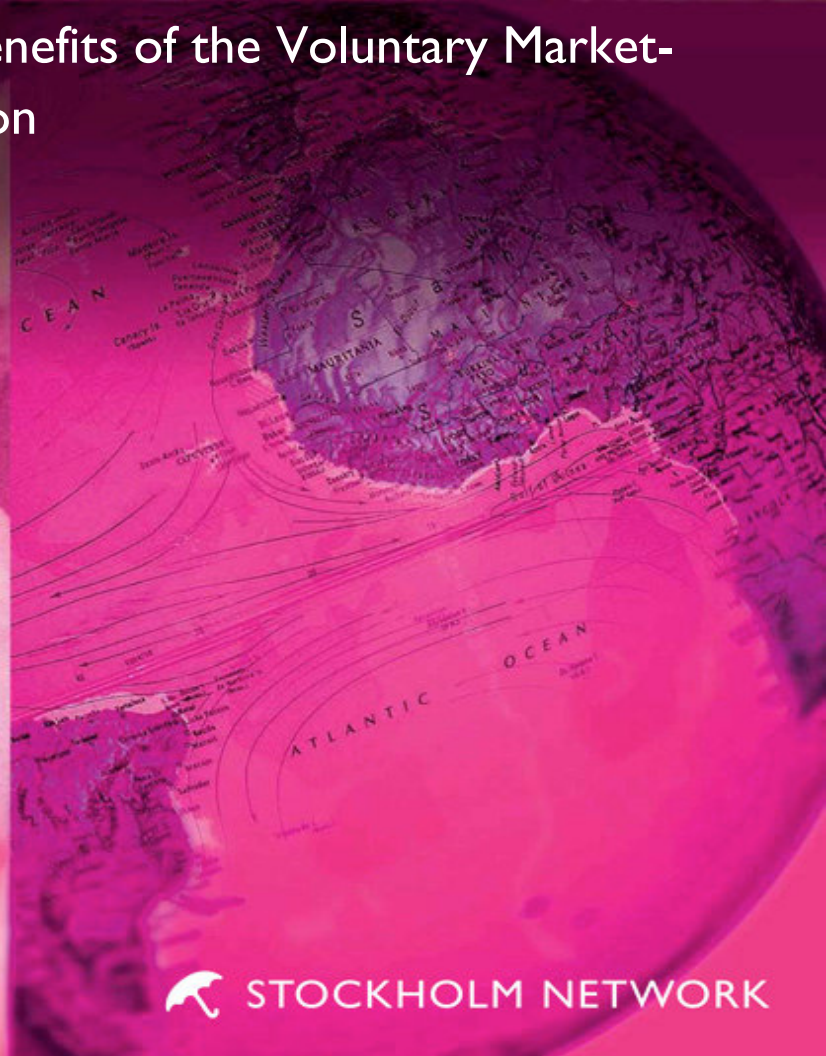
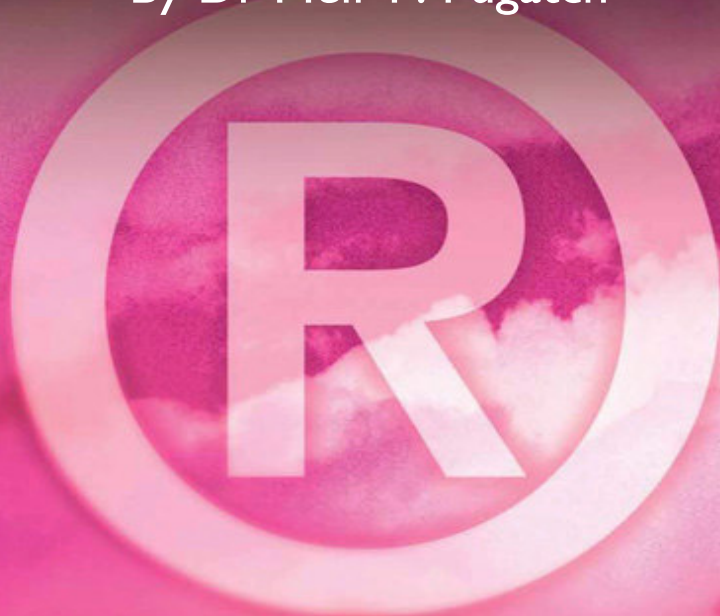




If it Ain't Broke, Don't Fix it

A Discussion Paper on the Benefits of the Voluntary Market-Driven Approach to Innovation

By Dr Meir P. Pugatch



STOCKHOLM NETWORK

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Executive Summary

Both developed and developing economies alike now fully recognise the importance and impact of innovation on their national economic performance, global competitiveness and overall wellbeing. There is no doubt that in the age of the 'knowledge-based economy' there has been intensifying interest in identifying the desired set of national policy tools needed to encourage innovation. This is especially true in Europe, both in the context of the EU's Lisbon Agenda goals and also as a result of Europe's desire to compete on the global economic stage.

Recently, however, some policy-making bodies in Europe and at the global level have embraced the notion that the current innovation model needs 'fixing'. This belief has been expressed at various levels; from cases involving individual companies, to inquiries focusing on entire sectors, to policy strategies that aim to provide global solutions.

The problem, however, does not lie with the popular perception of innovation but rather with the more detailed understanding and appreciation (or the lack of it) of the way in which innovation takes place; both in theory and in practice. The simple truth is that the existing innovation model is not broken. On the contrary, innovation is flourishing. From innovations that are based on collaborations, convergence, strategic alliances and standard setting through to more traditional in-house R&D, the market today is more innovative than ever.

Accordingly, this paper describes the nature, process and characteristics of technological innovation, as well as analysing its fundamental relationship with the creation and uses of knowledge, and the role that Intellectual Property Rights (IPRs) play in this process. Despite the complexity of this field, the paper highlights some key 'governing patterns' that underpin the innovation process:

- Technological Innovation cannot be characterised in terms of 'good' or 'bad' innovation. In some public discussions there is a tendency to argue that incremental innovation contributes less to society than radical innovation and, as such, is less desirable. In other circles, innovation which focuses on the components of a product is afforded a higher status than innovation which concerns the manner in which such products are introduced to the market and to the public. In real life, however, the contribution of innovation to society cannot be categorised in such a simplistic way. As demonstrated in this paper, incremental improvements can have effects which are just as significant as radical innovation, while innovations that concern the processes and architectures surrounding a product may be as essential to the market and to the public as the original product innovation itself.
- Technological Innovation cannot be dictated or anticipated via top-down processes. History suggests that even the brightest minds cannot be expected to anticipate the manner in which the nature of innovation will evolve and the way in which demand for such innovation will manifest itself. Certainly, the professional pursuit of innovation underpins the ability to introduce new products to the market. But, of equal importance is the fact that innovation can be unpredictable, influenced by external events and

ultimately nurtured by the ability of entrepreneurs to identify and seize opportunities once they present themselves.

- Technological innovation is deeply rooted in market forces. It is the incentives and rewards provided by the market which drive innovators to make the risky, time consuming and costly investments needed to bring new products to the market. To this extent, the innovation process is driven by the voluntary will of the innovator to create and use knowledge, rather than by any form of compulsion.
- If we accept that technological innovation is based on these voluntary, market-driven efforts, certain mechanisms need to be put in place. One such mechanism is the existence of IPRs, which provide the incentives both for the creation and the exchange of knowledge for the sake of promoting technological innovation. IPRs function as a safety net that allows the process of knowledge creation to take place, not least in the phases preceding the introduction of these technologies to the market. IPRs also allow entities to exchange and share their knowledge assets in a manner that guarantees their expected share of market reward from a given innovation.

Nevertheless, this paper identifies a worrying trend towards the belief that alternative models of innovation can be found. This trend is based on the notion that innovation can be directed by a top-down process in which policy-making bodies are afforded a greater degree of discretion concerning the desirable direction and forms of technological innovation. Consequently, this approach encourages - or at least legitimises - the use of compulsory mechanisms (a compulsory licence, for example) under which knowledge assets may be taken from one entity and transferred to another for the sake of facilitating more and 'better' innovation.

This paper suggests that this perception is highly problematic. First, it is not backed up by theoretical or empirical underpinnings. On the contrary, the theoretical and empirical evidence reviewed in this paper suggests that innovation does not seem to occur in this way. Second, the paper suggests that the exercise of this approach may be based on ideological or political considerations rather than a rational discussion of its merits. Third, it would seem that advocates of this model are suggesting turning the process on its head, i.e. they advocate implementing the concept first, in the hope and anticipation that it will work. In other words, the experimentation is taking place at the possible expense of innovation itself and, as a consequence, at the expense of the consumer and the taxpayer.

The paper concludes that policy-makers should exercise great caution when considering pursuing this type of compulsory, non-market-driven model. Specifically, when advocating an innovation process that is guided, and to some extent directed, by a top-down approach that relies on the compulsory use and transfer of knowledge, policy-makers must ask themselves one simple question: is this decision based on an understanding of the realities that govern the innovation process, or is it based on a vision of how the world should look and consequently how innovation should take place?

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I. Introduction

The concept of innovation enjoys wide-ranging, if not universal, support. Today, both developed and developing economies alike recognise the importance and impact of innovation on their national economic performance, global competitiveness and overall wellbeing. As part of their wider strategies for economic growth, they aim to put in place frameworks under which innovation can flourish. Indeed, there is no doubt that in the age of the 'knowledge-based economy' there has been intensifying interest in identifying the desired set of national policy tools needed to encourage innovation.

In Europe, policymakers are trying to find ways to encourage innovation, which seems to hold the promise of allowing European countries not simply to compete in a globalised world, but also to retain some of their expensive social support. Take the most recent work programme of the French Presidency of the EU, for example, which is entitled *Europe Taking Action to Meet Today's Challenges*. It states that "education, training and innovation constitute the pillars of the knowledge-based society upon which Europe needs to base its investment and develop its value-added."¹

Innovation is, however, a complex concept, and takes place in various shapes and forms. Peter Drucker, one of the gurus of innovation and entrepreneurship in the 20th Century, considered innovation to be a social and economic phenomenon as much as it is a technological one. He found that innovation can be generated both from the supply side, via "the consistent manner of changing the yield (or maximising the output) of existing resources", or from the demand side, by "changing the value and satisfaction obtained from resources by the consumers", or through a combination of the two.² Other scholars have classified innovation not only according to its technological features (be it a product, a process or a service) but also according to other characteristics such as administrative or organisational structures (including the strategy, structure, system and human capital of an organisation), as well as the market itself (including pricing and marketing practices).³

How does innovation occur? Which fundamentals is innovation based on? Who is best suited to bring innovation to the market? Is the current innovation model broken? And, can an alternative model be proposed? These are just some of the questions that are being debated in various policy and business forums.

¹ French Presidency to the Council of the European Union, *Europe Taking Action to Meet Today's Challenges*, Work Programme – 1 July 2008 – 31 December 2008: Paris, 2008, p.12, http://www.ue2008.fr/webdav/site/PFUE/shared/ProgrammePFUE/Programme_EN.pdf (accessed 3 July 2008)

² Drucker, P. F. *Innovation and Entrepreneurship*, Harper Business: New York, 1985, p. 33

³ Popadiuka, S. and Choo, W. C. 'Innovation and Knowledge Creation: How Are These Concepts Related?' *International Journal of Information Management*, Vol. 26, 2006, pp. 302-312; See also Afuah, A. *Innovation Management: Strategies, Implementation, and Profits*, Oxford University Press: New York, 2004

Recently, some policy-making bodies, in Europe and at the global level, have embraced the notion that the current innovation model needs 'fixing'. This belief has been expressed at various levels; from cases involving individual companies, to inquiries focusing on entire sectors, to strategies that aim to provide global solutions.

Yet the simple truth is that the existing innovation model is not broken. On the contrary, innovation is flourishing. From innovations that are based on collaborations, convergence, strategic alliances and standard setting through to more traditional in-house R&D, the market today is more innovative than ever. As a result, the public is exposed to a streamline of innovation that takes place on a daily basis. This phenomenon is not limited to a certain sector but rather takes place across a variety of knowledge-based industries.

Now more than ever, innovation is based on market incentives aimed at providing rewards (financial, reputational, and others) to voluntary endeavours that seek to introduce new innovations to the market. Indeed, the rapid pace at which innovation takes place, and the willingness to accept the high risks, costs and time required for turning innovation into tangible products, are both consequences of the incentives and rewards provided by the market. The nature of innovation means that it is also highly dependent on market mechanisms which provide the security, transparency and predictability required to commit to such endeavours and investments.

In this paper, we will seek to describe in brief the nature, process and characteristics of technological innovation as well as to analyse its fundamental relationship with the creation and uses of knowledge, and the role that IPRs play in this process. We will also consider the extent to which compulsory, non-market-driven tools, advocated by some, can promote innovation. Based on our analysis, we submit that the case for the latter model is intellectually flawed and empirically weak. Moreover, the paper expresses the concern that, if applied on a greater scale, this compulsory non-market-driven model may actually damage the innovation system and, as such, harm consumers.

The paper does the following. First, it provides an overview of the nature of technological innovation by looking at different innovation models, examining the process of innovation and the manner in which innovation is influenced by external factors and events.

Second, the paper looks at the role of knowledge creation and the uses of knowledge for the purpose of stimulating technological innovation. A distinction is made between vertical and horizontal aspects of the creation and uses of knowledge.

Third, the paper looks at the crucial role of IPRs in providing the security for the process of innovation to take place, as well as giving a platform for collaborative efforts aimed at enhancing the pace and direction of innovation. Throughout these sections, concrete examples are provided in order to support the theory and illustrate its practice in the real world.

Fourth, the paper looks at alternative models which focus on the use of compulsory, non-market-driven tools for the sake of promoting innovation. In this section, the paper discusses recent incidents of the use - and consideration - of such interventions.

Finally, the paper goes on to provide conclusions and policy considerations for the future of innovation.

II. The Nature of Technological Innovation

Given the broad nature of innovation, it is necessary to place our discussion within a more focused and concrete context. Accordingly, in this paper, we deal with forms of innovation associated with technological and technical advances which are aimed at providing the market with new and improved products. To this end we can use the definition given by the OECD Frascati Manual which defines technological innovation as “the scientific, technological, organisational, financial and commercial steps, including, investments in new knowledge, which actually, or are intended to, lead to the implementation of technologically new or improved products and processes.”⁴

It is certainly true that technological innovation takes a variety of different shapes and forms. Indeed, examination of the innovation literature reveals that there are different types of technological innovation. However, as the empirical evidence suggests, firms do not choose to engage in just one form or another. The literature also suggests that innovation both influences, and is influenced by, a number of exogenous or external factors - social, cultural and demographic trends, for example. Innovators are driven to look to these factors to gauge market demand for new products and to respond to the shifting needs and desires of the consumer that technological progress can bring about.

Let us first address some of the common types of innovation - and innovation strategies - that have been identified by the literature, and which are also supported by concrete empirical evidence.

II.1 Innovation Models

Several different types of technological innovation are described in the academic literature. Most commonly, a distinction is made between ‘radical innovation’ and ‘incremental innovation’.

Radical innovation is usually described as innovation that is based on completely new knowledge (radical inputs) with outcomes that involve large technological advancements, and often render existing products in the market

⁴ Organization for Economic Co-operation and Development (OECD), *Proposed Standard Practice for Surveys of Research and Experimental Development*, Frascati Manual: Paris, 2002, p. 18

obsolete.⁵ Radical innovation is also often perceived to have disruptive features (most commonly referred to as the *Disruptive Innovation Model*, as described by Clayton Christensen)⁶ and is associated with the Schumpeterian concept of “creative destruction”.⁷ The invention of the telephone, followed by the load coil innovation that permitted the cost-effective transmission of services over long distances; the creation of the browser interface; and the discovery and subsequent purification of penicillin are just a few examples of technologies that have created entire industries and had profound societal effects.

Incremental innovation, on the other hand, encompasses the improvement of already existing knowledge and resources. Its outputs are translated into improved products that subsequently compete in the market against existing products. Indeed, more fundamental innovations are usually followed by these ‘incremental’ improvements in a variety of different directions and go on to compete with and sometimes displace their competitors in the market place.⁸ In other words, when a breakthrough occurs, this lays the foundations for even more innovative advances to take place over time. For example, pharmaceutical medicines which are introduced for the first time to deal with a condition that was not previously treated are often followed by additional medicines, which may be similar in terms of the medical condition they seek to deal with, but that have significant innovative therapeutic properties, such as reducing side effects, increasing effectiveness, changing the dosage frequency or improving delivery systems.⁹ Similarly, the software market is punctuated by technological transitions that have transformative effects, such as the development of the World Wide Web, XML integration and web services. Such technologies render existing competencies obsolete while providing opportunities for ‘follow-on’ innovation. Consider the web browsers (such as the Internet Explorer browser, Mozilla, Firefox, Safari) and servers, generated by the rise of the World Wide Web.¹⁰

Naturally, we are not talking about a binary state, i.e. that innovation is either radical or incremental, but rather a continuum within which technological innovation can be characterised as ‘more radical’ or ‘more incremental’. And, it is not only radical innovations that can achieve ‘disruptive’ status. Many products that have profound societal, economic and market effects are built closely on the work of predecessors. The World Wide Web, as we know it today, was built on the prior invention of packet switching, HTML and the graphical browser.¹¹ Indeed, in many cases innovations which set the standard for future innovation are not the first of their kind on the market. The IBM PC for example was by no means a technological breakthrough, yet its success, based on its operating system, quickly enforced a period of design uniformity.¹²

⁵ Abernathy, W. and Clark, K. B. ‘Mapping the Winds of Creative Destruction’, *Research Policy*, Vol. 14, 1985, pp. 3-22

⁶ Christensen, C. M. *The Innovators Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business School Press: Harvard, 1997

⁷ Schumpeter, J. S. *Capitalism, Socialism and Democracy*, Harper: New York, 1975, pp. 82-85

⁸ Kauffman S. *At Home in the Universe*, Oxford University Press: New York, 1995

⁹ Wertheimer, A. I. and Santella, T. M. *Pharmacoevolution: The Advantages of Incremental Innovation*, IPN Working Papers on Intellectual Property, Innovation and Public Health, International Policy Press, 2005

¹⁰ Cohen, J. E. & Lemley, M. A. ‘Patent Scope and Innovation in the Software Industry’ *California Law Review* Vol. 89, No. 1, 2001, pp. 1-57

¹¹ Hobbes Zakon, R. Hobbes Internet Timeline v8.2, 2006 see <http://www.zakon.org/robert/internet/timeline/> accessed 30 June 2008

¹² Utterback, J. M. *Mastering the Dynamics of Innovation*, Harvard Business School: Harvard, 1991

The above dichotomy has been further developed to reflect additional and hybrid aspects of technological innovation. For example, a well documented model developed by Henderson and Clark argues that the ability to innovate is not only dependent on the characteristics of the technology (radical or incremental), but also on the knowledge associated with the different technologies.¹³ The Henderson-Clark Model makes a distinction between the knowledge of different *components* of a given product and the knowledge of the *linkages* between these components.

Subsequently, the model suggests that these added layers generate a typology of innovation that can be divided into four categories.

- (i) Incremental innovation - focusing on the gradual improvements of a given component and/or its linkages with other components;
- (ii) Modular innovation - focusing on more disruptive (radical) improvements of different product's component(s), yet without having a significant effect on its linkages with other components. Modular innovations take place across sectors, from the substitution of the ferrite read/write heads with thin-metal heads which occurred in the hard disk industry in the 1980s, the replacement of the ball-based computer mouse with the optical mouse, the replacement of analogue subsystems by digital or electronic components, etc.¹⁴
- (iii) Architectural innovation - focusing on the possible disruptive (radical) improvements of the linkages between components, yet without having a significant effect on the structural and technological integrity of the components themselves. According to the Henderson-Clark Model, architectural innovation focuses on the manner in which changes are made to "the way in which the components of a product are linked together".¹⁵ Indeed, experimentation with design and the rearranging of components into new patterns (architectures) to achieve higher levels of system performance have had profound effects on competition within the technology-based sectors throughout its history. Henderson and Clark take the example of Xerox, which pioneered plain-paper copiers only to be displaced by competitors offering smaller, simpler and cheaper table-top copiers. These new products required little new scientific or engineering knowledge; instead architectural knowledge of the core technology behind the product was used in order to re-design the photocopier with smaller dimensions.¹⁶ Indeed, today 'miniaturisation' is a key aspect of medical device innovation, benefiting younger patients by allowing pacemakers, implantable

¹³ Henderson R. M. and Clark, K. B. 'Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms', *Administrative Science Quarterly*, Vol. 35, 1990, pp. 9-30

¹⁴ Ibid; See also the Innovationzen website: <http://innovationzen.com/blog/2006/08/11/innovation-management-theory-part-3/>

¹⁵ Ibid, p. 10; This term also appears in Davies, A. 'The Life Cycle of a Complex Product System', *International Journal of Innovation Management*, Vol. 1, 1997, pp. 229-256

¹⁶ Henderson and Clark, 1990

cardioverter defibrillators and brain stimulation devices to be placed in patients who are unable to use adult-size models, and thus reducing the need for invasive surgery.¹⁷

- (iv) And, last but not least radical innovation - in which a radical change affects both the component and its linkages (architecture) with other components.

These typologies have been further developed to reflect the ever-growing complexity of technological innovation. For example, some models focus on the extent to which technological innovation generates changes in the market or even leads to the creation of new markets¹⁸ while other models focus on the relationship between innovation and customers' needs (again, generating different typologies of innovation).¹⁹

The axis of time (as well as timing itself) is also crucial to technological innovation - as well as innovation in general. It seems that the process and outcomes of technological innovation have their own life cycles and face important 'junctures' (predicted as well as un-anticipated, and even accidental events) that affect the direction and pace of such innovations. One of the most notable contributions to this school of thought is the concept of 'diffusion of innovation', developed by Everett M. Rogers who defined the diffusion of innovation as the "the process by which an innovation is communicated through certain channels over time among the members of a social system"²⁰. Generally speaking, Rogers identified four major components that affect the diffusion process:

- (i) The innovation itself;
- (ii) The channels of communication that are used in order to spread the word about the innovation;
- (iii) The relative time of adoption. According to Rogers this component consists of different phases including the innovation decision-making process (which includes knowledge, persuasion, decision, implementation, and confirmation); and the relative time in which an innovation is adopted by an individual or a group (here Rogers described the process as akin to a Bell Curve, with early adopters of the innovation placed at the left end spectrum of the curve, the majority of the public at centre of the curve and the last to adopt the innovation, the laggards, at the far end of the curve);

¹⁷ Advanced Medical Technology Association, "Future Trends in Medical Device Innovation", April 2004,

<http://www.advamed.org/MemberPortal/About/NewsRoom/MediaKits/futuretrendsinmedicaldeviceinnovaton.htm> accessed 23 June 2008

¹⁸ Tushman, M. L., Anderson, P. C. and O'Reilly, C. 1997, "Technological Cycles, Innovation Streams, and Ambidextrous Organizations: Organizational Renewal Through Innovation Streams and Strategic Change" in M. L. Tushman and P. Anderson eds., *Managing Strategic Innovation and Change: A Collection of Readings*, New York: Oxford University Press, 2004

¹⁹ Chandy, R. K. and Tellis, G. J. 'Organizing for Radical Product Innovation: The Overlooked Role of Willingness to Cannibalize', *Journal of Marketing Research*, Vol. 35, No. 4, 1998

²⁰ Rogers, E. M. *Diffusion of Innovations*, The Free Press: New York, 3rd edition, 1983, p. 5

- (iv) The innovation's rate of adoption which, according to Rogers, is akin to an S Curve in which innovation goes through a period of slow, gradual growth before experiencing a period of relatively dramatic and rapid growth;²¹
- (v) The social system that, through its overall internal interactions (between different actors, such as opinion formers, so called change agents and change agencies and the different groups of adopters, as a whole) forms its opinion and perception about the innovation.

The 'diffusion of innovation' concept has been updated, refined and revised (including by Rogers), but its basic concepts remain as powerful today as they were 40 years ago. Additional models have been created that aim to capture the dynamic effects of technological innovation. For example, Abernathy and Utterback developed a model that describes the dynamic nature of the innovation life cycle.²² The life cycle of technological innovation is described as occurring in three phases (the fluid phase, the transitional phase and the specific phase), as well as being characterised by a shift in focus from 'product' innovation, which focuses on the various components of the product, to 'process' innovation, which concerns the equipment, work force, task specifications, material inputs, work and information flows, etc., that are employed to produce a product or to provide a service.²³ The fluid phase is characterised by a high degree of market uncertainty in which companies focus on product innovation, with much less attention given to the processes by which products are made. The transitional phase is characterised by a higher level of acceptance of the innovation and consequently a greater focus on product design and standards. At this stage, there is convergence towards a dominant design. In the final stage (the specific phase), product innovation becomes more gradual (or incremental) and greater emphasis is placed on process innovation in terms of production costs, volumes and market capacity. The iPhone, for example, was by no means the first of its kind on the market, nor was any of the technology that it used particularly novel; it is, however, expected to be the product that finds the right balance between price, quality, usability, design and features – in this case the integration of the Smartphone and the iPod onto a single platform.

II.2 The Impact of External (Exogenous) Factors

The influence of external factors on the nature and direction of technological innovation has also been extensively documented and discussed in the literature.

Drucker identifies several external factors that affect innovation.²⁴ One of which is the 'unexpected outside event', defined as an event that is not recorded in the information or the figures by which a management steers its

²¹ Rogers, E. M. 1983; See also Deshpande, R, 'A Comparative Review of Innovation Diffusion Books', *Journal of Marketing Research*, Vol. 20, No. 3, 1983, pp. 327-334; See also Surry. D.W. 'Diffusion Theory and Instructional Technology', Paper presented at the Annual Conference of the Association for Educational Communications and Technology (AECT), Albuquerque, New Mexico February 12-15, 1997

²² Abernathy, W. J. and Utterback, J.M., "Patterns of Innovation in Technology", *Technology Review*, 1978, Vol. 80:7, pp. 40-47; See also Utterback, J. M. *Mastering the Dynamics of Innovation*, Harvard Business School Press, 1994

²³ Abernathy and Utterback, 1978

²⁴ Drucker, 1985, pp. 52-53

company. Drucker argues that unexpected outside events are just as important to the practice of innovation by an institution as the developments that are taking place within a company or an industry and that indeed “they are often more important”.²⁵ The case of the personal computer is just one example. Until the late 1970s, it was the general consensus within IBM (both at the executive and scientific levels) that the future of computing would be heavily led and dominated by the demand for computer main-frames (huge computers manufactured for use in large organisations for the purpose of conducting long and complicated calculations and processing and analysing big databases). This view was shared by other companies which believed that personal computers would be both very costly to produce (and technologically inferior in terms of computing and storage capacities) as well as unattractive in terms of market demand. It is reported that Ken Olsen, President, Chairman and founder of Digital Equipment Corp., argued in 1977 that “there is no reason for any individual to have a computer in their home”.²⁶ However, while predictions about the complexity and cost of the personal computer turned out to be correct, the assumption about market demand turned out to be completely wrong. Driven by the popularity of computer games among US teenagers, the market experienced a dramatic surge in household demand for personal computers. In just five years (between 1979 and 1983), the annual sales volume of personal computers (\$US 15-16 billion in 1983) matched sales of the mainframe market which had been around for more than 30 years.²⁷ Despite its failure to predict market demand, and contrary to other companies, IBM did produce its own personal computer and, by 1983, dominated the market. When asked why IBM chose to take this path, executives argued that “we realised that everything we'd assumed, everything we were so absolutely certain of, was suddenly being thrown into a cocked hat, and that we had to go out and organise ourselves to take advantage of a development we knew couldn't happen but which did happen”.²⁸

Drucker goes on to enumerate other external factors that are of equal significance (positive and negative) to innovation.

Firstly, demographic changes (i.e. in population size, age structure, composition of the population, level of employment, educational status and income) that pose both opportunities and threats to technological innovation (here one may emphasise the gap between the ‘predictability’ of demographic changes and the ability and willingness to change business practices, if necessary on a daily basis, to accommodate these changes). Consider the rising demand for healthcare among a population - especially the elderly, who are becoming the largest age group in the population - placing a much greater emphasis on individual health and physical wellbeing. The ongoing demand for more sustainable and longer-term treatment of conditions, which allows patients to manage their illnesses and live longer and healthier lives, has brought about significant breakthroughs in the fields of pharmaceuticals and medical devices. For example, we see innovative treatments that have changed cancer from an incurable illness into a chronic disease; new medical devices and delivery systems (inhalers and patches instead of

²⁵ Ibid

²⁶ Olsen, 1977, cited in The Quotations Page, <http://www.quotationspage.com/quote/868.html> accessed 19 June 08

²⁷ Drucker, 1985, pp 52-53

²⁸ Ibid

injections) which allow patients to be treated more comfortably and with fewer side effects; revolutionary imaging technologies, such as the PillCam capsule endoscopy, a disposable, miniature video camera contained in a capsule that can be easily ingested by the patient;²⁹ and new technologies that allow doctors to diagnose patients much more rapidly and effectively, avoiding the need for hospitalisation and lengthy recovery periods.³⁰

Second, changes in the perceptions of societies about their own economic, political and social conditions and standing, both collectively and individually, have a profound impact on the types of technologies that are both in demand and accepted. The inventive shift towards the disappearance of network limitations in favour of mobility and interoperability, for example, has occurred largely as a result of the changing market needs brought about by globalisation and the growing need for 24/7 connectivity. This has created a shift away from the personal desktop computer towards a more mobile and high speed way of networking, giving rise to the introduction of mobile handsets that incorporate web applications in the way that the iPhone does.³¹ The development of *in vitro* fertilisation, its increasing application and subsequent improvements were driven in some part by social and religious attitudes that brought about a wider cultural acceptance of these kinds of technologies.³²

And, last but not least, innovation is also affected by changes in awareness caused by new knowledge. This awareness is heavily influenced by the long time gaps (sometimes as much as a generation long) between the emergence of new knowledge and the ability to turn this knowledge into applicable technologies, as well as by the convergence phenomenon, which is able to harness different types of knowledge for the purpose of creating new technological innovations.³³ For example, many current medical technology breakthroughs build on the progress made in other scientific and technical areas, harnessing the increasing power and sophistication of computers, advancements in communications capabilities, and information learned from previous scientific breakthroughs such as deciphering the human genome. Nanotechnology breakthroughs, for example, have the potential to create microscopic devices to deliver treatment options to individual diseased cells.³⁴

Empirical studies confirm that market needs have a crucial impact on technological innovation. For example, in a 1970s survey of the empirical literature, James M. Utterback found that “market factors appear to be the primary influence on innovation. From 60-80% of important innovations in a large number of fields have been in response to market demands and needs.... The remainder have originated in response to new scientific or technological advances and opportunities.”³⁵

²⁹ See Given Imaging website, <http://www.givenimaging.com/en-us/Pages/GivenWelcomePage.aspx> accessed 30 June 2008

³⁰ Science Daily, ‘New Science Technology Enhances Lung Cancer Detection’, December 4, 2003, <http://www.sciencedaily.com/releases/2003/12/031204074705.htm> accessed 30 June 2008

³¹ Apple, ‘Social Networking: Most Recent’, <http://www.apple.com/webapps/socialnetworking/> accessed 23 June 2008

³² Wang, J. and Sauer, M. V. ‘In Vitro Fertilisation: A Review of 3 Decades of Clinical Innovation and Technological Advancement’, *Therapeutics and Clinical Risk Management*, Vol. 2, No. 4, 2006

³³ Drucker, P. F. 1985, Chapter 7

³⁴ Advanced Medical Technology Association, “Future Trends in Medical Device Innovation” 2004;

<http://www.advamed.org/MemberPortal/About/NewsRoom/MediaKits/futuretrendsinmedicaldeviceinnovaton.htm> accessed 23 June 2008

³⁵ Utterback, M. J. ‘Innovation in Industry and the Diffusion of Technology’, *Science*, New Series, Vol. 183, No. 4125, 1974, pp. 626-626

There is no doubt that while technological innovation can certainly influence the external environment and the world in which we live (not least in the context of the market), it is equally affected by its environment (so-called 'exogenous' factors), in particular those that affect demand side factors. Thus, innovation is a highly dynamic process - both responding to existing patterns of demand as well as creating new demand that was previously unrecognised or unarticulated by the consumer.

To summarise, technological innovation is highly complex, dynamic and time-sensitive. The composition, characteristics, pace and direction of technological innovation is influenced by a myriad of factors, external as well as internal, technological as well as social. The manner in which technological innovation takes place is not subject to black or white patterns, neither can it be divided into good or bad categories. On the contrary, as discussed and explained above, we can identify different forms of innovation - incremental, radical, modular and architectural - all of which have a role to play in the overall lifecycle of innovation and its interaction with society's progress. In this context, and as discussed later in the paper, it is important to note that, from a policy-making perspective, any attempt to dictate a certain direction of innovation (or when dealing with absolutes such as which innovations are desirable and which are not), using special "top-down instruments" will most likely end in failure. Rather, it is the dynamic relationship between firms, markets, the public, and the environment as a whole, that directs the manner in which technological innovation is conducted, as well as the nature and direction it takes.

III. Voluntary, Market-Driven Efforts Aimed at Promoting Knowledge Creation and Technological Innovation

Knowledge is intrinsic to the innovation process. In fact, it is knowledge that serves as the basis upon which technological innovation takes place. This technological innovation can be the timely outcome of the ability to translate and convert new knowledge into concrete and usable technologies at a given point in time. However, it can also be the outcome of the accumulation of knowledge of existing technologies (the so-called components) that lead to the creation of both new and improved technologies (be they more incremental or more radical). Knowledge of the linkages between technologies (architectural knowledge) can also lead to new technological innovations. Equally importantly, the knowledge that is accumulated and processed by society over time about a given innovation has a profound impact on demand for that innovation and consequently affects its overall cycle and evolutionary process (the so-called S curve, described above).

Given the complexity of the concept of knowledge, there is a need to narrow the scope of our discussion to focus on more specific types of knowledge that contribute to the process of technological innovation. For the sake of simplicity we shall consider the 'vertical' and 'horizontal' processes that affect knowledge creation, its transfer and its use for the purpose of technological innovation.

We also consider the types of knowledge described as *voluntary or market-driven* forms of knowledge, in so far as they are dependent on the intentional, market-driven decision of an innovator to develop, acquire or share existing or new knowledge for the purpose of increasing their capacity to introduce technological innovations to the market. The decision to pursue a certain avenue of knowledge creation for the purpose of enhancing one's capacity to innovate is influenced by a multitude of factors, both internal and external. To a large extent, this decision is driven by a “bottom-up” approach, whereby an innovator analyses his internal strengths and weaknesses and considers the opportunities and threats presented by the market. Of course, there are cases in which the market may force an innovator to pursue a certain path concerning the creation and use of knowledge, which may run contrary to their own internal preferences and objectives. Such cases can derive from changes of circumstances in the market (as described previously in the section dealing with external events) or from predatory behaviour within a given set of market conditions, for example, when one company is taking over another company (part of the integration model that is discussed later). Yet, at an aggregate level, even in these cases we can still safely argue that it is market conditions and the overall intentional behaviour of different companies that leads to the creation and use of new knowledge for the purpose of bringing new innovations to market.

By contrast, *compulsory, or non-market-driven* forms of knowledge transfer and sharing describe the conditions under which a central authority (a national government, a regional agency or an international body), may force an innovator to share its knowledge assets (for example, via a compulsory licence) or appropriate the use of these assets, for the sake of encouraging innovation. This “top-down” type of approach is described later in the paper.

III.1 Generating Vertical Knowledge: The Importance of In-House R&D to the Innovation Process

We use the term *vertical knowledge* in reference to the processes that eventually lead to the creation of a new product and to its subsequent improvement and modification. In this respect, the process of Research and Development (R&D) is one of the most important channels through which vertical knowledge is generated, processed and used for the introduction of a new technological innovation.

The official definition of R&D is as follows:

“Research and experimental development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications.”³⁶

³⁶ OECD, Frascati Manual, 2002, p. 17

For the purpose of this paper, it may be useful to consider ‘research’ and ‘development’ in isolation from one another in order to gain an understanding of the process by which knowledge flows from one stage to the next.

With regard to research there are, broadly speaking, two types: basic research and applied research. Basic research is undertaken “primarily to acquire new knowledge of the underlying foundations of phenomena or observable facts, without any particular application or use in view”.³⁷ This kind of experimental or theoretical research is considered to create knowledge that is too broad or too general to be directly applied as a source of production for a specific purpose. On the other hand, applied research is “directed primarily towards a specific practical aim or objective”,³⁸ thus creating knowledge that has a direct, specific and applicable use. It should be noted, however, that it is often very difficult to distinguish between basic and applied research on the basis of their results. Nelson, for example, explained that “significant advances in scientific knowledge, the types of advances that are likely to result from successful basic research projects, very often have practical value in many fields”.³⁹ Machlup, in support of this view, notes that “difficulties are especially great where ‘intentionally basic’ research has resulted in new substances or devices and where ‘intentionally applied’ research has resulted in a better understanding of physical or organic phenomena”.⁴⁰ Nevertheless, this paper places more emphasis on applied research and assumes that it is this type of research that produces commercially-oriented results.

While research is concerned with the generation and use of new and existing knowledge, development is defined as: “systematic work, drawing on existing knowledge gained from research and practical experience that is directed to producing new materials, products or devices; to installing new processes, systems and services; or to improving substantially those already produced or installed”.⁴¹ According to this definition, there is a clear distinction between the research and the development stages. Yet, since development is also concerned with experiments, tests and in some cases, further research, it is preferable to describe it as a process beginning from the point at which raw findings are obtained and ending once those findings are at the stage of production.

Taking all these elements into account, we can argue that the R&D process, which consists of the generation and compilation of new knowledge as well as the ability to translate inventions and discoveries to applicable uses, is the backbone of innovation at the vertical level. In this context, it should be emphasised that the financial resources, the time needed and the risks (including the risk of failure) involved in the process may be overwhelming. For this reason, applied R&D aimed at creating and bringing new technological innovations to the market, is predominantly carried out by private entities (it is rather prohibitive for a public entity, as explained later in the paper). Indeed, since the late 19th century, the nature of R&D has become much more organised, specialised and embedded in corporate culture. This change was identified by Alfred Khan in the 1940s:

³⁷ Ibid, p. 29

³⁸ Ibid

³⁹ Nelson R. R. ‘The Simple Economics of Basic Scientific Research,’ *Journal Of Political Economy*, Vol. LXVII, 1959, p. 302

⁴⁰ Machlup, F. *The Production and Distribution of Knowledge In the United States*, Princeton, New Jersey: Princeton University Press, 1962, p. 147

⁴¹ OECD, Frascati Manual, 2002, p. 29

“The systematic, planned experimentation which characterizes modern technological method, swifter and surer than the old, has enhanced the interdependent, cooperative nature of invention. Technology has become so vast and so complex that the individual is more than even dwarfed in relation to it. Invention has in addition become much more consciously cooperative. In the great modern research laboratories, tens, hundreds of men focus upon single, often minute problems. With scientific organization thus systematically mulling over all the well known problems, inventions become increasingly inevitable. It becomes more than ever impossible to isolate any one contribution as the invention or any one man as sole inventor and rightful patentee....Hence inventors are for the most part trained salaried professionals, hired to learn and to work in the great laboratories provided by those who can afford them. Patents are automatically assigned to the corporation which pays the salaries and provides the facilities. Because it takes the risks the business takes the speculative reward”.⁴²

Fast forward to the 21st century, the age of the knowledge-based economy and R&D has become one of the most strategically and operationally important elements of the knowledge-intensive company. A 2005 EU survey confirmed that R&D is seen as a strategic core activity by knowledge-based firms, with the expectation of creating new products or processes and increasing sales or market share.⁴³ With this goal in mind, worldwide corporate R&D investment has accelerated year on year, growing by 10% worldwide from 2006 to 2007 with all world regions experiencing significant growth in the R&D investments made by scoreboard companies. Indeed, according to 2007 EU figures, R&D investment rose exponentially in the knowledge-based industries, notably in the pharmaceutical sector where a 15.7% boost in investment elevated the industry to the top investor worldwide. In the same year the software, telecommunications and healthcare equipment sectors underwent similarly dramatic growth rates in their R&D investment rates with a rise of 13.2%, 12.9% and 17.3% respectively.⁴⁴ The table below provides an overview of the level of investment in R&D by the different technological sectors:

⁴² Kahn, A. E. ‘Fundamental Deficiencies of the American Economic Law’, *The American Economic Review*, Vol. 30, No. 3, 1940, p. 481

⁴³ European Commission, Joint Research Centre, DG Research, *Monitoring Industrial Research: The 2005 EU Survey on R&D Investment Business Trends in 10 Sectors*, Office for Official publications of the European Union: Luxembourg, 2006

⁴⁴ European Commission, Joint Research Centre, DG Research, *Monitoring Industrial Research: The 2007 EU Industrial Investment Scoreboard*, Office for Official publications of the European Union: Luxembourg, 2007, p. 15

Ranking of industrial sectors by aggregate R&D from the world top 1400 companies in the 2007 EU Industrial R&D Investment Scoreboard ⁴⁵

Sector (No. of companies in top 1338)	R&D Investment (Euro Million)	Share in R&D
Pharmaceuticals & biotechnology	70523.5	19.3%
Technology hardware & equipment	64531.5	17.6%
Automobiles & parts	60807.1	16.6%
Electronic & electrical equipment	27138.9	7.4%
Software & computer services ⁴⁶	26522.8	7.3%
Chemicals	17186.0	4.7%
Aerospace & defense (civilian R&D)	15991.3	4.4%
Leisure goods	14208.6	3.9%
Industrial engineering	9319.3	2.50%
General industries	8867.6	2.40%
Fixed line telecommunications	7283.1	2.00%
Health care equipment & services	6446.1	1.80%
Oil & gas producers	4923.7	1.30%
Food producers	3918.5	1.10%
Household goods	3911.9	1.10%
Total 15 Sectors	341580.0	93.40%
Rest of 22 Sectors	24243.9	6.60%
Total	365823.9	100%

Indeed, nurturing and guarding internal R&D capabilities provides the essential underpinnings of competitive advantage.⁴⁷ Knowledge-intensive firms dedicate significant resources to conducting R&D in order to develop novel technologies as well as to make improvements to existing technologies. Big corporate labs have been responsible for inventions such as the laser, the transistor and the personal computer's distinctive elements, such as the processor, the operating system, graphical user interface (GUI) and the Ethernet protocol for computer networking.⁴⁸ For the R&D-based pharmaceutical industry, more than 90% of all new drugs emanate from the laboratories of pharmaceutical companies and a large portion of the so-called blockbuster drugs, which have made profound differences to patients' lives, were discovered and developed by in-house R&D teams.⁴⁹

In recognition of how important R&D is to the survival of the knowledge-based firm, significant changes have been enacted within corporate R&D settings in order to allow knowledge to be more effectively generated, shared and applied in the form of innovative new products.

⁴⁵ Source: *The 2007 EU Industrial R&D Investment Scoreboard* DG JRC / DG RTD, European Commission. Note: The 1400 companies are spread across 36 sectors, http://iri.jrc.ec.europa.eu/research/docs/2007/sb_2007.pdf accessed 23 June 2008

⁴⁶ It should be noted that the category of Software and Computer Services does not necessarily represent the full scale of R&D in this sector as there are likely to be other sectors, such as in the fields of medical devices or automobile and parts etc also incorporate software related components as part of their R&D activities

⁴⁷ Teece, J. D. *Managing Intellectual Capital*, Oxford University Press: Oxford, 2000

⁴⁸ *The Economist*, 'The Rise and Fall of Corporate R&D: Out of the Dusty Labs', 06 April 2007

⁴⁹ Pfizer, 'Public Policy: Research and Development', 2007, http://www.pfizer.com/about/public_policy/research_and_development.jsp accessed 19 June 2008

III.2 Harnessing Horizontal Knowledge for the Sake of Technological Innovation

We broadly use the term *horizontal knowledge* to describe the different channels through which companies either obtain knowledge assets from other organisations or transfer knowledge assets to them (be they companies, academic institutions, government research bodies, etc.) for the purpose of using this knowledge to support their efforts to introduce technological innovations to the market.

There are different channels through which horizontal knowledge may be generated, but for the sake of simplicity we refer to three broad prototypes (emerging from the models developed by Teece).⁵⁰

The first model is the contractual model, which enables different entities (say, different companies) to enter into agreements with one another in order to gain or provide access to complementary knowledge assets (such as a new technology or an innovative manufacturing process) that are needed for the introduction of new technological innovations to the market.⁵¹ In this context the licensing option is one of the most common forms of contractual arrangements that define the legal and economic conditions under which an intellectual property owner (the licensor) can allow other parties (the licensees) to gain access to his proprietary knowledge assets.⁵²

There are different and diverse forms of licensing options.⁵³ There is the option of licensing-out, whereby the owner of the knowledge asset seeks to licence this asset to others in exchange for a financial return (which again can take place in different forms, such as upfront payments, royalties and fixed sums) or licensing-in, under which one entity seeks to gain access to a knowledge asset that is owned by another entity. There is also the option of a non-exclusive licence, under which the intellectual property owner grants a licence to numerous bodies (ranging from a limited number of licensing agreements to a mass quantity - for example, when one installs a new piece of software, legally, he essentially becomes a licensee, as he does not own the software but rather receives a licence to use the software under pre-defined conditions). Alternatively, one can use an exclusive licence. This is a much more complicated option as it involves permission to use the knowledge asset on an exclusive basis (i.e. by only one individual or company). This type of licensing usually requires much more detailed and complicated arrangements between the licensee and the licensor.⁵⁴ One can choose to grant or to seek a licence that merely involves permission to use the proprietary technology or a product (depending on how far 'downstream' one is in the innovation process) or enter into licensing agreements that involve the transfer of additional components such as know-how and trade secrets. Companies can also enter into cross-licensing agreements, which are more common in knowledge intensive industries where there are multiple sources of innovation (such as in the semi-conductors and telecommunications sectors). Teece explains that, where relevant, "cross-licensing enhances the ability of knowledge intensive companies to develop innovations utilising technologies from a wide variety of

⁵⁰ Teece, 2000, Chapter 5

⁵¹ *Ibid.*, pp. 101-103

⁵² For a general discussion on this issue see Pugatch, M.P. *Management and Exploitation of Intellectual Property Rights in Government-Owned Hospitals in Israel*, prepared for the Gertner Institute, February 2005, Chapter 2

⁵³ Megantz, C. R., *Technology Management: Developing and Implementing an Effective Licensing Program*, John Wiley & Sons, 2002

⁵⁴ Teece, 2000, Chapter 8; Megantz, 2002 Chapter 5; Pugatch, M.P., *The International Political Economy of Intellectual Property Rights* (Edward Elgar: Cheltenham, UK, June 2004), Chapter 3

sources, which may overlap technology developed independently by other firms.”⁵⁵ Consequently, cross-licensing focuses on the exchange of rights to technologies in a rapid manner, eliminating the risk of infringement.

The second model relevant for horizontal aspects of the creation and transfer of knowledge (and consequently for technological innovation) is the integration model. Generally speaking, this model essentially focuses on the acquisition of complementary knowledge assets, i.e. the focus here is on the ownership of the asset rather than on the permission to use it. Integration is likely to take place in cases where an innovative company has a strategic interest in a complimentary knowledge asset (which is not owned by that company) that is essential for its own innovation process. Integration is mostly likely to take place in sectors that are undergoing rapid technological change, in which it is unlikely that a single company will have the ability to dominate the entire spectrum of innovations that are introduced to the market in a timely and cost effective manner. The nature of integration also takes different forms and is influenced by several factors, amongst other things, the critical needs of the innovator (i.e. to what extent the knowledge asset is urgently needed by the innovator, whether it is the only asset in the market that suits the needs of the innovator and whether the seller is aware of the value of his knowledge asset to the prospective innovator), the market and financial positions of the buyer and the seller (i.e. their bargaining positions) and the nature and characteristics of the sector in which they operate. Accordingly, integration is exercised in various ways, ranging from the simple acquisition of a knowledge asset to the wholesale acquisition of the entity that owns the knowledge assets, if necessary via hostile takeover.

The third model combines practices that are based both on contractual arrangements and on integration. Teece argues that “the real world rarely provides extreme or pure cases. Decisions to integrate or license involve trade-offs, compromises and mixed approaches. It is not surprising that the real world is characterized by mixed modes of organization, involving judicious blends of contracting and integration. Relationships can be engineered which render contracts factually akin to integration, internalization can be so decentralized as to be akin to contracts”.⁵⁶ As in the previous cases, mixed models are aimed at creating horizontal knowledge transfer via a variety of forms, such as joint ventures and strategic alliances.

For example, in the case of a joint venture, two or more innovators can seek to create a new partnership, usually via a spin-off company, in which they share their knowledge assets (or the relevant ones) for the purpose of developing and introducing a new technological innovation to the market (generally speaking, in these cases the new spin-off company would also be the owner of that innovation). Joint ventures are not only limited to a partnership between two or more innovators, but can also be based on a partnership between an innovating entity and a financial one, for example a venture capital company or so-called ‘angel investors’. Other forms of joint ventures involve numerous partners, such the innovator(s), financial investor(s) and partners with manufacturing, logistical and marketing capabilities that are essential for the overall success of the project. Partners in joint ventures can be motivated purely by financial interest i.e. by the profit they would make on their financial

⁵⁵ Teece, 2000, p. 139

⁵⁶ Ibid, p. 105

investment or by interests that are strategic, for example, partners in the venture that consider the prospective innovation to be essential to their future operations in the market and to the overall success of their business.⁵⁷

Companies can also enter into strategic alliances (long-term and short-term). Strategic alliances are a more limited type of partnership. They allow each entity to maintain independence and ownership of their knowledge assets yet at the same time they create a framework that allows these companies to complement and exploit one another's capabilities for the sake of achieving greater success in the market. For example, two companies (that may not even compete in the same market) can share their respective knowledge assets and capabilities (so-called technology partnering) for the sake of introducing new innovations into their own markets.⁵⁸

III.3 Horizontal Knowledge and Technological Innovation: Turning Theory into Practice

Today, knowledge-based firms have well-established programmes for setting up and conducting joint projects with smaller firms and public research organisations in order to leverage their innovation assets and bring innovative new products and services to market. For example, Microsoft's External Research programme aims to build relations with universities, government agencies, industry partners and professional organisations⁵⁹ while IBM's Technology Collaboration Solutions Group works to ensure close collaboration for innovation.⁶⁰ Obtaining proprietary knowledge via mergers and acquisitions has also been highly significant in the increasingly competitive software market. Recently Microsoft purchased Powerset, a private Silicon Valley company, and with it its "natural language" technology which can be used to search the web. Rather than raising its own capital in order to build the technology, which it had itself licensed from Xerox's Palo Alto Research Center, the company instead sold to Microsoft to combine the technology with work being done at Microsoft Research.⁶¹

In the pharmaceutical sector, many research-based pharmaceutical companies are 'opening up' their R&D laboratories, employing strategic alliance teams to identify research gaps that could benefit from outside collaboration. The strategy has proven to be effective and successful. The total value of licensing agreements in the sector rose from \$3.5 billion in 1996 to \$10.5 billion in 2000⁶². A number of successful blockbuster drugs have been developed in this way. The cancer drug Taxol, for example, originated from collaborative research carried

⁵⁷ Smith, G.V. and Parr, R.L. *Valuation of Intellectual Property and Inangible Assets*, John Wiley & Sons, 2000, Chapter 12; Pugatch, 2005, Chapter 2

⁵⁸ Narula R. and Hagedoorn J. 'Innovating Through Strategic Alliances: Moving Towards International Partnerships and Contractual Agreements', Paper No. 25, Research Memoranda from Maastricht : MERIT, Maastricht Economic Research Institute on Innovation and Technology, 1998; See also Hagedoorn J. 'Inter-firm R&D Partnerships. An Overview of Major Trends and Patterns since 1960', in J.E. Jankowski, A. N. Link and N. S. Vonortas, *Strategic Research Partnerships: Proceedings from an NSF Workshop*, National Science Foundation: Washington DC, 2001, p. 63-92

⁵⁹ Microsoft Research, 'External Research and Programs', <http://research.microsoft.com/ur/default.aspx> accessed 18 June 2008

⁶⁰ IBM, 'Collaborative Innovation: Bringing Ideas to Life and Market', 2006, http://www-304.ibm.com/jct03004c/businesscenter/smb/us/en/contenttemplate/!!!gcl_xmlid=62606/ accessed 18 June 2008

⁶¹ Waters, R. 'Microsoft in \$100m Deal with Powerset' *Financial Times: Companies and Markets*, 02 July 2008

⁶² Seget, S. *The Pharmaceutical Licensing Outlook: A Strategic Guide to Effective Deal-making and Profitable Partnerships*, Business Insights Management Report, 2002

out by the National Cancer Institute at the USA's National Institutes of Health with Bristol Myers Squibb⁶³ while the Alzheimer's drug Exelon was developed at Hebrew University and licensed to Novartis using a technology transfer agreement.⁶⁴

In the medical devices industry we see a strong tendency towards horizontal collaborations between multinational companies and smaller entities.⁶⁵ Innovations that emanate from universities, public research organisations or small companies have been licensed to industry, often with the assistance of commercialisation companies who aim to identify ideas, and assist with the management of intellectual property and the development and licensing of technology. A variety of new technologies have been introduced to the market in this way ranging from drug discovery software, medical instruments and mechanical devices.⁶⁶ One example from recent years is the licensing agreement between the University of Colorado and Philips Medical Systems Inc. for the commercialisation of 3-D reconstruction software for coronary artery structures which provides cardiologists with more accurate, higher quality images of the beating heart.⁶⁷

In the telecommunications sector, a survey carried out by the Economist Intelligence Unit found that 54% of responding telecommunications firms had collaborated with third parties to introduce new products or services over the past two years.⁶⁸ Even in firms which place a great emphasis on internal R&D to generate value there has been a shift away from the 'not invented here' mindset. The iPod, for example, was originally dreamt up by an outside consultant who Apple had hired to run the project. The technology was licensed in and rebranded as iTunes.⁶⁹

A further factor in the trend towards greater R&D collaboration has been the rise of technological bundling and convergence, in which different technological functions and applications are integrated onto a single platform and/or the tendency to allow different devices to perform the same multiple functions (watch a movie on your phone, or surfing the Internet on TV, etc). The iPhone for example created a new product type by combining email, SMS, web browser, camera, audio and video within a single application, allowing the user to stay socially connected in a more profound way than ever before. The success of these kinds of technologies signals that the fortunes of telecommunications firms will increasingly depend on providing user-friendly, integrated solutions to

⁶³ Bristol Myers Squibb, 'Doing our Part - Case Histories: The Power of Total Commitment', http://www.bms.com/alliances/doing_our_part/content/data/fg_alliances_doing_our_part_4471.html accessed 23 June 2008

⁶⁴ Barki, T. 'Biotech Focus: Rapid Growth in Isreal's Life Sciences Industry', *Drug Discovery Today*, Vol. 10, No. 23-24, pp. 153-159

⁶⁵ A. Kahn, 'The Dynamics of Medical Device Innovation: An Innovators Perspective' in A. C. Gelijns, E. A Halm, *The Changing Economics of Medical Technology*, National Academy Press, National Academy Press: Washington DC, 1991

⁶⁶ See Imperial Innovations, 'Licensing Technology', <http://www.imperialinnovations.co.uk/?q=licensing-technology> accessed 10 May 2008

⁶⁷ University of Colorado, 'CU's Technology Transfer Reports Licence Agreement with Philips Medical Systems Inc.', 2000, https://www.cu.edu/techtransfer/about/newsreleases/2002/news_philips.html accessed 01 June 2008

⁶⁸ Campbell-Smith, D. *Opening Up: How R&D is Changing in the Telecommunications Sector Today: An Economist Intelligence Unit Report*, The Economist Intelligence Unit, April 2008

⁶⁹ *The Economist*, "Innovation: Lessons From Apple", 07 June 2007

customers rather than on introducing genuinely novel technologies.⁷⁰ In a similar move, Ericsson licensed its Bluetooth wireless technology to Intel in order to enhance the latter's wireless computing solutions.⁷¹

In recent years, the process of pharmaceutical drug discovery has also been undergoing a gradual shift away from the traditional model based on the vast screening of molecules (the so-called 'trial and error' model) to a more sophisticated model that relies on advanced IT systems and innovative computational models (bio-informatics).⁷² Today major software developers have departments dedicated to providing IT solutions for healthcare,⁷³ as well as an emphasis on growing partnerships with life-science companies aimed at introducing new products to the market, such as innovative diagnostic tools, delivery systems and personalised medicines. For example, IBM collaborations with the medical device industry have yielded portable MRI devices, a wireless pill counter that informs both patients and doctors of medicines that need to be taken, and a portable system that programs ICDs (implantable cardioverter defibrillators) and pacemakers, designed by IBM in collaboration with a cardiac medical device company.⁷⁴

The convergence phenomenon also captures the way in which different operating systems communicate with each other via different protocols in order to enhance the user experience of a single technology. This aspect encompasses the need for IT systems to be able to exchange information, as well as to allow consumers to piece together systems based on products from different suppliers. Both the rise of the Internet and network computing have reinforced this trend, to the point where it is now very difficult to sell a product that does not easily interact with other complementary products. There is a strong market need for collaboration in the development of 'platform' products and in particular for coordination among rights holders in the form of cross-licences, patent pools and package licences. Even the fiercest rivals have teamed up to promote new standards. In 1997 Microsoft and Netscape agreed to include compatible versions of Virtual Reality Modelling Language in their browsers so that consumers could view 3D images on the web more easily.⁷⁵

Finally, within the framework of the mixed innovation models, one can also find the more 'open' forms of knowledge creation being used for the sake of bringing new innovations to the market. Here we can make a distinction between knowledge transfer under the 'open standards' and 'open source' innovation models.

With regard to the former, compatibility standards (which may be part of the so-called dominant design phase, as described above) are a set of rules for the design of new products which allow independently designed products to

⁷⁰ Rao, P. M. 'Convergence and Unbundling of Corporate R&D in Telecommunications: Is Software Taking the Helm?', *Telecommunications Policy*, Vol. 23, 1999, pp. 83-93

⁷¹ Business Services Industry, Business Wire, 'Ericsson and Intel Team on Bluetooth Intellectual Property', 2007 http://findarticles.com/p/articles/mi_m0EIN/is_2000_Dec_4/ai_67534870 accessed 12 June 2008

⁷² Huerta, M. Haseltine, F. Liu, Y. Downing, G. and Seto, B. NIH Working Definition of Bioinformatics and Computational Biology, 2007 see <http://www.bisti.nih.gov/CompuBioDef.pdf> accessed 23 June 2008

⁷³ See for example IBM's Computational Biology Centre <http://domino.research.ibm.com/comm/research.nsf/pages/r.compbio.html> or Microsoft's computational biology team <http://research.microsoft.com/ero/biosciences/compbiology.aspx>

⁷⁴ IBM, 'The Integration of IT and Medical Devices: Collaborative Innovations, Enhanced Medical Devices', http://www-03.ibm.com/industries/electronics/doc/content/landingtw/2057615112.html?g_type=pspot accessed 28 June 2008

⁷⁵ Shapiro, C. 'Navigating the Patent Thicket: Cross Licences, Patent Pools and Standard Setting' in Jaffe, A. B., *Innovation Policy and the Economy*, Vol. 1, MIT Press, 2001

'communicate' and interact with one another (usually referred to as interoperability). To this end, standard setting occurs in order to establish a set of rules for the design of products that will allow them to communicate with each other.⁷⁶

Standards are developed (or approved) and maintained in a consensus-driven way in voluntary standard setting organisations. While standardisation processes tend to vary, in general these organisations practice collaborative innovation via technology and knowledge sharing.⁷⁷ Examples include the International Telecommunications Union Telecommunication Standardisation Sector, which coordinates standards for the Telecommunications sector,⁷⁸ or W3, a consortium that aims to develop interoperable technologies (specifications, guidelines, software, and tools) for the World Wide Web.⁷⁹ In the telecommunications sector innovation is enhanced and facilitated by standards, which are based, among other things, on cross licensing, patent pools and open innovation agreements among standard setting organisations.⁸⁰ In many cases the existence of standards speeds up product introduction and network implementation by helping to avoid standards wars like the recently-fought, high definition optical disc format war between HD-DVD and Blu-Ray. Innovations brought to market in this way include the Third Generation Mobile System (3G) and MPEG.⁸¹ In the MPEG case, a pool of patents was created to enable manufacturers to produce MPEG-2 products, providing a 'one stop shop' for makers of televisions, digital video disks and players, telecommunications equipment and cable satellite and broadcast television services. A wide variety of new products were invented and deployed in this way, such as MP3 technology.⁸²

In the computer and software field one can identify important standards that were created by the voluntary and collaborative efforts of private companies. For example, the Universal Serial Bus (USB) standard, which today is the most dominant interface standard for different types of hardware (originally developed for computer-related hardware but now also used in other fields, such as cameras, mobile phones, and televisions), was developed in 1995 as a result of the joint collaborative efforts of Intel, Microsoft, Philips and US Robotics.⁸³ These companies (as well as additional ones) founded a non-for-profit organisation - the USB Implementers Forum - to act as a support organisation and forum for the advancement and adoption of USB technology. De facto standards can also emerge as a form of dominant design. For example, the area of internet security was developed in 1993 by the company Check Point Software Technologies, one of the leaders in the field of internet security (Firewall etc.). In 1993, the company developed and patented a technology called Stateful Inspection (which was used as the basis for its

⁷⁶ Simcoe, T. 'Open Standards and Intellectual Property Rights', to appear in *Open Innovation: Researching a New Paradigm*, Oxford University Press (in press)

⁷⁷ Ibid

⁷⁸ See <http://www.itu.int> accessed 14 June 2008

⁷⁹ See <http://www.w3.org> accessed 14 June 2008

⁸⁰ Shapiro, 2001

⁸¹ See <http://www.3gpp.org> accessed 14 June 2008

⁸² See <http://www.m4if.org> accessed 14 June 2008

⁸³ USB Implementers Forum, Inc., <http://www.usb.org/>

software Firewall-I), and which went on to become the industry standard for enterprise-class network security solutions.⁸⁴

Another manifestation of the more 'open' innovation style is the open source model. The model, which is currently more focused on the IT sector, offers free access to the source code leading to a 'communal' development style, under which anyone can modify and build on the original source code.⁸⁵

Open source modes of innovation were adopted to overcome the compatibility problems that can occur between software and hardware components. Arguably, the first instance of this kind of development occurred in 1998 with Netscape's announcement that it would make its source code available for modification and redistribution on the Internet. Many new products have been created under the open source model. Linux, the popular Unix-based operating system, was developed using the open source development process, as was the Apache web server, which today is one of the most widely used web servers in the world.⁸⁶

Open source has become associated with the voluntary ceding or pooling of knowledge assets to what is referred to as the 'creative commons' or, put another way, the common good of the creative community and, by inference, the benefit of the general public. Here, it should be noted that the decision of big companies to voluntarily donate their knowledge assets to the open source community is not necessarily based on altruism. Rather, this decision may be based on a strategic choice that is aimed at maintaining or even strengthening the overall market position of these firms. A firm may choose to give up some of its knowledge assets in the expectation that the use of such assets by the open-source community will lead to a greater demand for the complementary products and services that this company provides.⁸⁷ IBM, for example, has given up hundreds of software patents to the creative commons with the aim of developing improvements to Linux that enhance its functioning with their own complementary products (proprietary hardware or software) and services.⁸⁸ The decision of a given company to release some of its knowledge assets and IPRs to the market - or the decision not to pursue the IP option at all - is itself still voluntary, in so far as it meets the conditions highlighted above, i.e. that these decisions are based on the intentional, legal and commercial decisions of that company, taking account of its particular business model.

To summarise, while we have given just a few examples from across the knowledge-based industries there are a variety of different ways in which knowledge is created, used and shared for the purpose of introducing new technological innovations to the market. Today, voluntary market-driven efforts aimed at creating new knowledge are based on vertical efforts (whereby knowledge is created and shared via the traditional channel of in-house R&D efforts), as well as more collaborative, horizontal efforts (whereby information is generated and shared

⁸⁴ Check Point. *Stateful Inspection Technology*, August 2005; protected by U.S. patents number 5,606,668, 606,668, 5,835,726 - System for securing inbound and outbound data packet flow in a computer network, http://www.checkpoint.com/products/downloads/Stateful_Inspection.pdf accessed 1 September 2008

⁸⁵ See <http://www.opensource.org/> accessed 03 June 2008

⁸⁶ Netscape, 'Netscape Communicator Open Source Code White Paper', 2000, <http://wp.netscape.com/browsers/future/whitepaper.html> accessed 20 June 2008

⁸⁷ West, J. & Gallagher, S. 'Challenges of Open Innovation: The Paradox of Firm Investment in Open-Source Software' in *R&D Management*, Vol. 36, No. 3, 2006

⁸⁸ *Ibid*

collaboratively among industry and research bodies). The latter consists of different models, such as the creation and use of knowledge via contractual arrangements (for example, the licensing option), the creation and use of knowledge based on integration models, such as via acquisitions, and mixed models that combine the more flexible arrangements of knowledge creation and use, such as joint ventures or strategic partnerships. Efforts in this area can be based on the more commercial and strategic use of proprietary knowledge assets and their associated IPRs or via more 'open' models that put less emphasis on the exercise and use of IPRs and may even involve the decision to 'donate' some proprietary knowledge assets to the market.

However, underlying these models is the voluntary nature of knowledge transfer. In other words, the creation of knowledge via these channels is based on the intentional, market-driven choices of different companies in their quest to bring new technological innovations to the market and in light of their respective business models.

IV. On the Role of IPRs

IV.1 The Economic Rationale for the IP System

Before discussing the role of IPRs in the process of knowledge creation and innovation, it would be useful to briefly describe the economic rationale underlying the IP system.

In the process of exploring ways of efficiently allocating scarce resources to unlimited wants, economists have come to find that private property rights are an efficient way of dealing with the problem of scarcity. Knowledge and other forms of intellectual creations, however, are a unique resource, given that they are not inherently scarce (at least not in the way economists understand the word). Theoretically speaking, the potential use of existing knowledge or any other form of intellectual creation (for the purposes of this paper, knowledge-based products) is unlimited and may be diminished only when they become obsolete or irrelevant to society. In fact, the use of any intellectual creation or knowledge-based product by one individual does not reduce its accessibility to others but is actually more likely to increase it. Economically speaking, innovative products that are based on knowledge and other expressions of artistic and intellectual creations (be they a new piece of software, a medical technology, a drug or an innovative telecommunications product, to name just a few modern examples) have the characteristics of a 'public good'. They are 'non-rival', in the sense that the use of such a product by one individual does not reduce its quantity or availability for others (i.e. there is not less of that creation to use). They are also 'non-excludable', in that the use of that creation by one individual does not prevent other people from using it at the same time.⁸⁹ For example, consider a case in which an author has introduced a brilliant masterpiece or the case of an innovator who was able to come up with a revolutionary invention in the medical field. Once these creations

⁸⁹ For a discussion on this issue see Hindley, B. V. *The Economic Theory of Patents, Copyrights, and Registered Industrial Designs: Background Study to the Report on Intellectual and Industrial Property*, Ottawa: Economic Council Of Canada, 1971; Mankiw, N. G., *Principles of Economics*, Dryden Press, 1998, pp. 219-234; Hardin, G. 'The Tragedy of the Commons', *Science*, 162, 1968, pp. 1243-1248; Pugatch, 2004, chapter 2. See Arrow, K. 'Economic Welfare and the Allocation of Resources for Invention', in: *The Rate and Direction of Inventive Activity: Economic and Social Factors*, ed. National Bureau of Economic Research, Princeton University Press: Princeton, New Jersey, 1962. pp. 609-626

are introduced to the market, there is no physical limitation on the ability of others to freely use these creations to their own benefit. This is what makes knowledge-based products so special – the fact that they are not inherently scarce.

However, this is what also makes such products so vulnerable – in the absence of necessary protection mechanisms (such as IPRs) there is an intrinsic temptation to use these products at the expense of the efforts and investment of their creators. Indeed, and as described above, the development of knowledge-based products is a very expensive, risky and time-consuming endeavour (for example, in terms of the efforts and resources required for the creation of a new pharmaceutical drug, an album of music, or a new piece of software). Yet, compared with the difficulties of creating a knowledge product, the cost of copying or downloading this product is negligible. As such, knowledge-based products are highly susceptible to the so-called free-rider problem; a philosophical as well as an economic dilemma referring to the act of using or deriving benefit from a social or economic outcome or activity without paying or contributing towards the cost or effort required to create it.⁹⁰ Consider a case in which an innovator was able to develop a revolutionary technology which doubled the speed of computer processing. If the innovator decides to sell his invention in the market, he cannot expect potential buyers to pay for the invention without first assessing its potential uses, effectiveness and value. Yet, doing so will effectively allow potential buyers to obtain information from the innovator free of charge. Moreover, once a potential purchaser has gained sufficient information and, provided he has the capabilities, he finds himself able to copy the innovation without paying for it at all, as well as to sell the product at a lower price, since he has no need to recoup the costs associated with the development of this innovation.

Thus, economic theory suggests that in the absence of any institutional provisions that establish property rights in knowledge-based products, the tendency to free-ride will increase.⁹¹ Consequently, the incentive to create these products will significantly decrease. This problem was recognised and noted by Bentham who argued that “without the assistance of the law, the inventor would almost always be driven out the market by his rival, who finding himself without any expense, in possession of a discovery which has cost the inventor much time and expense”⁹² Bentham concludes that “he who has no hope that he shall reap will not take the trouble to sow”.⁹³

In order to prevent the problem of free-riding, society has designed various systems of IPRs, such as patents, copyrights, trademarks, etc. Generally speaking, IPRs may be treated as a contract between society and the individual innovator (be it a person or company) that develops the new knowledge product or intellectual creation. This contract stipulates that in exchange for society’s ability to enjoy and use this new product or creation (which is a result of the time, money and efforts invested by the individual) the innovator will be granted ownership, albeit for a limited period of time, of that product or creation. Generally speaking, during the term of ownership, as determined by the IPRs attached to it, the innovator will have legal powers to determine who can use his

⁹⁰ Arrow, K. 1962

⁹¹ Pugatch, 2004, chapter 2

⁹² Bentham, J. 'A Manual of Political Economy', in: *The Collected Works of Jeremy Bentham*, ed. J. Bowring, Vol. 3, Edinburgh, 1842, p. 71

⁹³ Ibid

innovation and under what conditions. After the relevant IPRs expire, society can free-ride the innovation or creation for as long as it wishes to do so.

IV.2 The Importance of IPRs to Knowledge Creation and Innovation

Prior to discussing the role of IPRs in greater detail it is useful to make one important methodological observation. While in this paper we treat IPRs as a more general and homogenous concept in order to underscore its importance to the process of innovation, it is important to remember that the concept of IPRs essentially encompasses different types of rights. Different IPRs, such as copyrights, patents, trademarks, etc, vary in the subject matter for which they are granted, in the criteria and the procedures by which they are tested and rewarded, in the scope and term of protection that they provide, and in the legal limitations to which they are subordinate. Accordingly, different sectors rely on different forms of IP protection and/or on the combination of these rights. For example, the music, film and software industries rely heavily on copyrights as the main form of IP protection, while the pharmaceutical, telecommunications and engineering sectors rely heavily on patent protection. That said, the complex nature of innovative products today suggests that different products rely on more modular and hybrid layers of IP protection. Thus, many products in the software industry enjoy the protection of copyrights, patents and designs, while pharmaceutical products rely today not only on patent protection but also on other forms of protection, such as data exclusivity and orphan drug exclusivity, for example. Even more traditional sectors, such as the clothing and sports industry, are increasing relying on a broader array of IPRs in order to protect their products. The most recent and most topical example is Speedo's LZR Racer®, the famous swimsuit that was recently used in the Beijing Olympics. Speedo has invested significant resources in developing the revolutionary technology of the LZR Racer, which acts as a kind of a water repellent material and, as such, sought to fully protect its IPRs by applying for international patents, designs and trademarks, probably making it the most “heavily protected” swimsuit on earth.⁹⁴

Broadly speaking, IPRs have two major functions with regard to knowledge creation (and its uses) and innovation. First, IPRs provide confidence and security to the overall process of knowledge creation and innovation.

Consider the process of R&D (part of the vertical process of knowledge creation), which is extremely expensive, risky and time consuming. For example, in the pharmaceutical industry, the cost of developing and getting new drugs approved has been steadily climbing. In 1979, the total cost of developing and getting a drug approved for public sale was \$138m. By 2003, this figure had reached a staggering \$802m.⁹⁵ This cost consists mainly of two research and data-gathering elements: pre-clinical trials and clinical trials, the purpose of which is to establish whether or not the drug proposed for approval is safe for human consumption. Grabowski estimates that the accumulation and compilation of the data included in a pharmaceutical registration file (i.e. the data generated in

⁹⁴Speedo LZR Racer – Legal Notice, 2008, http://www.speedo80.com/lzr-racer/legal_notice/ accessed 01 September 2008

⁹⁵ DiMasi, J. A., Hansen, R.W. and Grabowski, H. J. 'The Price of Innovation: New Estimates of Drug Development Costs', *Journal of Health Economics*, vol. 22 (2003), pp. 151-185

clinical trials) is around \$US467m, more than 60% of the total cost of pharmaceutical R&D.⁹⁶ Industry figures suggest that as few as 1 out of 5,000 molecules screened actually make it onto the market as pharmaceutical drugs.⁹⁷ Moreover, it is estimated that only 3 out of 10 prescription drugs which make it onto the market generate revenue that equals or exceeds the average cost of research and development.⁹⁸ Consequently, the ability to secure IPRs very early in the R&D process is crucial to the successful development of a new drug, from the test tube to the introduction of a new medicine to the market. In other words, during the pre-marketing phase of the drug (or any other innovative product for that matter) IPRs are used as 'insurance' during the different stages of research and development.

Patents, for example, were and remain one of the most dominant and important forms of IP protection for many research-based companies. It is estimated that between 60 to 65% of pharmaceutical products would not have been introduced or developed in the absence of patent protection.⁹⁹ Also, according to the recent 2007 Annual Report of the European Patent Office (EPO) some of the biggest applicants for patents come from the Information and Communications Technology (ICT), electronics and telecommunications sectors such as Phillips (3222 patent applications), Samsung (2478 patent applications), Siemens (1474 patent applications), Robert Bosch (1166 patent applications), LG (108 patent applications) and Nokia (873 patent applications).¹⁰⁰

Regardless of their specific features, the security and confidence that IPRs provide to innovators in order to allow them to introduce new technological innovations to the market is becoming more important than ever, not least because knowledge is becoming one of the most important 'commodities' of our time. To illustrate this, one need only to look at the rising share of the workforce who are occupied in knowledge-based employment. Between 1995 and 2005, employment in the manufacturing industries was stable or decreasing in both Europe and the United States, while employment in knowledge based industries has increased by 15% in America and almost 13% within what was then the EU-15.¹⁰¹ In the United States and the then EU-15, almost 40% of the workforce is now based in the knowledge economy, and in some European countries and American states the proportion is even higher.¹⁰² Consequently, the risks to the economy of not securing IPRs are in many cases prohibitive.

As to their second function, IPRs also provide for the commercial platform upon which knowledge (mostly the horizontal type) is created, exchanged and used for the purpose of advancing technological innovation.

Here we can make a distinction between the more direct effects and the more complex, dynamic effects of IPRs with regard to the role that they play in the use and exchange of knowledge.¹⁰³ The former refers mainly to the fact that in exchange for obtaining protection in different countries, intellectual property owners are required to

⁹⁶ Grabowski, H. *Patents and New Product Development in the Pharmaceutical and Biotechnology Industries*, Duke University, July 2002, p. 5 and Figure 1; Data is adjusted to 2003 R&D expenditures

⁹⁷ Association of the British Pharmaceutical Industry, (ABPI), *Briefing Paper: The Development of Medicines*, ABPI: London, 2005

⁹⁸ Grabowski, H. and Vernon, J. 'Returns to R&D on New Drug Introductions in the 1980s', *Journal of Health Economics*, Vol. 13, 1999.

⁹⁹ Mansfield, E. 'Patents and Innovation: An Empirical Study', *Management Science*, February, 1986, pp. 173-181

¹⁰⁰ European Patent Office, Annual Report, 2007, p. 21

¹⁰¹ Brinkley, I. and Lee, N. *The Knowledge Economy in Europe*, The Work Foundation: London, 2006, p. 10-11

¹⁰² *Ibid*

¹⁰³ Pugatch, 2004, Chapter 3

make the technology embodied in their products (or processes) available and accessible in these countries. For example, consider the direct effects of patents on technological access and availability. Patent laws require every patentee to disclose the particulars of his inventions to the patent office of the granting country. Therefore, by granting such patent rights a country enables its domestic firms to gain direct access to new inventions. These firms in turn are able to use the newly disclosed invention either as a basis for further innovative activities or in order to imitate the original invention (once the patent expires) for the purpose of acquiring further technological capabilities (sometimes referred to as innovation by imitation).¹⁰⁴ However, these types of interactions are limited in the sense that they involve a more top-down (or one-sided) relationship between firms (i.e. the technology is essentially disclosed by the innovator to be used by the future recipients).

The more complex the innovation process is, therefore, the more important it is to make sure that the innovator is comfortable in disclosing his additional information, knowledge and know-how to other parties. Here, IPRs play a crucial role in the facilitation of knowledge transfer. Consider the option of licensing, which, as explained above, is one of the most important forms through which horizontal knowledge is acquired and utilised. The willingness and ability of an innovator to grant others (even to one individual on an exclusive basis) the permission to use his knowledge assets, as well as the associated know-how, ultimately depends on the innovator's IPRs, as it is the ownership of these knowledge assets and the legal rights derive by that ownership which allow the innovator to enter into such activities in the first place. Consequently, the more complicated and sophisticated the licensing deal, the more important it is to ensure that relevant IP issues are addressed and agreed upon in advance.¹⁰⁵

The same applies to joint ventures, in which there is a great need to define and agree in advance on the manner in which partners may use the different IP assets that each of them bring to the partnership, as well as to decide what to do with the ownership of the new knowledge assets that are generated as a result of the joint venture. Indeed the importance of these issues has been emphasized in relation to requests for funding that are submitted to the EU's 7th Framework for R&D (so-called FP7) as part of the creation of a consortium. As explained by the European Commission's Intellectual Property Help Desk:

“Intellectual property (IP) management becomes important for a research project funded under the Seventh Framework Programme (FP7) from the very beginning of the negotiations related to the submission of the proposal and the building of the consortium. Indeed, the participant that drafts the proposal (usually the coordinator) has to describe the consortium's plans for the management of IP. At the same time, it needs to ensure good communication with the other participants when exchanging information regarding the technical part of the proposal. IP issues are also discussed between participants, both during the negotiations and the drafting of the consortium agreement...If the nature of the project (mainly SME¹⁰⁶ actions), the

¹⁰⁴ Glass A.J. *Imitation as a Stepping Stone to Innovation*, OSU Working Paper, No 99-11 Ohio State University, Department of Economics, July 14 1999

¹⁰⁵ Megantz, 2002, Chapter 5

¹⁰⁶ SME - Small and Medium Sized Enterprise. Defined by the European Commission as a company having less than 250 employees, http://ec.europa.eu/enterprise/enterprise_policy/sme_definition/index_en.htm accessed 03 July 2008

nature of the research work (work in close cooperation between participants) or even the will of the participants are likely to lead to a joint ownership situation, participants should mention that they are willing to reach an agreement for the effective management of the jointly owned results. If they have already agreed on the main features of their agreement (ownership shares, exploitation, licensing to third parties, etc.) they may also provide an overview of their plans...Participants may show that they are aware of the adequate IP rights to serve the protection and exploitation of the expected results, and, in addition, that they would consider the application of the most adequate policy, making use of internal or external resources.”¹⁰⁷

Finally, it is also important to note the positive role that IPRs play at the macro-economic level, not least in the context of global knowledge transfer activities and foreign direct investment. Evidence suggests that, when IPRs are strengthened, technology transfer is likely to flow as a consequence. From a technology transfer perspective, weak levels of IP protection in developing countries prevents both down-stream and up-stream technology transfer activities; the fear of the unauthorised use of proprietary knowledge prevents foreign companies from entering into technology transfer activities with local entities (down-stream technology transfer); on the other hand it also deprives local innovators of the opportunity to license their inventions to foreign entities (up-stream technology transfer). For example, Mansfield, in one of the most comprehensive and best-known survey studies on the subject published in the early 1990s, sampled 100 US firms to examine the importance of IPRs to foreign direct investment (FDI) and technology transfer.¹⁰⁸ He differentiates between 5 types of FDI: sales and distribution outlets, rudimentary production and assembly facilities, facilities to manufacture components, facilities to manufacture complete products, and R&D facilities. His conclusion is that the percentage of firms indicating that IP protection has a major effect on their foreign direct investment decisions depends greatly on the type of investments in question. Crucially, his findings suggest that as the level and sophistication of technological investment rises, so does the importance of IPRs. Only 20% of the firms reported that IPRs are important to them for investments in sales and distribution outlets, while around 80% regarded them as important for investment in R&D facilities. Mansfield also shows that different sectors, such as the chemical and the transportation equipment industries, attach varying importance to the effect of IPRs on their decision to invest in a given country.

A more recent study by Lippoldt and Park examines the extent to which changes made to the strength of patent rights were associated with a change in trade & FDI via licensing agreements. The study finds that patent rights have a positive effect on FDI inflows; a 1% increase in the strength of patent rights (as measured by the Ginarte Park or GP index) is associated with a 0.5% increase in the stock of FDI. They find that this effect is strongest for least developed countries.¹⁰⁹ Léger has conducted a similar study, focusing on developing countries only. The

¹⁰⁷ IPR Helpdesk, *FP7: Intellectual Property-Related Issues at the Proposal Stage*, July 2007, http://www.ipr-helpdesk.org/controlador/resources/showDocument?len=en&idFicha=0000006574&formato=xml_html&nomFichero=IP_Proposal_Stage&idFichero=00&cod_padre=t_02.03.01&localizador=doc accessed 01 June 2008

¹⁰⁸ Mansfield, E. 'Intellectual Property Protection, Foreign Direct Investment and Technology Transfer', International Finance Corporation, Discussion Paper No. 19, Washington DC: World Bank, 1994; See also Mansfield, E. Lee J.Y. 'Intellectual Property Protection and US Foreign Direct Investment', *The Review of Economics and Statistics*, Vol. LXXVIII No. 2, 1996, pp. 181-186

¹⁰⁹ Lippoldt, D. and Park, W. *International Licensing and the Strengthening of Intellectual Property Rights in Developing Countries During the 1990s*. OECD: Paris, 2005

author estimates the link between innovation and IPRs, and corrects for other determinants of innovation such as market demand, past innovative activities, economic conditions, political stability, human capital, financial capital and openness to trade. Comprising observations from 36 developing countries and 26 years (1970-1995), Léger reports that IPRs have a strong positive impact on investment.¹¹⁰ Robbins also finds that based on the GP index of patent rights, countries that have a robust system of patent rights, including developing countries, such as Taiwan and South Korea, are the largest recipients of income from IP based activities, in the form of royalties and licence fees. The author finds that these countries benefit considerably from activities that are based on the licensing of patents and trade secrets.¹¹¹

To sum up, IPRs play a vital part in the virtuous chain of knowledge creation and innovation as it occurs both vertically and horizontally. First, IPRs provide innovators with the confidence and security needed for taking on the risky, costly and time-consuming process of knowledge creation and innovation. This aspect is particularly important to efforts aimed at developing innovative products and technologies via the traditional (vertical) process of R&D. Second, and of equal importance, is the function that IPRs play with regard to the horizontal use of knowledge assets and technological innovations. As discussed above IPRs provide the platform upon which knowledge may be acquired, used and further utilised via collaborative R&D models, such as licensing agreements and joint ventures, which, as previously outlined increasingly play a crucial role in introducing new products to the market.

Now that we have talked about the three fundamental layers involved in the voluntary, market-driven process of technological innovation (the nature of technological innovation, the types of knowledge that are involved in this process and the role of IPRs in allowing the creation and use of this knowledge) we can go on to discuss and examine the alternative model of compulsory, non-market-driven innovation which is currently being debated and, to some extent, exercised in various forums.

V. Contemporary Suggestions for a Compulsory, Non-Market Driven Use of Knowledge for the Sake of Technological Innovation - A Slippery Slope

It is important to conceptualise this model at the outset, in order to address the proposals and applications of what we term the compulsory, or non-market-driven, model for using knowledge for the purpose of technological innovation. This is not an easy task, not least because the model is not intellectually underpinned by existing theoretical literature. Nor is this model supported by empirical evidence in terms of the ability to show that technological innovation has indeed been generated as a result of the non-voluntary transfer of knowledge.

¹¹⁰ Léger, A. *Intellectual Property Rights and Innovation in Developing Countries: Evidence from Panel Data*, Proceedings of the German Development Economics Conference, Berlin 2006

¹¹¹ Robbins, C. A. *Measuring Payments for the Supply and Use of Intellectual Property*, International Association for Official Statistics (IAOS) Ottawa: Canada, 2006

Personal and political views differ about the intellectual and practical dangers that such a model poses to real life efforts to promote technological innovation (as discussed later in this section), but we should nevertheless try to provide a clearly defined framework for discussing this model before looking at its practical manifestations.

V.I Non-Market-Driven Efforts Aimed at Promoting Technological Innovation

Let us first discuss non-market-driven efforts to promote technological innovation. Such efforts do take place in practice and are legitimate as regards the academic theory. The most typical example concerns the knowledge that is created in the public sector, particularly in academia and public research organisations (PROs). Generally speaking, the major part of the research taking place in academia or in PROs is not intended for commercial use. Rather the traditional mission of these institutions and their employees (the academic staff and the researchers) is to generate knowledge and to make it public.¹¹² There are other cases in which knowledge and technological innovations created by the public sector are not made known to the public. For example, technological innovations that are developed for the purpose of military and security applications are kept confidential as they aim to serve an entirely different set of national needs, unrelated to the market.

Nevertheless, there is strong empirical evidence to suggest that, since the mid 1980s, knowledge creation and innovation by these institutions is shifting away from the 'pure' non-market-driven approach, towards a mixed model based on public-private collaborations and a much stronger focus on the market, particularly with regard to technological innovations. This has largely been the result of two path-breaking pieces of legislation adopted by the United States in the 1980s - the Patent and Trademark Law Amendments Act of 1984 and 1986, commonly referred to as the Bayh-Dole Act,¹¹³ and the Stevenson-Wydler Technology Innovation Act, later amended by the Federal Technology Transfer Act of 1986 and the Technology Transfer Commercialisation Act in 2000¹¹⁴. Both of these attempted to supply federal laboratories (such as the National Institutes of Health - NIH, NASA and even security agencies) and universities with the incentives to work with industry for the purpose of translating early stage research into usable products for the benefit of the public. The Bayh-Dole & Stevenson-Wydler Acts sought to secure the above goals through three major changes to the IP system. First, they allowed universities and federally funded bodies to retain ownership of the proprietary knowledge stemming out of the research and daily activities of these institutions, including the ability to own patents on their inventions. Second, they encouraged these institutions to become much more proactive and professional in the management and exploitation of their IPRs by creating professional technology transfer offices. Finally, the legislation sought to stimulate the commercial and financial aspects of public-private collaboration, with the intention of creating new businesses (such as spin-off companies) and generating income for the institutions, as well as for the researchers.

¹¹² This is not to say that the creation of this knowledge is based on altruism, as the individual or group of individuals that are generating the knowledge (be it as a result of basic research or a more applied research) expect to be rewarded in different ways, for example being promoted in the academic ranks, gaining publicity and reputation, influencing existing paradigms, etc.

¹¹³ US Code, Title 35, Chapter 8 – Patent Rights in Inventions made with Federal Assistance

¹¹⁴ US Code, Title 15, Chapter 63 – Technology Innovation

The Bayh-Dole & Stevenson-Wydler Acts led to a flood of knowledge creation and innovation activities based on the exploitation and commercialisation of IPRs generated in universities and PROs by private entities. A decade after the legislation was passed the combined campuses of the University of California became the top recipient in the US of biotechnology patents; a position previously held by the pharmaceutical company Merck.¹¹⁵ In 2005 alone, universities generated 3,278 US patents, signed 4,932 new licences, launched 527 new products and created 627 spin-off companies.¹¹⁶ The total income of research institutes was estimated at 1.4 billion USD.¹¹⁷ In December 2002, *The Economist* called Bayh-Dole, “possibly the most inspired piece of legislation to be enacted in America in the last half-century”.¹¹⁸ Indeed, university technology transfer activity is recognised by policy-makers to be a powerful driver of national economic growth and to this end many countries have sought to emulate and develop models that are based on public-private partnerships. Canada (1985), Japan (1998), Great Britain (1998), Germany (1998, 2001), France (1999), Austria (2002), Italy (2001), Belgium (1999), Spain (1986), Denmark (2000), Switzerland (2002), The Netherlands (1998) and Korea (1998, 2000 and 2001) have all adopted frameworks aimed at promoting technology transfer between public and private entities through the exploitation of IPRs.¹¹⁹

In this context, the role of university faculty and of researchers in PROs has been the focus of recent research on university-industry technology transfer activities. This research suggest that researchers' involvement goes well beyond simply disclosing research to the relevant technology transfer office (TTO), with the faculty often identifying licensees as well as working with licensees in further development. Thursby, Jensen and Thursby provide evidence from a survey of university technology transfer personnel to suggest that the majority of inventions licensed are so embryonic that successful commercialisation depends critically on the faculty's participation in further development.¹²⁰ Another study presents the results of a survey of businesses that license-in university technologies, and in particular looks at the extent to which the nature of faculty research is a factor in the business's interaction with universities with regard to the commercialisation and exploitation of university research.¹²¹ Businesses in the study sample reported that the overwhelming majority of university inventions they seek to license-in are no more than a lab scale prototype, and that for early stage technologies they often employ faculty assistance in further development. Furthermore, when inventions are too embryonic to licence, firms often pursue the invention by sponsoring faculty research instead of a licence. Finally, there is a bulk of academic research suggesting that personal rewards to faculty and researchers in PROs, in the form of royalties or equity,

¹¹⁵ United States Patent and Trademark Office (USPTO) Technology Profile Report, 'Patenting Examining Technology Center Groups', *Biotechnology*, Washington, 2006, pp. 1630-1660

¹¹⁶ Association of University Technology Managers (AUTM), *FY 2005 Licensing Survey*, Northbrook IL: AUTM, 2005

¹¹⁷ *Ibid*

¹¹⁸ *The Economist*, 'Innovation's Golden Goose', *Technology Quarterly*, December 14, 2002, p.3

¹¹⁹ OECD, *Turning Science into Business: Patenting and Licensing at Public Research Organisations*, OECD: Paris, 2003, p.26

¹²⁰ Thursby, J, Jensen, R. and Thursby, M. "Objectives, Characteristics and Outcomes of University Licensing: A Survey of Major U.S. Universities." In: *Journal of Technology Transfer*, 26(1,2), 59-72 (2001)

¹²¹ Thursby, J. and Thursby, M. "Are Faculty Critical? Their Role in University-Industry Licensing". *Contemporary Economic Policy*, Oxford University Press, 22(2), 2004, pp. 162-178

for example, are very important to the overall success of the technology transfer activities carried out by these institutions.¹²²

Yet regardless of the shift towards a mixed model of private-public partnerships, the non-market-driven approach towards knowledge creation and innovation is valid in the case of publicly funded research. But it should be emphasized that in this case the knowledge creation and innovation taking place in these institutions is largely funded and supported by the state (i.e. via government funding generated via taxation). This is a crucial point, as it is public funds that are being used to support non-market-driven innovation efforts as opposed to endeavours based on the resources of the private sector (not counting the actions of philanthropists who wish to donate funds). Yet even in this case the objective of making knowledge available to the public does not exclude the use of IPRs as a tool for securing it. As explained above, public institutions can choose different tools in order to bring the results of their R&D endeavours to the public. These efforts can be based on academic publications, participation in conferences and the general sharing of knowledge or information or, as explained above, on the use of the IP system as a way of allowing these institutions to be able to translating their R&D outputs to concrete products to the benefit of society.

In other words, there still remains little theoretical and empirical evidence to suggest that the non-market-driven approach has been adopted willingly by the private sector, whereby individual entities are required to invest their own resources into the process of knowledge creation and technological innovation. This is unsurprising, as for these entities, as well as the private sector as a whole, it is the market that provides both the incentives and rewards that fuel the innovation process.

V.2 Compulsory Uses of Knowledge Assets and IPRs for the Promotion of Technological Innovation: Theoretically or Empirically Justified?

With regard to the compulsory aspect of the above model, we broadly define the term compulsory as the act by a national or supra-national authority of forcing the innovator to give up (in total or in part) proprietary knowledge assets, be they technology, knowledge, know-how, trade secrets, etc. For the sake of this definition we can argue that compulsory practices can be based either on the specific revocation of the legal rights of the innovator to prevent others from free-riding his proprietary knowledge asset without his permission, or by forcing the innovator to actively disclose all the particulars relevant to the use of knowledge assets (for example, the know-how and trade secrets), or both. Finally, it is by definition that compulsory practices seek to erode and at times completely nullify the innovator's IPRs.

¹²² Daimant, R. and Pugatch, M, *Measuring Technology Transfer Performance in Public-Private Partnerships - A Discussion Paper*, London: Stockholm Network, 2007

Here we should also make a distinction between the use of compulsory practices (such as the issuance of a compulsory licence in the case of a patent) that are aimed at promoting access to existing proprietary knowledge assets or products, and practices that are aimed at using the proprietary knowledge assets for the purpose of promoting further technological innovation.

It is useful to address first the issue of the use of compulsory licences in order to promote access to knowledge and knowledge-based products. Discussions on the legitimacy of using compulsory licences for the purpose of securing access to existing knowledge assets are far from being new.¹²³ Generally, the fundamental policy consideration that should be taken into account when considering the issuance of a compulsory licence in this context should be the extent to which the existence of IPRs at a given point in time may lead to a market failure in terms of the ability to supply the proprietary product to the public. For example, imagine a case in which there is a need for a massive and immediate production of a patented medicine - say in the light of an unexpected outbreak of a pandemic, such as Avian influenza or a bio-terror attack involving the use of anthrax¹²⁴ - then compulsory licences mechanisms may be considered on the basis of the following conditions:

- That the quantity of the medicines required is beyond the production capacity of the company owning that medicine and that the company is both unable and/or unwilling to solve the problem of production (for example, by providing a voluntary licence).
- That the company refuses to take into consideration the sudden increase in demand when negotiating prices with the governments.

If these conditions are met then this use of compulsory licence may be justified. However, history suggests that in both the cases of the anthrax threat (in the aftermath of 9/11) and the bird flu scare, pharmaceutical companies pledged to cooperate with governments in order to solve the kinds of problems detailed above, without being forced to license their patents.

Subsequently, there is a need to consider whether the use of compulsory licences can actually solve problems relating to access, or at least form a significant component of the solution. This is particularly relevant to the field of pharmaceuticals, where debate is taking place over the desirability of using compulsory licences for the sake of providing greater access to medicines to poor populations in developing countries. Take, for example, the 2001 Declaration on the Agreement on Trade Related Aspects of Intellectual Property Rights Agreement on Public Health (TRIPS) as part of the Doha Development Agenda, and the August 2003 Agreement on the implementation of Paragraph 6 of the declaration (focusing on the manner in which least developed countries with no

¹²³ Penrose, E. *The Economics of the International Patent System*, Johns Hopkins Press: Baltimore, 1951, chapters 7-7; See also Penrose, E. 'International Patenting and Less-Developed Countries', *The Economic Journal*, Vol. 83, September 1973, pp. 768-765.

¹²⁴ For the case of anthrax, see Pugatch, 2004, Chapter 9; See also Pugatch, M.P. and Disney H, 'The Uses and Abuses of Health Related Compulsory Licence', *Know-IP-Stockholm Network Monthly Bulletin on IPRs*, Issue 9, November 2005

manufacturing capacities can import generic substitutes to existing patented pharmaceutical drugs).¹²⁵ There is a wide consensus that these agreements made the use of compulsory licences much easier and more 'flexible' under the TRIPS regime for the purpose of providing (as its advocates argue) greater access and affordability to medicines in developing countries.¹²⁶

However, the evidence suggests that, aside from diluting the level of IP protection provided under the TRIPS Agreement, the use of compulsory licences does little to promote access to medicines in these countries.¹²⁷ The fact is that pharmaceutical patents are probably the least problematic aspect of the issue of access to essential medicines for poor people in less developed countries. In fact, of the 300 drugs listed by the World Health Organisation (WHO) on its Model List of Essential Drugs (2001), fewer than 5% (fewer than 20) are under patent protection anywhere in the world.¹²⁸ However, this should not come as a surprise, as the challenges facing the least developed countries in the area of healthcare, including medicines, are formidable and much more fundamental than the issue of patents and compulsory licences. To quote the WHO: "One third of the world's population continues to lack regular access to essential drugs. In the poorest parts of Africa and Asia, this figure rises to over 50%. The reasons are well-known and include inadequate financing and poor health care delivery. This is especially so given that total pharmaceutical expenditure, as well as other health expenditure, is linked to the economic development level of a country, and tends to increase only when GDP increases".¹²⁹

As for the use of compulsory licences for the purpose of encouraging further technological innovation, here we are faced with even greater theoretical and empirical difficulties.

Conceptually, one could think of two possible scenarios in which one could try to justify the use of this method, though neither has a great deal of merit. The first is a case in which we could persuasively demonstrate that issuing a compulsory licence against an innovator (say, company A) will allow another entity (say, company B) to develop subsequent technological improvements (which are incremental by nature) that are superior to the improvement that may be developed by the original innovator himself. Here we would need to show that the benefit to society from the improvement provided by company B (compared with the improvement provided by the innovator) outweighs the costs to society from the innovator's lack of incentive to invest in the modifications and improvements to his own original technology (as he may choose not to invest in this option), and more importantly his lack of incentive to create knowledge assets in the future (given that the innovator will be aware that he may be faced with the compulsory transfer of his knowledge assets). We would also have to prove that this option would be superior to any other economic benefit that may arrive from a voluntary arrangement that could take place between the innovator and other entities concerning the use and improvement of his product (for

¹²⁵ World Trade Organisation (WTO), *Ministerial Declaration on the TRIPS Agreement and Public Health*, Adopted 14 November 2001; See also Council for TRIPS, *Implementation of Paragraph 6 of the Doha Declaration on the TRIPS Agreement and Public Health*, 30 August 2003

¹²⁶ *Ibid*

¹²⁷ Pugatch M. P. 'Much Ado About Nothing: The WTO TRIPs Deal on Drugs' Patents', in Debroy, B. Saqib, M. and Mitra, M. eds. *WTO at Ten: Looking Back to Look Beyond*, Konark Publishers: New Delhi, Vol. 2, Chapter 11, 2005, pp. 333-347.

¹²⁸ Watal, J. 'Background Note for the Workshop On Differential Pricing and Financing of Essential Drugs', WHO-WTO Secretariat Workshop, 8-11 April 2001, p.6

¹²⁹ WHO, *Essentials Drugs and Medicines Policy: Access Strategy*, 15 May 2002

example, if the innovator decides to enter into a joint venture that does not include company B or may even try to obtain ownership of this company). In other words, trying to justify the use of compulsory action against the innovator in the above case by pointing to a positive net benefit to society may prove a difficult if not an impossible task.

Another option would be to argue that there is a need to issue a compulsory licence in cases where company B requires access to the knowledge asset of company A (the innovator) in order to introduce a completely new technological innovation to the market. In a case where the innovator (company A) refuses to enter into a voluntary agreement with company B, one could argue for the use of a compulsory licence.

This principle was indeed applied in the ruling of the European Court of Justice in the 1995 Magill case.¹³⁰ In this case, Magill (an Irish businessman) sought to develop a new television programme guide which combined the TV programmes of the various TV channels at the time (until that point Irish TV viewers had to buy separate guides for each TV channel) and was subsequently sued by Irish broadcasters for infringing copyrights related to the lists of TV programmes included in their individual guides. In this case the European Court of Justice confirmed that the refusal of the broadcasters to license their guides to Magill infringed Article 82 of the EC Treaty (which deals with abuse of dominant position). In particular, it was held that the exercise of an exclusive right such as copyright may in 'exceptional circumstances' infringe Article 82. The exceptional circumstances in this case included the fact that the refusal to license the lists of programmes to Magill prevented the launch of a *new product* for which there was proven consumer demand.¹³¹ Yet even in this case the emphasis should be put on the use of a compulsory licence only in exceptional circumstances that involve the introduction of a new product to the market. Also in this case the Magill precedent was based on the use of copyrighted materials which did not incorporate any additional technologies that were needed for the sake of developing the new product (the TV guide).

Thus, the justification for the use of compulsory licence for the purpose of encouraging future technological innovation is akin to walking on very thin ice. As a general rule the intellectual considerations and empirical evidence provide a strong case against its use. Consequently the use of this tool should only be considered as a measure of last resort and even then be considered on the basis of exceptional circumstances which are based on a very detailed observation of the case at hand (as discussed, looking not only at the short-term benefits but also at the long-term costs associated with the decision to use a compulsory licence).

Nevertheless, and despite the above, it seems that a perception is emerging in some segments of the policy-making community that the use of compulsory, non-market-driven tools in the private sector will lead to greater innovative output, compared to the existing models of innovation that are based on voluntary market-driven

¹³⁰ RTE and ITP v Commission, 1995, ECR I-743. For an analysis of the full case see Curley D, *Innovation, Intellectual Property and Competition: A Legal and Policy Perspective*, Stockholm Network Experts' Series on Pharmaceutical IPRs and Competition, Stockholm Network: 2006

¹³¹ Ibid

efforts. In turn, efforts have been made to translate this perception into concrete actions, both at a strategic level as well as at the operational one. The next section elaborates on some of these efforts.

V.3 Recent Developments

Microsoft's high profile anti-trust case in Europe is one example in which the compulsory use of knowledge assets has been invoked. In this case, the European Commission's competition authority (DG COMP) argued that the refusal by Microsoft to supply interoperability information to its competitors, in order to allow them to offer their own work group server operating systems to users of Windows PCs and servers, qualified as an abuse of dominant position under Article 82 of the EC Treaty. Subsequently, the European Commission instructed Microsoft to "disclose complete and accurate interface documentation which would allow non-Microsoft work group servers to achieve full interoperability with Windows PCs and servers". DG COMP argued that "this will enable rival vendors to develop products that can compete on a level playing field in the work group server operating system market. The disclosed information will have to be updated each time Microsoft brings to the market new versions of its relevant products."¹³²

The ruling was upheld by the European Court of First Instance in 2007, which confirmed that Microsoft was to make available indispensable interoperability information to allow its competitors to develop workgroup server products that work properly and on an equal footing with Microsoft products. The ruling stated that "consumers have a right to the increased choice and innovation, and the decreased prices that competition brings. Competition in this market requires interoperability."¹³³

By forcing Microsoft to provide proprietary information (in this case, its own trade secrets but also information on technology covered by patents) to its competitors to enable their products to interoperate with Microsoft's on an equal footing, DG COMP (and in this case the Court of First Instance) adopted the concept of compulsory, non-market-driven use of knowledge assets to the purported end of promoting innovation. DG COMP seemed to argue that such an approach would encourage others to enter the market for work group server operating systems, and to come up with innovative improvements and products of their own for the benefit of the consumer. It was considered that these perceived benefits would outweigh the potential negative impact of this approach on Microsoft and other innovators in the market.¹³⁴ Indeed, the decision was endorsed by the European Commission as a way to "give consumers more choice in software markets and to maintain incentives for all companies in these markets to innovate to the benefit of consumers".¹³⁵

¹³² European Commission, 'Commission Concludes on Microsoft Investigation, Imposes Conduct Remedies and a Fine', IP/04/382, 24 March 2004

¹³³ Kroes, N. 'Introductory Remarks on CFI Ruling on Microsoft's Abuse of Dominant Market Position', Press Conference, Brussels, SPEECH/07/539, 17 September 2007

¹³⁴ See the text of Article 82, sub-paragraph (b).

¹³⁵ Kroes, 2007

It remains to be seen what impact the current approach of DG COMP will have on the incentives and ability of well established knowledge-based companies to innovate in future, as well as on their competitors. In the case of Microsoft vs. DG COMP, much emphasis has been placed on the more immediate outcomes of the ruling with regard to the ability of Microsoft's competitors to gain access (via compulsory means) to its proprietary assets. Yet if one considers the dynamic and longer term implications of this approach on the future of innovation, one could identify some areas of concern which may have a rather negative impact. Spulber, for example, argues that this approach can diminish the incentive to innovate in several critical ways.¹³⁶ First, he argues that by reducing the level of protection provided to IPRs (by making it secondary to the doctrine of essential facilities) this approach can reduce the incentive to invest in costly R&D. Secondly, Spulber argues that, in this case, this also raises barriers to international trade by attacking the entry of foreign firms into the European marketplace, thus further reducing incentives to innovate.. Thirdly, and perhaps most importantly, he notes that the current approach effectively penalises companies which have managed to become market leaders through successful innovation, since the focus of this approach is on market outcomes rather than anti-competitive behaviour.

Nevertheless, and perhaps emboldened by this victory, DG COMP has gone on to launch several new enquiries into licensing practices across the knowledge-based sectors. Indeed, the Competition Directorate-General appears to be pursuing an agenda, under which forced disclosure remedies against an innovator look likely to be sought more freely, based on the belief that such remedies will lead to greater innovation in the market.¹³⁷

Although different in kind to the Microsoft case, the EU Commission investigation into Qualcomm based on complaints by rival companies over its alleged excessive licensing terms draws some parallels in terms of the Commission's approach towards the innovation process. Amongst the allegations is Qualcomm's alleged refusal to licence essential patents to potential chip set competitors on standard terms.¹³⁸ Qualcomm has built its business on developing and licensing IP for mobile communications, in particular the CDMA standards, which it invented. Rival firms now complain that the royalties it charges on key patents on the technology underlying the 3G standard are too high and to the end of lowering these royalties, they advocate interference into Qualcomm's licensing practices.

In another recent high profile intervention the European commission launched a sectoral enquiry into pharmaceutical markets in the EU in response to a perceived reduction in the number of new products being brought to market. In particular, the inquiry has set out to examine whether agreements between pharmaceutical companies have blocked or led to delays in market entry and whether companies have created artificial barriers to

¹³⁶Spulber, D. F. "Competition Policy and the Incentive to Innovate: The Dynamic Effects of Microsoft v. Commission", *Yale Journal on Regulation*, Volume 25, Number 2, Summer 2008

¹³⁷Curley, 2006

¹³⁸For more details see 'Antitrust: Commission Initiates Formal proceedings Against Qualcomm,' Brussels, 01 October 2007, MEMO/07/389 <http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/07/389&format=HTML&aged=0&language=EN&guiLanguage=en> accessed 19 June 2008

entry for innovative products through the ‘misuse’ of patent rights, for example.¹³⁹ Although in this case the remedies have not been yet decided, the starting point of this enquiry is based on the assumption that the current innovation model in the pharmaceutical industry is in need of ‘repair’. In particular, the belief is that innovation has not been best served by patenting or the exercise of patents and that as a result investment in R&D, innovation and consumer choice have been limited. Restoring competition in the sector envisages taking measures against individual entities possibly resulting in decisions based on Article 81 and/or Article 82 of the Treaty establishing the European Community.¹⁴⁰

Arguably, it is the pharmaceutical and medical devices sector that has seen the strongest moves towards the compulsory, non-market-driven use of knowledge, particularly at the global level. As previously described in this paper (see section V.1), the bulk of the debate on the use of compulsory licences in the pharmaceutical field, as well as the real-life practices of these measures by countries such as Brazil, Thailand and the Philippines, focuses on the issue of access to medicines, most notably on the tensions between the price of innovative drugs versus generic ones.

Yet recently the use of compulsory licences as well as the intentional restriction of IPRs (both at the upstream and downstream phases), have also been advocated as necessary tools for promoting the development of innovative new products to combat diseases primarily affecting the developing world. Thus the 2006 report of the WHO’s Commission on Intellectual Property Rights, Innovation and Public Health (CIPIH) states that “countries should provide in their legislation powers to use compulsory licensing, in accordance with the TRIPS agreement, where this power might be useful as one of the means available to promote, *inter alia*, research that is directly relevant to the specific health problems of developing countries.”¹⁴¹ Among the policy recommendations the CIPIH makes for promoting R&D into innovative new products are mandatory patent pools to facilitate access to needed technologies and compulsory licensing to allow access to upstream technologies.¹⁴²

Subsequently, these issues have also been addressed by the WHO’s Intergovernmental Working Group on Public Health, Innovation and Intellectual Property (IGWG), which was asked to prepare a global strategy and plan of action on essential health research to address conditions affecting developing countries disproportionately”.¹⁴³ Although the final text of the Global Strategy is much less explicit in its language in terms of the use of compulsory non-market-driven mechanisms, one can identify some paragraphs that encourage further thinking into this direction.¹⁴⁴ To provide a few examples, article 2.2 of the Global Strategy seeks to “identify incentives and barriers,

¹³⁹ The sector inquiry was opened by Commission Decision in January 2008. For more details see ‘Pharmaceuticals: Sector Inquiry’, <http://ec.europa.eu/comm/competition/sectors/pharmaceuticals/inquiry/index.html> accessed 19 June 2008

¹⁴⁰ DG COMP, Commission Decision of 15 January 2008: Initiating an Inquiry into the Pharmaceutical Sector Pursuant to Article 17 of Council Regulation (EC) No. 1/2003, Case No. COMP/D2/39.514

¹⁴¹ WHO, Public Health, Innovation and Intellectual Property Rights: Report of the Commission on Intellectual Property Rights, Innovation and Public Health, 2006

¹⁴² *Ibid*

¹⁴³ WHO-IGWG, Draft Global Strategy and Plan of Action on Public Health, Innovation and Intellectual Property, A/PHI/IGWG/2, 31 July 2007

¹⁴⁴ WHO-IGWG, Global Strategy and Plan of Action on Public Health Innovation and Intellectual Property, WHA61.21, 24 May 2008

including intellectual property-related provisions, at different levels – national, regional and international – that might affect increased research on public health, and suggest ways to facilitate access to research results and research tools”; Article (2.3)(c) of the Global Strategy seeks to “encourage further exploratory discussions on the utility of possible instruments or mechanisms for essential health and biomedical R&D, including *inter alia*, an essential health and biomedical R&D treaty”; Article (2.4)(e) seeks to “consider, where appropriate, use of a ‘research exception’ to address public health needs in developing countries consistent with the Agreement on Trade-Related Aspects of Intellectual Property Rights”; Article (2.4)(b) calls for the promotion of “public access to the results of government funded research, by strongly encouraging that all investigators funded by governments submit to an open access database an electronic version of their final, peer-reviewed manuscripts”.¹⁴⁵

Finally, some non-governmental organizations are proposing to create an alternative incentive model (such as the proposed *Treaty to Access to Knowledge*)¹⁴⁶, which would shift from a property-based system towards a “liability-based” one. This model seeks to re-define the IP system in such a way that would significantly restrict the ability of innovators to prevent (exclude) others from using their proprietary assets without their consent (which is one of the fundamental legal aspects of the IP system), as well as significantly limit the scope of the types of knowledge that may be eligible to the protection of IPRs. According to this model, although right holders may be entitled to a compensation for the use of their proprietary assets, their ability to prevent third parties from using these assets or to determine what should be the monetary compensation for such use (royalties) would be considerably restricted. Also, in this model, compulsory licenses are presented as a necessary and a preferable mechanism for the transfer of knowledge, especially in the case of developing countries. Suffice is it to say that while this model does not intellectually deny the use of IPRs, its applications is aimed at significantly reducing the ability of innovators to make use of the rights conferred under the current IP model.

To summarise, the above developments point to a tendency towards the use of knowledge assets for the sake of promoting technological innovation. As discussed above, the intellectual and theoretical justifications for the use of this approach is rather poor. Theory and logic suggest that in most cases (especially those that concern innovation stemming from the private sector) such an approach will not lead to greater innovation but rather may end up hurting existing innovators. Also, to date there does not appear to be sufficient evidence to convince us of the merits of this approach.

Nevertheless, we are witnessing a growing tendency of some policy-making entities, not least in Europe, to use the compulsory non-market-driven approach more freely, especially when addressing anti-trust cases.

It is currently very difficult to justify such actions on the basis of their intellectual or empirical merits, which were discussed and presented in this paper. One therefore needs to look for alternative explanations for the growing

¹⁴⁵ Ibid

¹⁴⁶ Consumer Project on Technology. *Treaty to Access to Knowledge* (2008) http://www.cptech.org/a2k/a2k_treaty_may9.pdf, accessed September 2008

tendency towards the use of this approach. While it is not within the scope of this paper to consider such explanations, one could consider the extent to which the tendency towards the adoption of compulsory, non-market-driven practices is based on values that clash with or that are in friction with the underlying logic of capitalism. It is not implausible to consider a scenario in which sympathy for concepts such as the free use of knowledge, or the narrowing of the scope of IPRs may lead to a political or philosophical belief that an alternative, non-capitalist model may be developed - and that such a model would be superior to the pace, composition and nature of technological innovation that is currently being provided by the market.

VI. Concluding Remarks

Innovation is one of the most popular buzzwords of our time. Universally accepted as a positive force, nations and regions identify innovation as a strategic element in achieving higher levels of economic and social well being, while politicians and policy-makers argue that their actions are aimed at promoting and enhancing innovation.

The problem does not lie with the popular perception of innovation but rather with the more detailed understanding and appreciation (or the lack of it) of the way in which innovation is taking place, both in theory and in practice. In this paper we have sought to provide some insights into the nature of technological innovation and its underlying processes. We have also provided a more structural analysis of the virtuous circle that involves the use of IPRs, knowledge creation and innovation, which essentially leads to the introduction of new products to the market.

The study of innovation is constantly evolving, adding to our knowledge and understanding of how innovation is taking place and how it may be improved or enhanced. Equally challenging is the attempt to better understand the relationship between knowledge and innovation, for example the manner in which the creation and use of knowledge leads to more innovation as well as the extent to which new innovations increase our knowledge. In other words, innovation is such a complex and deep concept that it would be impossible and even presumptuous to try to argue that one is able to predict and control the process.

Despite its complexity, however, one can still identify some 'governing patterns' that underlie the innovation process:

First, technological innovation cannot be characterised in terms of 'good' or 'bad' innovation. In some current public discussions there is a tendency to argue that incremental innovation contributes less to society than radical innovation and, as such, is less desirable. In other circles, innovation that focuses on the components of a product is afforded a higher status than innovation that concerns the manner in which such products are introduced to the market and to the public. In real life, though, the contribution of innovation to society cannot be categorised in such a simplistic way. As demonstrated in this paper, incremental improvements can have effects which are just as

significant as radical innovation, while innovations that concern processes and architectures surrounding a product may be as essential to the market and to the public as the original product innovation itself.

Second, technological innovation cannot be dictated or anticipated via top-down processes. History suggests that even the brightest minds cannot be expected to anticipate the manner in which the nature of innovation will evolve and the way in which demand for such innovation will manifest itself. Certainly, the professional pursuit of innovation underpins the ability to introduce new products to the market. But, of equal importance is the fact that innovation can be unpredictable, influenced by external events and ultimately nurtured by the ability of entrepreneurs to identify and seize opportunities once they present themselves.

Third, technological innovation is deeply rooted in market forces. It is the incentives and rewards that the market provides that drives innovators to make the risky, time consuming and costly investments needed to bring new products to the market. To this extent the innovation process is driven by the voluntary will of the innovator to create and use knowledge rather than any form of compulsion. In other words, we consider the voluntary market-driven efforts of innovators as a bottom-up process.

Fourth, if we accept that technological innovation is based on these voluntary, market-driven efforts, certain mechanisms do need to be in place. One such mechanism is the existence of IPRs which provide the incentives both for the creation and the exchange of knowledge for the sake of promoting technological innovation. IPRs function as a safety-net that allows the process of knowledge creation to take place, not least in the phases that precede the introduction of these technologies to the market. IPRs also allow entities to exchange and share their knowledge assets in a manner that guarantees their expected share of market reward from a given innovation.

Nevertheless, and in contrast to the above, this paper identified a worrying trend towards the belief that alternative models of innovation can be found.

This model is based on the notion that,

- a. Technological innovation can be directed by a top-down process in which policy-making bodies are afforded a greater degree of discretion concerning the desirable direction and forms of innovation;
- b. Compulsory mechanisms may be used, (a compulsory licence, for example) under which knowledge assets may be taken from one entity and transferred to another for the sake of facilitating more and 'better' technological innovation.

This perception is highly problematic. First, it is not backed up by theoretical or empirical underpinnings. On the contrary, the theory and empirical evidence reviewed in this paper suggests that innovation does not seem to occur in this way. Second, it is more likely that the exercise of this model is based on ideological or political

considerations rather than a rational discussion of its merits. Third, it would seem that advocates of this model are suggesting turning the process on its head i.e. they advocate implementing the concept first in the hope and anticipation that it will work. Certainly experimentation with different models of innovation is not something that should be prohibited, as long as these experiments are undertaken at the expense and efforts of those who wish to pursue them. In this case alternative models are being touted not as complementary innovation models but as replacements to the long-established innovation process. In other words, the experimentation is taking place at the possible expense of innovation itself and, as a consequence, at the expense of the consumer.

Policy-makers should therefore be wary and certainly exercise great caution when considering pursuing this type of model. Specifically, when advocating an innovation process that is guided, and to some extent directed, by a top-down approach that relies on the compulsory use and transfer of knowledge, policy-makers must ask themselves one simple question: is this advocacy based on an understanding of the realities that govern the innovation process, or is it based on an ideological vision of how the world should look and consequently how innovation should take place? While we leave it to policy-makers to consider these questions for themselves, the answer for us is clear; voluntary market-driven forces have been and remain the strongest and most robust sources of the innovations that we all hold dear.