; 514/530

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Primary Examiner—Sam Rosen
Attorney, Agent, or Firm—John P. White

[57] **ABSTRACT**

Ocular hypertension and glaucoma can be effectively controlled in primates through topical application of an effective amount of an eicosanoid or an eicosanoid derivative to the surface of an afflicted eye. Eicosanoids, particularly the prostaglandins PGE_2 and $PGF_{2\alpha}$, and derivatives thereof, have been found effective in quantities less than about 1000 μg per eye. Ophthalmic compositions containing C_1 to C_3 alkyl esters of $PGF_{2\alpha}$ are presently preferred for use in treating ocular hypertension and glaucoma in primates, including man.

19 Claims, No Drawings

USE OF EICOSANOIDS AND THEIR DERIVATIVES FOR TREATMENT OF OCULAR HYPERTENSION AND GLAUCOMA

The invention described herein was made in the course of work under U.S. Public Health Service Research Grant Numbers EY 00333 and EY 00402 from the National Eye Institute, Department of Health and Human Services.

BACKGROUND OF THE INVENTION

In primates, intraocular pressure is measured with a tonometer. A normal reading for a healthy, adult primate eye would be in the range 14 to 24 mm Hg. [See generally DeRousseau, C. J. and Bito, L. Z., EXP. EYE RES. 32:407–417 (1981); Kornblueth, W., et al., ARCH. OPHTHALMOL. 72: 489–490 (1964).] An increase of about 4 to 7 mm Hg. above the average reading for a specific subject would be indicative of ocular hypertension.

Glaucoma, an eye disorder afflicting various mammals, including primates, is characterized by increased intraocular pressure (ocular hypertension). In man, such ocular hypertension results from an imbalance between the rate of secretion of aqueous humor by the ciliary epithelium into the anterior and posterior chambers of the eye and the rate of outflow or drainage of the aqueous humor from the anterior and posterior chambers, primarily via the canal of Schlemm. It is generally believed that obstruction of aqueous humor drainage is the primary cause of the imbalance.

Chronic glaucoma typically results in slow, progressive loss of visual fields, and, if not controlled, ultimately in blindness. Initial treatment usually involves topical application of miotics, particularly pilocarpine and carbachol. If treatment with miotics is not effective, systemic administration of carbonic anhydrase inhibitors may be employed. If such approaches are unsuc-

and intravitreal injection of PGs into mammalian eyes. Accordingly, most research in this area focused on the use of prostaglandin antagonists rather than prostaglandins per se in the treatment of glaucoma.

More recently, studies of the effect of exogenous administration of PGs in cannulated and uncannulated rabbit eyes showed that topical and intravitreal application of about 25 to 200 μg. PGE_2 or $PGE_{2\alpha}$ per eye produced a short hypertensive phase, followed by hypotony. [Camras, C. B., Bito, L. Z. and Eakins, K. E., INVEST. OPHTHALMOL. VIS. SCI., 16:1125–1134 (1977)] However, a small dosage of $PGF_{2\alpha}$, about 5 μg, topically applied on rabbit eyes, produced a long period of hypotony, without any significant initial rise in intraocular pressure. Id. Other studies have shown that rabbits produce tolerance or tachyphylaxis to intracamerally or topically administered PGs. [Eakins, K. E., EXP. EYE RES., 10:87 (1970); Beitch, B. R. and Eakins, K. E., BRIT. J. PHARM., 37:158 (1969); Bito, L. Z. et al., ARVO, 22(No. 3):39 (1982)]

In addition, studies on species variations in ocular irritative and inflammatory response have shown that vertebrates such as primates and birds, which depend primarily on vision for sensory input, have more complex eye structures than rabbits, including more sophisticated ocular defense mechanisms. Accordingly, the eyes of primates and birds respond to topical application of chemical irritants in a manner unlike those of rabbits. This phenomenon may be due to the fact that the ciliary processes in rabbits are morphologically different from those of other species. In rabbits, there are abundant iridial ciliary processes which are uniquely susceptible to breakdown, e.g., by neuronal irritation or paracentesis, and deterioration of the blood-aqueous barrier. This propensity for breakdown appears to have an important protective function for rabbits which have highly exposed eye globes. Because of its exaggerated ocular irritative response, the rabbit has been widely used in studies of the role of PGs in ocular inflammation. In

Application: Linking FDA-approved drugs to public funding

- Life sciences may be the best case for patents, patent citation data
- In addition, for drugs the FDA's *Orange Book* links patents to products

Did you ever wonder how the Orange Book got its nickname?

When the first print edition of *Approved Drug Products with Therapeutic Equivalence Evaluations* was being prepared October 1980, staff members in the Office of Generic Drugs had to choose a color for the cover. The project manager suggested, "It's almost Halloween. How about orange?"

Before long, *The Orange Book* had become a popular short title for this important publication.

Direct and indirect links to public sector research (retrospective)

- Example of Direct Link
- Example of Indirect Link

EXHIBIT 1

New Drugs Approved By The Food And Drug Administration, 1988–2005, With Direct Or Indirect Public-Sector Support

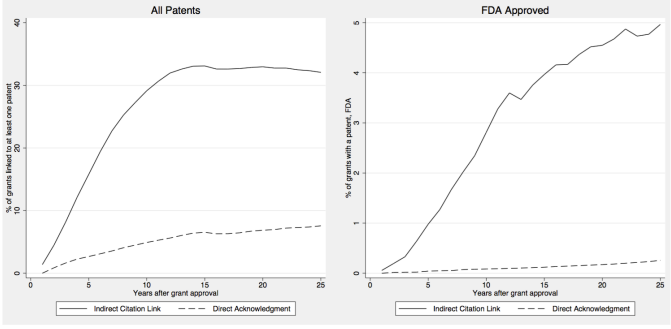
	Standard-review drugs	Priority-review drugs	All drugs
Number of drugs	224	155	379
Had public-sector patent	3.1%	17.4%	9.0%
Patent cited at least one public-sector patent	15.6%	39.4%	25.3%
Patent cited at least one government publication	31.3%	56.1%	41.4%
Patent cited either a public-sector patent or a government publication	36.2%	64.5%	47.8%

SOURCE Authors' analyses of data from Notes 21–24 in text. **NOTE** "Government publication" means an article in PubMed acknowledging support from a US government agency (see Note 21 in text).

Source: Sampat, Bhaven N., and Frank R. Lichtenberg. "What are the respective roles of the public and private sectors in pharmaceutical innovation?." *Health Affairs* (2011): 332-339.

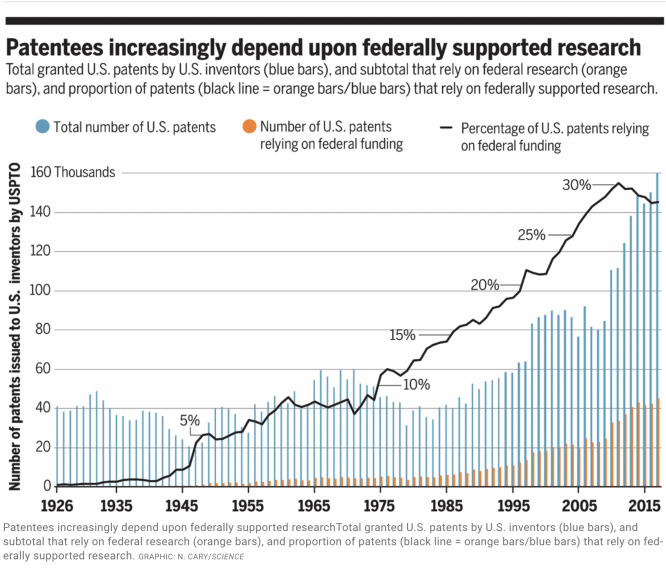
Direct and indirect links to public sector research (prospective)

Figure 1: Grant-Patent lags, direct vs. indirect patenting



Note: Based on a sample of 365,380 NIH grant cycles awarded between the years 1980 and 2007. A grant is *directly* linked to a patent if the patent contains a government interest statement explicitly referencing the grant. A grant is *indirectly* linked to a patent if a publication acknowledges the grant within five years of the start of a particular cycle for the grant, and a patent lists this publication as prior art in the header of the patent document. For each year after approval, the percentage of linked patents is calculated using only grants that have reached that age.

Source: Li, Danielle, Pierre Azoulay, and Bhaven N. Sampat. "The applied value of public investments in biomedical research" *Science* (2017): 78-81.



Source: Fleming, L., Greene, H., Li, G., Marx, M., Yao, D. (2019). Government-funded research increasingly fuels innovation. *Science*, 364(6446), 1139-1141.

Limitations: government-interest statements

- Underreporting: NIH data suggests a large share of patents reported in iEdison don't have government interest statements, and vice versa (Rai and Sampat 2012)
- Sometimes buried in "Certificates of correction" to patents
- Not uniformly required before Bayh-Dole. Especially limiting for "license" agencies like DoD.

Limitations: patent-science citations

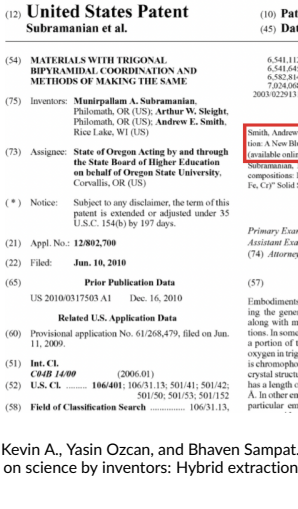
- Front-page patent citations are “prior art”, reflect patent strategy and prosecution dynamics, not clearly related to “research impact” or “reliance on science”

- How to scale? How crucial is each article cited to final patent? What is counterfactual?

Really new tools

Tool 1: In-text science citations to publicly-funded science

▸ Background on in-text ▸ Details on in-text



(12) **United States Patent**
Subramanian et al.

(10) **Patent No.: US 8,282,728 B2**
(45) **Date of Patent: Oct. 9, 2012**

(54) **MATERIALS WITH TRIGONAL BIPYRAMIDAL COORDINATION AND METHODS OF MAKING THE SAME**

(75) Inventors: **Munirpallam A. Subramanian**, Philomath, OR (US); **Arthur W. Sleight**, Philomath, OR (US); **Andrew E. Smith**, Rice Lake, WI (US)

(73) Assignee: **State of Oregon Acting by and through the State Board of Higher Education on behalf of Oregon State University**, Corvallis, OR (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 197 days.

(21) Appl. No.: **12/802,700**

(22) Filed: **Jun. 10, 2010**

(65) **Prior Publication Data**

US 2010/0317503 A1 Dec. 16, 2010

Related U.S. Application Data

(60) Provisional application No. 61/268,479, filed on Jun. 11, 2009.

(51) **Int. Cl.**
C04B 14/00 (2006.01)

(52) **U.S. Cl.** **106/401**; 106/31.13; 501/41; 501/42; 501/50; 501/53; 501/152

(58) **Field of Classification Search** ..... 106/31.13, 6,541,112 B1 4/2003 Swiler et al.
6,541,645 B1 * 4/2003 Canary et al. 549/5
6,582,814 B2 6/2003 Swiler et al.
7,024,068 B2 * 4/2006 Canary et al. 385/15
2003/0229131 A1 * 12/2003 Sessler et al. 514/410

OTHER PUBLICATIONS

Smith, Andrew E. et al., "Mn3+ in Trigonal Bipyramidal Coordination: A New Blue Chromophore" J. Am. Chem. Soc. vol. 131, No. 47 (available online on Nov. 9, 2009) pp. 17084-17086 *

Subramanian, Muniprallam A. et al., "Novel tunable ferroelectric compositions: Ba1−xLnxTi1−xMnO3 (Ln=La, Sm, Gd, Dy; M=Al, Fe, Cr)" Solid State Sciences 2 (2000) pp. 507-512.*

(Continued)

Primary Examiner — Jessica L Ward
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(74) *Attorney, Agent, or Firm* — Klarquist Sparkman, LLP

(57) **ABSTRACT**

Embodiments of compositions comprising materials satisfying the general formula $AM_{1-x}M'_xM''_yO_{3-\delta}$ are disclosed, along with methods of making the materials and compositions. In some embodiments, M and M' are +3 cations, at least a portion of the M cations and the M' cations are bound to oxygen in trigonal bipyramidal coordination, and the material is chromophoric. In some embodiments, the material forms a crystal structure having a hexagonal unit cell wherein edge a has a length of 3.50-3.70 Å and edge c has a length of 10-13 Å. In other embodiments, edge a has a length of 5.5-7.0 Å. In particular embodiments, M' is Mn, and Mn is bonded to

TABLE 8-continued

Crystal data and structure refinement $Yb_{0.67}Mn_{0.67}O_3$

Crystal system	Hexagonal
Space group	$P6_3cm$
Unit cell dimensions	a = 6.1709(6) Å c = 11.779(2) Å
Volume	388.17(8) Å3
Z	6
Density (calculated)	5.437 mg/m^3
Absorption coefficient	28.267 mm^{-1}
F(000)	576
Crystal size	0.05 x 0.03 x 0.01 mm
Theta range for data collection	3.46 to 28.31°
Index ranges	−7 ≤ h ≤ 8, −7 ≤ k ≤ 7, −15 ≤ l ≤ 15
Reflections collected	3766
Independent reflections	363 [R(int) = 0.0263]
Completeness to theta = 28.31°	98.0%
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.7653 and 0.3322
Refinement method	Full-matrix least-squares on F2
Data/restraints/parameters	363/0/31
Goodness-of-fit on F2	1.178
Final R indices [I > 2sigma(I)]	R1 = 0.0219, wR2 = 0.0407
R indices (all data)	R1 = 0.0288, wR2 = 0.0438
Largest diff. peak and hole	0.934 and −0.629 e·Å3

TABLE 9

Atomic coordinates and equivalent isotropic displacement parameters (Å^2 x 10^3)

	x	y	z	U(eq)
Y1	0	0	0	3(1)
Y2	⅓	⅔	0.9636(1)	13(1)
Mn/Ta*	0.3342(4)	0	0.721(4)	6(1)
O1	0.322(4)	0	0.878(5)	21(6)
O1′	0.289(5)	0	0.493(2)	0(6)
O2	0.635(3)	0	0.661(2)	0(3)
O2′	0.655(5)	0	0.034(2)	7(8)
O3	0	0	0.202(2)	24(4)
O4	⅓	⅔	0.349(1)	13(3)

U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

TABLE 11

Anisotropic displacement parameters (Å^2 x 10^3)*

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
Y1	2(1)	2(1)	6(1)	0	0	1(1)
Y2	6(1)	6(1)	28(1)	0	0	3(1)
Mn/Ta	7(1)	5(1)	5(1)	0	−1(1)	2(1)
O3	33(7)	33(7)	5(7)	0	0	17(3)
O4	3(3)	3(3)	33(7)	0	0	1(1)

The anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U^{11} + \ldots + 2hka^*b^*U^{12}]$

*Split atoms O1, O1′, O2, and O2′ were refined with isotropic displacement parameters.

First-Principles Calculations

First-principles calculations were performed with plane-wave density functional theory using the Vienna Ab-initio Simulation Package (VASP). (Kresse, G., and Furthmueller, J., *Phys. Rev. B* 54, 11169-11186 (1996); Kresse, G., and Joubert, D., *Phys. Rev. B* 59, 1758-1775 (1999).) Exchange and correlation effects were treated using the local-spin-density with an on-site Coulomb repulsion U=5.0 eV and an intra-atomic exchange splitting of J=0.9 eV for Mn-d states. (Liechtenstein, A. I., Anisimov, V. I., and Zaanen, J., *Phys. Rev. B* 52, R5467-R5470 (1995).) A global antiferromagnetic ordering with ferromagnetic (001) planes was adopted for the simulations. Intermediates within periodic boundary conditions were studied using the supercell approach with lattice constants taken from experimental values presented in FIG. **7**. The 40-atom supercells permit concentrations of x=0, 0.25, 0.5, 0.75 and 1.0 while maintaining equal numbers of In and Mn atoms in each layer. An ordering was chosen in which the minority component was maximally separated in space; thus, the possibility of In or Mn clustering was ignored.

All structures were initialized in the centrosymmetric $P6_3/mmc$ space group and all atomic degrees of freedom were optimized until forces were less than 0.1 meV/Å. This strict tolerance allowed accurate study of delicate features of the atomic structure, such as tiltings of the polyhedra that are responsible for ferroelectricity. (Fennie, C. J., and Rabe, K. M., *Phys. Rev. B* 72, 100103(4) (2005).)

Summary of Convergence Parameters:

Sources: Bryan, Kevin A., Yasin Ozcan, and Bhaven Sampat. "In-text patent citations: A user's guide." *Research Policy* (2020): 103946. and Marx, Matt, and Aaron Fuegi. "Reliance on science by inventors: Hybrid extraction of in-text patent-to-article citations." *Journal of Economics Management Strategy* (2022): 369-392.

Tool 2: The Government Patent Register

WHEREAS there exists among the several executive departments and agencies a need for a more adequate source of information with respect to patent rights and interests owned or controlled by the United States Government ... The Secretary of Commerce shall cause to be established in the United States Patent Office a separate register for the recording of all rights and interests of the Government in or under patents and applications for patents (Roosevelt's Executive Order 9424, 2/18/44)

- Register value-added

Figure 1: Example Government Register index cards

Tool 3: More complete data on direct government interests in life-science patents

- Combining information from front-page, iEdison, USPTO Assignments Database, and that buried in Certificate of Collection images
- Exploring determinants of under-reporting (and potential policy solutions)
- Exploring using patent-paper pairs to smuggle in grant acknowledgements from “twin” papers

Towards a user guide

Best practices

- Be careful about assuming patents=innovation. Differences within and across fields.
- When possible, triangulate any results (assessments) using patent data with non-patent measures as well.
- Adjust for patent quality, even imperfectly (citation counts; family size; Kogan et al market value data; novel patents). Pay attention to the top of the distribution.
- Government interest statements: Go beyond the front-page. Where possible (it is for agencies) look at iEdison data as well, and PTO assignment database.
- Frontier research goes beyond “front page” citations to measure spillovers from public research. In-text citations (and other text-based approaches) increasingly common (and exciting!) though validation is needed.

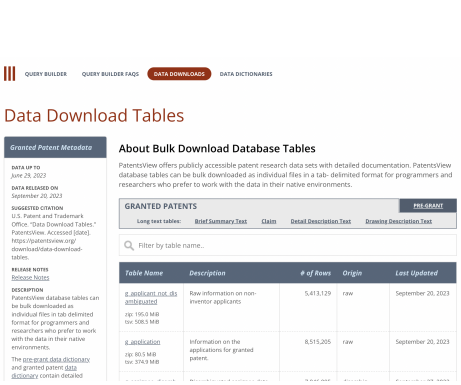
For funding agencies

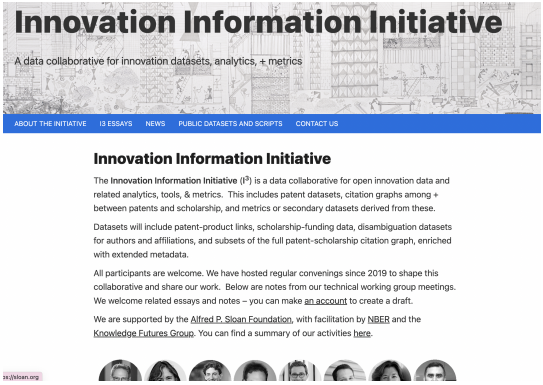
- Much of what we can reasonably say using patent data is context-specific (for a given field, agency, program)

- Qualitatative understanding of what patents mean in a specific agency (field) context is important
  - What share of “innovation” is patented in the field?
  - How “innovative” are patents on average?
  - What share of research impact is reasonably seen through patents, vs other channels? (Think about HIV, or Covid-19).

- Where can funding agencies help?
  - Systematic validation studies of patent-based measures needed, even for the standard measures. Academic incentives need to change to get these done.
  - Surveys of funded researchers may also be useful in validating patents, citations, and other metrics for impact.
  - In many (most?) cases, investing in creation/validation of new non-patent measures of impact will be crucial (cf. Lazear 2003)

Where to get it?





USPTO PatentsView: `https://patentsview.org/download/data-download-tables`
NBER I3: `https://iii.pubpub.org/`

Where are we, 3 decades later?

Journal of Economic Literature
Vol. XXVIII (December 1990), pp. 1661–1707

Patent Statistics as Economic Indicators: A Survey

By Zvi Griliches
Harvard University

I am indebted to my friends and collaborators for many ideas and comments. Parts of this survey borrow heavily (often verbatim) from our earlier work on this topic, especially from Griliches, Ariel Pakes, and Bronwyn Hall (1987), Griliches, Hall, and Pakes (1988), and Griliches (1989). I am indebted to the National Science Foundation (PRA85–12758 and SES 82–08006) and the National Bureau of Economic Research Productivity Program for financial support of this work and to B. Hall, A. Pakes, K. Pavitt, M. Schankerman, and F. M. Scherer for their comments on an earlier draft. The first draft of this survey was begun while I was a guest of the Rockefeller Foundation at the Bellagio Study and Conference Center in Italy. An earlier version of this paper was presented as the W. S. Woytinsky Lecture of 1989 at the University of Michigan.

Overheard at a Catskills Resort (one guest to another):
—The food is so terrible here.
—Yes. And the portions are so small.

Appendix

Direct links

National Eye Institute grant R01EY0333, "Ocular Fluid Composition and Tissue Physiology" (First Awarded in 1967)

Patent 4,599,353," Use of eicosanoids and their derivatives for treatment of ocular hypertension and glaucoma" (Filed in 1982, Granted in 1986)

Government interest section of the patent references the '333 grant:

> The invention described herein was made in the course of work under U.S. Public Health Service Research Grant Numbers EY 00333 and EY 00402 from the National Eye Institute, Department of Health and Human Services.

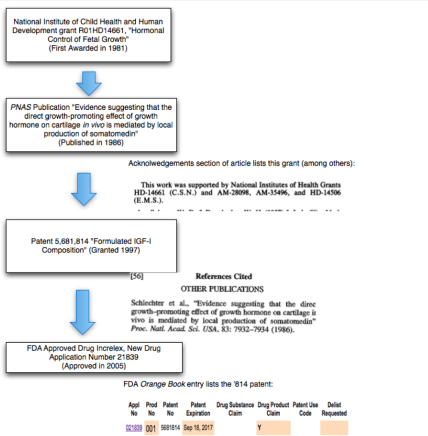
FDA Approved Drug Xalatan, New Drug Application Number 20597 (Approved in 1996)

FDA *Orange Book* entry lists the '353 patent:

20597,1,"LATANOPROST; XALATAN","4599353

▸ Back to Sampat/Lichtenberg

Indirect links



▸ Back to Sampat/Lichtenberg

In-text citations: motivation

- Front-page citations: duty of disclosure; In-text: help with enablement requirement; more likely from inventors (than lawyers or examiners)

- Narin and Noma (1985): In-text references “may be more related to the history, usefulness, and development of the invention”... but front-page “far easier to extract”

Back to in-text citations

In-text citations: details

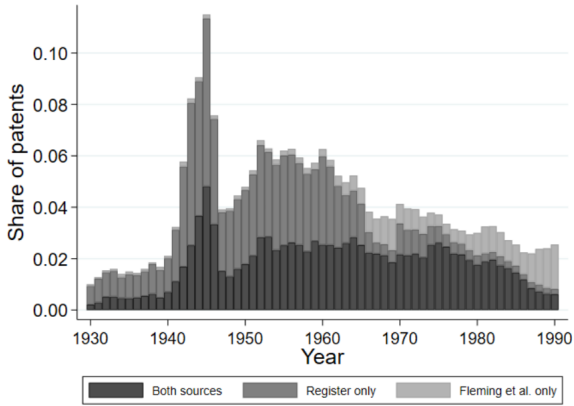
- Bryan, Ozcan, Sampat (2020): Develop an algorithm to extract front-page/in-text citations to 248 journals, for patents issued since 1984 (2,786,041 citations)
- Only 24 percent of the front page citations are cited in-text in the same patent, and only 31 percent of the in-text citations are cited on the front page
- Three validation studies suggest in-text are more related to various other measures of knowledge flows
- In-text also unrelated to patent value; front-page are (cf. Sampat 2010)
- Marx and Fuegi (2022) scale up the Bryan et al algorithm to the universe of patents/article, include front-page citations as well

Back to in-text citations

The Government Patent Register: value added

Figure 6: Comparison to Fleming et al. (2019)

Panel (A): All interests (title + license)



Back to Register