Knowledge Management and the Contextualisation of Intellectual Property Rights in Innovation Systems

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KNOWLEDGE MANAGEMENT AND THE CONTEXTUALISATION OF INTELLECTUAL PROPERTY RIGHTS IN INNOVATION SYSTEMS

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Abstract

Intellectual property rights play a central role in biotechnology innovation. Patents, in particular, preoccupy research funding agencies, venture capitalists and governments, despite the fact that the value of patents is disputed and their impact continues to foster controversy. Perhaps more crucially to a fuller understanding of innovation, focus on instruments of intellectual property protection over-illuminates one stage of the flow of knowledge in innovation, leaving up- and down-stream phases in relative obscurity. Knowledge is an intangible asset, and is produced, tracked, managed, and accounted for in innovation systems. Yet what remains unclear, and this is problematic, are the respective roles of knowledge and intellectual property management, their relation, and the potential of a broadened perspective on knowledge flows in innovation. Participants at a Canada-U.K. workshop in Edinburgh examined the relationship between intellectual property rights and knowledge

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management by framing innovation in terms of knowledge management while attempting to bracket off the effects of patenting – the “Un-IP” approach. Eight critical issues arising at the heart of knowledge management and intellectual property rights were articulated, and general consensus emerged that, conceptually speaking, intellectual property rights needed to be subsumed under knowledge management as a particular class of intangible asset. At the same time, however, practical issues associated with patents continued to dominate the discussion, causing deviation away from the primary theme of the workshop, and highlighting the need to more fully explore eight emerging themes and contextualise the role of intellectual property rights.

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1. Introduction

Wealth creation and the assessment of prosperity are increasingly tied to science and technology based innovation. Knowledge drives innovation, but knowledge is intangible and defies easy management using methods developed to create, track, value and account for tangible assets. Inventors, innovators, venture capitalists, companies, governments and civil society all have a stake in the management of knowledge, and recognise the magnitude of the challenge behind any demand for effective management of innovation systems. For these and related reasons, formal law-based systems for intellectual property management have come to the fore, demonstrating that innovation is indeed occurring. Intellectual property, particularly patents, have a multiplicity of functions as countable inputs and outputs of innovation systems, exchange tokens, social signals, factors in the coordination of innovation, strategic building blocks in securing competitive market positions, and so on. Patents are so central to conceptions of innovation that entire innovation systems are being conceived in terms of the dynamics of intellectual property protection.

Whether patents can be relied upon to serve all of the functions demanded of them, and whether there is a need to reconceptualise innovation systems was the question put to a group of Scottish and Canadian experts. Recognising that critiques of patenting, and especially licensing behaviour, have in recent years gained notoriety as alternatives such as open-source and patent pools are considered and tested, the workshop participants explored a path that is less often taken. The less common, alternative, approach to intellectual property views it as one among other kinds of intangible asset requiring active management. Although an extensive knowledge management literature exists, it has not effectively located formal intellectual property management within the broader and more important exercise of knowledge generation and management.

The exploration of these themes begins with a discussion of the advent of knowledge-based economies in which the management of intellectual assets is a serious challenge. Intellectual property rights are but one type of knowledge asset, and there is a broader context of intangible asset management that is easily lost when attention is paid exclusively to intellectual property rights. How this happens is explained in the third section, in which the over-reliance on intellectual property rights as a metric of innovation is discussed. The several problems discussed in this section, combined with the discussion of knowledge management from the preceding section, sets the context for a new conception of intellectual property rights as a type of managed knowledge in innovation systems. By contextualising and deemphasising the role of intellectual property rights – the ‘un-IP’ heuristic – a set of alternative priorities emerges regarding the management of knowledge in innovation systems. These eight themes are discussed in detail in the latter half of the paper, and lead to some general conclusions about how knowledge management and innovation systems ought to be construed, and how intellectual property rights within such systems should be interpreted, as well as suggestions for the direction of future research.

2. Knowledge Management, Intellectual Property Rights and Innovation

Post-industrial economies are often called 'knowledge economies,' reflecting their transition from resource extraction and primary manufacturing to an economy based on a greater proportion of high technology manufacturing and knowledge intensive services. Firm resources are now eighty percent intangible assets and twenty percent tangible and capital resources – the inverse of the relative contribution of tangible and intangible assets fifty years ago.[1] In addition to the changing composition of corporate assets, hallmarks of knowledge economies include literate and numerate citizens, demographic transition, robust internet and telecommunications infrastructure, and extensive government coordination of research and development in science and technology. To maintain a competitive trajectory in the knowledge economy, countries expend considerable resources directly on the maintenance of their scientific and technological base. Annual government expenditure on research and development in knowledge economies, as a proportion of gross domestic product, tends to be maintained at two percent, but in exceptional cases may be over three percent.

Being increasingly reliant on science and technology as a means of remaining globally competitive, governments implement policies and programs to stimulate and coordinate private and public investment in science and technology research and development.[2] Government involvement is closer to cultivation than it is to implementation, for constant encouragement and a watchful eye are necessary to support "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies."[3] A useful expansion of Freeman's original definition of 'innovation system' by Fagerberg reveals the extensive linkages and complex interdependencies in innovation systems:

> The narrow definition would include organisations and institutions involved in searching and exploring – such as R&D departments, technological institutes and universities. The broad definition . . . includes all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place.[4]

With such significant system interdependencies and economic dependence on science and technology innovation driving the knowledge economy comes recognition of the

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[1] N Al-Ali, *Comprehensive Intellectual Capital Management* (Hoboken, NJ: John Wiley and Sons, 2003).

[2] PWB Phillips and D Castle "Science and Technology Spending: Still no Viable Federal Innovation Agenda" In B Doern and C Stoney *How Ottawa Spends 2010-2011: Recession and Realignment in the Harper-Ignatieff Minority Parliament, 31st Edition* (McGill-Queen's University Press, 2010) 144-62.

[3] C Freeman, *Technology and Economic Performance: Lessons from Japan* (London: Pinter, 1987).

[4] B-A Lundvall, *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning* (London: Pinter, 1992).

need to identify tacit and codified knowledge stocks in an innovation system, and to manage the creation, tracking, circulation and ownership of knowledge.[5]

Theories of knowledge management seek to understand how knowledge, as an intangible asset, is produced, tracked, used, managed and valued in innovation systems.[6] In one general model of innovation, Phillips explicitly acknowledges that there is a range of types of knowledge—what Malecki and the OECD called know-why basic knowledge, know-what recipes, know-how abilities and know-who contextual knowledge—embedded in an array of stages of knowledge mobilisation, ranging from contextual information and knowledge systems through a variety of creation, innovation and socialisation processes (see Figure 1).[7,8,9]

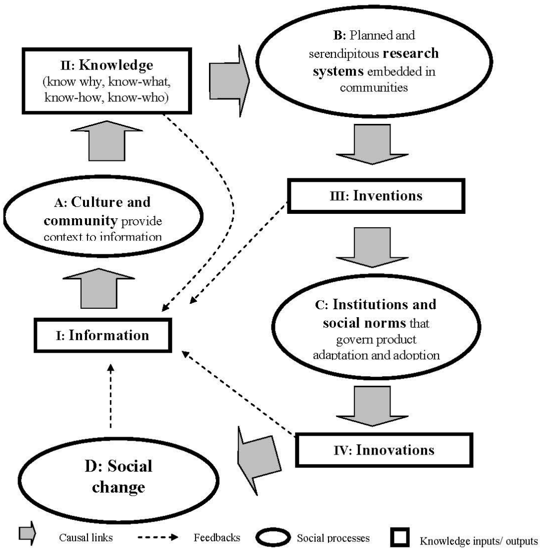

Figure 1: A general mapping of the innovation system

[5] P David and S Foray, "Assessing and Expanding the Science and Technology Knowledge Base" (1995) 16 *STI Review* 13 - 68.

[6] See for example: P Romer, "The Soft Revolution: Achieving Growth by Managing Intangibles" (1998) 11 *Journal of Applied Corporate Finance* 8-14. Reprinted in J Hand and B Lev, eds., I*ntangible Assets: Values, Measures, and Risks* (Oxford: Oxford University Press, 2003), pp. 63-94 at 64-65.; D Teece, *Managing Intellectual Capital: Organizational, Strategic, and Policy Dimensions* (Oxford: Oxford University Press, 2000); K E Sveiby, *The New Organizational Wealth: Managing and Measuring Knowledge-Based Assets* (San Francisco: Berrett-Koehler Publishers, 1997).

[7] PWB Phillips, *Governing transformative technological innovation: Who's in charge?* (Oxford: Edward Elgar, 2007).

[8] E Malecki, *Technology and economic development: the dynamics of local, regional and national competitiveness* (Toronto: Longman, 1997).

[9] Organization for Economic Cooperation and Development (OECD), "The knowledge based economy" (1996) available at www.oecd.org/dataoecd/51/8/1913021.pdf (last accessed 15 March 2010).

Different types of knowledge, whether tacit or codified, can thus be treated as an 'object' under the control of processes by which innovation systems operate.

How one draws distinctions between 'processes' and the 'objects' of those processes when discussing innovation turns out to be quite important. For more than forty years, 'innovation' has been characterised as a process – "…not a single action but a total process of interrelated sub-processes. It is not just the conception of a new idea, nor the invention of a new device, nor the development of a new market. The process is all of these things acting in an integrated fashion toward a common objective."[10] More recently, the Organization for Economic Cooperation and Development, in the third edition of the Oslo Manual for Collecting and Interpreting Innovation Data, described innovation as:

> [A] continuous process, and therefore difficult to measure […] Innovations are defined in the Manual as significant changes, with the intention of distinguishing significant changes from routine, minor changes. However, it is important to recognise that an innovation can also consist of a series of minor incremental changes.[11]

Conversely, elsewhere in the Manual the OECD defines 'innovation' not as a process, but as the outcome of a process: "[a]n innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations."[12] As an output or outcome, innovations would potentially lend themselves to quantification, thus providing long-desired metrics for evaluating innovative performance, for benchmarking OECD and other nations, and for better understanding the implementation of activities that foster measurable improvements. Unfortunately, innovation conceived as an output or outcome proves to be too diffuse and difficult to define – is it creative acts that are being measured, 'quanta' of knowledge, 'flows' of knowledge? Because of these and other difficulties in construing innovation as a process, the systems approach in which innovation is construed as a process dominates the innovation systems literature.

The matter of metrics for innovation is now largely left to intellectual property rights, which have been suggestively referred to as the 'quanta of innovation.'[13] Patents especially have been described as "the only observable manifestation of inventive activity with a well-grounded claim for universality," a perspective which has been

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[10] S Myers and DG Marquis, *Successful Industrial Innovations: A Study of Factors Underlying Innovation in Selected Firms* (Washington, DC: National Science Foundation, 1969).

[11] Organization for Economic Cooperation and Development (OECD), *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data, Third Edition* (Paris: OECD and Eurostat, 2005) at 40.

[12] Ibid at 46.

[13] A Holbrook, "Are Intellectual Property Rights Quanta of Innovation?" in D Castle (ed) *The Role of Intellectual Property Rights in Biotechnology Innovation* (Cheltenham, UK: Edward Elgar Press, 2009) 24-36.

echoed in some of the most influential writings on evaluating innovation systems.[14,15] Intellectual property rights function as currencies of exchange, and are treated as major assets of knowledge-intensive firms. Spin-off firms from university led research may have no other assets than what is held in their intellectual property portfolios, and patents are often singly responsible for attracting venture funding and attracting subsequent firm acquisitions. Patents, often treated as if they were substitutes for cash, function as measures of innovativeness and are themselves important endpoints in various sub-processes comprising innovation systems. As Lessig remarks, the conventional view is that "[g]etting more progress is the constitutional aim of patents."[16]

Significant disagreement exists about the role of patents in innovation systems, mainly as to whether they foster or hinder innovation, but that point is not being debated here.[17] At issue is the blind spot to other more fundamental issues about the types of knowledge that are created and exchanged. The literature on innovation is thoroughly engrossed with intellectual property rights, yet not all knowledge is the subject matter of a patent or copyright. Furthermore, the appearance of intellectual property rights is a late stage phenomenon in the path from invention to innovation, with many other acts of knowledge creation and exchange occurring upstream. Reflection on the suitability of intellectual property rights as tools to manage knowledge embedded throughout the myriad of exchanges and interactions in innovation systems leads to questions about whether there are alternative ways of being innovative without over-reliance on, or a preoccupation with, intellectual property rights.[18] Put differently, how would discourse about innovation systems develop if intellectual property rights were de-emphasised without entirely ignoring them – the 'un-IP' stance adopted here. Perhaps more crucially to a fuller understanding of innovation, a focus on instruments of intellectual property protection over-illuminates one stage of the flow of knowledge in innovation, leaving up- and down-stream phases in relative obscurity. Knowledge is an intangible asset, and is produced, tracked, managed, and accounted for in innovation systems. Yet what remains unclear, and this is problematic, are the respective roles of knowledge and

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[14] M Trajtenberg, *Economic Analysis of Product Innovation: The Case of CT Scanners* (Harvard: Harvard University Press, 1990).

[15] JL Furman, ME Porter and S Stern, "The Determinants of National Innovative Capacity (2002) 31 *Research Policy* 899-933, at 909.

[16] L Lessig, *The Future of Ideas* (New York: Vintage, 2002) at 205.

[17] See for example these different approaches to the same question: D Castle (ed) *The Role of Intellectual Property Rights in Biotechnology Innovation* (UK: Edward Elgar Press, 2009); WM Cohen and SA Merrill (eds) *Committee on Intellectual Property Rights in Knowledge-Based Economies*: *Patents in the Knowledge-Based Economy* (Washingon: National Academies 2004); M Heller, *The Gridlock Economy: How Too Much Ownership Wrecks Markets, Stops Innovation, and Costs Lives* (New York: Basic Books, 2008); AW Torrance and B Tomlinson, "Patents and the Regress of Useful Arts" (2009) 10 *The Columbia Science and Technology Law Review* 130-68.

[18] The International Expert Group on Biotechnology, Innovation and Intellectual Property. *Innovation and Intellectual Property, Toward a new era of intellectual property: from confrontation to negotiation*. (Montreal: The Innovation Partnership, 2008). Available at http://www.theinnovationpartnership.org/en/ieg/report/ (last accessed on 15 March 2010).

intellectual property management, their relation, and the potential of a broadened perspective on knowledge flows in innovation.

3. The Problem with Over-Reliance on Patents in Innovation Systems

The relationship between knowledge management and intellectual property rights was the topic of a 10 December 2008 workshop for researchers from the United Kingdom and Canada. Held at the Faculty of Law, University of Edinburgh, under Chatham House Rules, the workshop provided an opportunity for an open and frank conversation between researchers working in a wide range of academic and applied fields, both directly and indirectly relevant to the issue of knowledge management and its relationship to intellectual property.[19] Each participant was asked to come prepared to make a presentation or to offer details from case studies. As a heuristic, the group was asked to consider whether IP could be abandoned (in some or all cases) and, if so, what issues would arise for business, law, policy and funders. The focus of the discussion was to identify a program of research or research themes that emerge when an 'un-IP' stance is adopted.

The most general conclusion was that intellectual property rights are not a defining feature of innovation systems. That is, intellectual property rights and mechanisms for creating and managing them are contingent artefacts of innovation systems. Indeed in many instances, rather than being fundamental drivers of innovation, IPRs are somewhat incidental to innovation, and to innovation systems. If one adopts a more holistic and realistic approach to innovation, conceptualising the innovation system as a complex and comprehensive system of knowledge generation and management, then IPRs are clearly components, but not the system itself. This demonstrates that even when intellectual property rights are precisely defined and specific applications are clear, the use of the rights depends primarily on their role within innovation more generally. Broader systems of knowledge creation and exchange set the context for the IP rights to be protected, how IP rights relate to each other, and how others interpret the significance of the intellectual property claim.

Given these observations, the workshop participants identified and explored (at least preliminarily) eight associated themes about the role and position of intellectual property in the broader innovation setting. These themes are related by their basis in the literature of innovation systems and knowledge management discussed in the preceding two sections, and because they support understandings of innovation and further contextualise the role of IP rights. More specifically, the following propositions were identified as areas ripe for further consideration and research:

1. knowledge management is inclusive of intellectual property rights;
2. systems of intellectual property rights are not monolithic, consistent, or perfected;

[19] "When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed." Available at http://www.chathamhouse.org.uk/about/chathamhouserule/ (last accessed on 15 March 2010).

3. knowledge management strategies dictate the tactics of intellectual property rights;
4. interpreting the purpose of patents is contextualised in knowledge management;
5. knowledge mobilisation versus returns to inventors;
6. patent or perish?;
7. social control of knowledge: intellectual property rights in society;
8. no definitive role for patents in the management of knowledge in innovation systems.

3.1. Knowledge Management is Inclusive of Intellectual Property Rights

Conceptually speaking, within innovation systems intellectual property rights are a species of knowledge management. Some aspects of knowledge management well known in innovation policy circles include for example research funders' annual reports regarding their knowledge transfer / translation / mobilisation portfolios. At the same time academic literature, industry trade publications, and government reporting mechanisms focus on IP rights and their specific features related to individual technologies. Even though knowledge management is a more comprehensive activity involving the creation, transmission, use and storage of information and knowledge in a wide range of areas, IP rights are so widely discussed that they are lent the appearance of being comprehensive. Intellectual property rights are relevant and used in only a few of the sub-processes of innovation just mentioned, nor are they present in all of the interrelations described above in Fagerberg's broader definition of the innovation system. Knowledge management cannot, and should not, therefore be defined solely in terms of policies and practices geared toward the management of intellectual property rights. The converse is equally relevant: expectations of outcomes from the management of IP rights do not exhaust the expectations one might have for effective knowledge management.

3.2. Systems of Intellectual Property Rights are not Monolithic, Consistent, or Perfected

Advocates of and detractors from intellectual property rights - particularly academics who engage in policy debates about intellectual property but not legal debates about the law - often characterise systems of intellectual property rights as if they were self-consistent and universal. In reality, the variety of systems and complexity with which these interact is far greater than many imagine. Intellectual property rights are not anchored in a homogeneous global system, but comprise a set of incomplete, overlapping and interlocking subsystems of property protections and rules. Fundamentally, the systems are based on legal codes within civil and common law jurisdictions which ascribe rights to ownership and control to creators (i.e. authors, thinkers and inventors) and provide the base for transmitting those rights to others. While the systems have the same general intent, and have been increasingly subject to international harmonisation through international treaties, they operate in slightly different ways. Beyond basic distinctions between types of legal rights and authorities embedded in the legal systems, national governments have created a number of specific mechanisms to encourage creation and exploitation of specific types of knowledge and their resulting goods or services.

Here legal rights and moral rights generally mesh, but not in all countries (e.g. the United States), and differentially according to national laws, institutions and practices as well as international agreements (e.g. the Berne Convention). The subject matter of intellectual property rights also varies considerably. Copyright is almost universally provided for a range of works, including written, dramatic and musical works; trademarks protect proprietary identifiers; patents assign rights and duties in the case of the United States for 'anything under the sun made by man' (generally defined in legislation as novel, useful and non-obvious inventions) but restrictions are imposed on patentable subject matter in the European Union, Canada and Japan; trade secret protection addresses obligations - primarily that of confidentiality - related to proprietary knowledge embedded in production systems; and plant breeders' rights and animal pedigrees deal with innovations and advancements involving plants and animals. In addition to these specific systems, companies use an array of contracts and other civil agreements to bind and restrict the use of their knowledge (e.g. trademarks for extending protection to off-patent drugs, to restrict disclosure of trade secrets and to prohibit reproduction and use of proprietary knowledge, processes or materials).[20]

While all of these systems started as national compromises between the rights of creators/inventors (or at least importers of new knowledge) and the interests of potential users, the underlying concepts are becoming increasingly international in reach. International conventions over the past 150 years have harmonised various aspects of copyright, trademarks and patents. The difficulty is that each of the international agreements provides at most 'best efforts' adjudication by national courts, so that at the international level disputes about contested property rights remain. In 1994, with the establishment of the World Trade Organization and the negotiation of the Agreement on Trade Related Aspects of Intellectual Property (TRIPS), all Member states (153 in 2008) were required to develop minimum standards for property rights systems, and provide national treatment to all forms of intellectual property from all member states. Developed countries were immediately bound by TRIPs, developing countries were given until 2006 to phase in the requirements, and least developed countries have a longer time frame in which to fully implement TRIPS, exceeding the previously set deadline of 2006. While TRIPS would appear to meet the need of providing minimum standards for engaging countries in an international system of intellectual property rights, the system is far from complete and effective. The rules and enforcement of disputes remain the prerogative of individual nation states, which means there is still potential for conflict — as of 15 August 2009, the WTO reported 156 completed or on-going disputes involving matters covered under TRIPS. Moreover, flexibilities available under TRIPS that may be used by countries to develop a system suitable to their stage of development continue to foster controversy.

[20] PWB Phillips and G Khachatourians, *The biotechnology revolution in global agriculture: invention, innovation and investment in the canola sector* (Wallingford, UK: CABI Publishing, 2001).

3.3. Knowledge Management Strategies Dictate the Tactics of Intellectual Property Rights

The application and use of intellectual property mechanisms varies widely with the type of process or product involved. As noted, intellectual property rights are part of a complex system of knowledge management and are a relatively late-stage phenomenon on the path from invention to innovation. Thus, readily visible intellectual property rights, such as patents, are more representative of the tip of an iceberg rather than the entire system. The actual pattern of use varies by sector. Patents are probably a good reflection of the underlying property claims in product areas where they have been used for a long period, such as for industrial machinery and consumer products. Generally, economies of scale work to deter all but the most determined competitors. Innovators then use a mix of contracts, trade secrets and trademarks to control market access and competition. Patents, however, remain the baseline currency in those areas.

In contrast, biotechnology products such as genetically modified Bt (Bacillus thuringiensis) corn involve a wide range of patents (for transformation technologies, genes and seeds), trade secrets (on elite breeding lines), plant breeders' rights (on seeds), trade marks (on corporate brands), private contracts (on seeds) and copyrights (on underlying science published in journals). Other crops such as canola use most of those property mechanisms (except perhaps trade secrets) but the owners claim and defend their rights more narrowly. In the case of canola, for example, intellectual property rights are pursued largely in Canada and selectively in the United States and the European Union.[21] By contrast, in vegetable crops, patents are not at issue.[22] Transgenic or conventionally bred fish varieties are subject to few formal property rights; innovators instead rely primarily on the use of private contracts to control breeding stock.[23] Scientists and firms seeking to modify and use wood or fibre from trees tend to rely less on patents due to the long period before trees reach economic maturity (ranging from ten-seventy years) relative to the limited term of patents (twenty years).

Other technology and product markets use a different mix of intellectual property rights. Drugs are controlled closely through many of the rights regimes used by plant developers (excepting plant breeders' rights). But rights are usually claimed and defended only by multinational corporations in (mostly developed) nations where there is potential for profitable production and use of those products, although this is changing as the number of developing countries with drug development and manufacturing capacity increases. The international trade regime bolsters any owner's position by erecting rules forbidding trade in unlicensed intellectual property. In contrast, while software and business methods can be patented in the United States,

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[21] Ibid. (Phillips and Khachatourians 2001).

[22] PJ Heald and S Chapman, "Patents and Vegetable Crop Diversity" (2009) No. 09-017 *University of Georgia School of Law Research Paper Series* available at http://www.law.syr.edu/media/paper/2010/2/PATENTS_AND_VEGETABLE_CROP_DIVERSITY.pdf (last accessed on 15 March 2010).

[23] Culver K and D. Castle (eds), *Aquaculture, Innovation and Social Transformation* (Dordrecht: Springer, 2008).

because of the short lifecycle of most software, most developers either use copyright or protect their trade secrets through encryption; some programmers, taking the advice of Shapiro and Varian, offer open-source access. This approach offers access to source-code unrestricted by copyright, generally with specialised licensing conditions to contribute, in the case of software, to the evolution of the source-code. Additionally, a combination of network effects, branding and versioning are used to commercially exploit their innovation.[24] Meanwhile, chemicals, some industrial materials and many processed food stuffs (e.g. Coca Cola) rely on trade secrets rather than patents. In most cases, the recipes for making them cannot be determined by reverse engineering the end-product—the ingredients and process are masked because the end-use composite material has been transformed in the production process. These firms prefer to rely on trade secrets because they provide universal and - in contrast to the other time-limited forms of intellectual property rights - unlimited protection for their intellectual property. The risk calculation is the probability of disclosure of the trade secret after which protection no longer operates. In summary, this brief overview clearly shows that one cannot simply use a single intellectual property mechanism, such as patents, as a proxy for activity, value or innovation, as they play different, contingent roles in the economy, depending on the nature of the knowledge that needs to be managed and its market application.

3.4. Interpreting the Purpose of Patents is Contextualised in Knowledge Management

While the preceding section describes the variety of intellectual property protection that is available, the dominant form in the innovation system, and the one that has received the most attention, is patenting. The purpose of patents remains a source of significant debate. At root, there is a divide between those who see patents as a means and those who define them as an end in themselves. Ultimately, most scholars and practitioners would fundamentally agree that the value and purpose of patents and other IP rights is not to have the right, but rather to exploit the right to extract profits/rents from the market. Patents are important milestones in a research and development pathway, but do not generate value directly, in and of themselves, and actually require considerable resources to develop and maintain. Rather, one view is that the prospect of limited monopoly profits resulting from patents and other intellectual property rights encourages firms to invest in risky research and, perhaps more importantly, in efforts at commercialisation engaging in activities such as reducing to practice, scale-up and compliance with regulations.

The allocation of profits among inventors and assignees tends to support conventional wisdom that inventors get royalties and other payments equal to about one to three percent of the value generated by their invention. The remainder accrues to others in the supply chain and to end users. Nevertheless, many scholars and most users of legal property instruments tend to see patents or other complementary property mechanisms as valuable in their own right. This creates a potential problem as 'what gets measured gets done.' Public research institutions, universities and many

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[24] C Shapiro and H Varian, *Information Rules: A Strategic Guide to the Network Economy* (Boston: Harvard University Press, 1999).

entrepreneurial firms count and display patents and other intellectual property rights as 'outputs' of their systems—now more than 600 public institutions in North America have technology transfer programs or offices that count patents as one measure of output.[25] An Association of University Technology Managers survey of 189 public institutions in North America reported that in 2006 they managed 18,874 new invention disclosures, filed 15,908 American patent applications and saw 3,255 United States patents issued.[26] This focus on patents as having value in and of themselves is partly a response to the difficulty of measuring their real effect. While most property rights mechanisms have some identifiable, narrow, uniquely focused application and value, that value is almost always dependent on the nested, dense, complex system of governance of the technology or product. At the extreme, some technology offices practice a form of patent fetishism, where the patents are ends rather than the means of further commercialisation.

One alternate view is that patents have no intrinsic value. The Organization for Economic Cooperation and Development estimates that only about ten to twenty percent of academic patents ever earn any revenue, and many of those that earn revenue frequently do not recover the cost of setting up and negotiating the intellectual property relationship.[27] Many patents simply act as expensive 'vanity art' to decorate the walls of inventors' homes and offices. Indiscriminate patenting by technology transfer offices can also create patents of limited commercial value whose coverage cannot be improved once research results are published. Trajtenberg undertook a detailed analysis of patents used in the CAT-Scan industry, and concluded that value cannot be scientifically imputed or assigned to patents with any confidence; rather, patents are better seen as a signpost of activity along the value chain.[28] The more patents there are, the greater the volume of inventive activity (analogous to the rule that the number of articles reflects the volume of primary research activity). In this context, they should rather be seen as milestones in the innovation process.

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[25] See T Bubela and A Strotmann, *Designing Metrics to Assess Impacts and Social Benefits of Publicly Funded Research in Health and Agricultural Biotechnology. A Report to The International Expert Group on Biotechnology, Innovation and Intellectual Property* (The Innovation Partnership, 2008) available at http://www.theinnovationpartnership.org/en/ieg/cases/ (last accessed on 15 March 2010). See also T Bubela and CH Langford, "Evolution of Rules for Access to Megascience Research Environments Viewed from Canadian Experience" (2000) 29 *Research Policy* 169-79.

[26] Association of University Technology Managers (AUTM) *U.S. Licensing Activity Survey, 2006: A Survey Summary of Technology Licensing (and Related) Activity for U.S. Academic and Nonprofit Institutions and Technology Investment Firms* available at http://www.autm.net/AM/Template.cfm?Section=Surveys&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=3958 (last accessed on 15 March 2010).

[27] M Cervantes *Academic Patenting in OECD Countries. Presentation to 2nd EPIP Conference in Maastricht, Nov 24.* (2003) available at http://ec.europa.eu/internal_market/indprop/docs/patent/hearing/gambardella_en.pdf (last accessed on 15 March 2010).

[28] M Trajtenberg, *Economic Analysis of Product Innovation: The case of CT scanners* (Cambridge: Harvard University Press, 1990).

3.5. Knowledge Mobilisation versus Returns to Inventors

Lessig's remark about getting more progress out of patents is meant to be provocative and fruitfully vague. The 'access / incentive' paradigm of patents, according to which inventors disclose to the public in exchange for limited control over their inventions, promotes two conceptions of progress. Progress, for the public, is disclosure of knowledge, while for innovators it is financial. Is the social or financial return worth anything? Unfortunately, there are little more than platitudes regarding the value of the social benefits of disclosure and rich mythologies surrounding the returns that inventors receive for their patents.

The methodology of evaluating the returns to research and the value generated by patented technology and products varies widely. Economists attempt to estimate all of the costs and benefits to producers (resulting from changes in production efficiencies or changes in market shares or asset values), to consumers (from new consumer traits or changes in prices), to the environment and society (through positive externalities such as health benefits or negative externalities such as pollution) or to governments (through changes in taxes or expenditures). In the simplest case where there are competitive supply and demand markets, the gains to any innovation are the resulting increased consumer or producer surplus. Consumer surplus is value generated by consumption that exceeds the market price (i.e. any value of consumption that exceeds the market clearing price), while producer surplus is the differential profits gained by particularly efficient producers from selling products at market clearing prices above their marginal costs.

Economic analysis of the gains to research has progressed significantly over recent years, from Griliches's article on the returns to hybrid corn to the comprehensive 'bible' on economic valuation produced by Alston, Norton and Pardey.[29,30] In effect, economists have framed the issue as one of comparative statics, where value is generated through efficiencies in the supply chain or through new product attributes. Because of the availability of data related to research investments, innovations, production and consumption, much of the applied economics on the gains to innovation has been undertaken in the agri-food sector. Alston *et al* surveyed more than 294 studies in the agri-food sector undertaken in the previous 30 years and found 1,821 estimates of returns ranging from -100% (e.g. the project yielded no benefits for the investment) to +724,000% (a suspect return).[31] Ignoring the extreme results at both the top and bottom, they estimated that the mean internal rate of return to agri-food research was 72%. Recent debate has concluded that those estimates may be too optimistic because they (a) ignore many projects that failed, (b) many of the *ex ante* analyses assume a faster and longer period of economic return than many investments

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[29] Z Griliches, "Research Costs and Social Returns: Hybrid Corn and Related Innovations" (1958) 66 *Journal of Political Economy* 419-31.

[30] J Alston, G Norton and P Pardey, *Science Under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting* (Wallingford: CAB International, 1998).

[31] J Alston, M Marra, P Pardey and T Wyatt, "Research Returns Redux: A Meta-Analysis of the Returns to Agricultural R&D" Environment and Production Technology Division Discussion Paper No. 38 (Washington: International Food Policy Research Institute, 1998). Available at http://ageconsearch.umn.edu/bitstream/16056/1/ept-dp38.pdf (last accessed 15 March 2010).

actually realised, (c) many of the studies ignore any potential positive or negative externalities and (d) many of the successful investments destroy capital in other technologies or products, which lowers the net value of the investments. In fact, some longitudinal analyses suggest that a full accounting of investments could reveal that the return on investment has in some instances fallen below the cost of capital.[32]

Practitioners tend to be more sanguine about the returns to investment because they only value parts of the gains that economists examine. For example, venture capitalists and owners of capital are primarily concerned about the returns that they can extract. Hence, their estimates ignore the un-priced value to consumers, any spillovers to other producers and sectors and any social externalities. Similarly, governments tend to be most concerned about the returns that will accrue to firms, citizens and the treasury in their jurisdiction, and thereby tend to ignore benefits and costs that flow to offshore consumers, producers, investors and governments. As a result, when marginal investments are under discussion, economists may give an absolute green light while management consultants or governments may be less positive.

3.6. Patent or Perish?

Patents are often credited for creating limited monopolies with correspondingly limited monopoly profits – so long as no close substitute is available. While that may be true for a narrow range of technologies or products, it is not generally true. Patents have the greatest value when there are no close substitutes being produced, when there is no need for complementary investments or spending (such as expensive equipment to produce or use a product) and when consumer demand is relatively inelastic with respect to price. Drugs that treat specific diseases often fit that model. In contrast, innovations in the agri-food system often face close substitutes in production, for example open pollinated varieties of crops that are almost as good as comparators, and require expensive capital investments to produce and compete with competitively priced products that offer many of the same benefits. In those cases, the potential to extract a return on the research investment can be very limited. This at least partly explains the consistent gap in returns on investment during the past decade between the pharmaceutical industry, which earned greater than 35 percent, and the agri-food industry (including farming) that earned well below ten percent. Given the variation in returns by sector, and of course by technology, and the uncertainty that a best-case scenario will emerge, there may be better ways of using intellectual property systems for more effective knowledge management strategies. Drawing on sectors, such as aquaculture, that are not patent-intensive but are nevertheless profitable, suggests that the patent-or-perish paradigm is its own form of lock-in. To a major extent, sector-by-sector variation in patenting activity is guided by the cost of technology development and the time between innovations.

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[32] S Malla, R Gray, and P Phillips, "Gains to Research in the Presence of Intellectual Property Rights and Research Subsidies" (2004) 26 *Review of Agricultural Economics* 63-81.

3.7. Social Control of Knowledge: Intellectual Property Rights in Society

Discussion of the broader function of patents illuminates perspectives on knowledge management more than it does patents. Some see patents and other intellectual property rights as heuristics or signalling tools, signifying some other related concept. For example, venture capitalists are concerned to find signals indicating how well a market position can be developed and maintained. Patents play an important role in identifying the underlying value of an enterprise, and can further be used to signal the commercial orientation of scientists. In short: 'no patents, no investment.' The state, in contrast, sometimes uses patent policy to signal its degree of openness to business. Often it will make patents more binding as an inexpensive and focused way to signal its intentions to others. Similarly, many states use patents as the mechanism for assigning obligations and liabilities. Meanwhile many social action groups and non-governmental organisations knowingly use patents as a rhetorical focusing device to target debate on pre-selected villains and on specific target issues. The demonisation of genetically modified foods by making reference to 'frankenfoods" and of genetic use restriction technologies as 'terminator' seeds has effectively orchestrated international debate in a way that makes it difficult for other perspectives to engage effectively. Academics, management consultants and others, in contrast, use patents and other intellectual property rights as visible artefacts of social networks, letting them define and measure the interrelationships of individuals in specific fields and jurisdictions.

3.8. No Definitive Role for Patents in the Management of Knowledge in Innovation Systems

Given the various heuristic roles patents play as part of the larger knowledge management system, it perhaps makes sense that they have not been validated in any comprehensive way. Here we encounter a fundamental difficulty. We are still unable to agree on the meaning of the inventive concept such that inventions may be defined identically across all conceivable contexts and fields of science and technology. This situation and the size of the economic stakes that may be involved challenge our ability to comprehend objectively the "personal scale" of inventive activity relating to any given patent. Identification of sources of invention is inherently subjective. Consequently - beneath the scientific veneer - preconception, bias and assumptions prevail, some of which may be self-serving. There seem to be four ways in which people understand inventions and their origins, all of which cannot be correct in all cases. The problem is our temptation to generalise.[33]

First, inventions can be seen as 'thunderstorms' of activity, where the flashes of lightning and the booming thunder represent creative action, but the discrete individual events tend to get lost in the fury of the storm. In other words, inventions are inherently collective, comprising small acts or ideas identifiable to individuals which together make up the whole invention. This notion is convenient for businesses,

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[33] G Dutfield and U Suthersanen, *Creators in biotechnology and culture: Geniuses, or industrial stakeholders? Conference on Intellectual Property Rights for Business and Society. Hosted by DIME Network of Excellence. Birkbeck College, London* (2006). Available at http://www.dime-eu.org/wp14/conferences/london2006 (last accessed on 15 March 2010).

especially when all of the people concerned are employees of the same firm! Second, inventions might be seen as thunderbolts, or distinctive flashes of individual inspiration, where what was there before the storm is transformed and new. Some of these thunderbolts add value, others transmit energy without any lasting effect and still others lay waste to what previously existed. This is a rather old-fashioned view but it is very persistent. Historically, corporations dislike this conception, since it underpinned the flash of genius test which required a bigger inventive step than was commercially convenient. Third, inventions may be seen as being like a relay race, where the first past the post (either the actual invention in the United States or patent filing elsewhere) wins the prize, regardless of how narrow the margin of victory. Again, inventing is anything but an anonymous activity but it tends to be drawn out. Sometimes the winner is considered to be unfairly taking all when the 'spoils' ought to be shared with the other baton carriers who may have run further. Fourth, invention may be seen as being like a termite nest, where too many people are involved for it to be possible to name everybody. Consequently, for anybody to file a patent is tantamount to grabbing a piece of the intellectual commons. Given the wide array of metaphoric interpretations of inventions, it is only reasonable that the scholars and practitioners who work on patents and patent policy have not conclusively established the place, role and function of patents in the global knowledge management system.

4. Lessons Learned and Future Directions

Perceived and demonstrated ills of over-reliance on intellectual property rights, especially patents, have led many to think that the innovation system could perform better if fewer restrictions were placed on the flow of knowledge – that is, to bring more products and services to market to create wealth and foster the well being of citizens. Alternatives being explored include open-source licensing, patent pools and more open knowledge markets. Each proposes techniques for making knowledge more readily available, an end in itself, and to stimulate creativity in the 'useful arts.' None of the proposed approaches argues against intellectual property *per se*, rather each attempts to alter downstream effects of restrictive licensing practices and create alternative cultures of sharing that displace cultures of hoarding. The proposed approaches are more a matter of what one does with intellectual property, assuming one already has it.

The 'un-IP' stance suggests that there may be more radical work to be done in rethinking the role of intellectual property in innovation systems by re-contextualising intellectual property management within the broader context of knowledge management. Thinking upstream, for a moment, most laboratories keep detailed daily records and meticulously maintained databases. This is done partly for legal reasons. In the United States, records help establish priority claims regarding who was first to invent. Of greater legal importance, for patent filing purposes, is who made the inventive step, and, for purposes of ownership, under whose sponsorship the research was conducted. Whether the information contained therein is ever going to be patentable subject matter is anyone's guess, but the pursuit of scientific discovery or technical invention places priority on the careful record keeping and accountability that are indicative of good knowledge management practices. The scientific justification for careful record keeping is even more fundamentally important. It ensures that science is properly recorded so that others can build on it; observations peripheral to the initial purpose of the work can be recorded and used by others; the integrity and robustness of the work can be assessed and challenged.

Comparing the relative importance of legal and scientific justification for careful record keeping, there is a sense in which there is no intellectual property in an *invention*, but there is a tremendous amount of knowledge management. It is easy to say that beyond intellectual property rights there is knowledge management, and perhaps it comes as no surprise that the general conclusion is that intellectual property rights have to be subsumed under knowledge management. The more substantive contribution, however, is the observation that the eight themes articulated above reflect a three-fold tension between knowledge management and intellectual property rights that arose once the 'un-IP' stance was adopted.

First, there is still a lack of clarity about the overall relationship between intellectual property rights and knowledge as it is created and exchanged in innovation systems if they are not exhaustive of all creativity and value. The persistent and unresolved concern is that intellectual property rights are not natural kinds in the sense that they often capture knowledge in innovation systems contingently. What has been previously patented, for example, can deter innovators from returning to the same domain of research and development, or, depending on the field, the researchers, the available public funding or private financing, a return to the same field can be seen as strategic. One way of characterising the issue is that the knowledge management perspective requires the view that intellectual property rights *create* quanta of knowledge out of a larger knowledge pool, rather than *isolating* already individuated units of knowledge that are appropriate candidates for formal protection. A corollary is that intellectual property rights are neither an effective variable to explain much of knowledge management in innovation systems nor are they an appropriate proxy for the system.

Second, the predilection to equate value with intellectual property rights leads governments, the private sector, and increasingly universities and colleges, to pursue patenting strategies that may not be fruitful. Increased rates of patenting appear to be slowed only by trends in government research funding and the priorities of venture capitalists; meanwhile there is increasing evidence that the returns are not forthcoming. There is a strong need to assess the real role and value of patents, particularly if there are social opportunity costs of current patenting strategies that become all the more apparent when intellectual property rights are recast in light of the priorities of knowledge management. Two fundamental changes are needed in the way intellectual property rights are managed. One is to stop assuming the role of patents and develop more counterfactuals to test whether patents actually deliver what they promise. This approach is being used increasingly in research studies but has yet to have much impact on the debate about patents.[34] Another change involves more empirical research involving active engagement of scholars and practitioners in the construction of research projects and the implementation of fly-on-the-wall observation and analysis. Sociologists like Bruno Latour and Steve Woolgar did

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[34] S Morgan and C Winship *Counterfactuals and Causal Inference: Methods and Principles for Social Research* (Cambridge: Cambridge University Press, 2007).

groundbreaking work on the nature of laboratory life.[35] Perhaps it is now time for a wider range of social scientists to move into technology transfer offices, venture capital corporations, law offices, regulatory agencies and corporations to document and test the role of patents in the complex global knowledge management system.

Finally, perhaps the most remarkable aspect of these reflections on the relationship between knowledge management and intellectual property rights is the difficulty, faced even by willing workshop participants, of adopting the 'un-IP' stance. The general conclusion and the eight themes developed above help to orient the problem toward a discussion of what is wrong with patents, whether to patent or not, and what can be done to improve the advantages of patents while reducing the problems. Instead of being the dominant theme in the discussion, knowledge management in innovation systems frequently slipped into the role of *leitmotif* and patents were the *idée fixe*. This is a telling observation, one that suggests that adapting to a new discourse about knowledge management that tracks the proposed eight themes, or other themes that may be subsequently developed, will remain a challenge.

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[35] B Latour and S Woolgar, *Laboratory Life: the Social Construction of Scientific Facts*, (Los Angeles: Sage, 1979).