Lecture 9: Incentives for Firms: patenting system, cooperative arrangements

U.S. Constitution Article I Section 8 | Clause 8 – Patent and Copyright Clause of the Constitution. [The Congress shall have power] "To promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." 1790 US Patent Act granted a patent to a petitioning inventor for an invention/discovery "*not before known or used"* AND "*sufficiently useful and important"*.

Mark Twain: "a country without a patent office and good patent laws was just a crab and couldn't travel anyway but sideways or backwards" ; Abraham Lincoln: "The Patent System added the fuel of interest to the fire of genius."

"The origins of patents for invention are obscure and no one country can claim to have been the first in the field with a patent system." (UK Intellectual Property Office) . Dated back to the 1400s, Britain, Italian city-states.

From June 8, 1995, *utility and plant* patents protect article's function for 20 years after date applied for. *Design* patents protect an article's design – its unique external appearance- for 14 years from date patent is granted.

In 2018 the U.S. Patent and Trademark Office (USPTO) received 597,141 utility patent applications, of which 52.3% were of foreign origin – https://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.htm

World's most famous patent examiner:

Inventor and Patent owner for using FENUGREEN

So, what is a patent?

A temporary monopoly to deal with public goods aspect of knowledge. The patent gives incentive: to develop product for market; **and** to make public the information about the discovery. Gives people a legal document that distinguishes their product from others and makes it illegal to copy it exactly, though firms do copy and say "sue me".

Patents are solution to knowledge being a public good; people can use it without destroying its use by others (which makes knowledge better than public goods which degrade as more people use it → tragedy of common.) The fear is that if inventor/firm cannot prevent others from using any new idea they think of to produce a product/process, they cannot profit from it and **thus will have less incentive to invest in researching the knowledge. So give exclusive right to person to produce the patented invention. Prevents others using it but allow them to know about it**

Also meant to discourage industrial secrecy. You have idea but keep it hidden so only you can make money from it while others cannot build on that knowledge. But they might back-engineer it and find alternative way to produce your product. Secrecy provides less information about product and thus likely to be harder to work around than patent.

Having legal patent may have other virtues: signal investors that your technological innovation is real or potentially profitable: "patenting may be playing a heretofore under-appreciated and important role in helping start-ups to secure investment from various sources, including "friends and family" and commercial banks." (Berkeley Patent study). Another way go signal that your work has value is to get an outside grant: If I get a DOE, NIST, etc grant for R&D, management will view my project more favorably. Similarly for scientists-engineers in academia.

Countries often change patent policies. US has extended patents to biotechnology and other areas, Lerner examined 177 policy shifts across countries over time (*Lerner*, Josh, *150 Years of Patent Protection* January 2000. NBER Working Paper No. W7478) . US strengthened patent protection in 1980s and 1990s. Good? Bad? 2011 passage of the Leahy-Smith America Invents Act converted the patent system from a 'first to invent' to a 'first inventor to file' system.

What happens when you apply for patent

USPTO matches each application to a qualified examiner. First, each application is assigned to an "art unit" comprised of ... examiners who specialize in a particular technology. Then the application is assigned to an examiner within that art unit. … examiner specialization persists even after conditioning on technology sub-classes. Specialization is less pronounced in computers and software than other technology fields. More specialized examiners have a lower grant rate. These findings undermine the idea that random matching justifies instrumental variables based on examiner behaviors or characteristics. "Patent examiner specialization" Righia and Simcoeb **Research Policy 2019**

Three costs of patents

1)Gives monopoly power to charge P> MC and restrict output (think high prices of drugs by forbidding generics).

2) Sets up a tournament with a danger that Patent Race may cost more than value of prize: Too many resources on R&D to win the patent. Invention is worth $100 to society/ discriminating monopolist. In world of 20 firms each firm invests $10 to gain the monopoly. With 20 firms spending $10, the socially beneficial invention has negative social value: In equilibrium "excessive resources are allocated to search". If only one firm entered and spent < $100 would have social profit. (If monopolist gets all social value, they are richer and everyone else is the same, so society gains). But what is alternative world? Imagine everyone operated in secrecy race: 20 firms had similar idea in secret and spent the same. In science lots of duplicate discoveries and race to get answer to some puzzle. IF competitors add value in the form of knowledge, this would add extra benefit.

3) **Create an anti-commons feature that deters others from building on the patent:** If A has to pay B for the right to use their product as an input into other advances, this may deter A from research or building product. If there are lots of patents in an area –patent thicket – it may be difficult to make advances. Patent "trolls" gather up patents, do not produce an idea nor a product but "arbitrage" patent use. (Heller and Eisenberg, Can Patents Deter Innovation? The Anti-commons in biomedical research" Science, May 1, 1988) But maybe some inventors have incentive of selling patent to troll just as some start-ups sell to large firm to develop their discovery.

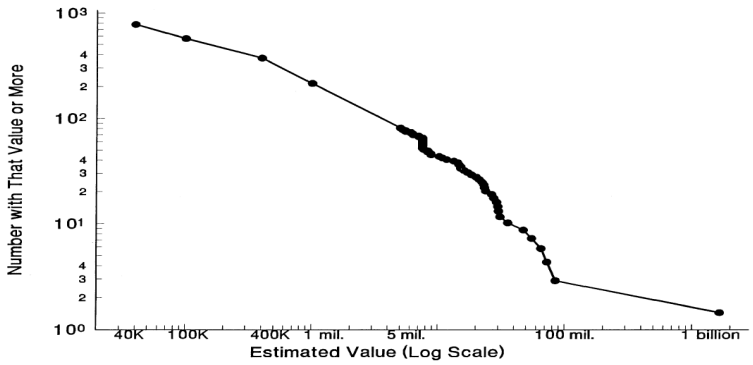
"On the other hand" (Vishnubhakat, GMU (https://sls.gmu.edu/cpip/wp-content/uploads/sites/31/2014/04/The-Commercial-Value-of-Software-Patents.pdf): argues for **Patent as Option to inventor /**owner to exclude others from economic activities centered on the patented invention: making, using, selling, offering to sell, and importing, (leaving) ...the patent owner the choice of engaging in those activities for itself. **Option is opportunity to participate in some type of market transaction.** US courts have long held that employees have the right to patent their inventions as first inventors, but employees and their employers are free to transfer these rights by contract... in contrast to Germany and Japan, which impose mandatory rules that all employees must receive patents on their own inventions.

"Microsoft's pioneering decision in the 1980s to license its Windows operating system to all computer manufacturers and software developers. Each of these reasons can lead to different business models and investment decisions in R&D as well as commerce. The flexibility of patents as options encourages the wide range of these choices in technological and commercial development. "

So HOW MUCH $$$ IS PATENT WORTH? Market Values Patents Positively (but values most as 0):

1) If you ask them, "If in 1980 you had known how its contribution to the future profitability of your enterprise would unfold, what is the minimum price for which you would have sold the patent, assuming that you had a good-faith offer to purchase?" Find heavy tailed distribution-- ln nornal **power law** (Economics, Law and Intellectual Property pp 279-309|Exploring the Tail of Patented Invention Value Distribution DHarhoff F M. Scherer Katrin Vopel

Figure 3
Plot of All Renewed German Patent Values on Pareto Coordinates



Data Source	Patents resp. Portfolio Firms	Value Share of Top 10% Patents/Firms
German Patents (1977)	772	88%
USPTO Patents 1977	222	83%
University Patents USA	411	92%

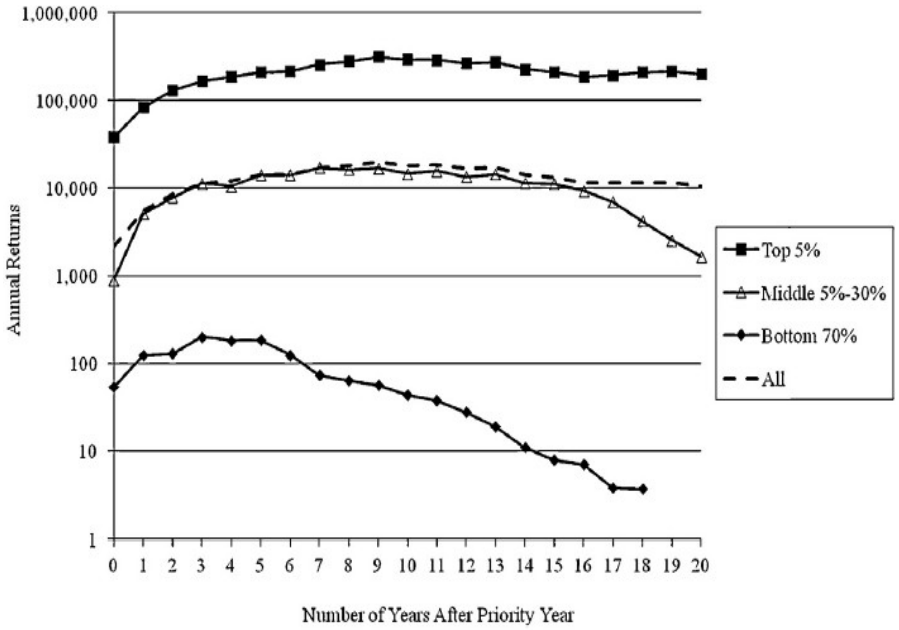
2) **Estimated from compensation to inventors bcs** The **German Employees' Inventions Act (**GEIA) requires

Valuation of Patent	Cases	Percent
< DM 100,000	203	27.0 %
DM 100,000 — 399,999	200	26.6 %
DM 400,000 — 999,999	154	20.5 %
DM 1 - 5 million	129	17.2 %
DM 5 - 10 million	28	3.7 %
DM 10 - 20 million	16	2.1 %
DM 20 - 40 million	15	2.0 %
DM 40 - 80 million	5	0.7 %
> DM 80 million	2	0.3 %
Total	752	100.0 %

German enterprises and affiliates of foreign companies operating in Germany to provide employees compensation beyond their normal salary and wages for inventions that specify that the **employee's compensation is to be proportional to the realized private value of the invention -->**Jesse Giummo, "Examination of the intertemporal returns of patented inventions" Research Policy 2014) – Returns earned by most patents dissipate rapidly, high valued patents tend to receive significant returns through the latter part of the patent term and account for the vast majority of the realized returns,

Table 1
Distribution of cumulative returns measured in 1977 DM.

Value DM	Cases (% total)	Value million DM (% total)
0	415 (37.69)	0 (0.00)
1–4,999	324 (29.43)	0.85 (0.28)
5000–49,999	191 (17.35)	2.98 (0.97)
50,000–499,999	67 (6.09)	16.24 (5.26)
500,000–1,999,999	63 (5.72)	63.64 (20.62)
2,000,000–4,999,999	28 (2.54)	91.93 (29.79)
5,000,000–9,999,999	7 (0.64)	44.10 (14.29)
10,000,000–19,999,999	6 (0.54)	88.82 (28.78)
≥20,000,000	0 (0.00)	0 (0.00)
Total	1101 (100.00)	308.56 (100.00



3)**Value estimated through the use of what people pay to license patent –** calculated based on the product of a representative royalty rate for a third party license of the non-exclusive right to use the invention and the relevant value of production associated with the invention. The value of invention externally utilized (such as inventions licensed or sold) is set equal to the net earnings of the invention, where net earnings are equal to earnings net the costs of developing the invention. BUT "Licensing estimates of patent value under-estimate the value of an invention, as the licensor in a licensing contract will not appropriate the full value of the invention to the licensee.

4)Another way to value patents is by looking at cost of taking out a patent and its renewal rate

It takes money and resources to apply for a patent. If it cost huge sums, few would take out a patent. Similarly it takes money and resources to renew a patent. The costs of applying and of renewals put bounds on the value of patents.

The implicit value of a patent is revealed when its owner pays a renewal fee, implying that the patent is worth more than the fee required to keep it in force.

Harhoff et al Research Policy 2009 "Patent validation at the country level—The role of fees and translation costs". show that these costs in the European Patent Office, where after gaining a patent, firms have to translate and validate in different countries to get it enforced impact the number of patents Using a gravity model with distance between countries affects the cross-country validation, they find that the costs matter.

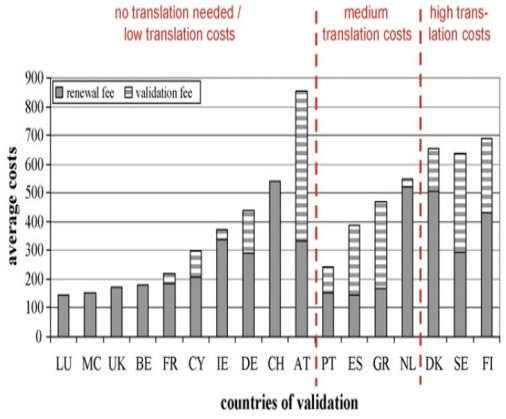


Fig. 5. Average costs (validation fees and renewal fees) to be paid to validate a patent in a particular member state of the EPC and to keep it in force for the years 4–6 (patents granted in 2003), costs sorted by translation cost groups.

Table 2
Multivariate analysis of patent flows between two countries for 2003 (heteroskedasticity-robust regression, N = 328).

Dependent variable	log(validation flows)					
	Model (1)	Model (2)	Model (3)	Model (4a)	Model (4b)	Model (5)
log(GDP per capita of country A)	1.698*** [0.201]	1.501*** [0.169]	1.503*** [0.166]	1.512*** [0.164]	1.502*** [0.165]	1.511*** [0.163]
log(GDP per capita of country B)	0.935*** [0.155]	0.630*** [0.132]	0.262* [0.151]	0.116 [0.153]	0.539*** [0.200]	0.406** [0.154]
log(population of country A)	0.789*** [0.042]	0.888*** [0.039]	0.887*** [0.038]	0.886*** [0.036]	0.888*** [0.037]	0.887*** [0.036]
log(population of country B)	0.311*** [0.040]	0.300*** [0.036]	0.225*** [0.039]	0.271*** [0.038]	0.265*** [0.042]	0.280*** [0.039]
log(distance between capital cities)		−0.502*** [0.046]	−0.485*** [0.044]	−0.474*** [0.043]	−0.485*** [0.044]	−0.473*** [0.044]
log(years of EPC membership of country B)			0.518*** [0.124]	0.401*** [0.124]	0.365*** [0.134]	0.368*** [0.125]
log(validation fees)				−0.083*** [0.021]		
log(renewal fees for years 4–6)					−0.300** [0.122]	
log(validation fee + renewal fees)						−0.341*** [0.084]

Renewal – Bessen paper Research Policy 37, 2008, 932-945 – cost of renewal and PV estimate of value

	Percent expired during			Percent full term	Percent small	Number
	4th year	8th year	12th year			
All	20.21	20.95	17.31	41.52	29.33	94,342
Assignee type						
Unassigned and individuals	36.05	26.14	15.43	22.38	88.24	17,786
Non-public organizations	18.21	20.41	17.00	44.38	45.34	17,229
Publicly listed firms	13.70	19.37	16.58	50.35	9.77	21,904
Foreign organizations	17.43	19.66	18.78	44.13	2.34	37,423
PTO entity status						
Small	32.22	25.72	16.66	25.40	100.00	26,768
Large	15.46	19.06	17.57	47.91	0.00	67,574
Technology category						
Chemical	19.10	21.19	18.63	41.08	15.73	18,175
Computers and communications	11.74	17.46	17.56	53.24	14.51	9,816
Drugs and medical	20.11	20.66	15.13	44.10	36.87	8,288
Electrical and electronic	16.28	19.28	17.45	46.99	18.91	16,481
Mechanical	21.65	21.62	17.72	39.00	31.73	21,561
Other	27.11	23.22	16.34	33.33	51.82	20,021
Mean fee ($92)	814	1562	2327			

Table 7
Comparison of estimates of patent value

Study	Patent issue year	Patent country	Group	Patent value (92 $U.S.)	
				Median	Mean
This paper	1991	U.S.	All U.S. patentees	7,175	78,168
	1985–1991	U.S.	U.S. public firms, manufacturing	18,010	113,067
Other U.S. studies					
Barney (2002)	1986	U.S.	All	5,849	61,896
Serrano (2005)	1983–2002	U.S.	Small business patentees	17,361	47,456
Putnam (1996)	1974	U.S.	Also filed abroad		188,355
			All (imputed)		78,800

Renewal Rate Analysis The value of invention patents in China: Country origin and technology field differences Zhang Gupeng, , Chen Xiangdong . estimate(s) value of the invention patents based on SIPO records in China and compare values of patents between local owners and owners from the U.S., Japan and European countries... **patent value from Chinese owners is much lower than that of overseas owners**. This larger value gap implies important difference in motive of the patenting and R&D quality between China and those technology intensive sources usually from economically advanced countries and regions. The model … is also applied to patent data in different technical fields, successfully differing technical sectors with higher value (e.g., machinery) and those with lower value (e.g., pharmaceuticals), in terms of China market based patent records.

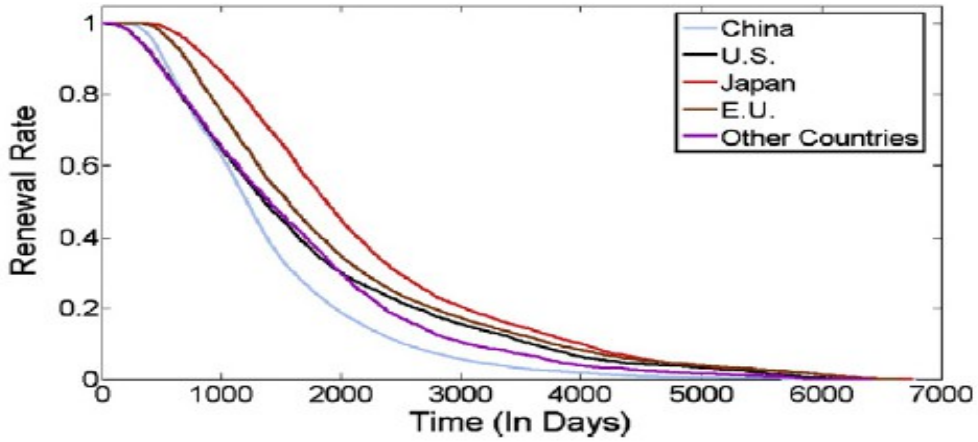


Fig. 2. Comparison of Kaplan-Meier survival curve by owners among different countries — patent records in China.

5)Patent Auctions – Ocean Tomo is a platform that offers periodical patent auctions. www.oceantomo.com/auctions/

(http://oceantomobidask.com/)

Ocean Tomo, the Intellectual Capital Merchant Banc™ firm, provides companies with financial services related to intellectual property and intangible assets including financial expert testimony, valuation, strategy consulting, patent analytics, investment advisory, innovation management consulting and transaction brokerage.

Table 1
Ocean Tomo sales 2006–2009.

Auction	Patents	Lots	Patents sold	Lots sold	Sales (mil. $)
Spring 2006	421	77	99	27	3.25
Fall 2006	251	71	36	21	5.74
Spring 2007	163	65	90	35	12.53
Summer 2007	155	44	35	13	7.22
Fall 2007	133	76	56	37	11.26
Spring 2008	166	83	115	51	19.24
Summer 2008	101	60	57	26	9.74
Fall 2008	158	99	58	43	12.15
Spring 2009	169	77	23	6	2.76
Summer 2009	67	26	4	3	1.22

Model 2a – OLS on price of all sold patents

Observations	573	
Dependent variable	Logarithmic price	
Variable	Coef.	(SE)
ln forward citations (five years)	.302***	(.059)
ln self-citations (five years)	.125	(.173)
ln backward references non-pat. lit.	.014	(.045)
ln backward references patent lit.	−.021	(.064)
Family size	.004***	(.001)
Number of four-digit IPC classes	−.045	(.057)
Generality	−.075	(.147)
Number of claims	.009***	(.003)
Patent age	−.0003**	(.0001)
Single-patent lot patent dummy	.764***	(.108)
Reassignments	−.071	(.056)
Patent portfolio size	−.000008	(.00002)
Patent application cohort controls	10 of 19 significant	
Auction controls	9 of 9 significant	
Four-digit IPC class controls	4 of 12 significant	

Testing patent value indicators on directly observed patent value—An empirical analysis of Ocean Tomo patent auctions Timo Fischer, Jan Leidinger RESEARCH POLICY Volume 43, Issue 3April 2014Pages 519-529

6) **Stock market values companies with patents: Value of patents in stock market** M. Hirschey, V.J. Richardson / Journal of Empirical Finance 11 (2004) 91–107:

7)

Table 3
Overall sample stock price equations with industry and period effects, 1989–1995 (n=1720)

	OLS model (no fixed effects)	Fixed industry effects	Fixed period effects	Fixed industry and period effects
Independent variables				
Intercept	−0.021 (−1.52)[a]	−0.052 (−3.29)[b]	−0.029 (−2.02)[c]	−0.058 (−3.46)[b]
Market value for prior period (P_{t-1})	0.339 (5.44)[b]	0.327 (5.18)[b]	0.347 (5.48)[b]	0.335 (5.23)[b]
Number of Patents (*Patents*)	1.373 (2.37)[b]	1.383 (2.37)[b]	1.366 (2.39)[b]	1.376 (2.38)[b]
Citations index (*CI*)	0.023 (3.79)[b]	0.024 (3.82)[b]	0.022 (3.61)[b]	0.024 (3.70)[b]
Non-Patent References (*NPR*)	0.010 (4.07)[b]	0.008 (2.48)[b]	0.009 (3.53)[b]	0.007 (2.01)[c]
Technology Cycle Time (*TCT*)	0.006 (1.26)	0.010 (2.10)[c]	0.006 (1.30)[a]	0.010 (2.13)[c]
R&D Expenditures (*R&D*)	3.240 (2.83)[b]	3.280 (2.79)[b]	3.199 (2.81)[b]	3.242 (2.77)[b]
Earnings (*Earnings*)	1.079 (2.21)[c]	1.087 (2.19)[c]	1.070 (2.22)[c]	1.079 (2.20)[c]
Fixed effects (F-stat.)		1.69[c]	5.16[b]	2.44[b]
R^2 (%)	86.5	86.9	86.8	87.1
F-stat. (entire model)	75.67[b]	58.56[b]	44.89[b]	40.73[b]

Dependent variable is market value for the current period (P_t).
All variables are entered using a natural log transformation (t-statistics in parentheses).
[a] Indicates significance at the 10% level (one-tailed test).

Bloom Van Reenen, EJ 2002 March: Event study: Find discrete event where information is released to market and see whether it affects share price. Sounds like great experiment. Just look before and after, but for reasons we do not understand, sometimes get immediate response and sometimes not. V = market value; K= book value of assets; G = stock of patents.

$$\log\left(\frac{V}{K}\right)_{it} = \delta\left(\frac{G}{K}\right)_{it} + \eta_i + \tau_t + \upsilon_{it}$$

Table 6

Market Value with Patents Measures

$log(V_{i,t}/K_{i,t-1})$	(1)	(2)	(3)	(4)	(5)
Patent Stock/Capital	1.221**			−0.533	1.002**
	(0.492)			(0.755)	(0.492)
Cite Stock/Capital		0.345***			
		(0.140)			
5 Year Cite Stock/Capital			0.435**	0.443**	
			(0.206)	(0.228)	
Cite Stock/Patent Stock (ave. cite per patent)					0.015
					(0.010)
Firm dummies	yes	yes	yes	yes	yes
Time dummies	yes	yes	yes	yes	yes
No. observations	2,138	1,821	1,821	1,821	1,821
No. firms	172	158	158	158	158

Notes: The dependent variable is 'log (market value/lagged capital)'. Due to the need for a lagged

AUSTIN, D. H. (*1993*), **An event-study approach to measuring innovative output: The case of *biotechnology*.** AER. (Papers and Proc. 105th Ann): The data consist of all 565 patents owned, as of November 1991, by the 20 largest biotechnology firms (by market value as of December 1988) and of associated returns to firm equity. I have identified **17 products for which there has been competition in R&D** among two or more sampled firms. Scanning the texts of the patents for product keyword . Compares the return post the event period with return in market. Key is whether the patent grants were announced in The Wall Street Journal (WSJ). This criterion is selective: only 17 of 258 patents in the sample are "WSJ" patents; 12 are also product-linked

TABLE 1—MEAN VALUES OF EXCESS RETURNS

		Percentage excess returns		
Group	N	Mean	SD	t (p value)
PROD = 0	198	0.33	5.41	1.58 (0.12)
PROD = 1	60	1.91	7.17	
WSJ = 0	241	0.27	5.42	3.09 (0.01)
WSJ = 1	17	6.78	8.58	

$$(r_{it} - r_{ft}) = \alpha_i + \beta_i(r_{mt} - r_{ft}) + \sum_{\upsilon} \delta_\upsilon D_{\upsilon t} + \varepsilon_{it} \qquad t = 1, \ldots, T$$

where

r_{it} = return on shares in firm i over the time-t event window;
r_{ft} = risk-free rate of return from inflation-adjusted 30-day T-bill rate at time t;
r_{mt} = return on value-weighted S&P 500 market index at time t;
$D_{\upsilon t}$ = indicator variable equal to 1 if event υ occurs within the time-t window, 0 otherwise. Here the D_υ dummy stands for

Patents are count data and right-skewed non-negative integer distribution. Issues with Count data: Poisson and Negative Binomial econometrics Joseph M. Hilbe Negative Binomial Regression, Second Edition Cambridge University Press A. Colin Cameron Pravin K. Trivedi Regression Analysis of Count DataTherefore should adjust calculations to take account of this, as with logit and probit for 0/1 variables. Poisson is the usual count distribution.

Poisson distribution – discrete random variable variables k = 0, 1, 2, has probability

$$f(k;\lambda) = \Pr(X = k) = \frac{\lambda^k e^{-\lambda}}{k!}, \qquad \lambda = \mathrm{E}(X) = \mathrm{Var}(X).$$

Useful with large number of rare events – patents with high values.

Poisson is related to Binomial and Normal. Binomial with B(n, p =λ/n) ---> Poisson distribution with parameter as n-->infinity and p is small. Poisson looks very normal when λ > 10.

Fundamental problem with Poisson is that distribution is parameterized with a single parameter so that all moments of y are a function of λ. Normal distribution has separate parameters for location (μ) and scale (σ2).

In fact, in many applications a Poisson density predicts the probability of a zero count to be considerably less than is actually observed in the sample. This is **excess zeros problem,** aka over dispersion. Variance in data is usually > mean so the single parameter specification is wrong..

Common way to deal with problem is to use **negative binomial, which has two parameters and thus gives extra degree of freedom to resolve over-dispersed/zeros problem** see Winkelmann (1995). A discrete choice model that progressively models Pr[y = j|y ≥ j − 1] is presented and issues of dependence also arise in time series.
The negative binomial model can be obtained in different ways – way is as a *mixture distribution.* Suppose the distribution of a random count y is Poisson, conditional on the parameter λ, which is distributed as a gamma distribution

Wikipedia. "The negative binomial distribution is a discrete probability distribution of the number of successes in a sequence of independent and identically distributed Bernoulli trials before a specified (non-random) number of failures (denoted r) occurs. For example, if we define a 1 as failure, all non-1s as successes, and we throw a dice repeatedly until the third time 1 appears (r = three failures), then the probability distribution of the number of non-1s that had appeared will be a negative binomial." Number of successes before r failure has expected number rp/(1 − p).
and variance is rp/(1 − p)2, which is bigger variance. **The key is that it adds a second parameter. This is mindful of problem of power laws – single parameter distribution that often falls short of predicting upper tail.**

What does the data look like? Bound et al in Griliches 1984 NBER volume: we set log patents to zero for all zero patent observations and allow those firms to have a separate intercept (PATDUM) in our regressions

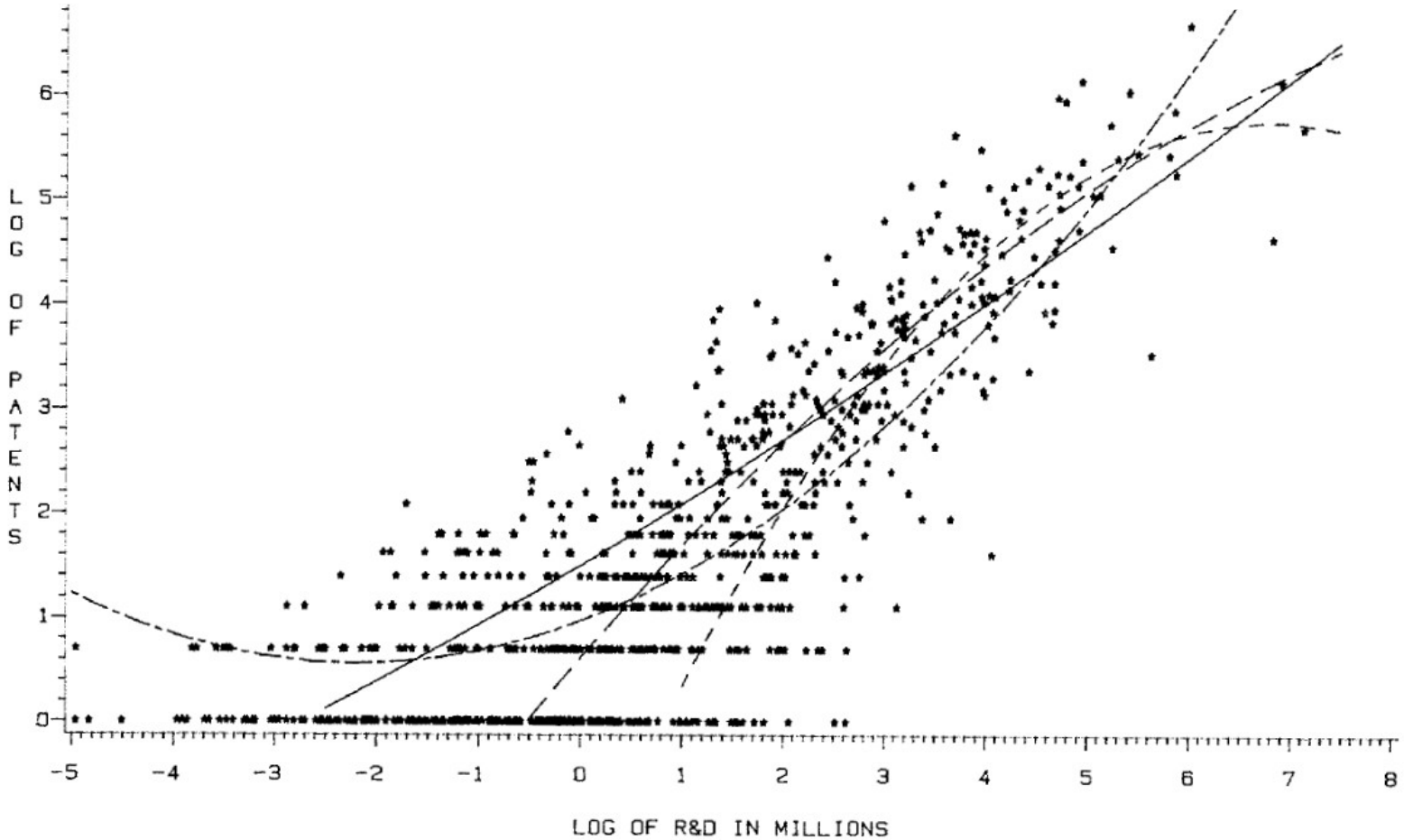
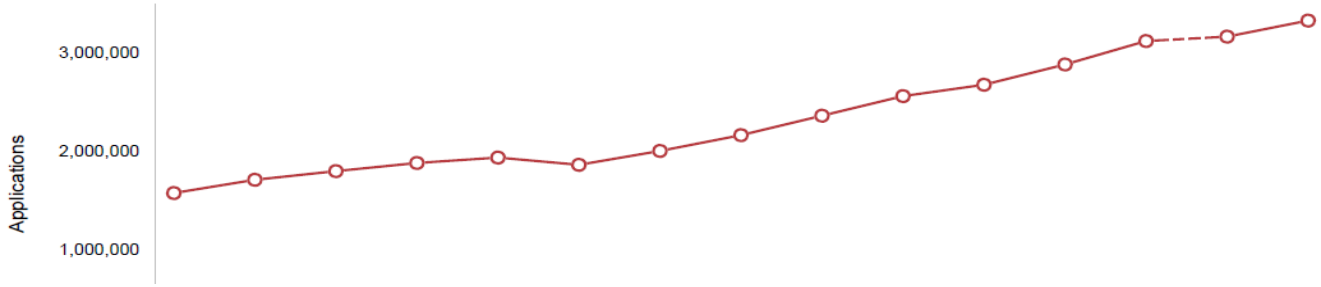


Fig. 2.5 Predictions for models with log R, $(\log R)^2$, $D(R = 0)$, no industry dummies, 831 observations plotted (tota = 2,582)(*** = data, — = NB, - - - = NLLS, — — — = OLS, —— = Pois).

WORLD PATENT FACTS

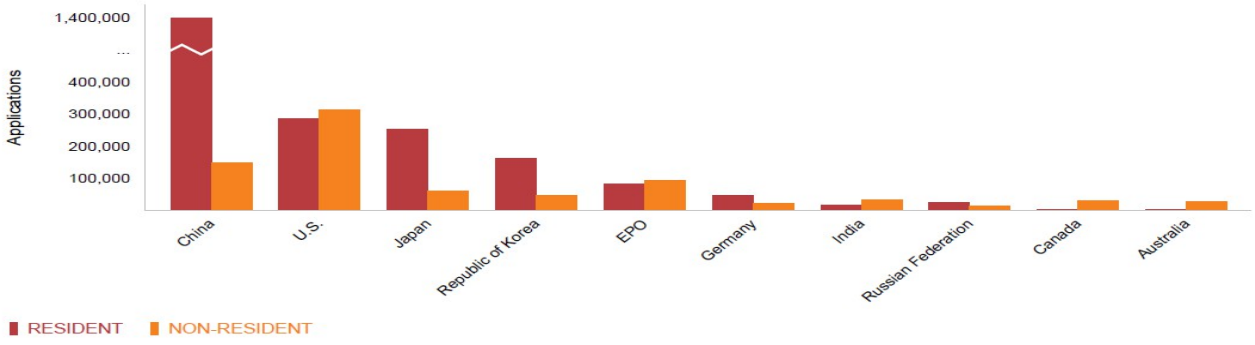
Patent applications filed worldwide reached 3.3 million

1.1. Patent applications worldwide, 2004–2018



China received 46.4% of all patent applications filed worldwide

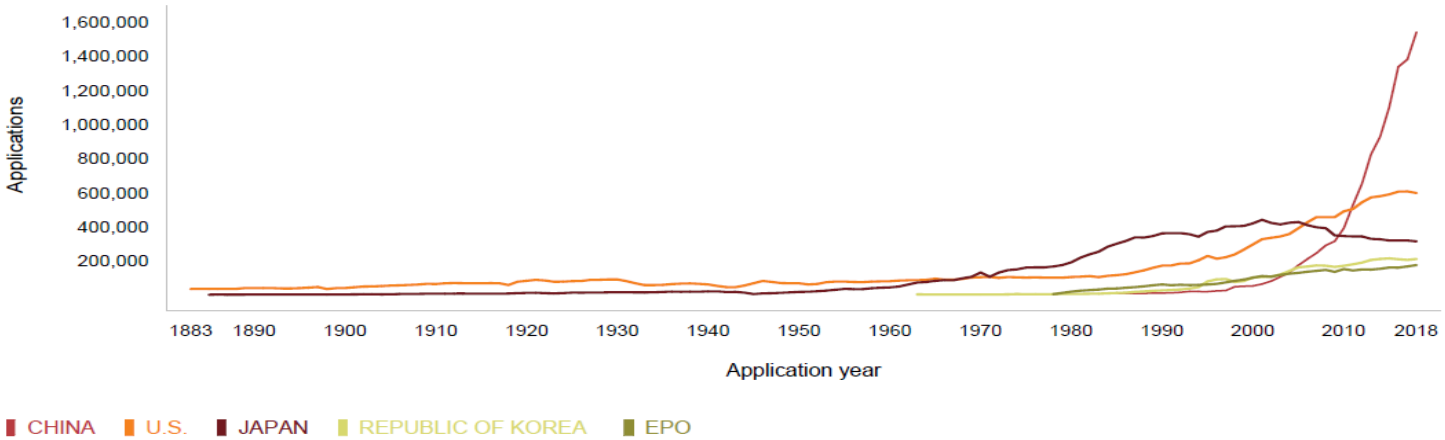
1.2. Patent applications at the top 10 offices, 2018



Patent filings since 1883

From 1883 to 1963, the patent office of the U.S. was the leading office for world filings. Application numbers in Japan and the U.S. were stable until the early 1970s, when Japan began to see rapid growth – a pattern also observed for the U.S. from the 1980s onward. Among the top five offices, Japan surpassed the U.S. in 1968 and maintained the top position until 2005. Since the early 2000s, however, the number of applications filed in Japan has followed a downward trend. Both the EPO and the Republic of Korea have seen increases each year since the early 1980s, as has China since 1995. China surpassed the EPO and the Republic of Korea in 2005, Japan in 2010 and the U.S. in 2011 – and it now receives the largest number of applications worldwide. There has been a gradual upward trend in the combined share of the top five offices in the world total – from 75.3% in 2008 to 85.3% in 2018.

Trend in patent applications for the top five offices, 1883–2018



Note: The IP office of the Soviet Union, not represented in this figure, was the leading office in the world in terms of filings from 1964 to 1969. Like Japan and the U.S., the office of the Soviet Union saw stable application numbers until the early 1960s, after which it recorded rapid growth in the number of applications filed.

Source: Figure A7.

Some Patent Excitement

BBC 15 January 2013: A surge in research into the novel material graphene reveals an intensifying global contest to lead a potential industrial revolution. Latest figures show a sharp rise in patents filed to claim rights over different aspects of graphene since 2007, with a further spike last year. China leads the field as the country with the most patents. South Korean electronics giant Samsung stands out as the company with most to its name. The figures, compiled by a UK-based patent consultancy, CambridgeIP, highlight how Britain, which pioneered research into graphene, may be falling behind its rivals.

Nationality	Number of graphene patent publications
Chinese entities	2,204
US entities	1,754
South Korean entities	1,160
United Kingdom entities	54

NEW YORKER NOVEMBER 22, 2013 Apple vs Samsung: A Patent War with Few Winners

Yesterday, Apple won the latest skirmish in a long-running global patent war against Samsung. The jury's awarded Apple more than two hundred and ninety million dollars in damages for patent infringements on both the iPhone's graphical user interface and its physical design. Altogether, after two trials in a federal court in California, Samsung now owes Apple nearly nine hundred and thirty million dollars. That's good for Apple, and for its mission to mark the iPhone as a singular accomplishment of technology and design.

But is it good for innovation? No. The verdict was a limited retrial, in which the jury was simply asked to re-calculate the amount of money that Samsung owed Apple after it lost the original trial, in August of 2012. At the time, the jury awarded Apple almost $1.05 billion.... Afterwards, Samsung's lawyers painstakingly "reverse engineered" the jury's verdict, and discovered that the jurors had made some mistakes. Judge Koh agreed that the jury miscalculated the time periods in which fourteen Samsung devices, such as the Galaxy Tab and Droid Charge, infringed on Apple's patents. In March, she readjusted the verdict, scheduled a second trial, so that a jury could re-calculate how much money Samsung owed Apple. The second trial concluded this week.

On Wednesday, the U.S. Patent and Trademark Office issued an intermediate decision invalidating Apple's "pinch-to zoom" patent as "anticipated or rendered obvious" by prior technologies. In other words, the Patent Office decided—at least preliminarily— that it should never have given Apple a patent for "pinch-to-zoom" in the first place, because somebody else had already invented it. In response, Samsung filed an emergency motion, arguing that the case should be frozen until the fate of "pinch-to-zoom" is determined. While Samsung's lawyers chose not to argue the point, they are expected to appeal the entire verdict. This is the latest patent-related setback for Samsung, a company that has had a difficult few months in courthouses around the world. This summer, the U.S. International Trade Commission found that Apple and Samsung infringed each other's patents. **While the Obama Administration vetoed the resulting I.T.C. ban on Apple products, it upheld ban on Samsung products.**

Apple wins $539 million from Samsung in latest chapter of ongoing patent trial: Is it over yet? May 24, 2018, Verge Apple and Samsung have finally put an end to their long-running patent battle whose central question was whether Samsung copied the iPhone. In a court filing today, Judge Lucy Koh said the two companies had informed her that they had reached a settlement. Terms of the settlement were not disclosed.

The patent battle started in 2011 and initially resulted in a $1 billion ruling in Apple's favor. But it didn't end there. A series of appeals pushed the dispute to the Supreme Court and back, as the companies continually rehashed which patents were infringed and, more recently, exactly how much Samsung owes Apple because of the infringement. The case revolved around a number of design and utility patents for basic functions of a smartphone, like tap to zoom and the home screen app grid. But while the fight was hashed out using specific patents, the battle was ultimately about whether Samsung copied Apple in the early days of smartphones to gain an edge. The jury decided that, in many ways, it had.Most recently, the verdict had been whittled down to $539 million for Apple. Samsung filed to appeal that earlier this month. But the two companies were able to reach an agreement before it could be litigated again. https://en.wikipedia.org/wiki/Apple_Inc._v._Samsung_Electronics_Co.

Apple declined to give terms of the settlement and pointed to a statement it made in May, when the case was last ruled on: This case has always been about more than money. Apple ignited the smartphone revolution with iPhone and it is a fact that Samsung blatantly copied our design. We're grateful to the jury for their service and pleased they agree that Samsung should pay for copying our products. Samsung declined to comment...

Apple and Samsung had one other major patent battle, which was first decided in 2014 but didn't end until last year. In that case, Apple won $120 million over violations of its slide-to-unlock patent and several others. The two companies also had patent fights going internationally, but they agreed to drop those lawsuits back in 2014. With both of these cases wrapped up, the seemingly endless, occasionally dramatic, and often extremely technical battle between these two smartphones giants is finally, officially over. At least until the next one.

CRISPR-CAS 9 Broad Institute vs Berkeley

Pivotal CRISPR patent battle won by Broad Institute Team from the University of California, Berkeley, loses appeal over coveted gene-editing technology. NATURE 10 SEPTEMBER 2018

A fierce and unprecedented patent battle between two educational institutions might be nearing a close,after a US appeals court issued a decisive ruling on the rights to CRISPR–Cas9 gene editing. On 10 September, the US Court of Appeals for the

Federal Circuit awarded the pivotal intellectual property to the Broad Institute of MIT and Harvard in Cambridge, Massachusetts, upholding a previous decision by the US Patent and Trademark Office. The decision spells defeat for a team of inventors at the University of California, Berkeley (UC), led by molecular biologist Jennifer Doudna..."

The dispute centred on the rights to commercialize products developed by using the CRISPR–Cas9 system to make targeted changes to the genomes of eukaryotes — a group of organisms that includes plant and animals. Although many patents have been filed describing various aspects of CRISPR–Cas9 gene editing, the Broad Institute and UC patent applications were considered to be particularly important because they covered such a wide swath of potential CRISPR-Cas9 products .

The zeal with which both institutions defended their patents was unusual, says Jacob Sherkow, a legal scholar at New York Law School in New York City. Normally, he says, such institutions would settle out of court before the case reached this point."This has been one of the single most heated disputes between two educational institutions over inventorship," says Sherkow. "..."UC could now appeal the decision to the US Supreme Court, but it is unclear whether the court would agree to hear the case. Since researchers filed the original CRISPR-Cas9 patents ….researchers have since discovered new enzymes to replace Cas9, and modified the CRISPRCas9 system to manipulate the genome in many ways, from editing individual DNA letters to activating gene expression.

Broad Institute Loses Appeal on European CRISPR Patent 24/01/2020

… the Boards of Appeal at the European Patent Office has revoked the claim of the Broad Institute to general patents on CRISPR/Cas9 gene editing technology,strengthening the position of its opponent UC Berkeley in Europe.
… While the Broad Institute has secured CRISPR patents in the US, the EuropeanPatent Offce (EPO) revoked one of its key patents (https://www.labiotech.eu/policy-legal-nance/crispr-patents-revoked-ers-genomics/) in 2018. Now, the Boards of Appeal of the EPO have corroborated this decision. The hearings that took place in Munich last week revolved around the filing date of one of the Broad Institute's CRISPR patents. The Broad was contending the decision of the EPO that the earlier filing date of a provisional application submitted in the US could not be considered the filing date of its patent application. The key issue was that the scientist Luciano Marrani, who was listed as an applicant in the provisional application, had not transferred his priority rights to the Broad Institute... (but to) Rockefeller University.

"This is important because if the rights were not sufficiently transferred to the Broad Institute then the filing date of the patent application would not have been the filing date of the provisional application, but the later filing date of the non-provisional application," said Ulrich Storz, Senior\Partner at Michalski Hütterman Patent Attorneys."This meant that journal articles that have been published in between those dates became novelty-destroying prior art.

Storz pointed out that there are other patents in the same patent family with the same ling date that might be affected by this decision and be revoked within the next few months. The main consequence of this decision is that the Broad Institute has lost its claim to general patents on CRISPR/Cas9 technology in Europe. However, the institute still has the option to make its claims narrower to secure its intellectual property in Europe... which might result in lower licensing and royalty fees."This situation is not very common in biotech," commented Storz. "We have similar
situations where there are rivaling patent pools from different parties in mobile communication technologies, but in biotech or pharma it is really something that is very rare. We weren't prepared, and that's why there have been so many problems with this technology, with this patent challenge."

The main reason behind this fierce battle is the potential of CRISPR/Cas9 technology to be used to create human therapies (https://www.labiotech.eu/crispr/crispr-technology-cure-disease/). Because these developments carry a high risk and involve huge investments, the exclusivity of intellectual property can be essential to secure investment. (But) ..."The situation is paralyzing small companies. They are afraid of being held liable for patent infringement so they'd rather not use the technology," **A solution to this problem would be setting up a patent pool, so that anyone that wants to use the technology can get a single license that covers the IP of all different parties. ...**The Broad Institute has stated it is open to discussing the possibility of a CRISPR patent pool in applications other than human therapies, but UC Berkeley has so far not positioned itself.

PATENT THICKET AND TROLLS

Concern about **patent thickets** from early days*: "In the manufacture with which I am connected – the sugar trade – there are somewhere like 300 or 400 patents. Now, how are we to know all these 400 patents? How are we to manage continually, in the natural process of making improvements in manufacture, to know which of these patents we are at any time conflicting with? So far as I know, we are not violating any patent; but really, if we are to be exceedingly earnest in the question, probably we would require to have a highly paid clerk in London continually analysing the various patents; and every year, by the multiplication of patents, this difficulty is becoming more formidable."* [Macfie, R.A., quoted in **Is the Granting of Patents for Inventions Conducive to the Interests of Trade?,** Transactions of National Association for the Promotion of Social Science 661, 665 (1865) (George W. Hastings, ed.)]

PATENT TROLLS? (Non producing entities) "They don't actually produce anything themselves," the President (Obama) said. "They're just trying to leverage and hijack somebody else's idea and see if they can extort some money out of them."

Apple ordered to pay patent troll more than $500 million in iMessage case The eight-year bale between Apple and VirnetX takes another turn VERGE Apr 10, 2018,

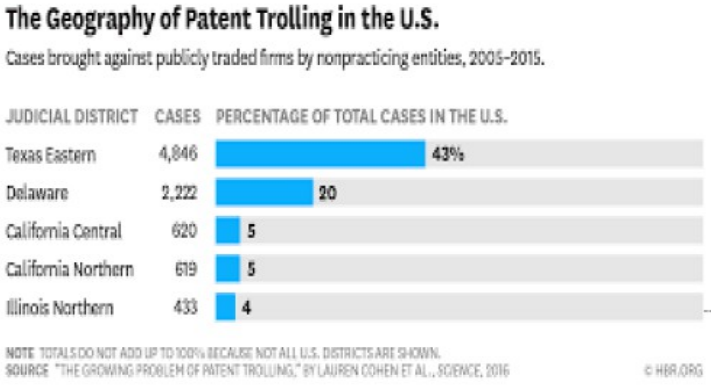
Apple has been ordered by a federal court in Texas today to pay $502.6 million to a patent troll called VirnetX, the latest turn in an eight-year-old legal battle over FaceTime and iMessage patents, according to Bloomberg. Apple and VirnetX have been fighting in court since 2010, when the patent-holding company said the iPhone maker infringed on four of its patents related to internet-based communications. The legal battle has been protracted, and it involves multiple lawsuits and a dizzying number of appeals. Last we heard of the fight was in October 2017, when Apple was ordered to pay $439.7 million, a ruling the company then appealed.

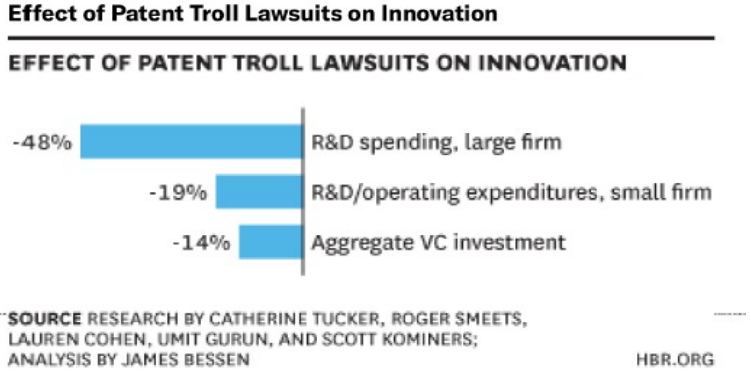
VirnetX is a patent-assertion entity, meaning its entire business model rests solely on suing companies that actually develop and sell products based on arcane patent infringement laws and loose interpretations of intellectual property regulations. VirnetX is based in Zephyr Cove, Nevada,and it filed its suit in patent troll-friendly East Texas, a district where patent holders have had a higher chance of success in intellectual property cases until the Supreme Court cracked down on the practice last year. VirnetX, in a SEC filing, described its approach to making money by saying its "portfolio of intellectual property is the foundation of our business model." The company's stock rose 44 percent today on news of the federal ruling in its favor, Bloomberg says. However, the ruling may eventually be struck down. The US Court of Appeals for the Federal Circuit in Washington is currently reviewing cases in which the Patent Trial and Appeal Board claims the patents in question are in fact invalid.

Apple Rebuffed by Supreme Court in $1 Billion VirnetX Dispute February 24, 2020,

The U.S. Supreme Court refused to consider an appeal by Apple Inc. as the iPhone maker seeks to avoid paying as much as $1 billion in patent damages to upstart software developer VirnetX Holding Corp. VirnetX, a Nevada company with less than $2 million in annual revenue, has waged a decade-long fight to collect royalties from Apple for secure communications technology used in FaceTime and virtual private network programs on devices including the iPhone, iPad and Mac computers. VirnetX jumped as much as 18% on the news.

The high court denied Apple's petition arguing that a $439 million judgment from the first of two cases brought by VirnetX was "grossly excessive" and should be thrown out because the U.S. Patent and Trademark Office, in separate proceedings, ruled that the patents at the heart of the dispute are invalid. A second case... resulted in a $503 million verdict over the same patents and newer Apple products. An appeals court has ordered a recalculation of damages in that case, although VirnetX has said it doesn't expect the number to be significantly smaller. **"It has always been our objective to create our own products with our proprietary technology," VirnetX Chief Executive Officer Kendall Larsen said in a statement.** "There is no need or justification to require a defendant to pay massive damages for infringing patent claims that the PTO has decided should never have issued in the first place," Apple said..**The Patent Trial and Appeal Board, established in a 2011 law as part of a sweeping overhaul of the U.S. patent system, is a favored venue for companies to challenge patents after they've been sued. The board has a reputation for siding with companies that challenge patents, and Apple is the most prolific user of the system.** Often, district court judges will put a civil suit on hold until the reviews are completed. When they don't, as in these cases, it becomes a race for the parties to see which forum will finish first. The case is Apple Inc. v VirnetX Inc., 19-832.





Supply of inventors and patents

Data from two surveys: Berkeley survey of startups

Patent survey data: Berkeley High Powered Patent file:///C:/Users/rbfre/Downloads/SSRN-id1429049.pdf

We used D&B's data on technology class[40] and founding date to construct a sample of 10,500 D&B-listed companies founded in our target industries after December 31, 1997. Thomson's *VentureXpert* data, which covers a substantial share of venture backed companies in the United States. Using Thomson's rich data on company characteristics, we selected 5,600 companies primarily in our target sectors founded in 1998 or later that received venture.

For the D&B sample, we achieved a 7.0% response rate, and after correcting for bad addresses that figure becomes 8.4%. Correcting further for telephone failures, the rate rises to 10.6%. In the *VentureXpert* sample, we achieved a 12.4% response rate among companies for which we had emails. After accounting for mailing and telephone failures, the corrected response rate is 17.9%

Table 1: Patents and Applications Held by Startup Companies[67]

Source / Industry	All respondents	Biotechnology	Medical Devices	Software/Internet	IT Hardware‡
Population of companies (D&B)					
Companies holding patents/applications (share)	39%	75%	76%	24%	—
Average # patents/applications held (all companies)	4.7	9.7	15.0	1.7	—
Average # filed by company (patent holders only)	8.1	8.5	13.0	5.0	—
Average # from founders (patent holders only)	1.9	2.0	3.0	1.2	—
Average # acquired (patent holders only)	2.1	2.4	3.7	0.9	—
Venture-backed companies					
Companies holding patents/applications (share)	82%	97%	94%	67%	91%
Average # patents/applications held (all companies)	18.7	34.6	25.2	5.9	27.4
Average # filed by company (patent holders only)	15.8	22.9	16.1	7.1	23.6
Average # from founders (patent holders only)	2.5	3.8	3.8	0.7	3.1
Average # acquired (patent holders only)	4.2	9.0	6.5	0.7	3.5

‡ Available only for *VentureXpert* listed companies.

Figure 1: Capturing Competitive Advantage from Technology, [illegible]

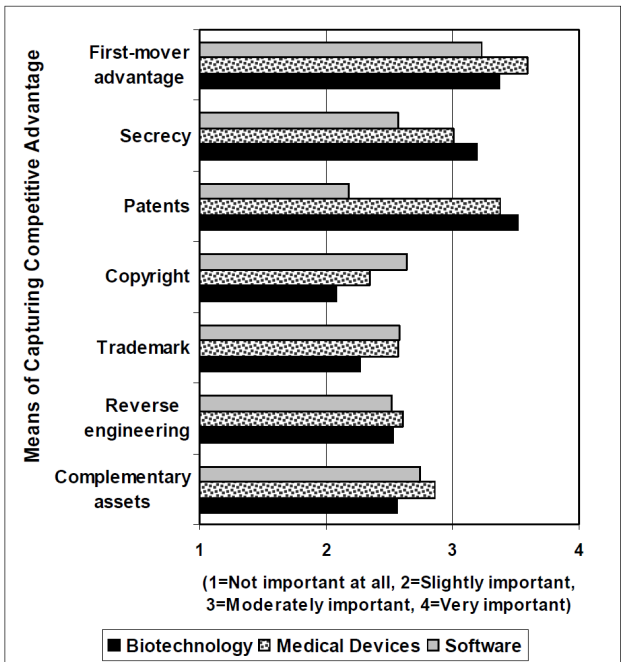


Figure 2: Motivations for Patenting – All Startups Filing Patents

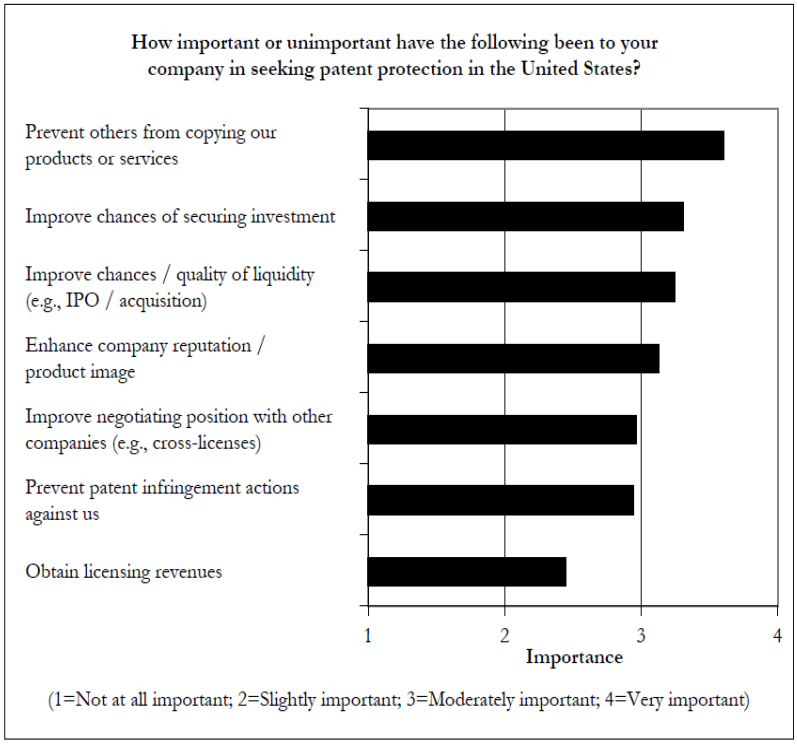
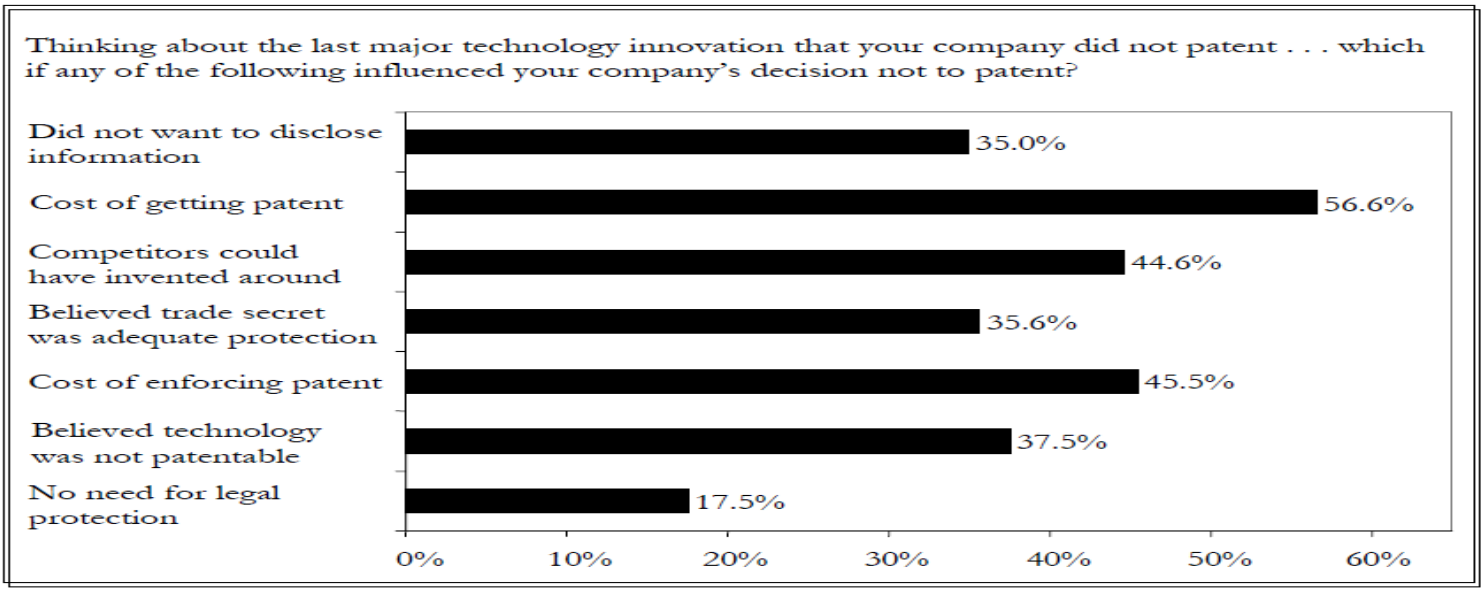


Figure 4: Reasons for Startups to Forgo Patent Protection on Major Technologies



Respondents were asked to indicate all the reasons that applied (share of respondents indicating that the option influenced the decision is reported).

Table 2: Reasons for Not Seeking Patent Protection – Selected Industries

Thinking about the last major technology innovation that your company did not patent . . . which if any of the following influenced your company's decision not to patent?

Reason / Category	All respondents	Biotechnology	Software	Difference	Test of difference
Did not want to disclose	35%	59%	25%	+ 34%	**
Cost of filing	55%	43%	64%	- 21%	**
Ease of inventing around	44%	42%	46%	- 4%	
Trade secret was adequate	36%	49%	29%	+ 20%	**
Cost of enforcing	44%	36%	52%	- 16%	**
Did not believe patentable	38%	28%	42%	- 14%	**
Did not need protection	17%	17%	20%	- 3%	
Total responses	1,057	136	589		

** Differences noted, significant at the 95% confidence intervals. Tests for differences in means were conducted between columns, within rows.

EU PATVAL Survey of inventors

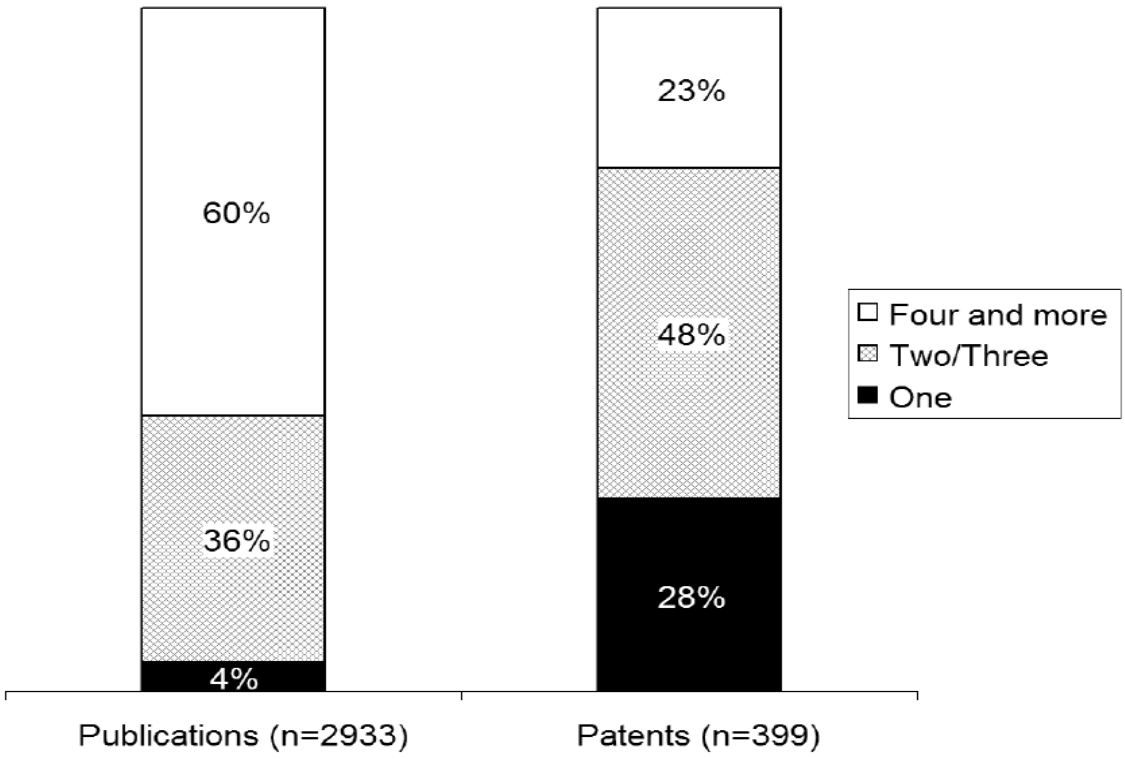
Table 3
Sex, age and education of inventors

	% of female inventors	Average age of inventors	% of inventors with tertiary education	% of inventors with PhD degree	% of inventors who changed employer after invention
Electrical Engineering	2.0	43.3	82.3	19.1	27.04
Instruments	2.7	44.6	82.0	33.4	25.42
Chemicals and Pharm	7.4	44.5	91.8	59.1	19.99
Process Engineering	2.1	46.6	72.7	22.4	21.20
Mechanical Engineering	1.1	46.2	66.3	9.3	21.54
Total	2.8	45.4	76.9	26.0	22.47

Distribution by technological class. Number of observations differs across columns, between 8861 (age) and 8963 (gender).

Inventors vs Paper-writers: Paper-writers are connected network; inventors are more divided group of separate bodies – co authors link vs co-inventors link

M. MEYER, S. BHATTACHARYA: Scholarly and technical collaboration



3 –From science to patents

Do patents rely on scientific knowledge, particularly new science? One of the reasons US passed Dole-Bayh Act was the belief that lots of federally funded academic research was not being commercialized bcs private sector could not patent it. The idea was to give patent ownership to group doing federally-sponsored R&D as an incentive to private sector development and utilization of federally-funded R&D. (Schacht, 2000, has short description of laws https://www2.bc.edu/~zlate/biotech/schacht2000dec.pdf) https://s-edison.info.nih.gov/iEdison/ site where fed R&D contractors report their inventions. In 2002 The Economist trumpeted the law as "possibly the most inspired piece of legislation to be enacted in America over the past half-century". Now more nuanced view.

See National Research Council. 2010. Managing University intellectual property in the public interest.

http://www.autm.net/Home.htmn for downloadable surveys of activity

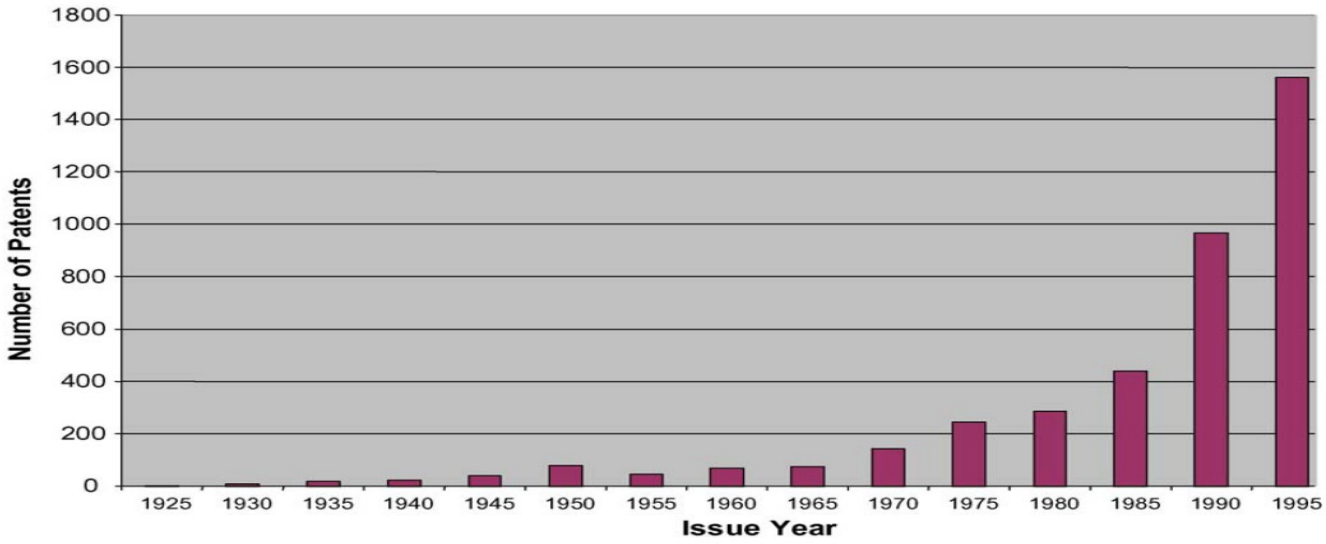


Fig. 3. Patents issued to research universities, by year.

Highly Unequal power law distribution of returns

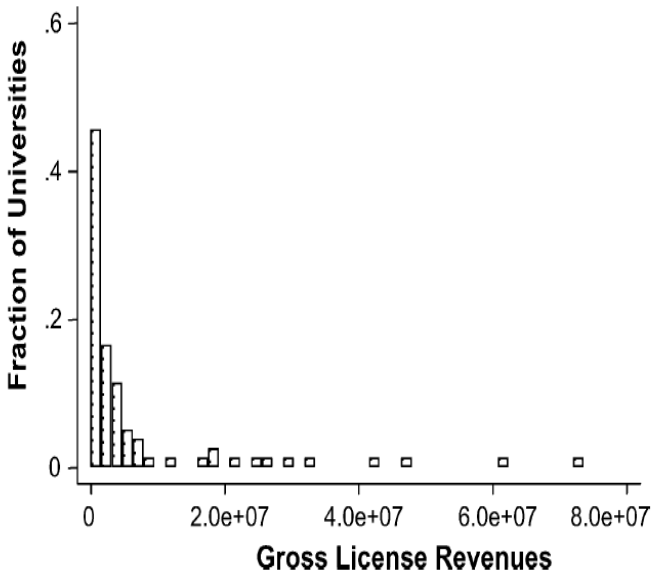
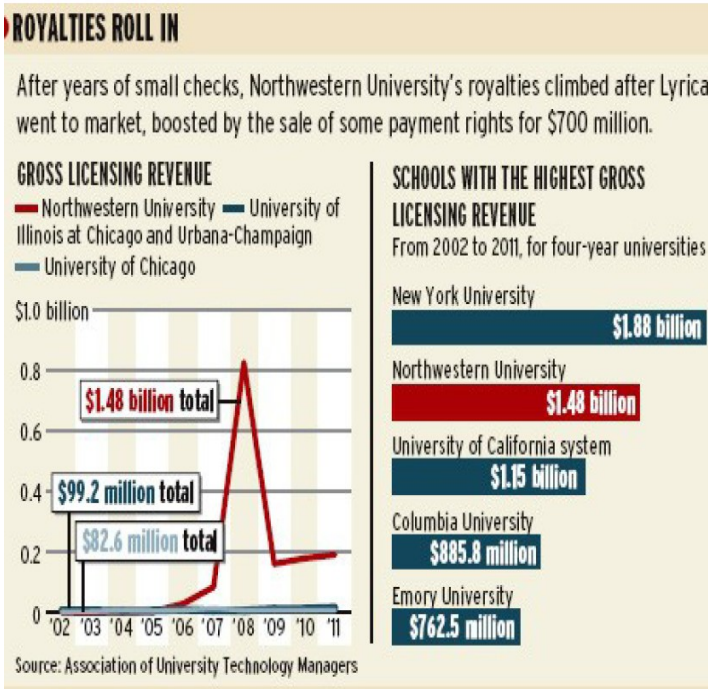


Fig. 5. Distribution of University License Revenues.



Do incentives have an effect? (1) payment per patent application/ registration and (2) revenue-based compensation plans linked to the firm's sales, profit, or license royalties. Some indication in K. Onishi / Research Policy 42 (2013) 367– 378; and in Harden, et al, where employee ownership and individual bonuses and "high performance work practices" → more innovative ideas but where profit-sharing does not.

Table 4
Effect of the compensation plans estimated using the fixed effects OLS and system GMM approaches.

	(1)	(2)	(3)	(4)
	Fixed effect OLS estimator			
	Log of number of Japanese patents	Log of number of US patents	Log of number of adjusted citations	Log of number of high cited patents
Payment per domestic patent application or registration	0.010	0.007	−0.008	0.005
	(0.012)	(0.014)	(0.006)	(0.006)
Payment per foreign patent application or registration	0.019***	0.016*	0.004	−0.009*
	(0.007)	(0.009)	(0.004)	(0.005)
Revenue-based compensation linked to sales, profit or license royalty	0.149**	−0.018	−0.041	0.121***
	(0.067)	(0.078)	(0.025)	(0.044)
ln(R&D)	0.081***	0.148***	0.004	0.139***
	(0.022)	(0.024)	(0.009)	(0.012)
ln(number of patents)			1.027***	0.495***
			(0.012)	(0.017)
Constant	4.120***	0.498***	0.533***	0.097
	(0.139)	(0.154)	(0.062)	(0.062)
Year dummy	Yes	Yes	Yes	Yes
Industry dummy	na	na	na	na
Ajusted_R2	0.074	0.278	0.857	0.548
AR(1) (*P* value)				
AR(2) (*P* value)				
Hansen *J* (*P* value)				
Observations	4321	4321	4321	4321
Number of firms	327	327	327	327