Do Patent Citations Predict Market Value? The Case of Agricultural Biotechnology Patents

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Selected Poster prepared for presentation at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August 4-6, 2013.

Factors Determining Quality of Agricultural Biotechnology Patents

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INTRODUCTION

- Quantitative valuation of technology patents is challenging as there exist no market data, such as licensing or other indicators of commercialization. In the absence of such data, firm decision to patent given technologies must be made on the less objective qualitative factors that can, at best, only give a probabilistic estimate of market success. In recent years, the bibliometric data has enabled researchers to understand better the quality of patents through citation analysis.
- The *objective* of this study is to examine factors affecting quality of agricultural biotechnology patents. The analysis considers agbiotech patents belong to academia as well as industry.
- A majority of the literature on agbiotech patenting focused on quality of university/academic level patents. These studies are Barham, Foltz, and Kim (2002), Foltz, Kim, and Barham (2003), Buccola and Xia (2004) and Xia and Buccola (2005). There are only few studies that analyzing both academic and industry patents. Heisey, King, and Rubenstein (2005) and Graff and Zilberman (2004) discussed and analyzed the patents filed by university and public sector inventors, biotech entrepreneurs and corporations; they found systematic differences in their attributes.
- There is no study that focused on examining factors affecting quality of agricultural biotechnology patents. This study examines the potential factors determining a patent quality using data at patent level.

METHODS

- In the empirical model, we assume forward citations as the dependent variable representing patent quality. Many studies have provided evidence of a strong positive relationship between value of a patent and the number of forward citations it received. In the past, other measures of patent quality have been also used in the literature. Nevertheless, forward citation is used more frequently, and has been established itself as the best indicator of patent value. The forward citations variable is assumed to have negative binomial distribution because the forward citations variable is highly skewed. Many studies have modeled forward citations variable in a negative binomial regression framework because of the skewed nature of the variable (Hu, Bian, and Wang 2008; Sterzi 2012; Lissoni and Montobbio 2012; Harhoff et al. 1999; Sapsalis, van Pottelsberghe de la Potterie, and Navon 2006). Negative binomial regression is usually employed for over-dispersed count outcome variables.
- More specifically, we estimate the following negative binomial model:

$$E(CRECEIVE \mid X) = \exp(\beta_0 + \beta_1 CLAIMS + \beta_2 CMADE + \beta_3 GENERAL + \beta_4 ORIGINAL + \beta_5 NOINV + \beta_5 FWDAPLAG + \beta_6 BCKGTLAG + \beta_7 SELFCTLB + \beta_8 SECDLWBD + \sum_i \alpha_i \, ASSIGNEE_i)$$

- The definitions and summary statistics of the variables (except *ASSIGNEE*) used in the model are presented in the next table. *ASSIGNEE* is a categorical variable that represents whether a patent holder is public/private organization and whether that organization in the U,S, or in other countries.

DATA/PARAMETERS

- The dataset is constructed by merging Agricultural Biotechnology Intellectual Property database (developed by ERS USDA) and National Bureau of Economics Research (NBER) patent citations data. King and Schimmelpfennig (2005) and their collaborators constructed a similar database to describing quantity, quality and technical composition of patent stocks of six large agbiotech firms. The agbiotech patent data comprises of a set of utility patents issued by the US Patent and Trademark Office (USPTO) between 1976-2000. The utility patents were identified as relevant to agricultural biotechnology and biological processes in food and agriculture.

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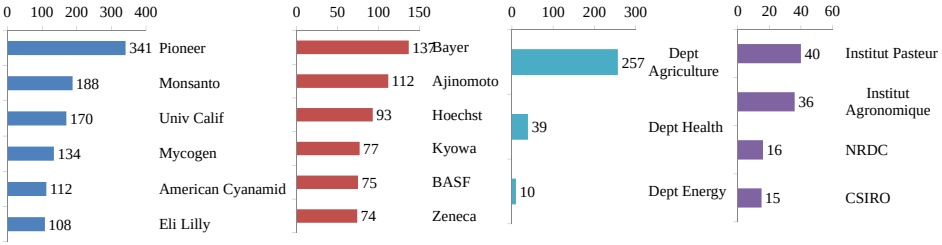
RESULTS

Summary Statistics of major variables

Variables	Definitions	Min	Max	Mean	Standard Error	Q1	Median	Q3	Mode	Std Dev	Skewness
CRECEIVE	Forward Citations	0	631	3.287	0.122	0	1	3	0	11.936	30.897
CLAIMS	Number of Claims	1	198	14.405	0.144	6	11	19	7	12.886	3.070
CMADE	Backward Citations	0	83	3.752	0.057	1	2	5	0	5.584	4.434
GENERAL	Measure of Generality	0	0.862	0.249	0.004	0	0.153	0.5	0	0.266	0.384
ORIGINAL	Measure of Originality	0	0.899	0.240	0.003	0	0	0.5	0	0.271	0.488
FWDAPLAG	Mean Forward Citation Lag	0	24.5	5.219	0.046	3	4.667	7.083	2	3.168	0.924
BCKGTLAG	Mean Backward Citation Lag	0	102	7.913	0.067	4.33	6.667	10	4	5.715	3.578
SELFCTUB	Share of Self-Citations Made	0	1	0.170	0.004	0	0	0.2	0	0.320	1.778
SECDUPBD	Share of Self-Citations Received	0	1	0.196	0.005	0	0	0.25	0	0.336	1.575
NOINV	Number of Inventors	1	18	2.765	0.018	2	2	4	2	1.737	1.804

Major Assignees



Regression estimates on patent-wise data

Variable	Model 1 (NegBin)	Model 2 (NegBin)	Model 3 (NegBin)	Model 4 (Poisson)
Intercept	0.061 (0.162)	0.328* (0.172)	0.089 (0.162)	0.221 (0.082)
CLAIMS	0.009*** (0.001)	0.009*** (0.001)	0.010*** (0.001)	0.009*** (0.001)
CMADE	0.025*** (0.003)	0.017*** (0.003)	-	0.023*** (0.001)
GENERAL	1.808*** (0.061)	-	1.798*** (0.061)	1.567*** (0.026)
ORIGINAL	-0.559*** (0.065)	-	-0.333*** (0.059)	-0.497*** (0.028)
NOINV	0.041*** (0.009)	0.049*** (0.010)	0.040*** (0.009)	0.072*** (0.004)
FWDAPLAG	0.140*** (0.005)	0.175*** (0.006)	0.138*** (0.005)	0.119*** (0.002)
BCKGTLAG	-0.031*** (0.003)	-0.028*** (0.003)	-0.026*** (0.003)	-0.042*** (0.002)
SELFCTLB	-0.084 (0.053)	-0.057 (0.057)	-0.101* (0.053)	-0.165 (0.023)
SECDLWBD	-0.145*** (0.053)	-0.221*** (0.057)	-0.134** (0.053)	-0.183*** (0.026)
ASSiGNEE				
U.S. non-Govt.	0.501*** (0.155)	0.494*** (0.165)	0.513*** (0.155)	0.574*** (0.079)
Non U.S. non-Govt.	0.213 (0.156)	0.125 (0.167)	0.187 (0.157)	0.200** (0.080)
U.S. Govt.	0.492*** (0.172)	0.495*** (0.183)	0.499*** (0.172)	0.501*** (0.085)
Non U.S. Govt.	-	-	-	
SCALE	0.576 (0.016)	-	0.586 (0.016)	-
N	3632 (9613)	3654 (9613)	3632 (9613)	3632 (9613)
-2 Log Likelihood	19453.06	20421.90	19512.17	35408.86
AIC	19481.06	20445.90	19538.17	35434.86
BIC	19567.82	20520.35	19618.74	35515.42

SUMMARY & CONCLUSIONS

- The number of claims an agbiotech patent has, and number of citations it is making have positive and significant effect on its quality.
- The coefficient on generality index was found to be positive and significant, which suggests that the more general a patent in its applications, the higher its quality.
- The coefficient on originality index was found to be negative and significant.
- Self-citations were also found to be negatively affecting the patent quality.
- Forward citations lag has a positive impact; however, backward citations lag has negative impact on a patent value.
- Apart from this, the patents registered by U.S. private firms were found to have the highest value followed by the patents from U.S. government, non-U.S. private firms

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