International Journal of Industrial Organization 31 (2013) 626–633

Contents lists available at ScienceDirect

International Journal of Industrial Organization

journal homepage: www.elsevier.com/locate/ijio

The economic value of patented inventions: Thoughts and some open questions ☆

Alfonso Gambardella *

Bocconi University, Milan, Italy

ARTICLE INFO

Available online 6 March 2013

JEL classification:
L1
L2
O3

Keywords:
Patents
Inventions
Technical change
Intellectual property rights
Market for technology
Patent premium

ABSTRACT

The economic value of upstream research outcomes has raised increasing attention. Not only are these outcomes central to the development of many innovations, but they are also the object of many transactions in technology. This note discusses a few representative papers that try to better understand the value of patented inventions. It deals with three topics: the value of patent rights, the value of patents as quality signals, and the value of patented inventions as a whole. In the latter case, it focuses on the creation of value through the number of inventions produced rather than increase in the value of individual invention. The note also sketches open questions for future research.

1. Background

The economic value of inventions is attracting increasing attention. Not only are inventions a key source of value of many new products or process, but their valuation is also crucial for the growth of technology markets (Arora et al., 2001), or in standard setting technology pools (Rysman and Simcoe, 2008), because inventions are the central object of these transactions. In addition, many firms assess the internal performance of their R&D departments by looking at the value of their outcomes. In fact, the size and quality of downstream assets explain a good deal of the value created during the development, production and commercialization of inventions (Rosenberg, 1982; Teece, 1986). However, a better understanding of the factors that affect the economic value of the earlier stages has become critical as well.

This note discusses a few results of a growing body of the literature that tries to better understand the economic value of patented inventions. We focus on patents because they are an indicator of invention. Not all inventions are patented. However, patents are an important asset of the firm; moreover, they often are the object of a license, or an important component of it, and on many occasions the value of relevant patents is central in defining the terms of a technological alliance or in technology pools. In most industries patented inventions need to be developed, produced or commercialized, and thus they are typical outcomes of upstream research.

Along with the value of patented inventions as a whole, the literature has focused on the value of the patent right — that is, the additional rents produced by the patent on top of the value of the unpatented invention. More recently, some studies have studied other aspects of the value of patented inventions, particularly the value of patents as signals of quality. This note discusses these three bodies of literature — the value of patent rights, patents as signals of quality, and the total value of patented inventions. The survey is not meant to be exhaustive, and it only discusses a few representative articles. However, it highlights questions arising from these studies, and offers suggestions for future research.

2. Value of patent rights

Work trying to uncover the value of the patent right, or the "patent premium" as Arora et al. (2008) called it, originates with the use of data on patent renewal payments. The working hypothesis is that how long a patent is "kept alive" is an indicator of the value of the patent right because it is expensive to patent holders to renew patent protection for an additional year. Based on such an approach, Schankerman and Pakes (1986) report that the median values for patents issued in 1970 in Germany, France and the UK are, respectively, $17,329, $847 and $1861 (all in 1980 prices). The distribution means are higher in France and the UK ($6656 and $6963, respectively,

☆ I would like to thank Claudio Panico, Rosemarie Ziedonis and an anonymous referee for very insightful suggestions on this note. Of course, all errors remain mine.

* Tel.: +39 0258363712.
E-mail address: alfonso.gambardella@unibocconi.it.

0167-7187/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.ijindorg.2013.02.007

$19,124 in Germany), indicating the skewed nature of the data. Schankerman (1998) and Lanjouw (1998) study specific industries in, respectively, France and Germany, using similar data and a similar approach. They obtain similar results. Table 1 summarizes the key features of the approach adopted by these and the other studies of this section to estimate the value of patent rights.

The approach employed by the studies that use renewal fees relies on the fact that a substantial amount of patents is not renewed until the end of the statutory life time. However, for patents that renewed till the end of their life, the renewal fees only provide a lower bound. Bessen (2008) estimates the value of the patent right using US data. His approach is to simulate the distribution of the value of patent right assuming that it follows a lognormal distribution. The patent fees (which increase over time) provide an observed lower bound for the value of the patent right at each cutoff point in which patents need to be renewed (in the US 4, 8, 12 years after their grant). He then run an ordered probit using information on whether the patent was not renewed in year 4, it was renewed in year 4 but not in year 8, it was renewed in year 8 but not in year 12, it was renewed throughout the life of the patent. Bessen finds a higher estimated mean and median than the European data, respectively $78,000 and $7000 in 1992 US dollars ($113,000 and $18,000 for public manufacturing firms).

Serrano (2012) combines information on renewals and patent trade to obtain a more precise estimate of the value of patent rights. His structural model hinges on the idea that traded patents that are renewed are worth more than untraded patents that are renewed, while expired patents are the least valuable. Traded patents are worth more than just renewed patents because the owner also considers the returns enjoyed by the buyers who earn more than they do from the patent. He estimates that the mean value of patent rights in 2003 US dollars is equal to $164,670 for traded patents and $50,162 for non-traded patents; the median values are, respectively, $58,320 and $10,605, while the mean and median for the sample average are $76,958 and $16,184. In addition, Serrano (2012) finds that a large volume of patents in his sample are traded (about 50%). He also finds that the gains from trade account for about 10% of the volume of traded patents, they are much skewed with few patents accounting for a large share of these gains, and they increase sizably with lower transaction costs in technology markets.

Serrano finds a smaller value of patent rights than Bessen (2008), considering that Bessen uses constant 1992 US dollars. However, Serrano only looks at patents by small firms (less than 500 employees). While this choice of sample is meant to focus on patents that are more likely to be traded, it explains the larger volume of patent exchange that he observes, and the lower value of patent rights. Larger companies may enjoy higher values of patent rights because of their downstream complementary assets, thus implying results closer to Bessen's. In this respect, Serrano's estimates may also be lower bounds both because of the reliance on renewal fees and the sample of small firms. Serrano's results also square with the analysis of Galasso et al. (2011) who show that patent trade may not stem not only from comparative advantages in the generation vs. commercialization of technology, but also from comparative advantages in the enforcement of patent rights.

Hall et al. (2005) and Bessen (2009) use stock market value of the patent-owning firms to estimate the value of patent rights. In particular, Bessen (2009) shows that the standard market value equation does not provide a direct estimate of the patent premium. Under the assumption of constant returns to scale, this equation is $V_{jt} = q_t \cdot (K_{jt} + W_{jt})$, where j and t account for firms and time respectively, V_{jt} is market value, K_{jt} is an aggregate capital stock in nominal terms, q_t is a time-varying marginal value, and W_{jt} is the present discounted value of firm rents. In turn, $W_{jt} = uP_{jt} + \mu_j K_{jt}$, where P_{jt} is patent stock, u is the mean patent rent, μ_j is the firm's mark-up for rents earned on the other assets K_{jt}. Bessen (2009) shows that we cannot directly estimate u. This is because patents may also account for higher quality of R&D, and thus it also enters the expression for K_{jt}. More precisely, $K_{jt} = A_{jt} + Q_{jt}$, where A_{jt} is some standard tangible asset and Q_{jt} is a measure of the firm's intangible assets. Specifically, $Q_{jt} = \alpha R_{jt} + \beta P_{jt}$, where R_{jt} is R&D stock, patents affect the quality of intangible assets beyond the mere R&D stock, and α and β are weights with which R_{jt} and P_{jt} enter the Q_{jt} stock. When we replace the expression for Q_{jt} in K_{jt}, the expression for K_{jt} in W_{jt}, and the expression for W_{jt} in V_{jt}, we obtain

$$\ln\frac{V_{jt}}{A_{jt}} = \ln q_t + \ln\left(1+\mu_j\right) + \ln\left(1+\alpha\frac{R_{jt}}{A_{jt}}+\gamma\frac{P_{jt}}{A_{jt}}\right) \quad (1)$$

where $\gamma = \frac{u}{1+\mu_j} + \beta$. Eq. (1) is the standard market value equation estimated, for instance, by Hall et al. (2005) through nonlinear least squares. As Bessen notes, given $\beta \geq 0$, the estimated coefficient of $\frac{P_{jt}}{A_{jt}}$ is an upper bound of the mean patent rent u. He estimates $\hat{\gamma} =$ $370,000 (in 1992 US dollars). This measure is robust across different estimations, and it is consistent with the estimates of the patent premium in other studies.

While all these studies infer the patent premium from the behavior of firms (or investors in the case of market value), the ideal experiment is to compare the value of a patented invention with and without the patent. This counterfactual is hard to observe. However, Arora et al. (2008) develop a structural model in which they take

Table 1
Estimates of the value of patent rights.

Study	Approach	Upper/lower bound	Sample	Estimates of the patent premium	Measure
Schankerman and Pakes (1986)[a]	Renewal fees	Lower bound	Patents issued in 1970 in Germany, France, UK	17.3; 0.8; 1.9 (median of distribution) 19.1; 6.7; 7.0 (means)	1980 USD (000)
Bessen (2008)	Renewal fees	Lower bound	Patents issued in 1991 in the US	7.0; 78.0 (median, mean; all) 18.0; 113.0 (median, mean; public mfr firms)	1992 USD (000)
Arora et al. (2008)	Structural model	–	790 US R&D labs 1991–1993	147% (conditional on patenting the invention) 60% (unconditional expected patent premium)	% of value of the invention if not patented
Bessen (2009)	Market value	Upper bound	3451 US firms 1979–1997	370 (mean)	1992 USD (000)
Jensen et al. (2011)	Inventor survey, value of granted vs. non-granted patents	–	1790 patent applications to the Australian Patent Office	256 (mean)	2007 Australian dollars (000)
Serrano (2012)	Renewal fees and patent trade	Lower bound (renewal fees and small firms)	54840 US patents granted to firms <500 employees 1988–1997	164.7; 50.2; 77.0 (means; traded patents, non-traded, all) 58.3; 10.6; 16.2 (median values; traded patents, non-traded, all)	2003 USD (000)

[a] Schankerman (1998) and Lanjouw (1998) obtain similar results using a similar approach.