Patents as Credence Goods

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producers and justified property rights in non-rivalorous goods.[2] Typically, the inventor has many ideas but few resources, and the producer has the resources but few ideas. The close relationship between the two is played out within research, development and manufacturing. The relationship is a tense one as, minus property rights, the inventor is unlikely to want to disclose his invention in full and the producer is unlikely to want to invest in ill-defined ideas. 'The value of information for the purchaser is not known until he has the information, but then he has in effect acquired it without cost.'[3]

The key to resolving Arrow's paradox is having well-defined property rights through patents, whether the invention is comparatively simple or complex. Such a view has allowed economists to focus on complex relationships among patents, innovation, competition and the diffusion of technology. Landes and Posner, for example in their classic account of the economics of patent law, focus on a related way of thinking about patents – as a response to economic problems inherent in trade secrecy and the market structure.[4] This sort of analysis has proved particularly fruitful in theoretical discussions about the appropriate scope of patent rights.[5] But Arrow's paradox is not always resolved merely by the granting of patents. When there is uncertainty in the 'property dimensions'[6] of patents, the *value* of the information contained in a patent is unclear. There are many indications that this view of patents as property rights in information is as simplistic as it is ubiquitous.

Patents are property rights but from a transaction perspective they are not like any other property right. The unclear metes and bounds of a patent make it an ill-defined entity with which to transact.[7] Typically, transaction costs are the costs of specifying what is being exchanged and of enforcing the consequent agreements. Measurements that need to be specified are the 'the property or physical dimensions of goods and services or the performance of actors'. While measurement of physical dimensions can be costly, property rights dimensions are specified by legal arrangements,[8] including enforcement costs. The physical and property dimensions of patents are measured and specified respectively by legal arrangements. Hence the efficiency of the patent system depends largely on the quality and certainty of those legal arrangements. A number of fundamental

[2] K.J. Arrow, 'Economic Welfare and the Allocation of Resources for Invention,' in R.R. Nelson (ed), *Rate and Direction of Inventive Activity* (Princeton University Press, Princeton 1962) 609-619.
[3] *ibid* 615.
[4] W.M. Landes and R.A. Posner, *The Economic Structure of Intellectual Property Law* (Harvard University Press, Cambridge, Mass 2003) 295–333.
[5] *ibid* 324.
[6] This is the term used by Douglass North in 'Economic Performance Through Time' (June 1994) 84(3) Am Econ Rev 359, 365.
[7] A. Arora, 'Refusal to License: A Transaction Approach' (2002) Prepared for FTC/DOJ hearings on competition and intellectual property law in the knowledge based economy'. Positive transaction costs in the patent system often lead to distortions in outcome. For example, when transactions are costly, bargaining strength can affect the efficiency of outcome.
[8] n 6 above.

misconceptions about the exactitude of these legal arrangements in certain types of patents perpetuate the myth of Arrow's resolution to the information paradox.

Uncertainty is endemic to patent rights, particularly in the context of 'immature technologies'.[9] As a result they have been described variously as 'signals' and 'probabilistic property' rights. While this uncertainty may provide the necessary flexibility in the application of patent law, over the years a number of adaptive mechanisms have developed that allow us to mark the value of patents. The existence and need for such mechanisms in turn institutionalise the uncertain nature of these rights, but is there a better way to categorise the information contained in these patents? It is argued here that patents, especially in the early stages of a new technology, function as 'credence goods' – goods of an 'unobservable' nature that force consumers to rely on external mechanisms for information about quality and quantity. The credence goods view of patent rights provides a useful framework to analyse uncertainty as well as the adaptive mechanisms that evolve to cope with the imperfections, at a transactional price.

This paper argues that in order to perform the market-improving function of a property right, the instrument must allow both parties involved in a transaction to make assessments of the value of the commodity being exchanged. Patents perform this function poorly due to intrinsic and extrinsic uncertainties that go beyond a mere administrative question of how these patents are granted. Patents are better understood as credence goods. This paper reviews how credence verification takes place in the patent system and demonstrates how the credence view of patents can help us better understand anomalies. While the arguments presented here are relevant to patents in general, they are particularly suited to

Clarisa Long argues for the need to transcend the 'simple view of patents' – the focus on patents as mechanisms of privatising information.[12] Long emphasises the need to reframe patents in the broader economic sense of informational mechanisms, rather than in the narrow sense of a regime of legal rules attempting to create exclusive rights to inventions. She argues that patents are a means of credibly publicising information.

Intellectual property serves as a signal of less readily measurable attributes. According to Long, if investors believe that the quantity of patents obtained by a firm in a time period (an easily measurable variable) is a measure of R & D output in that time period (a less easily measurable variable), then investors may take the firm's patent rate into account when attempting to extrapolate the future value of the firm.[13] Thus, patents can convey a wealth of quantitative information such as

In spite of the uncertainty and poor quality the market does not turn its back on patents – a puzzle that Parchamovsky and Wagner call the ‘patent paradox’.

Uncertainty in terminology

Claims are the most significant part of a patent instrument. The specification, which is the body of the patent, describes the invention in detail. The claims within the specification are crucial to the whole patenting process in any jurisdiction. In the UK patent applicants must comply with four criteria: (1) they

Recently the House of Lords had the opportunity to clarify the ambit of the process of claim construction and explicate the central role of the 'person skilled in the art' in a complicated biotechnological case:

> Construction, whether of a patent or any other document, is of course not directly concerned with what the author meant to say. There is no window into the mind of the patentee or the author of any other document. Construction is objective in the sense that it is concerned with what a reasonable person to whom the utterance was addressed would have understood the author to be using the words to mean.[28]

The facts in this case essentially called for the correct interpretation of the term 'host cell'. The patent, prima facie, was an invention where exogenous DNA is

for opportunistic behaviour by the applicant. Relying on the unilateral disclosure of patentees based on threats of disrepute or sanctions is not foolproof because of the cost of discovering dishonest conduct.[32] Once a patent has been granted, challenging validity and seeking revocation is an expensive process; hence there is considerable incentive under both US and UK law to do everything the system permits one to do in order to get a patent.

For example, under US law, in addition to the written description and enablement requirements, the law also mandates that the patent disclose the 'best mode' of carrying out the invention contemplated by the inventor.

Like the US and UK, New Zealand and other jurisdictions have a principle of equitable relief drawn from the 'clean hands doctrine',[38] although the way this doctrine applies has varied considerably among jurisdictions and over time.[39]

Extrinsic uncertainty – the search for the private value of patents

Extrinsic uncertainty is part of the process by which patent value is measured and perceived in capital and labour markets.[51] Such markets have a compelling need for information on patent value in order to value firms and the assets they hold, to employ 'productive scientific groups', and to make investment decisions. Often a thorough investigation directed towards intellectual property is called for in business transactions involving biotechnology firms,[52] information that is extremely hard to obtain in a credible way.

Patents contain information in varying amounts and in degrees of quality, a result of an attribute of knowledge that Clarisa Long refers to as 'lumpy'.[53] Patents can differ enormously in the value of the information they contain and hence patent counts are not in themselves proxies for the value of underlying inventions. This is borne out by extensive work on the relationship between patents and market value. It is the extremely skewed nature of the value distribution of individual patents (some are very valuable, while many are worth almost nothing) that makes firm patent totals a very noisy indicator of the underlying economic value of the innovations.[54] This point was first made by Scherer in 1965 and developed later by him and his co-authors.[55]

There are a number of factors used in the theoretical literature to value patents, and the field, although small, is a burgeoning one in economics. The principal problem that makes the intrinsic uncertainty described above qualitatively different from extrinsic uncertainty is the persistent inability to *quantify* the effect of novelty, inventive step, disclosure and breadth on a patent's economic value. Often the literature centres on parameters such as the number of times a patent is cited, the length of its renewal, or the number of countries where it is taken. Potential investors have to find a way to analyse the value of the single patent or, what is more likely, of the patent portfolio they are presented with,

[51] R. Pitkethly, 'The Valuation of Patents: A review of Patent Valuation Methods with Consideration of Option Based Methods and the Potential for Further Research', (1997) Oxford Intellectual Property

They cannot easily be turned into handy predictors of patent value for an individual case.[63] Valuation of patents in accounting theory is an instructive corollary to the difficulty in establishing the extrinsic value of these often opaque assets.

Patent valuation

Following the three main accounting strategies, a number of approaches can be used, with limitations, to estimate the value of patents.[64] First, an income valuation approach can be applied in some circumstances. If the income from owning a patent can be determined over a period of time, a value can be assigned to it, much like to a long-term bond. Where anticipated economic benefits can be identified, credible estimation of value may be made, although it is often difficult to identify a definite income stream. The classic example is the 'unproven' patent, covering technology that has not yet been commercialised.[65] Such estimations are even harder to make in new areas of technology where the market for the product and process of technology is relatively young and undeveloped.[66]

Thirdly, the cost basis approach is almost non-existent for patents since 'it costs as much to get a worthless patent as it does to protect a valuable invention'.[70] Using a cost approach for asset valuation for a patent is also impossible because a patent is irreplaceable. At least one commentator refers to the cost basis approach for patent valuation as useless for making rational decisions.[71]

A full micro-economic analysis of patents will ideally involve elements of insights from micro-economic theory applied within objective valuation methods. Such analysis should involve relationships between patents, product lines, licensing royalty rates etc. However, this is information that companies rarely make available to the public. This makes the cost of micro-economic analysis of a patent t11.52ess s98'it

What exactly does it mean to doubt the 'quality' of a patent? Recent empirical work suggests that patent office examinations are increasingly meaningless as guarantors of the quality of the underlying innovation.[75] This is a point well commented on by authors such as Merges and Lemley. Merges, for example, uses the test case of patents for business concepts in light of persistent reports that patents issued by the United States Patent and Trademark Office (USPTO) in the software area and business methods are of extremely poor quality.[76] He reports that: 'People familiar with the technology involved and the history of various developments in it report that patents in this area are routinely issued which overlook clearly anticipating prior art.'[77]

On average, each US business method patent carries reference to two non-patent citations, which, according to Merges, should immediately set off warning bells. 'Business people have been pioneering new concepts since commerce began and internet commerce has seen exponential growth in recent years. Very few of these developments have found their way into patents.'[78] Consequently, the error rate for such patents is likely to be quite high. Not dissimilar to this kind of 'error rate' is the simple possibility of 'mistakes', amply reflected in biotechnology, where anecdotal objections intermingle with more principled concerns.

A few stark accounts are often used. In 2000, the European Patent Office (EPO) admitted, after an investigation prompted by the environmental group Greenpeace and *Financial Times* Germany, that a 'very serious error' had been committed in granting a patent that included claims on technologies that could be used to alter the composition of the human germ line.[79] The errors and 'mistakes' may occasionally be due to the lack of resources. More worryingly, it may also reflect a change in objectives of patent offices in many countries. As Lemley reports, in the US the patent office 'reengineered' itself, declaring its mission to be 'to help our customers get patents'.[80] This is a disturbing position for the patent office that is entrusted with representing the public interest to take in deciding whether to issue patents. While the job of the Patent and Trademark Office is certainly to issue 'good quality' patents, it is also to reject 'bad quality' ones.[81]

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[75] PaBTc 03h003 ap pas error' had bcca080s49 -1.2347gP5(S/MCID9.8803 Tm[(P)r'bsCi5ries. AMEin (t608095(P)r/tEur)5(Rer)5(t u5(Rer)50,de pbl 39 7.5 iou(1.8757)5(0320s.td0.157)1

Many patent offices have also recently taken on new 'policy' roles, some of which include explicit efforts to expand intellectual property rights. Roles like this lead patent offices into ambiguous territory and potentially real conflicts of interest – an aspect recognised by the recent Gower Review of Intellectual Property in the UK.[82]

Patent quality is sometimes affected by evidence of the seemingly systematic failings of patent offices. The US Federal Trade Commission (FTC), for example, reported that a patent examiner in the US spends between 8 and 25 hours on average in reading a patent application, searching for and reading prior art, writing one or more provisional rejections, reviewing responses and amendments, often conducting an interview with the applicant's attorney and writing a notice of allowance.[83] Against this backdrop there are constant demands to increase productivity, often issuing from the patent office itself. The 2004 USPTO Annual Report sets the goal of accelerated processing times through 'more focused examination'.[84] Patent quality problems have also been experienced in the EPO. According to recent staff surveys, examiners at the EPO are losing confidence in its ability to ensure the quality of the patents that it issues. It is a devastating indictment to have two thirds of the 1,300 patent examiners state that productivity demands within the EPO did not allow them 'to enforce the quality standards set by the European Patent Convention'.[85]

Clearly, the effect of performance reports like these adds strength to the perception of 'poor quality' patent rights, with considerable implication for the system as a whole as well as the way the market values these rights. Biotechnology patents are often opposed in academic literature and popular media as having inappropriately low levels of inventiveness. This concern is the basis for one of the most theoretically coherent ideas to come out of the 'patent crisis' created by biotechnology - Heller and Eisenberg's theory of the development of an anticommons in downstream biomedical research caused by levels of non obviousness and overlapping patent rights. Their argument is essentially an argument against granting of technologically insignificant (bad quality) patents.[86]

There is a need to investigate adaptive processes that may develop to deal with, and ask the question whether such processes solve the problem of bad quality patents and, if so, what sort of transaction costs they entail. A good example of a 'private' adaptive process is the website BountyQuest.com that was set up in 2000 by Bezos, owner of the Amazon's controversial '1-click patent', and Tim O'Reilly, a publisher of software books and online information. The website offered a 'bounty' to members of the public who collected information that led to debunking a current patent.[87] Some scientists responded to the patenting of human gene sequences by making even greater efforts to make gene sequences publicly available as a preventive measure. Beefing up the public domain in this way, for example, defeats the low nonobviousness threshold for DNA structural information in the US. It has now become something of a 'scientific establishment standard' to make the genome of an organism publicly available as soon as it is sequenced.

Concern about poor patent quality is also reflected in a number of recent 'public' efforts to revitalise and scrutinise the performance of patent offices, through post-grant review procedures. In 1980 the United States introduced ex parte re-examination of patents to serve as an expedited and low-cost alternative to patent litigation for reviewing certain aspects of patent validity. The procedure was infrequently used.[88] Subsequently, in 1999, the American Inventors Protection

Post-grant review processes in the US are comparable in Europe to the opposition procedure in the EPO where under EPC art 99 allows oppositions to a

Some goods and services are more prone to this than others, and there are varying gradations of difficulty in discovering the veracity of claims about them. The problem of credence goods typically occurs in medical, legal and financial advice services, as well as a wide variety of repair professions, where it is often impossible to verify the expert's opinion. The asymmetry in information and the cost of verifying the expert's opinion is prohibitively high, and therefore creates the possibility of opportunistic, and sometimes fraudulent, behaviour on the part of the expert.[101] A transaction involves asymmetric information when one party to the exchange has more information (on quality of goods or relative price) than the other, leading to opportunities for fraudulent behaviour.[102]

Stigler dealt with the problem of ascertaining 'market price' of goods. He analysed search costs – a phenomenon that arises when a buyth

Darby and Karni then expanded Nelson's categories to include 'credence goods'.[105] Credence goods constitute a category for which the non-expert cannot verify the quality attributes of the goods. They discuss how reputation, market conditions and technological factors affect the amount of 'fraud'. For these goods, one must rely on a *third party* to provide truthful information to the consumer about quality. Certification is one way in which unobservable credence attributes are transformed into observable search attributes and can be enforced either privately or publicly with varying efficiency.[106] It provides theoretical backing for third party certification or introduction of government regulations, for example, for the eco-labelling of foods.[107]

The above discussion has a unique resonance for patents in immature technologies, particularly in current biotechnology. Patents in immature technologies also suffer from this 'unobservable quality', and consequent asymmetry in information. For example *intrinsic* and *extrinsic* uncertainty in the case of biotechnology patents carry the prospect of opportunistic or self-serving behaviour on the part of the patent applicant and patentee. The term 'fraudulent-expert', used in the context of the economics literature on credence goods, should be understood in the patent system as the opportunistic or self-serving expert – the patent applicant or the patentee who knows relatively more about the 'true value'[108] of the patent application or patent. In the context of the patent system, it is not 'fraud' to take advantage of the existing rules to get maximum proprietary protection for the subject-matter of one's invention.

Winand Eamons presents a simple framework that allows one to identify conditions under which the 'fraudulent expert' problem can be solved. According to his model, market mechanisms do a fairly good job of mitigating the information asymmetry of goods and services of credence quality. If buyers (or consumers) of credence goods and services rationally process ex ante information, the market does indeed solve the fraudulent expert problem. This is true typically in cases where the market is fairly unhampered, as is the case with private transactions involving sale and purchase of technology. If, as submitted here, the credence model is relevant for biotechnology patents, we can expect first that patent holders will invest in mechanisms that provide ex ante information about their capacity and, secondly, that 'buyers' will pay more attention to them.

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[105] M.R. Darby and E. Karni, 'Free Competition and the Optimal Amount of Fraud' (1973) 16 J L & Econ 67.

[106] E. Auriol and S. Schilizzi, 'Quality Signaling Through Certification: Theory and Application to Agricultural Seed Markets' (2003) IDEI Working Papers 165, Institut d'Économie Industrielle (IDEI), Toulouse at http://idei.fr/doc/wp/2003/certif5.pdf, accessed 5 January 2007.

[107] T. Leibi, 'Monitoring Eco-Labels: You can Have Too Much of a Good Thing' (2002) Discussion Paper, Department of Economics, University of Bern at nhttp://ssrn.com/abstract=318540, accessed 5 January 2007. See also C. Roheim, 'Early Indications of Market Impacts from the Marine Stewardship Council's Ecolabelling of Food' (2002) Marine Stewardship Council, 13 at http://www.wto.org/english/forums_e/ngo_e/ccc_msc_e.doc, accessed 5 January 2007. Kevin J. Lancaster, 'A New Approach to Consumer Theory' (1971) 74 78 J Pol Econ 132.

[108] In so far as the true value is discoverable.

In cases where the seller is a ‘credence good monopolist’, the market creates incentives for behaviour in ‘good faith’ by separating the ‘expert’ function into ‘statement’ and ‘verification’.[109] Patent holders can be regarded as credence good monopolists as no patent can be replaced by another.[110] Applying Emons’ model to the patent system would require the statement made by the ‘patentee-expert’ in his patent application to be verified by third parties. Both scenarios, analysis of ex ante information and the splitting up of ‘statement’ and ‘verification’ functions, are prevalent in the patent system and for syd

incentives to gather and process the necessary information'.[113] This seems to indicate that greater public or state regulation of the 'quality' of patents, or the mechanisms that identify the 'quality' of patents, would lead to a reduced incentive on the part of 'buyers' to decrease the informational asymmetry. Hence, new measures such as introduction of a post-grant review process in the US, or the giving of opinions on validity under the Patents Act 2004 in the UK, may fail fundamentally to decrease information asymmetry and may further distort the process of gathering information about the *quality* of patents.

CREDENCE VERIFIERS IN THE PATENT SYSTEM

'Patent portfolios' and the 'reputation' associated with scientific publications are two third-party verifiers of patent value, or credence mechanisms. The increasing incidence of patent portfolios shows a functionality that can be theoretically described as a credence verifier. An empirical study on reputation associated with good quality scientific publications indicates a similar function when the same firm produces non-proprietary scientific information and proprietary information in the form of patents. The existence and necessity of 'credence mechanisms' signals two propositions of value. First, patents are ind1aynd1aBDC44[(de8d0.5976 Tm( )TjET768 Tposie>.aynd5i

Empirical and theoretical studies contradict a monolithic view of what adds value to patents that is based solely on the 'appropriability' problem. [116] Portfolios provide advantages that undercut the 'weakness' of individual patent rights. The benefits of a patent portfolio, according to the authors, can be divided into two broad categories: those related to the scale features of portfolios and those related to diversity features. Scale features cause the portfolio to work as a 'super patent' and provide rights to exclude others on a larger, broader scale. Diversity features make the portfolio a 'purposeful combination of distinct but related individual patents', that allow the owner to address some of the fundamental uncertainties associated with innovation.[117]

There are a number of advantages of scale that a patent portfolio can provide by covering a wider range of technological options: it increases the possibility that both end-result and development efforts will be covered in-house and reduces the possibility of infringement of other patents. It can provide ways to avoid litigation

biotechnology patents, examples of 'uncertainty in the law' affecting the value of existing patents are not uncommon.

On the one hand, the market, based on the evidence, distrusts the quality of patents being granted and may be unwilling to make an opinion on the long-term viability of any firm based on individual granted patents. On the other hand, credibility cumulates over a patent portfolio and adds to the standing of the firm.[120] Going through multiple examination procedures acts as a 'certification' of the reputation and credibility of the firm holding the patent portfolio. It removes the need to engage in individual patent valuation and is a better indicator of the market position of a firm in respect of both the technology protected and the bargaining position with respect to competitors. It reduces the scope for opportunistic behaviour by the patent portfolio holder and ameliorates the asymmetry in information between the patent holder and competitors or potential investors. Patent portfolios therefore function as 'third party verifiers', 'third tier information mechanism'[121] or 'credence verifying' mechanisms. The patent portfolio theory of patent value is a very important piece in the jigsaw of the credence view of patents, as it illustrates that market mechanisms can induce non-opportunistic behaviour,[122] albeit at a transactional cost.

Reputation and patents

Another mechanism of third party verification is provided by the scientific peer review system. Firms regularly publish the results of their scientific research in peer-reviewed journals. Publishing peer-reviewed articles allows firms to convince investors and potential collaborators of the worth of their ideas. Recent empirical findings on innovation in UK biotechnology firms by K Kumaramangalam shows that these gains are indeed realised by biotechnology firms. Based on unique data from firms in the UK biotechnology sector for the period 1988–2001, on average publishing 14 scientific papers has the same effect on market value as obtaining a single patent.[123] The following is a summary of the results (see Box 1) and their implications for the credence view of biotechnology patents.

Market value is a dependent variable that measures performance. R & D is generally believed to be the dominant operating expense for biotechnology firms.[124] Simply counting the number of patents awarded to a firm is a poor

[120] A related problem can arise when patent holders to attempt to multiply the patent rights they hold by fragmenting a single inventive concept. Patent holders may also choose other intellectual property rights, such as trade marks, in addition to lead time or secrecy, to augment the credibility of the knowledge assets they hold.

[121] n 12 above, 670.

[122] W. Emons is concerned to show the same from his analysis of credence goods: n 102 above.

[123] For a full explanation of the mathematical model, see K. Kumaramangalam, 'Science and Profit:

indicator of innovative success because they are extremely volatile indicators.[125]

Citation-weighted publications
or reputation
---------- = Credence Value of Innovation
Millions of R & D $

A single extra *citation* to a paper written by the employee of a firm per million dollars spent on R & D increases the market value by 0.013%. On average, the study found that a scientific paper is cited 11.47 times. Therefore, on this basis it would appear that, typically, 14 published scientific papers are worth more than a patented innovation.

The key questions raised by these results are *why* giving away information in the form of scientific papers appears so valuable, and *how* that relates to the value of patents. Arrow's approach suggests that firms should seek to protect knowledge resources by giving away as little information as possible while engaged in an R & D race for valuable patents.[128] Yet firms regularly reveal information about their R & D program in peer-reviewed journals. Why should they do so? By publishing scientific papers, firms send out a signal of the underlying *quality* of their R & D program. Financial markets use this information more accurately to gauge the present value of a firm's knowledge assets including its patents, and therefore publishing better-quality research translates into real financial gains in the immediate present for biotechnology firms.

Specifically, a number of economic theorists have suggested that high technology firms adopt open science norms in order to develop routines and skills that allow them effectively to utilise advances in publicly funded research.[129] There is also evidence to suggest that adopting open science norms confers labour cost advantages, as scientists are often willing to accept a lower wage in exchange for permission to continue publishing scientific papers and thus maintaining their links with open research.[130] It is already known that 'star' scientists (ie scientists whose work is cited far more often and who appear in more prestigious journals than their cohorts) play a very powerful role in the growth of young biotechnology firms.[131] While these 'star' scientists bring a wealth of human and, often, physical

[128] K. Arrow, 'Economic Welfare and the Allocation of Resources for Invention' in R. Nelson (ed), *The Rate and Direction of Inventive Activity* (Princeton University Press, Princeton 1962) 609. For a more recent use of this classic assumption, see also P. Dasgupta and P. David, 'Towards a New Economics of Science' (1994) 23 *Research Policy* 487. Also see R.P. Merges, 'A New Dynamism in the Public Domain' (2004) 71 U Chi L Rev 183; O. Bar-Gill and G. Parchamovsky, 'The Value of Giving Secrets Away' (2003) 89 Va L Rev 1857.

[129] W. Cohen and D. Levinthal, 'Absorptive Capacity – A New Perspective on Learning and Innovation' (1989) 35 Administrative Science Q 128; I. Cockburn and S. Henderson, 'Absorptive Capacity, Co-authoring Behaviour and the Organisation of Research in Drug Discovery' (1998) J Ind Econ 157.

[130] S. Stern, 'Do Scientists Pay to Be Scientists?' (1999) NBER Working Paper Series 7410 (1999). This dual public–private behaviour is well documented, particularly in the context of biotechnology. See F Murray, 'Innovation as Co-evolution of Scientific and Technological Networks: Exploring Tissue Engineering' (2002) 31 *Research Policy* 1389.

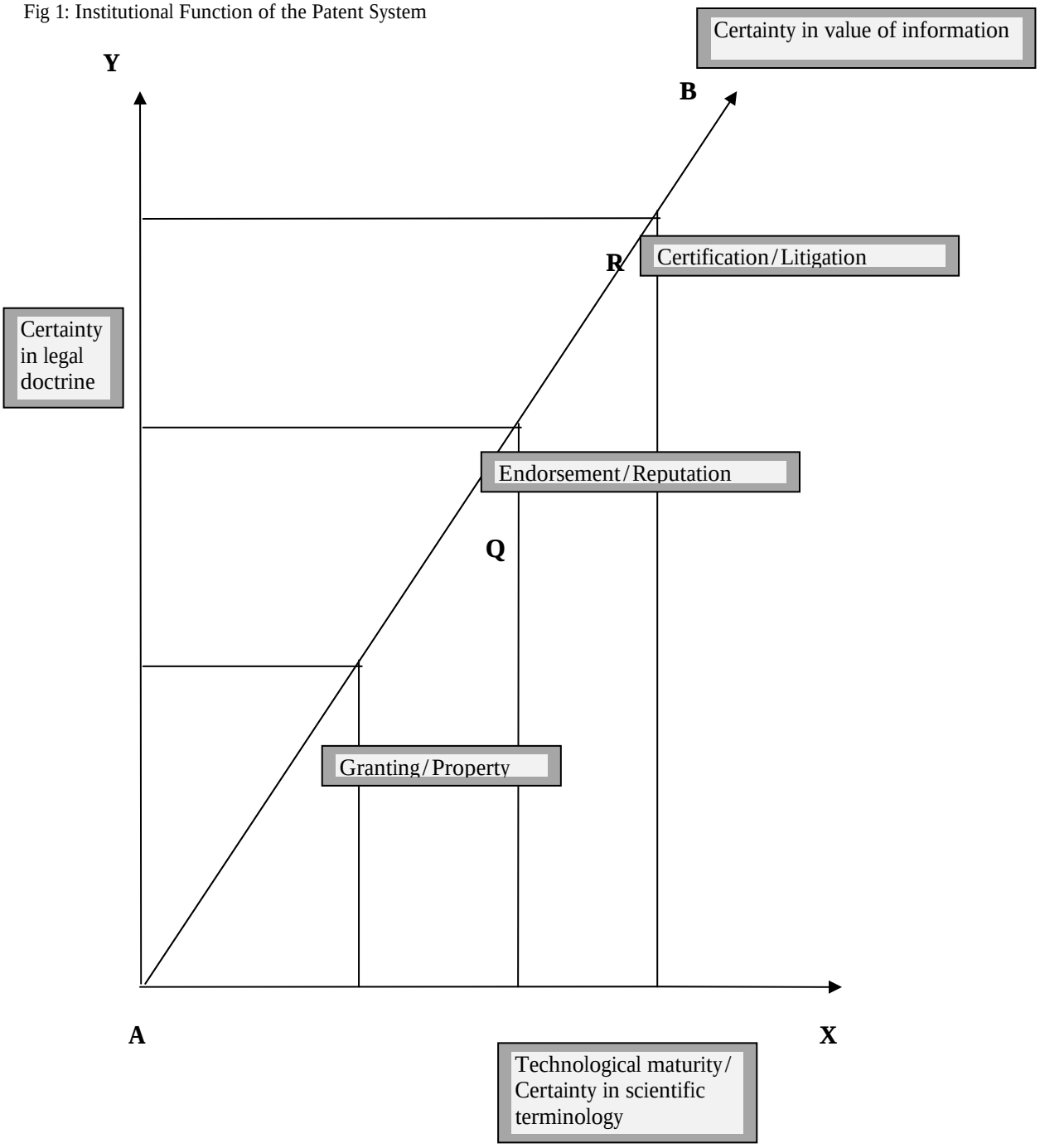
[131] Their study, albeit based in a Japanese context, is not unique to the Japanese biotechnology industry: L.G. Zucker and M.R. Darby, 'Capturing Technological Opportunity Via Japan's Star Scientists: Evidence

rather than broad patents in cumulative innovation industries, the authors also suggest a critical reform to the disclosure rules in the American patent system. The long grace period and the fact that it can take up to 18 months before a patent is published mean that currently competitors cannot rely on the signal conveyed by such publication.[136]

The credence view of patents may also provide a unique insight into Heller and Eisenication.

technological maturity. The assignment of property rights does not have the finality indicated by Arrow's resolution of the information paradox – it cannot be used immediately to negotiate, but is a rather early step in specifying value; other necessary steps include endorsement and certification.

Fig 1: Institutional Function of the Patent System



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CONCLUSION AND PROGNOSIS

Patents, at least in immature technologies, are square pegs in the round hole of Arrow's resolution of the information paradox. Patents for new technologies retain many of the problematic aspects of uncertainty of exchanging intangibles in a market. The credence model provides a better, more accurate way of appraising patents. To be unaware of what exactly is being transferred is to be reconciled to positive transaction costs on a greater scale than previously acknowledged. The credence view takes into account the transaction costs entailed in the efforts to rectify the uncertainty and crucially illustrate why patents can be a particularly costly way to encourage innovation. Specific conclusions presented here include the surprising one that that verification or endorsement under law may be less useful than allowing the market to improvise its own methods. On a practical level the credence model should be investigated further in order to bolster such verification measures by helpful non-intervention if necessary.

The uncertainty described here at the micro level is translated into empirical uncertainty on a macro level about the effect of patents in capital markets. This macro-level uncertainty results in an inability to verify or measure patent performance, which is a significant informational inadequacy that undermines policy making. This problem is tangible for example in Hall and Soskice's attempt to use patents as indicators of 'radical innovations' or 'incremental innovations' in 'liberal market economies' and 'coordinated market economies' respectively.[140] The authors' assumptions that biotechnology, telecommunications and semiconductors are characterized by radical innovations, while transport and mechanical engineering experience more incremental innovation, are based not on the quality of individual patents but patent filings as 'signals' of quality coupled with external factors such as technological patterns. [141] The information shortfall in this influential work reflects the notorious opacity of patents.

Institutions such as property rights including patents are crucial determinants of the efficiency of markets.[142] The informational inadequacies and transaction costs associated with patents highlighted here by the credence model, makes this field of law and policy particularly conducive to economic perspectives that modify the instrumental rationality assum