Does Innovation Lead to Academic Entrepreneurship?

For Presentation at:

The Labor Market and Human Resource Management Implications of Entrepreneurship.

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Introduction

A university is a "series of individual faculty entrepreneurs held together by a common grievance over parking."

Clark Kerr, President, University of California, 1958-1967.

Introduction

Advancing Innovation:

"Innovations are the lifeblood of entrepreneurship. Without them, critical technologies and life-saving medicines cannot be developed, superior ways of delivering products and services go untapped, new companies fail to be started, and job creation falters. Unfortunately, a great number of innovations are failing to be developed and brought to market as they should be—some languishing on university lab shelves, and some simply getting caught in institutional overload. Others are never disclosed by university researchers.

Kauffman Foundation Website

Introduction

- Innovation and Entrepreneurship are often linked in the literature
  - But the two have distinct definitions and outcomes
- Innovation: "the action or process of innovating--a new method, idea, or product."
  - Patents, for example.

Introduction

- Entrepreneur: "a person who organizes and operates a business or businesses, taking on greater than normal financial risks in order to do so."
- Entrepreneurship is a continuum:
  - Self-employed
  - Starting a business
- Academic Entrepreneurship is different:
  - Patenting
  - University spin-offs
  - Company Directorships

Academic Entrepreneurship

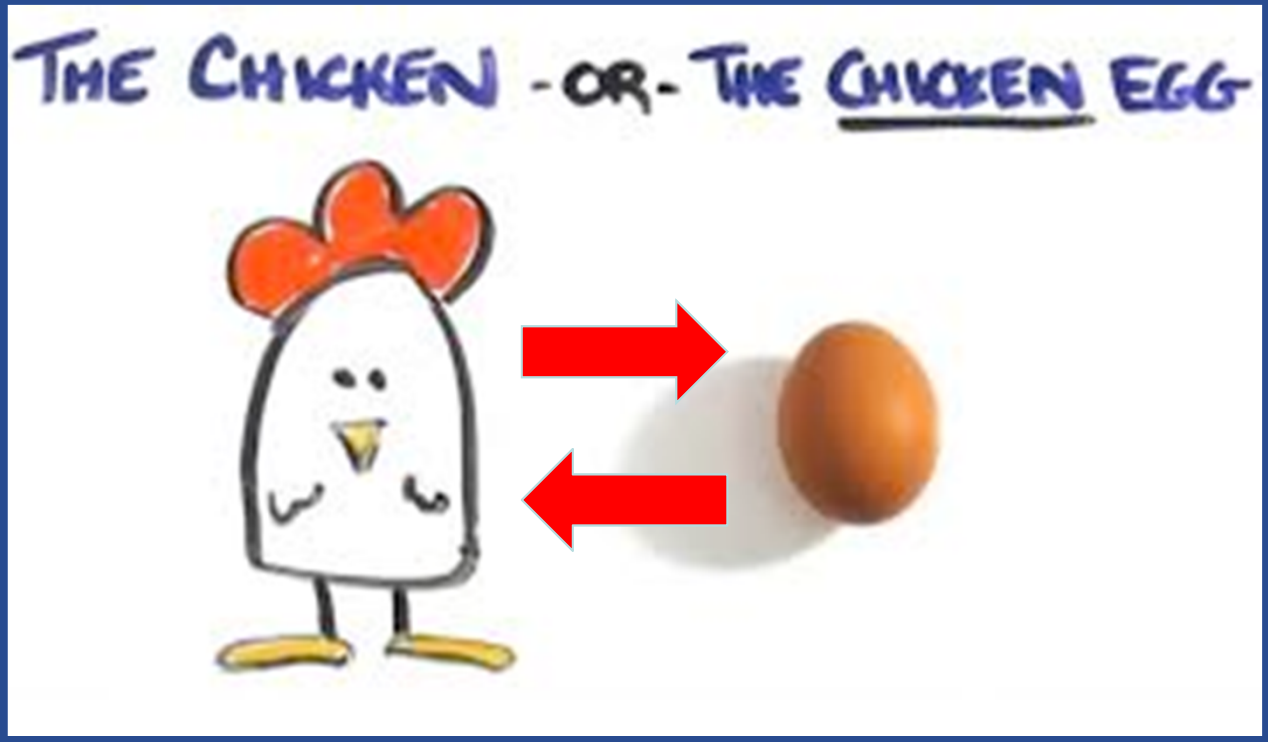
- Academic Entrepreneurship usually tied to the commercialization of science.
- Rothaermel et al (2007):
  - Commercialization of research & tech transfer
  - Productivity of University TTOs
  - New firm creation based on IP
  - Environmental context including Stars, science parks, networks, technology
- Grimaldi, Kenney, Siegel & Wright (2011):
  - Patenting, Licensing, start-up formation, university-industry partnerships

Academic Entrepreneurship

- Others argue for a broader definition.
- Fini, Lacetera & Shane (2010):
  - Two-thirds of businesses started by academics are not tied to IP or patents.
- Perkmann et al (2013):
  - "Academic Engagement" with industry including: collaborative research, consulting, sponsored research, contract research, patenting with industry, co-founding or directing a firm.
- Abreu & Grinevich (2013):
  - Any work beyond teaching & research that is innovative & financially rewarding: licensing, forming a company, consulting & contract research.

Which Comes First?

- The Entrepreneurial Chicken or
- The Innovative Egg



The majority of the literature finds that the innovative egg comes first

Research Question

- In other words, does innovation lead to entrepreneurship in the academy?
  - Patent applications measure innovation
  - Patent Commercialization—traditional measure of entrepreneurship
  - Second, non-teaching job used as a proxy for academic entrepreneurship.

Research Questions

- What factors are associated with patenting in academia?
- What factors are associated with entrepreneurship in academia?
- Is there a relationship between the two?
- How do patents and academic entrepreneurship affect labor market outcomes including hours, earnings & leaving academia?

Outline

- Data & Methods
- Findings:
  - Limited overlap between patents & academic entrepreneurship.
  - Patents are associated with an increase in Academic Entrepreneurship.
  - Academic Entrepreneurship is also associated with an increase patent applications.
  - Academic entrepreneurship pays well.

Survey of Doctorate Recipient Data

- Use 1995 -2003 & 2008 Survey of Doctorate Recipients (SDR)
  - Biennial, Longitudinal Survey of U.S. Doctorates—Nationally representative sample.
- Combined with information from:
  - 1994 NRC Rankings by quartile
  - University Patent Counts 1974-2010
  - AUTM TTO office data

SDR Data

- PhDs who worked full-time at least once at 4-year academic institutions.
  - Computer Science & Mathematics
  - Biology and Life Sciences
  - Chemistry
  - Earth Science
  - Physics and Physical Sciences
  - Engineering
  - Health
- Excludes Social & Behavioral Sciences

SDR Outcome Variables

- Patents & Publications are counts of the previous five years in the 1995, 2001, 2003 & 2008 surveys.
- Interpolate data for entrepreneurship estimates for intervening years.
- Innovation measured by patents:
  - Number of Patent Applications as Inventor
  - Number of Patents Granted
  - Number of Patents Commercialized
    - Also a measure of entrepreneurship

SDR Outcome Variables

- Academic Entrepreneurship is available in the 1995-2001 & 2008 Surveys:
  - Whether the academic holds a second job that is not related to teaching
  - Previous studies have used corporate affiliations (unobserved in SDR)
- Leaving Tenured or Tenure Track Academia
- Number of publications
- Probability of federal research support
- Hours of Work, Salary & Earnings

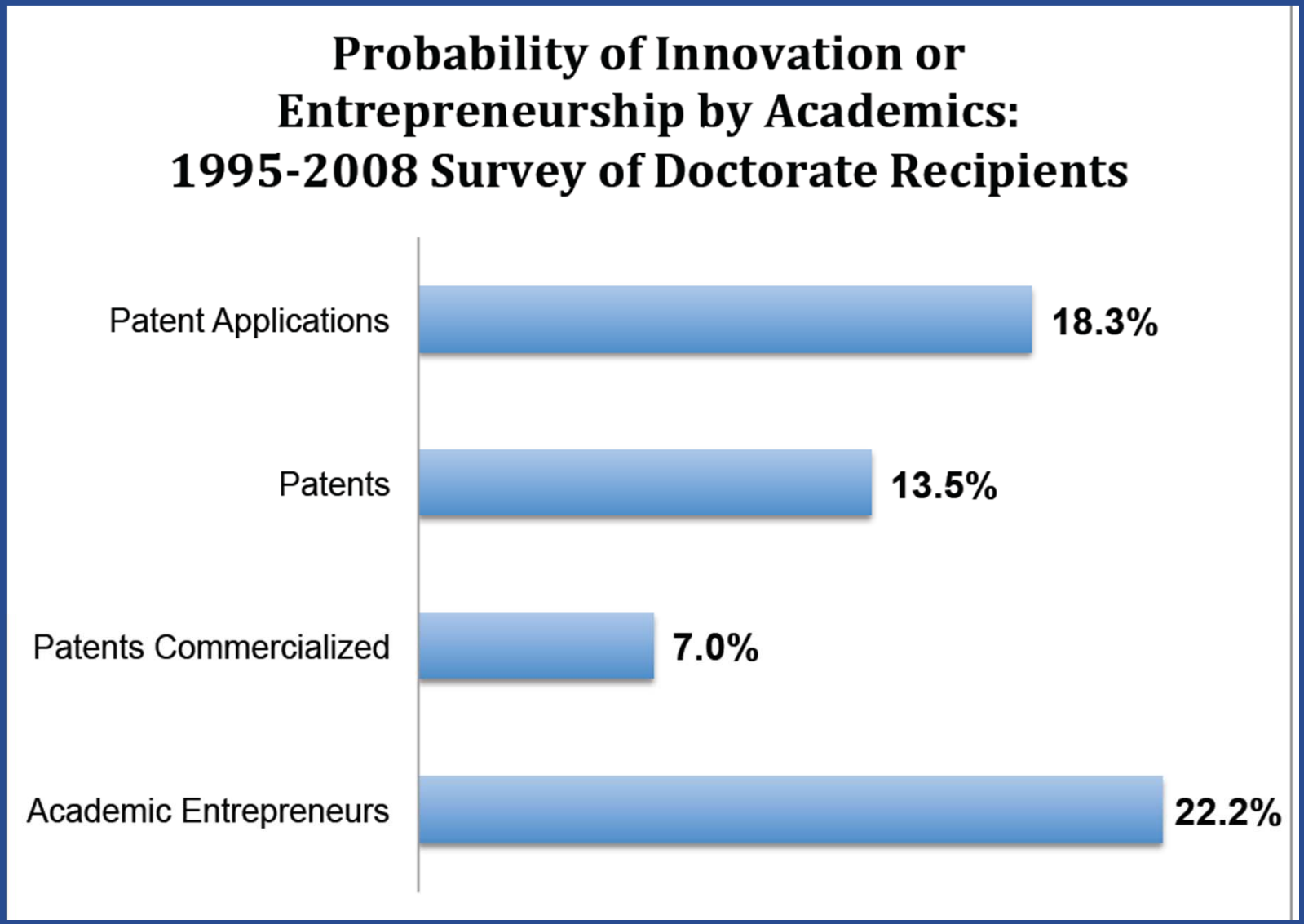
Independent variables:

- Academic field
- Degree institution characteristics
- University employer characteristics
- Tenure status
- Government Support of Research
- Publications
- "Star" in terms of Publications
  - 95th percentile of publications in field
    - Broader than Zucker et.al. measures

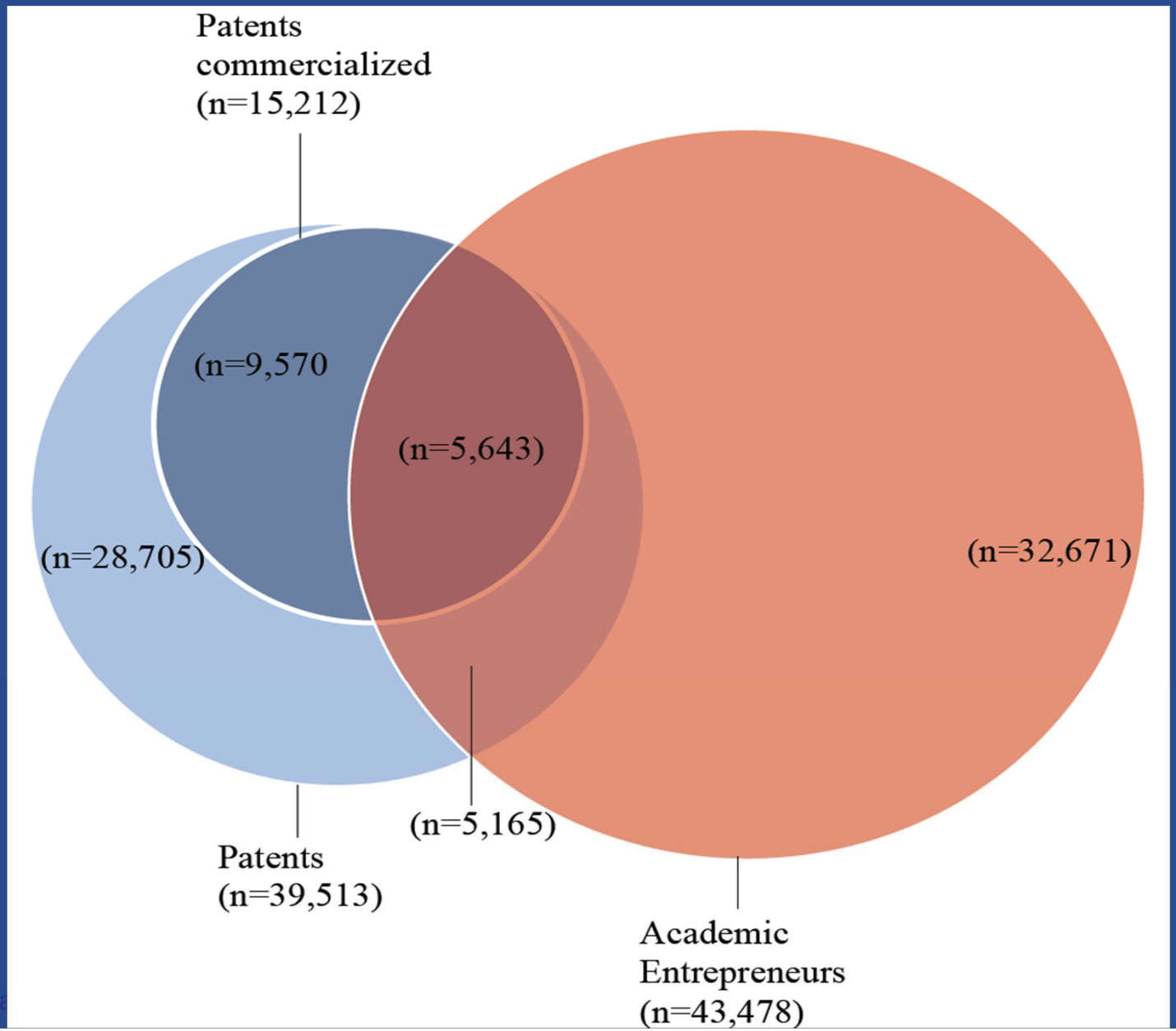
Independent Variables

- 1994 NRC Ranking of Employing Institution.
- Patent counts of Employing Institution
- Primary work activities
  - Teaching, Research, Management, Computer Programming & Development
- Networking Characteristics
  - Log University Patents lagged 5 years
  - Log of Employer Academic entrepreneurs
  - Employer & PhD Institution has TTO

Academic Innovation & Entrepreneurship



Surprisingly Limited Overlap between Entrepreneurship & Patenting

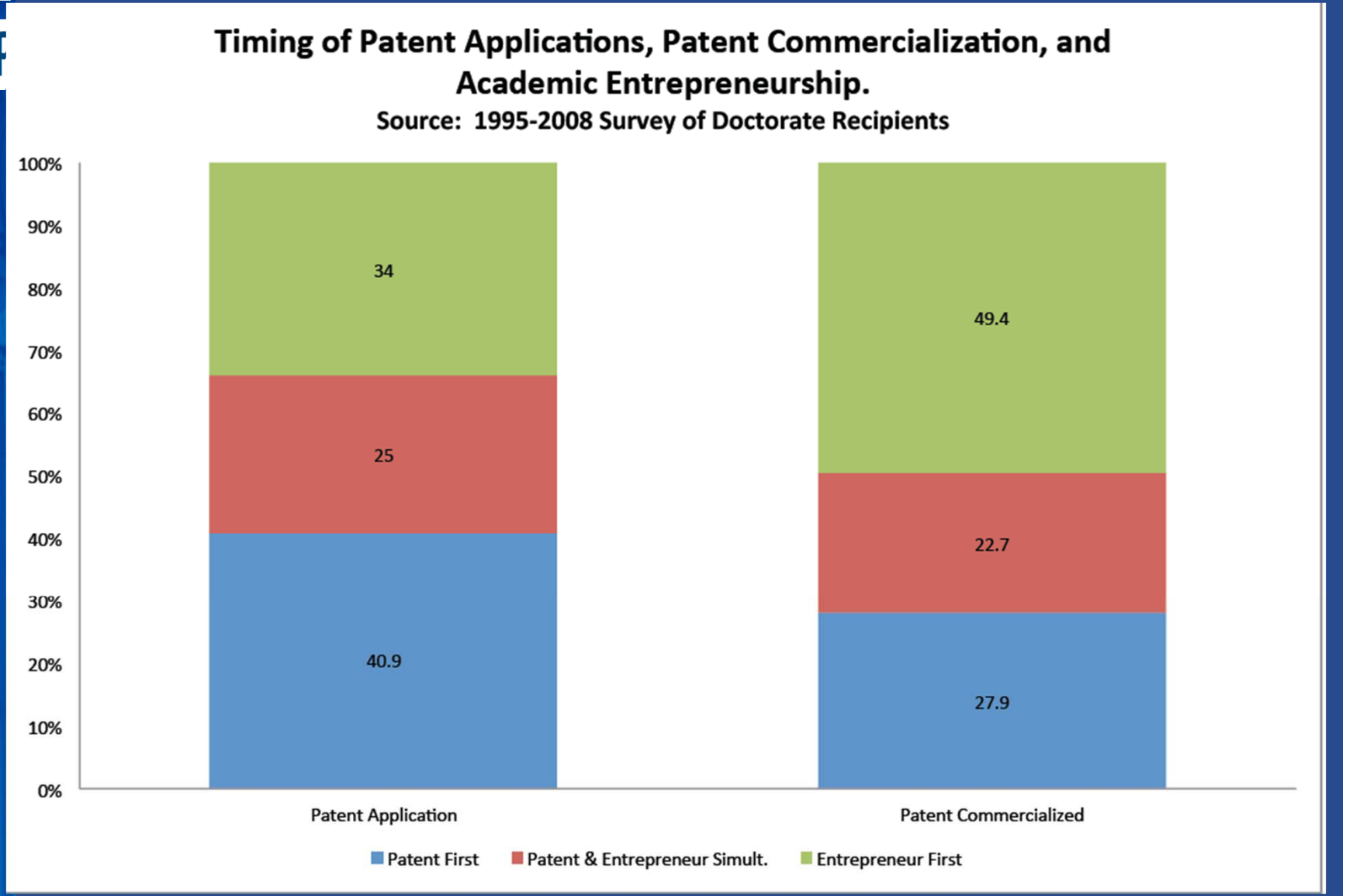


Patenting & Entrepreneurship by Field

Field	Weighted Count	% Entrep	% Patent	% Both
Computer Science & Math	29,683	16.9%	8.9%	2.8%
Life Sciences	86,621	17.7%	19.3%	4.3%
Chemistry	15,798	18.4%	27.0%	7.3%
Earth Science	9,255	16.1%	5.4%	1.0%
Physics	15,042	15.8%	16.2%	4.4%
Engineering	38,096	27.6%	30.9%	10.7%
Health	19,986	29.3%	5.9%	1.4%
Total	214,482	20.3%	18.4%	5.0%

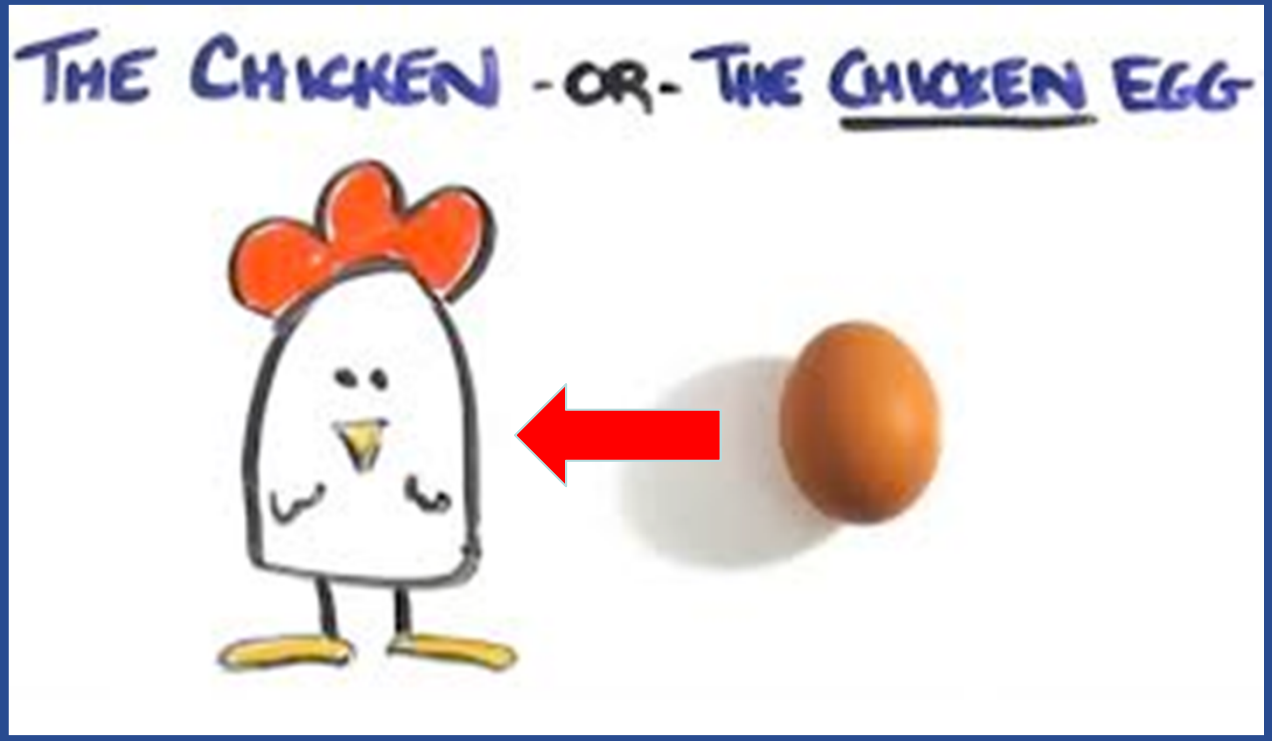
Engineering, Chemistry and Life Science have high rates of Patenting & Academic Entrepreneurship.

Timing of Patenting & Entrepreneurship



Does this Mean. . .

- That the Innovative Egg Comes First?



Econometric Considerations

- Patenting and Academic Entrepreneurship are choices—it is difficult to find sources of exogenous variation.
- Azoulay etal (2009) argues that university characteristics are likely correlated with patenting and can affect productivity directly.
- Individual Fixed Effects not useful because patenters have different productivity than nonpatenters
- Rely on econometric methods to examine aspects of this relationship, but difficult to make causal arguments.

Econometric Considerations

- What factors are correlated with patenting in Academic Science?
- Is Innovation/Patenting correlated with Entrepreneurship?
- Is Entrepreneurship correlated with Innovation/Patenting?
- What is the relationship between patenting, entrepreneurship and other labor market outcomes?
  - Use probit, conditional logit and hazard models to investigate these questions.
  - Attempt to identify which comes first.

VARIABLES	Patent Applications	Acad. Entrepreneur-ship	Patent Applications	Acad. Entrepreneur-ship
Articles	0.001***	-0.000	0.001***	-0.000
	[0.000]	[0.000]	[0.000]	[0.000]
Presentations	0.001***	0.001***	0.001***	0.001***
	[0.000]	[0.000]	[0.000]	[0.000]
Star Researcher	0.028**	0.010	0.015	0.013
	[0.009]	[0.011]	[0.008]	[0.012]
Government Support	0.046***		0.017***	0.005
	[0.004]		[0.004]	[0.005]
Employer has TTO			-0.008	-0.002
			[0.006]	[0.008]
PhD Institution has TTO			0.003	
			[0.005]	
Log of Employer Patents Lagged 5 Years			0.009***	
			[0.002]	
Log of Employer Academic Entrepreneurs				-0.009*
				[0.003]

Who Patents in Academic Science?

- Demographics: White Men with PhD from Research I more likely to patent.
  - Women & blacks less likely
- Chemistry, Engineering, Biologists are more likely to patent
- Publications, Presentations, Government grant support
  - Stars NOT more likely to patent
- Employed at medical schools, research is primary work activity.
- Employer has lots of patents, TTO has no impact.

Factors Associated with Academic Entrepreneurship

- Demographics: Women, Asians, Foreign-born less likely to be academic entrepreneurs.
  - Immigrants more likely to be entrepreneurs in the private sector.
- Productivity has different effects compared with patenting:
  - Articles & government support have no effect.
- Employer academic entrepreneurs reduced entrepreneurship

Factors Associated with Patent Commercialization

- Demographic and institutional factors do not predict patent commercialization.
- Productivity:
  - Articles, presentations increase commercialization.
- Employer patents increases commercialization
  - But TTO have no significant impact.
- Academic entrepreneurs are 12.4 ppt more likely to commercialize.

Variables	Conditional Logit			Cox Proportional Hazard Models		
	Patent Applications	Patent Granted	Patent Commerc.	Patent Applications	Patent Granted	Patent Commerc.
Academic Entrepreneur	0.235	0.206	0.199	1.916***	1.759***	2.033***
	[0.132]	[0.151]	[0.195]	[0.220]	[0.231]	[0.343]
Lag Academic Entrepreneur				1.073	1.095	1.409
				[0.144]	[0.164]	[0.254]
Log of Employer Patents	0.014	0.129	0.057	1.125***	1.136***	1.158**
Lagged 5 Years	[0.056]	[0.067]	[0.097]	[0.038]	[0.044]	[0.061]
Log of Employer Academic	-0.052***	-0.068***	-0.084***	1.042	1.012	0.974
Entrepreneurs	[0.015]	[0.017]	[0.023]	[0.032]	[0.035]	[0.045]
Employer has TTO	0.629**	0.307	0.117	0.942	0.854	0.776
	[0.243]	[0.282]	[0.403]	[0.103]	[0.103]	[0.124]
Articles	0.066***	0.049***	0.034***	1.003	1.005	1.005
	[0.006]	[0.005]	[0.006]	[0.004]	[0.004]	[0.005]
Presentations	0.034***	0.034***	0.027***	1.011***	1.012***	1.012***
	[0.004]	[0.004]	[0.005]	[0.002]	[0.003]	[0.003]
Star Researcher				1.133	0.962	1.139
				[0.138]	[0.130]	[0.196]
Government Support	-0.022	-0.032	-0.303	1.289*	1.293*	1.166
	[0.112]	[0.133]	[0.191]	[0.129]	[0.148]	[0.183]
Observations	5,010	3641	1854	18993	19,738	20,570

	Conditional Logit			Cox Proportional Hazard Models			
Variables	Entrepren.	Entrepren.	Entrepren.	Entrepren.	Entrepren.	Entrepren.	Entrepren.
Patent Applications	0.048*			1.012			1.045*
	[0.022]			[0.011]			[0.023]
Lag Patent Applications				1.084***			1.177*
				[0.019]			[0.081]
Patent Awards		0.033			1.018		0.869*
		[0.034]			[0.019]		[0.053]
Lag Patent Awards					1.079***		0.935
					[0.020]		[0.084]
Patent Commercialized			0.082			1.031	1.122
			[0.060]			[0.033]	[0.072]
Lag Patent Commercialized						1.075**	0.981
						[0.028]	[0.062]
Log of Employer Patents	0.001	0.002	0.001	1.007	1.008	1.008	1.006
Lagged 5 Years	[0.051]	[0.051]	[0.051]	[0.034]	[0.034]	[0.034]	[0.034]
Log of Employer Academic	0.646***	0.644***	0.644***	1.082*	1.081*	1.081*	1.081*
Entrepreneurs	[0.035]	[0.035]	[0.035]	[0.042]	[0.042]	[0.042]	[0.042]
Employer has TTO	-0.317	-0.319	-0.320	0.986	0.987	0.987	0.984
	[0.200]	[0.200]	[0.200]	[0.104]	[0.104]	[0.104]	[0.104]
Articles	-0.010	-0.009	-0.010	0.987	0.986*	0.986*	0.989
	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]	[0.007]

Additional Employment Outcomes

VARIABLES	Probit Left Academia	Probit Left Academia	Negative Binomial Articles	Negative Binomial FE Articles	Probit Govt. Support	OLS FE Govt. Support	OLS Hours	OLS FE Hours
Academic Entrepreneur	0.019**	0.030*	0.035	-0.002	0.011	0.017	-1.622***	-0.869***
	[0.007]	[0.013]	[0.031]	[0.031]	[0.012]	[0.010]	[0.238]	[0.194]
Patent Applications	0.002	0.011*	0.233***	0.095*	0.011	0.003	0.015	-0.077*
	[0.002]	[0.005]	[0.040]	[0.041]	[0.009]	[0.003]	[0.050]	[0.038]
Patent Awards	0.002	-0.008	0.107	0.071	-0.006	-0.002	0.110	0.132*
	[0.003]	[0.010]	[0.055]	[0.051]	[0.007]	[0.006]	[0.078]	[0.057]
Patents Commercialized	-0.014	-0.019	0.134*	-0.044	-0.020	-0.014*	-0.156	-0.108
	[0.009]	[0.020]	[0.060]	[0.055]	[0.010]	[0.007]	[0.155]	[0.106]

Academic Entrepreneurship: 1) increases probability of leaving academia, especially for untenured; has no impact on publications or grants; and decreases hours of work.
Patenting: 1) increases probability of leaving academia if untenured; 2) increases publications; applications decrease hours; awards increase hours.

Do Innovation and Entrepreneurship Pay?

VARIABLES	(2) Salary	(1) Earnings	(5) Salary FE	(4) Earn FE
Academic Entrepreneur	0.025***	0.185***	-0.018***	0.045***
	[0.007]	[0.008]	[0.005]	[0.007]
Patent Applications	0.004	0.006*	0.003*	0.003
	[0.002]	[0.003]	[0.001]	[0.002]
Patent Awards	0.003	0.007*	-0.000	0.006*
	[0.003]	[0.003]	[0.002]	[0.003]
Patents Commercialized	0.002	-0.008	-0.001	-0.016***
	[0.007]	[0.011]	[0.003]	[0.005]

There is a small salary premium for academic entrepreneurship that is likely explained by selection.

There is a large earnings premium for academic entrepreneurship after controlling for FE.

Patent commercialization reduces earnings & applications & awards have a small positive effect on salary and earnings.

Conclusions

- Patenting and Academic Entrepreneurship are largely distinct undertakings: only 25% of academic entrepreneurs patent and only 27% of patent holders are entrepreneurs.
- Patenting is a complement of scholarship
- TTO offices have no significant impact on patent commercialization
- Academic entrepreneurship increases patent commercialization by 12.4 ppt.
- Implications of Academic Entrepreneurship for the academic job:
  - More likely to leave academia
  - No effect on publications & grants, but reduces hours.

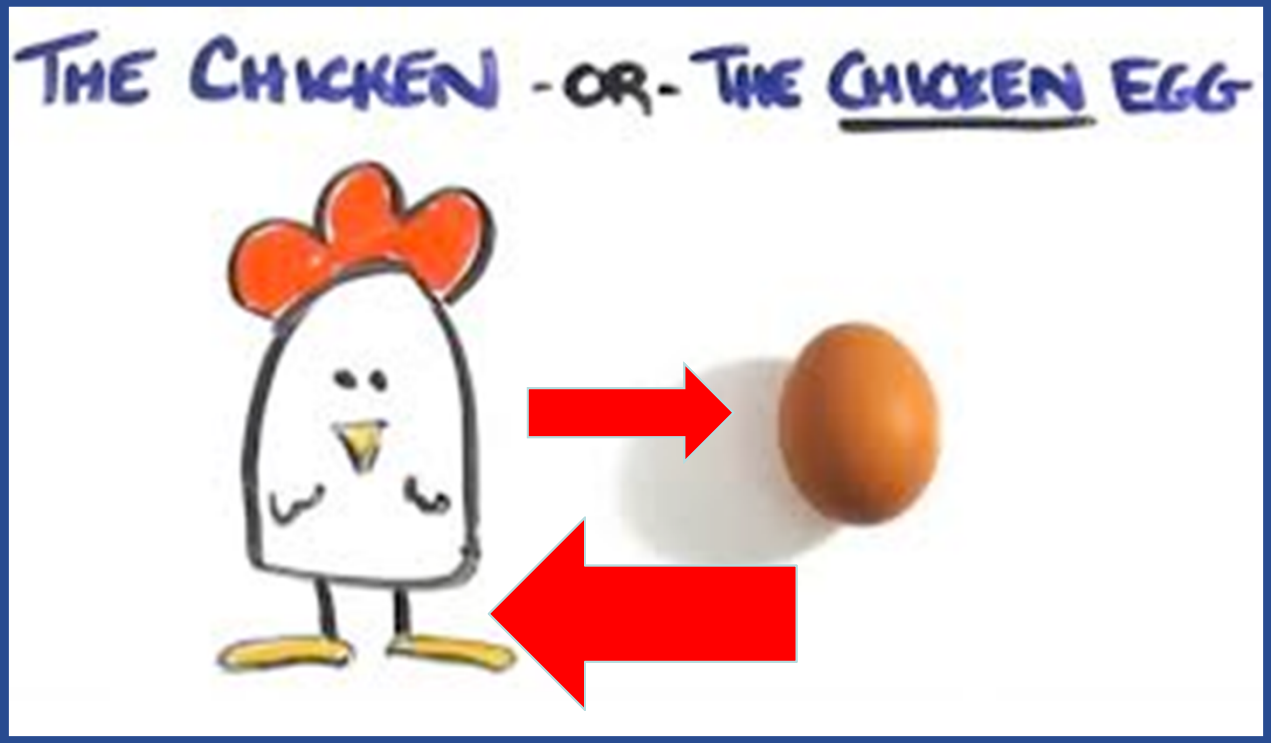
Implications for the Literature

- The broader definition of Academic Entrepreneurship (having a second job) is a form of “academic engagement” that pays very well.

- The narrow focus on academic entrepreneurship==research commercialization will understate the amount of academic entrepreneurship.

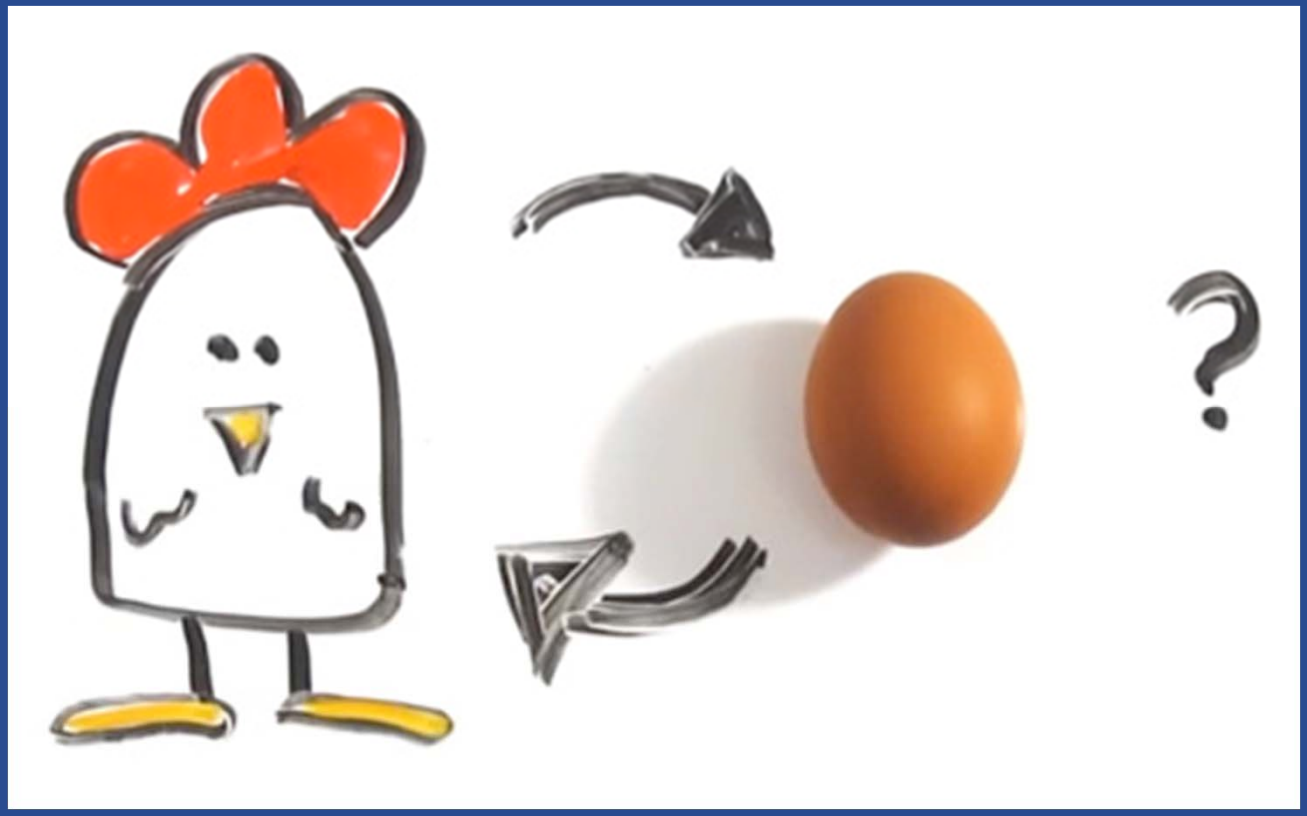
Which Comes First?

- Entrepreneurial Chicken more likely to come before patent commercialization.



- The Patent Application Egg comes before academic entrepreneurship.

Which Comes First?



- Perhaps that was the wrong question to ask.


Thank You
Mahalo
Kiitos
Tack
Toda
Grazie
Thanks
Obrigado
Takk
Merci
Gracias