Entrepreneurial Innovation: Identifying Schumpeterian Shocks and Kirznerian Competition using Patent Rank

http://crie.org

Monte J. Shaffer

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Technical background

- undergrad math/physics
- web-application developer
- software/database engineer
- internet marketing consultant (SEO)

Master's work

- MBA, marketing research
- M.S., statistics

Ph.D., Marketing

- "Entrepreneurial Innovation: Patent Rank and Marketing Science"
- Len Jessup served on my dissertation committee

Defining the value of patent innovations

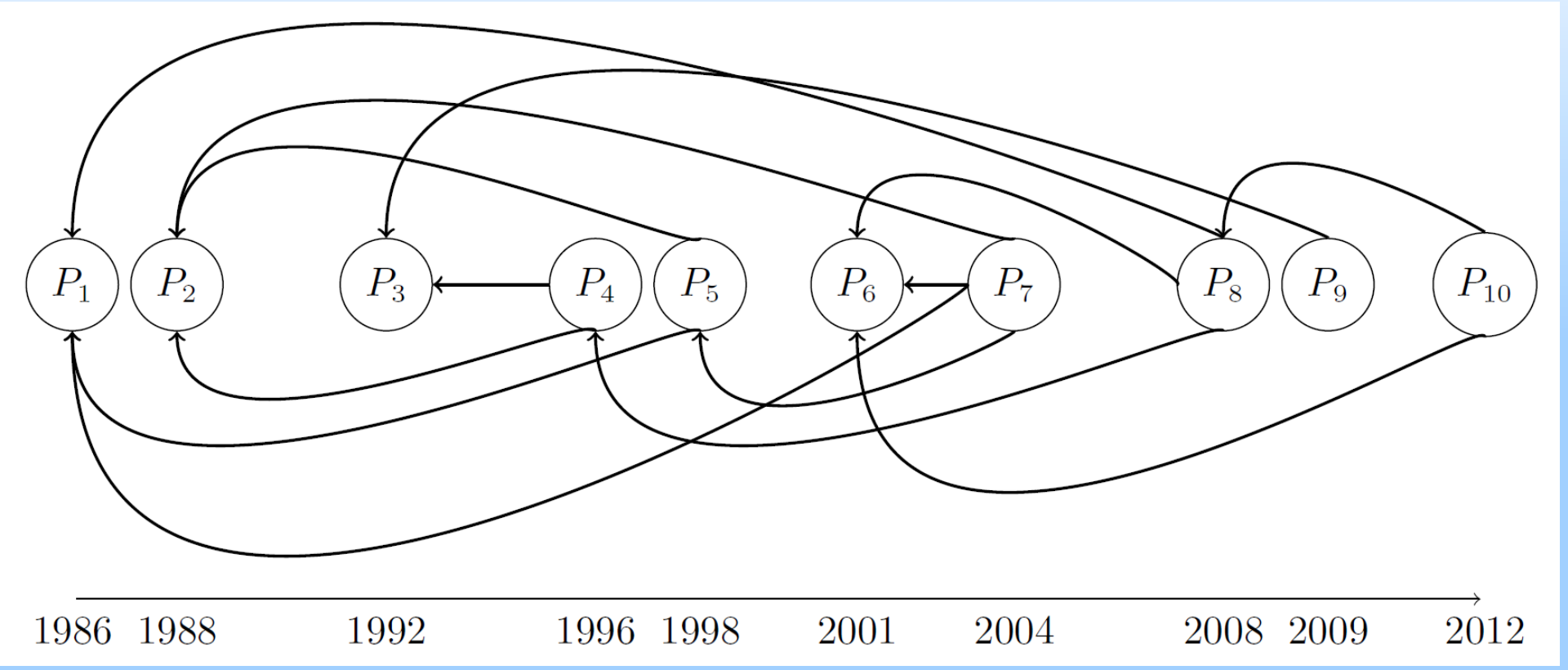
- Trajtenberg (1990)b

Opportunity Costs: If the firm cannot extract value it should sell the patent.

Goal of the Firm: The goal of the firm is to maximize firm value by monetizing consumer surplus from social value based on its monopolistic position.

Trajtenberg (1990)a		Shaffer (2011)
Not all patents are equal, so let's weight them by their subsequently cited patents.	**Weighting Logic**	If not all patents are equal, why would we equally weight subsequently cited patents?
Forward Citations	**Weighting Schema**	Patent Rank
Nonrecursive	**Weighting**	Recursive
Indegree Centrality	**Network Mathematics**	Eigenvector Centrality
Importance Effects	**Network Effects**	Total Effects

Which patent is most valuable?



Computation

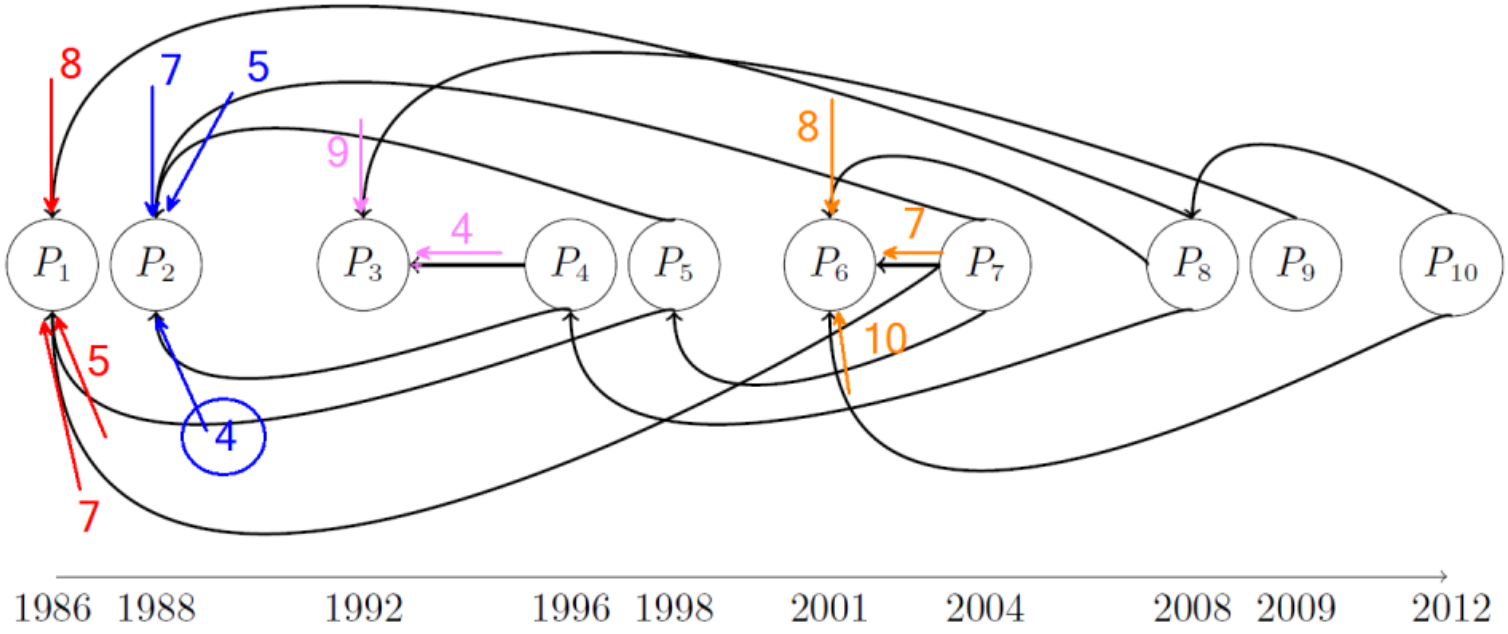
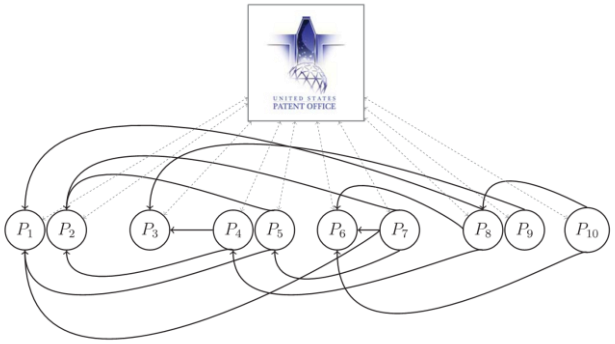


Figure 1 Toy Example Patent Network. We provide a very simple example of a directed patent graph to illustrate the patent network. Nodes represent patents, links represent citations between patents. The direction of the arrows defines the nature of the link—newer patents borrow innovativeness from older patents.

http://www.youtube.com/watch?v=hxlBON6ebr0

Patent Rank: The FICO® score for patents



Parent Patent

Child Patent →	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}
P_1	0	0	0	0	0	0	0	0	0	0
P_2	0	0	0	0	0	0	0	0	0	0
P_3	0	0	0	0	0	0	0	0	0	0
P_4	0	1	1	0	0	0	0	0	0	0
P_5	1	1	0	0	0	0	0	0	0	0
P_6	0	0	0	0	0	0	0	0	0	0
P_7	1	1	0	0	1	1	0	0	0	0
P_8	1	0	0	1	0	1	0	0	0	0
P_9	0	0	1	0	0	0	0	0	0	0
P_{10}	0	0	0	0	0	1	0	1	0	0

Patents and citations as *prior art*

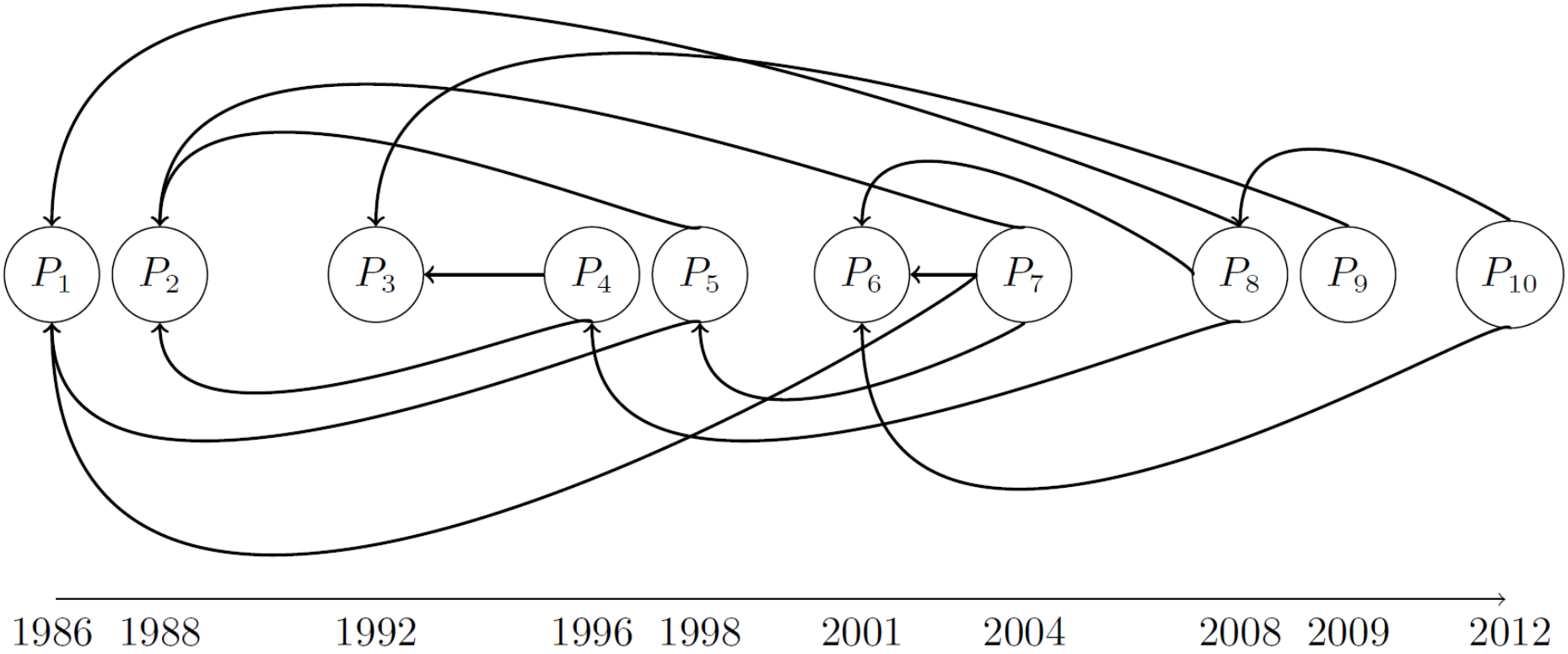
- Patents claim novelty in context of all prior art
- *Backward* citations suggest a borrowing of technology
- Subsequent *forward* citations suggest a lending of technology

Measuring network dynamics

- *Recursive* weighting of all citations
- Capturing *cumulative* or *marginal* effects
- Updating the network annually (or weekly)

Patent Rank

- *Intrinsic* measure of patent's value within network
- Measuring Patent Rank over time allows us to predict a patent's lifetime value



R Console

```
> myAnswer/sum(myAnswer);
 [1] 0.13191812 0.13949962 0.13267627 0.09097801 0.08188021 0.12736922
 [7] 0.06823351 0.09097801 0.06823351 0.06823351
> myAnswer/solveMe[3];
 [1] 0.9456522 1.0000000 0.9510870 0.6521739 0.5869565 0.9130435 0.4891304
 [8] 0.6521739 0.4891304 0.4891304
```

Validating Patent Rank

Year Ending	1980	1985	1990	1995	2000	2005	2009
Patents (N)	1083196	1759719	2451518	3132481	3959151	4886372	5608070
Correlation($\mathbf{WPC}_t$,$\mathbf{PR}_t$)	0.872	0.867	0.849	0.828	0.782	0.746	0.716

Table 5 **Diminishing Correlations between forward-citation counts (WPC) and Patent Rank (PR) scores over time.**

		Snapshot Approach		*Dynamic, Longitudinal Approach*
		$\mathrm{WPC}_{\text{Trajtenberg (1990a)}}$	WPC_{1981}	$\widehat{\mathrm{PR}}_{t+3}$
Social Value	ΔW	0.755	0.7200	0.8537
	TW	0.685	0.6075	0.8747

Systematic Error

1976–2000 Patent Rank	1976–2000 Patent Rank score	Patent Title	Patent Number	1976–2000 forward-citation count	1976–2010 forward-citation count
1	217.395	Process for amplifying nucleic acid sequences	4,683,202	732	2256
2	208.643	Process for amplifying, detecting, and/or-cloning nucleic acid sequences	4,683,195	748	2018
3	150.947	Process for producing biologically functional molecular chimeras	4,237,224	214	286
4	130.271	Crystalline Zeolite ZSM-5 and method of preparing the same	3,702,886	393	558
5	122.930	Arrangement of writing mechanisms for writing on paper with a colored liquid	3,747,120	148	297
6	116.960	Specific DNA probes in diagnostic microbiology	4,358,535	309	427
7	110.004	Novel amorphous metals and amorphous metal articles	3,856,513	193	206
8	103.333	Bubble jet recording method and apparatus in which a heating element generates bubbles in a liquid flow path to project droplets	4,723,129	1006	1955
9	98.040	Droplet generating method and apparatus thereof	4,463,359	929	1691
10	89.447	Antibiotics	3,950,357	88	91
11	*87.834*	*Method for the direct analysis of sickle cell anemia*	*4,395,486*	*47*	*70*
12	86.202	Method of producing tumor antibodies	4,172,124	118	136
13	85.657	Mask for manufacturing semiconductor device and method of manufacture thereof	5,045,417	148	168
14	85.559	Chiral smectic C or H liquid crystal electro-optical device	4,367,924	412	463
15	85.216	Method and apparatus for measuring x- or .gamma.-radiation absorption or transmission at plural angles and analyzing the data	3,778,614	133	143
16	84.583	Software version management system	4,558,413	295	619
17	**84.103**	**Bubble jet recording method and apparatus in which a heating element generates bubbles in multiple liquid flow paths to project droplets**	**4,740,796**	**879**	**1656**
18	83.301	Microorganisms having multiple compatible degradative energy-generating plasmids and preparation thereof	3,813,316	15	16
19	82.645	Apparatus and method for producing images corresponding to patterns of high energy radiation	3,859,527	108	152
20	80.806	Ink jet recording method	4,345,262	853	1550

Entrepreneurial Innovation: Identifying Schumpeterian Shocks and Kirznerian Competition using Patent Rank

Entrepreneurial Innovation: entrepreneurial activities geared around technological advancement based on “creative destructions” (Schumpeterian shocks) and “market arbitrage” (Kirznerian competition)

How can we *objectively* measure the value of innovation?

- public data (patent data)
- comprehensive metric (entire U.S. patent network)
- not a popularity contest (e.g., annual surveys to CEOs on *innovative* firms)

Measuring the value of intellectual property is a nontrivial task!

Entrepreneurial Innovation

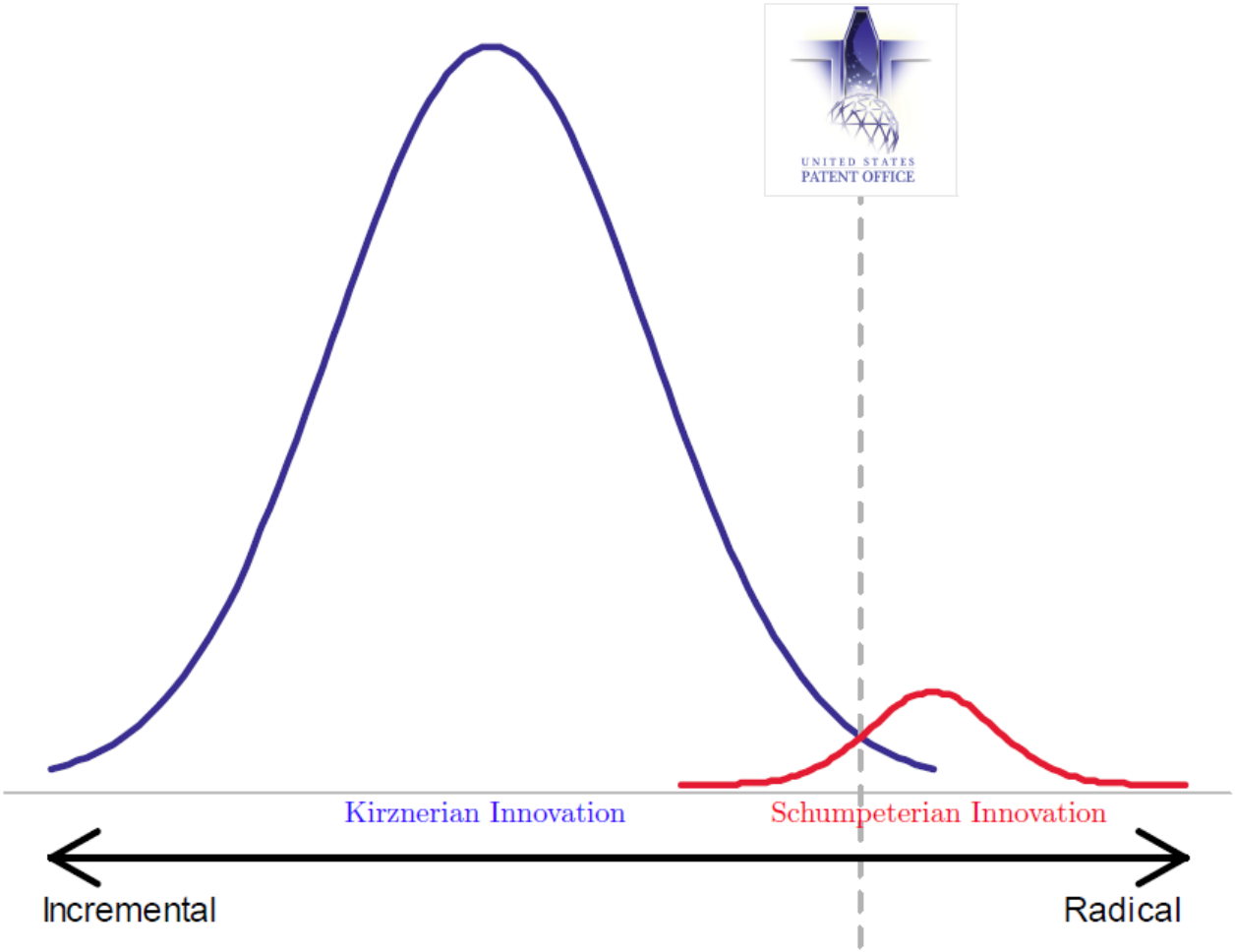
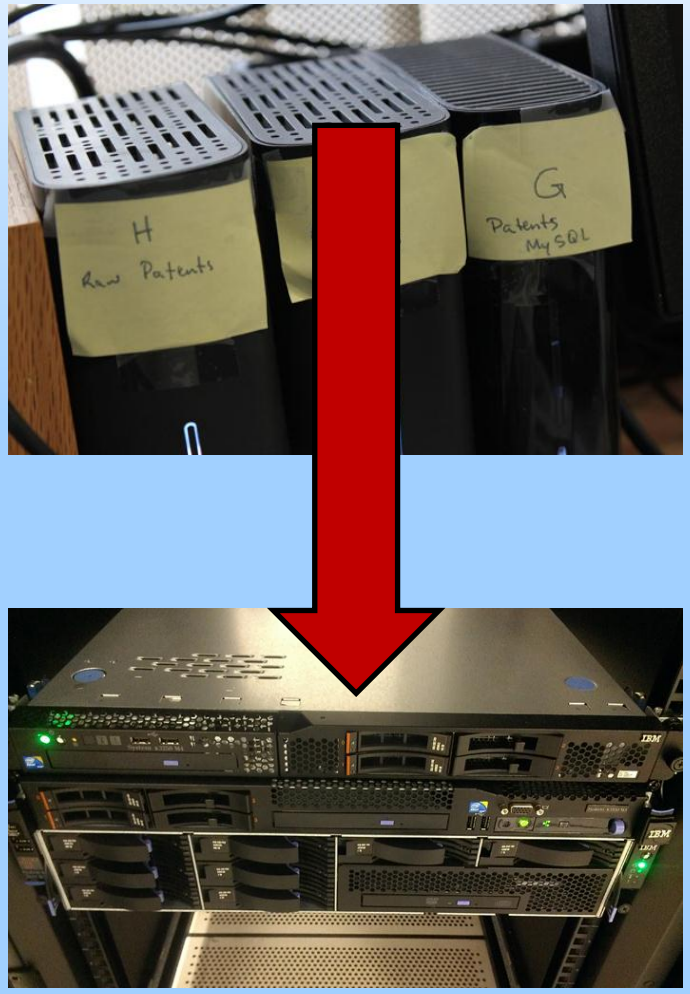


Figure 2 Continuum of Entrepreneurial Innovation: Schumpeterian entrepreneurial activity occurs less frequently (y-axis as frequency) and inherently represents changes that are more radical (x-axis as impact of innovation on society).

The patent data repository



Beginnings

- To compute Patent Rank, Monte had written code to harvest and parse all 8 million patents
- Monte was looking to do a postdoc to continue preparing his data repository for academics (USC)
- Len invited Monte to visit Eller as a postdoc and bring the patent data repository to Arizona
- http://www.crie.org/ is the result – a patent data repository for academics

Austrian Economics

- Opportunity Costs
  - Resource / Product Matrix (Penrose 1959)
- Marginal Utility
  - On the margin as 'competitive market process'
- Subjectivism
  - perceptions dictate whether or not an individual engages in entrepreneurial activity
- Entrepreneur
  - "the heroic intervention of individual men who appear as leaders toward new economic shores."

Austrian Economics

Israel Kirzner		Joseph Schumpeter
		
Kirznerian Entrepreneur		**Schumpeterian Entrepreneur**
Alert Entrepreneur	**Key Character**	Creative Entrepreneur
incremental and continuous	**Innovation**	radical and discontinuous
often	**Frequency**	rare
equilibriates	**Market Process**	disequilibriates
value appropriation		value creation
market-sensing, customer-linking Day (1994)		market-making, customer-driving Kumar et al. (2000)
discovers/exploits	**Entrepreneurial Opportunities**	creates
entrepreneur can be capitalist capitalist can be entrepreneur	**Entrepreneur/Capital**	entrepreneur is mutually exclusive from capitalist

Austrian Economics

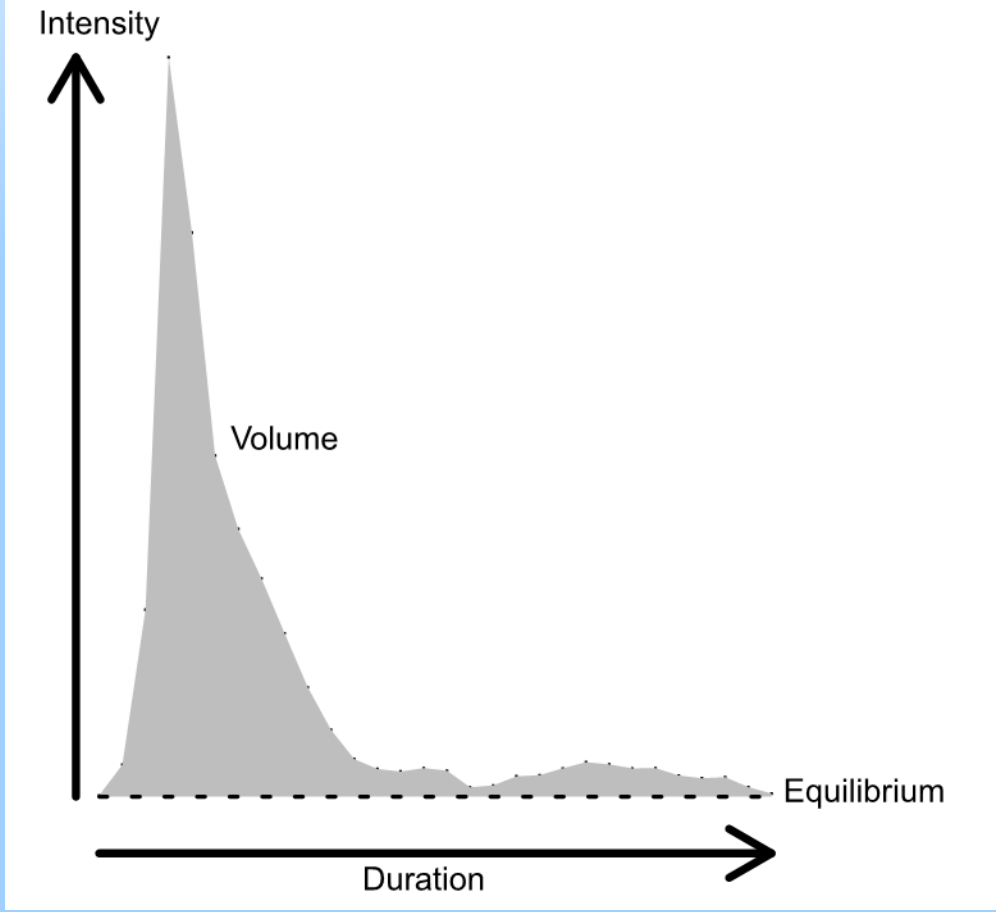
Israel Kirzner		Joseph Schumpeter
		
Kirznerian Entrepreneur		**Schumpeterian Entrepreneur**
Arbitrageur	**Leadership**	Innovator
Imitator		Pioneer
Competitor		Captain of Industry
Homo agens	**Motivation**	Unternehmergeist
competition		creation
execution		vision
profit-generating strategies		strategies for potential profits
short-term		long-term
extrinsic		intrinsic
economic growth	**Outcome**	economic development

Calculating a patent's marginal utility within the patent network by forming a moving-window network.

- Form the network by considering all citations that exist in a 5-year window (Hall 2001)
- Compute Patent Rank scores for all patents in this formed network.
- Move forward one year, dropping the old citations (both forward and backward), adding the new citations.
- Compute Patent Rank scores
- Longitudinal Patent Rank scores thus formed (normalized to 1 to match the Trajtenberg measure) represents the patent's marginal utility.
- Collectively, these Patent Rank scores define the patent's Schumpeterian shocks.

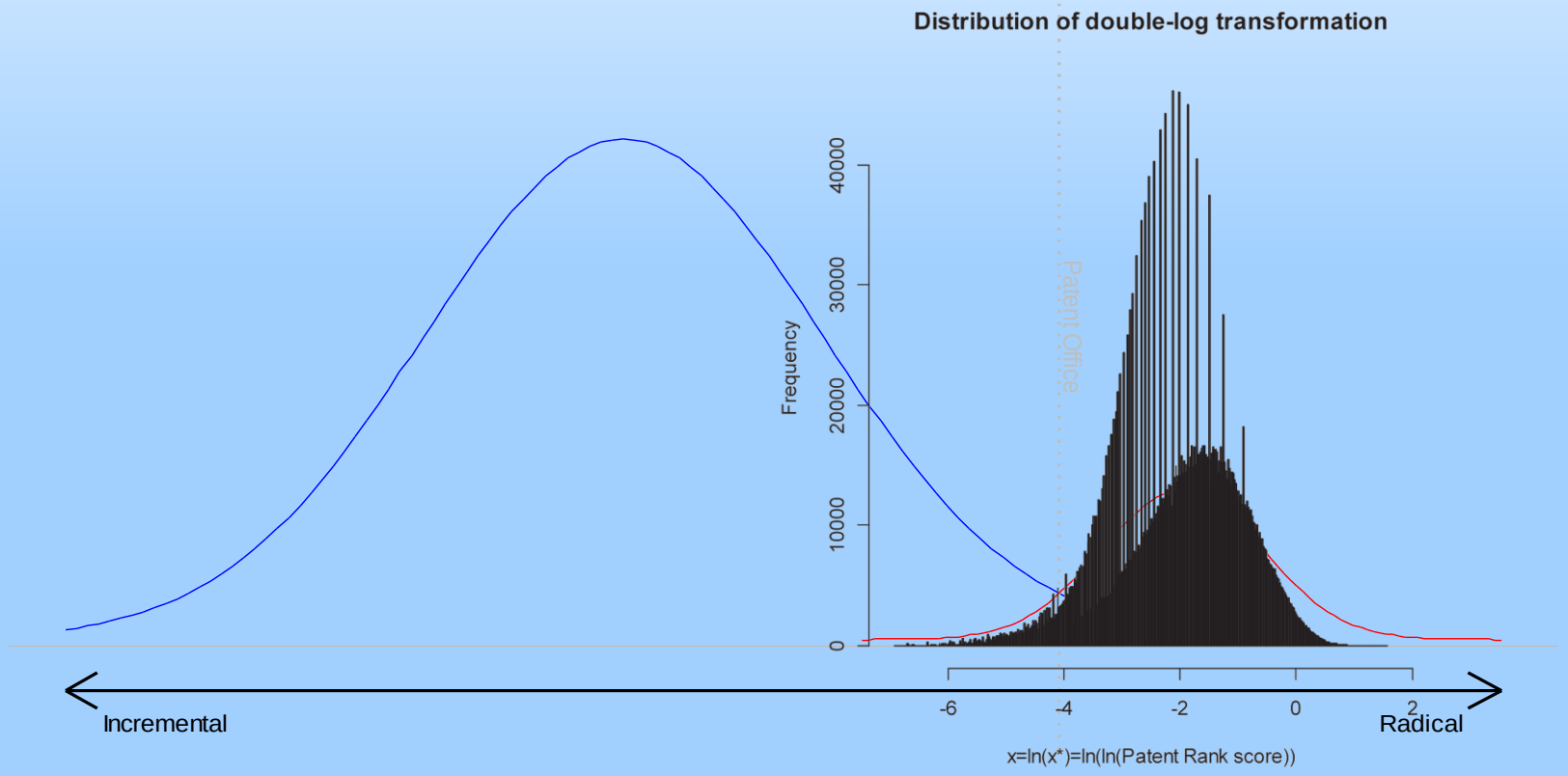
Patent Rank models: Marginal Utility

Patent Rank in marginal form identifies unique Shumpeterian shocks for patent innovations.



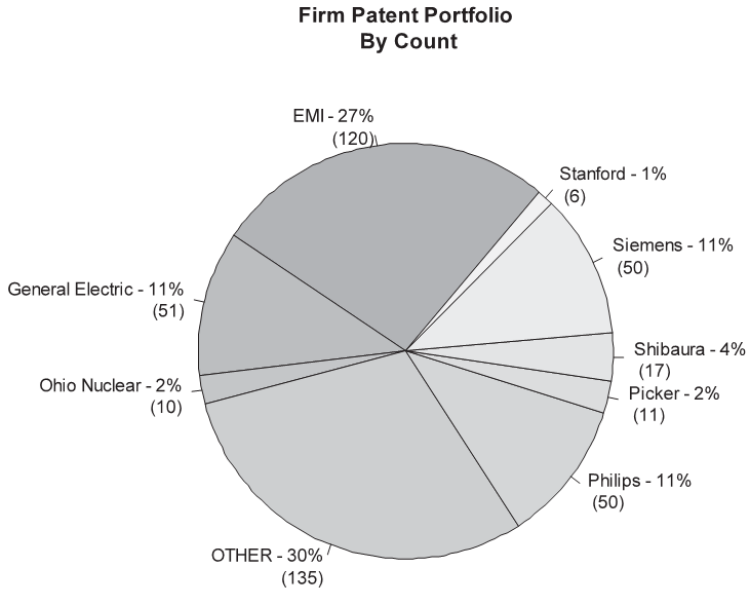
Patent Rank models: Distribution of cumulative model

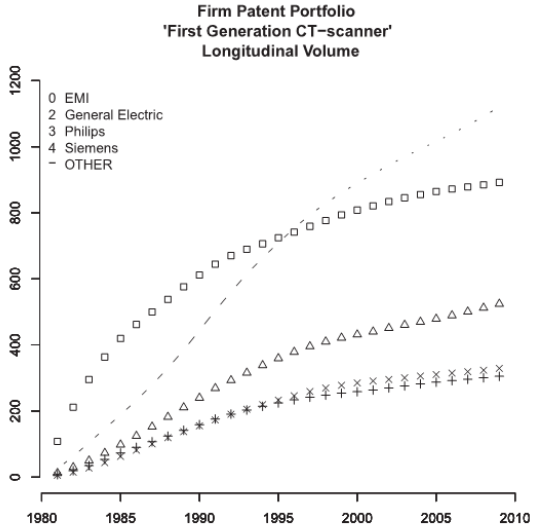
Structure of competition identifies
Kirznerian/Schumpeterian entrepreneurial activity.



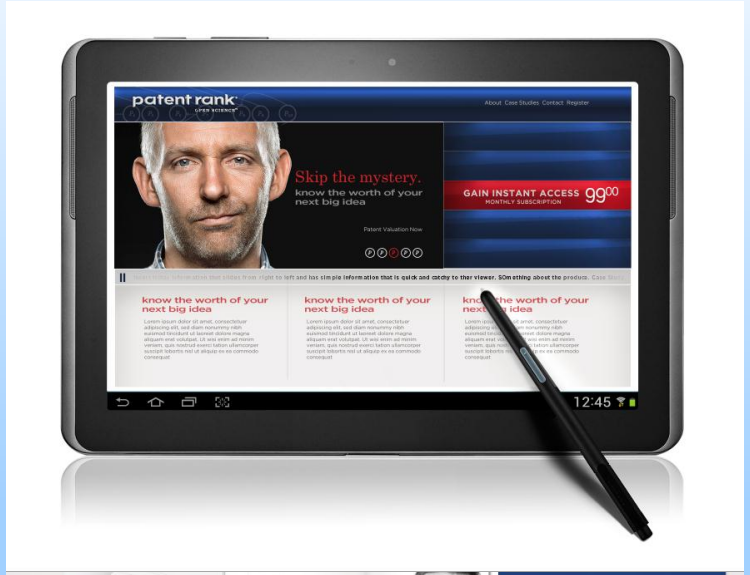
Austrian Economics

Trajtenberg (1990a) data demonstrates the 'Texas two-step' of Schumpeterian shocks followed by Kirznerian competition.





Commercial Opportunities for Patent Rank



Status

- Monte has two patents pending
  - computation of Patent Rank
  - prediction model
- Monte brought his invention to the University of Arizona (UA)
- Monte formed *Entrepreneurial Innovation, LLC* (EI) as a research and development company
- A cross-license to *share* know-how, algorithms, programs and data has been signed between *EI* and *UA*.
- Patent Rank as a C-corp will utilize these EI's technologies to deliver branded products
- Executive education started with two publicly traded companies

Branded Product Offerings

patentrank

- MyPatentAssets.com
  - content-rich website to compete with freepatentsonline and patentbuddy (5+ million web pages)
  - dashboard of a patent data (free with $199 subscription to access special data)
- MyPatentReports.com
  - new algorithm (n-class model) is being developed that creates a network of networks
  - Consumer Reports-type website (ratings on patents, inventors, examiners, lawyers, and technology classifications)
  - options for customer-driven specific reports with one-time fee (let's consult to build your reports) and recurring revenues (how often do you want updates on these reports: annually, quarterly, monthly, weekly)
- MyPatentIdeas.com
  - using Latent Semantic Indexing, can we quickly identify if an idea is worth pursuing by comparing (it costs ~$10K for a patent lawyer to prosecute a patent)
  - $499/year for unlimited searching; $59.95 for three searches (one-time use by an inventor)
- MyPatentAnalytics.com
  - porting CRIE.ORG for commercial entities
- Partnerships with http://ipstreet.com/ and http://lexmachina.com/

Entrepreneurial Innovation

Patent Rank and Marketing Science

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