Intellectual property rights, innovation and technology transfer: a survey

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Abstract

Following the conclusion of the TRIPS Agreement, much has been written on the potential costs and benefits of stronger Intellectual Property Rights (IPRs) protection in terms of its impact on innovation and technology transfer, as well as economic growth and welfare. This paper documents the development of IPR regimes within countries and internationally, before surveying the theoretical and empirical literature linking the protection of IPRs to economic growth, innovation and technology diffusion.

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1. Introduction

The argument underlying public policy intervention to protect Intellectual Property Rights (IPRs) is that without such protection competitive market systems fail to provide private agents with sufficient incentives to undertake the costly and risky investments that generate the new ideas and technologies (knowledge) now widely recognised as the main source of sustained economic growth. This is because knowledge has "public good" attributes. Knowledge is typically *non-excludable*; in that it is not possible to prevent others from applying new knowledge even without the authorisation of its creator. If a new technology is valuable, it is therefore likely to be copied or imitated, reducing the potential profits of the original inventor and potentially removing the incentive to engage in innovative activities. Where "imitation" has lower costs than "innovation", imitators have the advantage over innovators unless the latter can restrict access to their innovation. This characteristic provides the argument for strong IPR protection. IPRs create ownership of intellectual property by giving innovators the legally enforceable power to prevent others from using an intellectual creation or to set the terms on which it can be used. That is, IPRs encourage innovation by granting successful inventors temporary monopoly power over their innovations. The consequent monopoly profits provide the return on successful investment in R&D.

The other public good aspect of knowledge compounds the costs of granting this monopoly power. Knowledge tends to be *non-rival*, in that the marginal cost for an additional firm or individual to use the knowledge is often negligible. Once an innovation has been created, its non-rival character suggests that benefits will be maximised if its use is free to all at marginal cost. Although a policy of free access will yield benefits in the short run, it will severely damage the incentive for further innovations. IPRs allow successful innovators to appropriate some of the consumer surplus their innovation generates, both as a reward for their innovative efforts and to provide an incentive to future investors. Because research is a risky activity, returns on successful R&D (which produces intellectual property) must be large enough to compensate for the high proportion of R&D that is unsuccessful, generating in this way a normal return on R&D as a whole.[1]

Choice of IPR policy then reflects a balancing of these considerations. The awarding of a temporary monopoly, although second-best, is intended to restore the incentive to innovate, which in turn should encourage long-run growth and improved product quality. It is not an all or nothing decision, however. Even in the absence of IPR protection there may exist natural incentives to innovate depending upon market lead times, marketing strategies and the difficulties in copying and imitating (Maskus, 2000a), and these features are likely to be more

[1] Evidence suggests that IPR protection stimulates innovation and that the social rate of return to innovation appears to be considerably higher than the rate of return to the innovator (Mansfield et al., 1977).

important than IPR protection under certain circumstances. Excessive IPR protection is likely to lead to an inadequate dissemination of new knowledge, which in itself could slow growth to the extent that access to existing technology is necessary to induce further innovation[2]. Other costs to society of strong IPR protection include rent seeking behaviour, the wasteful duplication of investment in R&D (i.e. patent races) and the costs of judicial actions to enforce property rights (Maskus, 2000a). Giving innovators too much protection may also limit the spread of new ideas and lead to permanent monopoly. Entry by rivals may be impeded, and successful innovators may have reduced incentives for developing and exploiting subsequent innovations[3].

If IPRs were set and enforced by a global authority then, in principle, this authority would be in a position to determine the appropriate strength of IPR protection for the world as a whole. But IPRs are conferred by national governments and valid only within the relevant jurisdiction. Consequently, national IPR systems have largely focussed on what was perceived to be in the best interests of the country concerned, and different countries perceived the trade-off between profits and innovation differently. Thus (developed) countries, with many potential innovators, have tended to opt for relatively strong IPR systems, with the aim of encouraging inventive and creative activities, which are seen as an important source of long-run economic growth.[4] With R&D spending concentrated in a handful of the world's richest countries however, genuinely innovative activities are limited in most developed and developing countries, and the majority have taken a different approach, providing only weak IPR protection, if any, as a way of allowing the rapid diffusion of knowledge. For many of these countries imitation can be a significant source of technological development, and providing stronger IPR protection is seen as shifting profits from domestic imitative firms to foreign firms and reducing output in the domestic economy, rather than encouraging domestic innovative activity (Deardoff, 1992). The counter argument is that stronger IPR protection can help reward creativity and risk-taking even in developing economies, with those countries that retain weak IPR protection remaining dependent on dynamically inefficient firms that rely on counterfeiting and imitation (Maskus, 2000a).

Until 1995, the international Intellectual Property Regime (IPR) consisted of various voluntary conventions under the stewardship of the World Intellectual Property Organisation (WIPO). With the globalisation of markets and the resulting increases in trade and investment flows

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[2] Hence the argument, discussed below, that in many countries weak IPR protection actually stimulated R&D activity by encouraging knowledge spillovers from transnational companies (TNCs) and other domestic firms (Cohen and Levinthal, 1989).

[3] Gilbert and Newey (1982) show that under certain conditions a monopolist may accumulate patents and allow them to "sleep", thus deterring entry into an industry.

[4] Indeed there has been a general strengthening and broadening of IPRs over time in developed countries (Mazzoleni and Nelson, 1998).

across borders, particularly flows of technology and technology-intensive products[5] differences in national IPR standards have taken on additional significance. Firms have looked increasingly to foreign markets to sell their goods and to foreign destinations as platforms for production, making it easier for intellectual property to be accessed and copied in countries that provide weak IPR protection. This is one of the major reasons why firms investing heavily in R&D put pressure on national governments to strengthen the international IPR regime. The increasing importance of technology for international competition, the emergence of new technologies (e.g. computer programs or biotechnology) associated with high externalities and limited appropriability and the perception of developed countries that their technological lead has been diminished by countries that have caught up by imitation also contributed to this pressure (Correa, 2000: pp. 3-4). The outcome was the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS), a product of the Uruguay Round (1986-94) of trade negotiations. TRIPS is the first comprehensive and global set of rules covering IPR protection[6]. It sets minimum standards of protection to be provided by each World Trade Organization (WTO) member in each of the main areas of intellectual property covered, as well as requiring countries to develop mechanisms to enforce these rights. While for most developed countries TRIPS compliance only requires minor adjustments of their national IPR systems, for developing countries TRIPS often implies a major rise in their level of IPR protection. The TRIPS Agreement does allow countries to pursue different policies with respect to IPR protection, but does specify minimum standards that should be attained by a designated time. Box 1 highlights some of the major requirements of TRIPS. The areas covered are copyrights and related rights, trademarks, geographical indications, industrial designs, patents, the layout designs of integrated circuits and undisclosed information including trade secrets and test data. Table 1 provides more information on these forms of intellectual property and how they are covered by international agreements.

From the preceding discussion it might be difficult to see why developing countries agreed to TRIPS. One factor was pressure from advanced countries (the US and the EU in particular). Developing country governments also thought that agreeing to TRIPS would encourage negotiations allowing developing countries wider access to agricultural and textile markets in developed countries. In addition business interests within many developing countries encouraged their governments to adopt stronger IPR protection in order to protect their own innovative activities tailored to the domestic market (Sherwood, 1997; Maskus, 1998a).

[5] The share of knowledge-intensive or high-tech products in total world goods trade doubled between 1980 and 1994 (Fink and Primo Braga, 2005).

[6] There have been international agreements on IPRs since the nineteenth century. Until recently the main instruments of international law regarding the substantive protection of IPRs were the Paris Convention for the Protection of Industrial Property (1883) and the Berne Convention for the Protection of Literary and Artistic Works (1886). The TRIPS Agreement has been analysed extensively by Primo Braga (1996), UNCTAD (1996) and Maskus (1997).

Stronger IPR protection can also encourage increased imports, inward Foreign Direct Investment (FDI) and technology licensing, all of which can lead to increased technology transfer[7]. Indeed Article 7 of the Agreement states that "[T]he protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge in a manner conducive to social and economic welfare, and to a balance of rights and obligations". The various areas of IPR protection covered by TRIPS are likely themselves to have differing impacts on innovation and technology diffusion, and some of these differences are discussed in Box 2.

The remainder of this paper is set out as follows: Section 2 describes the historical development of patent regimes both within countries and globally. Section 3 discusses the economic rationale for patent protection, while Section 4 surveys the literature linking IPR protection to innovation. Section 5 surveys the literature considering the relationship between IPRs and the channels of technology diffusion, namely international trade, FDI, licensing and foreign patenting. In Section 6 we discuss the relationship between IPRs and economic growth, firstly describing theoretical contributions, and secondly by discussing the available empirical literature. Section 7 discusses some issues of importance for developing countries and Section 8 concludes.

2. A Brief History of Intellectual Property Rights

2.1. Development of Intellectual Property Rights Regimes across Countries

The name patent derives from the Latin words "litterea patentes" which literally translated means open letters. These "letters" entitled the holder to certain rights, titles, or privileges. During the 14th and 15th century the main purpose of these privileges was mostly to foster technology transfer from foreign countries by giving the importer the right to exclusive exploitation of the technology for a certain period of time. This, of course, is quite contradictory to today's purpose of patent protection (David, 1993). The first formal patent law[8] was enacted by the Venetian Senate in 1474:

> "We have among us men of great genius, apt to invent and discover ingenious devices (...). Now, if provision were made for the works and devices discovered by such persons, so that other who may see them could not build them and take the inventor's honour away, more men would then

[7] It is now widely accepted, for example, that the assimilation of foreign technology was a critical component of the Asian Miracle (see for example Nelson and Pack, 1999).

[8] There is evidence that the Venetian Senate had been granting similar rights long before their formal recording in 1474 (Kaufer, 1989).

> apply their genius, would discover, and would build devices of great utility to our commonwealth." (cited in Kaufer, 1989)

The Republic of Venice though was not the only one to grant these kinds of privileges. There is evidence that this practice existed informally in Electoral Saxony, the Austrian Archduchy, England under Edward III and the Republic of the Seven United Netherlands, while France started to use this practice on a regular basis during the middle of the 16th century as a part of its mercantilist policy (Kaufer, 1989). The purpose of these practices was the same in all countries: the introduction of devices or processes unknown in their respective countries.

During this time most technological knowledge was embodied in skilled artisans rather than machinery. Therefore patent privileges were in the first place used to encourage the immigration of foreign skilled artisans. In order to protect the immigrated artisan from competition from their apprentices and students the sovereign normally granted them monopoly rights for two or three service-terms of an apprentice[9]. From the sovereign's point of view granting monopoly rights was especially convenient since they did not burden the budget and moved the market risk to the immigrated artisan (David, 1993).

Despite some differences among European countries the fact that patent privileges were typically granted by the sovereign without the possibility of interference led to substantial abuses of the monopoly privileges. In early 17th century England for example, the misuse of monopoly privileges hindered the development of whole sectors (for example, the paper industry) and raised prices considerably since the Crown handed out monopolies for products such as salt, soap, vinegar and coal. In 1624 the British Parliament curbed this practice by forcing the Crown to implement the "Statute of Monopolies". This Statute was not an explicit patent law but rather regulated the granting of monopolies. It nullified all working monopolies and declared them illegal, with one exception; the grant of patent privileges to the "true and first inventor and inventors" of new manufactures. The "true and first inventor and inventors" referred only to those inventors from England however (Kaufer, 1989). Thus, patents on new manufactures developed and protected abroad could be patented by the person transferring it to England. This indicates that, just like the Venetian Senate, the British Parliament considered technology transfer and industrial development an integral feature of patent protection.

While the British Parliament was able to cut back the excessive grants of monopolies with the "Statute of Monopolies", in France it was not until after the French Revolution that the patent system was reformed. While the intention of the reformers from 1791 was to abrogate the previous system of grants and privileges, in reality many institutional features survived. France

[9] It comes from this tradition that the length of patents do not vary among branch or industry (David, 1993).

was the only country in which the natural right of the inventor to his invention played an important role in the discussion. In this vein the decree declared: "every discovery or invention, in every type of industry, is the property of its creator; the law therefore guarantees its full and entire enjoyment." The actual clauses and the practice made clear though, that industrial development and mercantilist policies played at least an equally important role. An inventor lost his right to his invention if they tried to obtain a patent abroad. The importer of an invention new to the territory could also apply for patents, and the decree included a working requirement (Khan, 2002).

The first patent laws on the American continent were passed during the second half of the 17th century (Kaufer, 1989).[10] These early versions drew heavily on the British model and granted patents for "such new inventions that are profitable for the Country"[11] (David, 1993). The next major change to the American patent system did not come until 1782 when the first Article of the United States Constitution gave Congress the authority "to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries". Eight years later Congress passed the first federal patent law (Kaufer, 1989). It included a clause that required an examination of novelty. Though for a short period of time replaced by a registration system, the examination of novelty was reintroduced in the patent statute from 1836, which also established a Patent Office to examine the claims and resembled in this sense the structure of the modern patent system. In contrast to the British and the French system which, in spite of numerous reforms, for a long time suffered from their historical origins as Crown privileges, the American system was affordable – at least for nationals – and was transparent and predictable. The American patent law recycled the phrase used in the British patent law concerning the "true and first inventor" just that this time it was used literally. As a consequence Americans could not apply for "import patents". The American patent law continued to discriminate against foreign inventors however. Initially, foreigners were not allowed to obtain a patent at all. Subsequently, followers could place claims but had to pay patent fees that were about one hundred times as high as those for nationals[12] and were subject to a working requirement (Khan, 2002).

The views among German states concerning patent protection differed greatly. Prussia[13], under a free-trade oriented government, dismissed patents as mercantilist policy. Other countries however, most notably the territories close to the Rhine, adopted a French style

[10] Massachusetts (1641), Connecticut (1672) and South Carolina (1691) (Kaufer, 1989).
[11] Patent law passed by the General Court of Massachusetts Bay in 1641 (David, 1993).
[12] British nationals were an exception – they faced even higher fees (Khan, 2002).
[13] In spite of its free trade position - which it followed roughly since its defeat by Napoleon in 1806 - Prussia had a patent law in place since 1815. But the law was designed to minimise the potential threat of monopolies by the inclusion of an examination of newness, working requirements, the exclusion of agricultural machinery and pharmaceuticals, an obligation to disclose the patent information, and a short patent length (Kaufer, 1989).

patent system. The increasing dominance of Prussia over other German territories added further tension to the patent question. Prussia was pushing for a German free trade area and patents were considered as barriers to trade. After a lively debate and strong lobbying from industrialists and inventors, Germany implemented a national patent law in 1877[14], which was one of the most business friendly of its time (Khan, 2002). While in the beginning inventors and industrialists together pushed for the implementation of a national patent law the diverging interests of the two groups soon prevailed. The requirement for disclosure, the high and over time rising patent fees, and the transferability of patent ownership as well as working requirements and compulsory licensing in the end favoured companies over individual inventors. In 1891 utility models[15] were introduced, which suited the needs of inventors with little capital. The coexistence of a rather business friendly patent law and utility models on a registration basis complemented each other (Khan, 2002). While the German patent law was one of the most stringent of its time, it still tolerated the infringement of foreign IPRs by German companies on a regular basis. Since British companies suffered especially from trade mark violations by German companies, they revised the Merchandise Mark Act in 1887 in order to make it mandatory to specify the country of manufacture. This did not have the desired effect however (Chang, 2001; Khan, 2002).

Although the anti-patent movement in Germany was defeated by the intensive lobbying of industrialists, the movement in other countries was more successful. The Netherlands abolished its patent law in 1869, while Switzerland simply refused to implement a patent law until 1907. An interesting development in these two cases was that industrialists took up an anti-patent position, unlike in Germany. Due to their lack of patent protection Switzerland and the Netherlands are especially interesting case studies. Schiff (1971) analysed the economic development of the Netherlands and Switzerland in the time when they had no patent law and compared this period to a period when they had such a law. Further, he compared their development in the period when they were without a patent law to the experiences of other European countries at that time. His comparisons of the number of patents held by Swiss and Dutch nationals in other countries during the time without a patent law and afterwards did not deliver any conclusive evidence. While Schiff found slight evidence, that "the reintroduction of a patent system in 1912 [has] given an extra spur to Dutch inventive capacity" and that during the time without patent laws industrial progress in the Netherlands relied to a greater degree on foreign invention than afterwards, there is no similar evidence for Switzerland (Schiff, 1971). Swiss inventors were – measured by patent applications in other countries – among the most productive before and after the introduction of a patent system. Among the important inventions made without a national patent system

[14] A factor favouring the introduction of a federal patent law was that by that time Prussia had already abandoned its free trade position (Kaufer, 1989).

[15] Utility Models (Gebrauchsmuster) were granted on registration basis for three years (with a maximum length of six years) and required a lower degree of novelty than ordinary patents (Kurz, 2000).

were the Honegger loom, Sulzer Steam engine, milk chocolate, and instant soup to name just a few (Schiff, 1971). Regarding the industrial progress of the two countries a similar picture appears. While the progress of industrialisation was rapid in Switzerland during its period without a patent law, and the absence of a patent law did not even deter foreign investment, the case of the Netherlands is less decisive. The progress of industrialisation in the Netherlands was rather moderate but it still compared well with most other European nations. However, trade, which had a historically important role in the Netherlands, and not industry, remained the main pillar of the economy. On the other hand, a case study of two Dutch industries indicates that at least in their case the absence of patent protection was a supporting rather than hindering factor (Schiff, 1971). So while for the Netherlands at least, Schiff could not find conclusive evidence for negative effects from the abolition of the patent law, in the Swiss case it seems as if the absence of patent protection actually fostered its industrial development.

Moser (2005) raises another interesting issue in her paper. In contrast to Schiff she focuses on the direction rather than the rate of innovation. Analysing data from 19th century World Fairs, Moser found that the absence of patent protection influences the choice of technological change since in countries without patent protection innovative activity focuses on industries (e.g. food processing, dye stuffs and scientific instrument) where other viable mechanisms of protection, such as secrecy, exist. Moser suggests that in the long run the lack of IPRs did have a negative effect on economic development since it stirred innovation away from the future leading sectors, manufacturing and machinery, which are highly dependent on patent protection. This however, as Moser points out, should not be considered as a reason for developing countries to introduce stronger IPR protection since this would only redirect their innovative activity towards sectors in which competition from developed countries is strong[16] (Moser, 2005).

In sum, Schiff (1971) and Moser's (2005) findings lend some support to the weak patent protection thesis. However, Schiff's findings should not be overstated. Part of the reason why he could not find explicit differences between the countries within and outside patent protection as well as between the development of the countries before and after the introduction of a patent system could be found in the deficiencies of most of the patent systems of that time. Another reason could be that Swiss and Dutch nationals had the possibility to protect their inventions abroad. This along with the fact that both countries are rather small could have been a sufficient incentive for invention. Despite this, one should not simply dismiss the questions the history of these two countries raise. This is especially the case since the experience of other countries considered point to similar conclusions; namely that at

[16] This different interpretation for the case of the Netherlands and Switzerland on the one hand and developing countries today on the other hand is attributed to their different position in the world economy. Neither the Netherlands nor Switzerland was a "backward country" from a global point of view.

an early stage of economic and industrial development the possibility to "learn" or copy from advanced countries was more important than the stimulation of national inventive capabilities. Most countries chose to violate the property rights of advanced countries until they were able to build their own ample industrial base (Kaufer, 1989).

Before any firm conclusions are drawn however, we move on to consider more recent examples of successful industrialisers, and in particular those of Japan, South Korea and Taiwan. A great deal of research has been undertaken investigating the "growth miracle" of a number of East Asian countries. Many factors have been identified as being important for the rapid and sustained growth of these countries. While there is still much disagreement about the causes it is widely accepted that the ability to adapt advanced technology was a crucial aspect (Kumar, 2002).

The first Japanese patent law was launched in the course of the modernisation and industrialisation era fostered by the Meiji-Restoration. The Patent Monopoly Ordinance from 1885, which was largely based on the U.S. and French patent law, was revised in 1888. After Japan's accession to the Paris Convention a new revision, which acknowledged the rights of foreigners became necessary. This version as well as the amendment for utility models which was passed in 1905 drew heavily on the German model (Kotabe, 1992). Japan, as with many countries in their early phase of industrialisation excluded pharmaceutical products, chemical compounds, food, and beverages from patentability until 1975 (Kumar, 2002). Besides deferred examination – the examination of a claim begins only if the applicant requests it and could be delayed by up to seven years – Japan's patent system contained other abnormalities (Kotabe, 1991). Japan required pre-grant disclosure and allowed competitors to use the invention without approbation of the applicant or any royalty payments until the patent was issued. During this phase companies were also allowed to oppose the patent, which could considerably lengthen the examination phase since the applicant was required to give a written response to all oppositions (Maskus and McDaniel, 1999). This was shrewdly used by Japanese firms to slow down the actual granting of a patent (Kotabe, 1992). This procedure both lowered the protection term, which started with the filing of the application and fostered technological diffusion by allowing competitors to use the invention during the examination phase and even allowed for follow-up patents (or utility models) if a substantial improvement was made. There were considerable complaints about this practice from foreigners, who seem to have been more strongly affected than nationals. For Japanese companies it took about 1-3 years from the application to the grant of a patent, while the same procedure took about 7-8 years for a foreign firm (Maskus and McDaniel, 1999; Kotabe, 1992). Kotabe (1992) presents empirical evidence indicating that foreign firms were indeed discriminated against.

Of more importance than the question of whether or not the Japanese patent system discriminated against foreigners is whether it was suited to advance the country's technological and economic development. This issue is considered by both Ordover (1991) and Maskus and McDaniel (1999). Ordover (1991) analysed the specifics of the Japanese patent system and came to the conclusion that "[t]he Japanese patent system subordinates the short-term interest of the innovator in the creation of exclusionary rights to the broader policy goals of diffusion of technology" (Ordover, 1991). A narrow patent breadth, weak novelty requirements and pre-grant disclosure in Japan tended to favour technological diffusion, reverse engineering and small modifications on existing inventions rather than "major technological breakthroughs". In conclusion, Ordover (1991) states that the Japanese patent system was especially suited for a technology importing country.

Maskus and McDaniel (1999) reach a similar conclusion from their empirical analysis of the effect of the patent system on total factor productivity in post-war Japan. Their findings also suggest that the narrow breadth and pre-grant disclosure stimulated technological diffusion. They found that the patent system in place in Japan encouraged incremental and adaptive innovation and the diffusion of knowledge into the economy. This resulted from a number of measures, but most notably the use of utility models. Such utility models were found to have a large positive impact on Japanese TFP growth[17]. Paradoxically these effects were stronger for domestic patents, indicating that the Japanese patent system worked better to diffuse domestic technological knowledge rather than foreign ones. It seems therefore that domestic innovation was more important than the imitation of foreign inventions for Japan's growth in TFP between 1960 and 1993. While the direct impact of patent applications on TFP growth was smaller it was still positive, and patent applications were found to have an indirect impact on TFP growth through stimulating later utility models.

South Korea's first patent law was implemented in 1961 and revised in 1981 in order to comply with the 1967 Stockholm revision of the Paris Convention. This patent law drew heavily on the Japanese Patent system prior to 1975, in particular regarding the range of product groups excluded from protection; food stuffs, luxury consumer goods, nuclear devices, chemicals and pharmaceuticals. Further the revision allowed for the granting of patents to foreigners, for multiple claims in a single patent application and it weakened the provisions for patent cancellation in the case of non-working of the patent. In 1986 the Republic of Korea again revised its patent law in response to increasing U.S. government pressure. The revision allowed for the protection for pharmaceuticals and chemicals and the protection term increased from 12 to 15 years. Despite these changes, enforcement remained a problem long after the revision of 1986 (La Croix and Kawaura, 1996). Kim (1997) points out that in the early phase of Korea's industrialisation reverse engineering and imitation played

[17] Further case study evidence of the benefits of utility models includes Dahab (1986) who finds that utility models were important in allowing domestic producers to capture a significant share of the farm machinery industry by adapting foreign technology to local market conditions in Brazil and Mikkelsen (1984) who describes how such utility models allowed the successful adaptive innovation of rice threshers in the Philippines.

a crucial role, while only at a later stage of development did FDI and licensing become important. It is in the wake of this development that IPRs became an issue for local firms (Kim, 2003). Kumar (2002) highlights another aspect of the Republic of Korea's patent law; utility models and industrial designs seemed to have served as a viable mechanism to foster local adaptation of foreign technology. This is evident from patent statistics, which indicate that 92-95 percent of all design patents and utility models are held by Korean nationals (Kumar, 2002). Kim (2002) argues further that in the early stages of development the Republic of Korea acquired and assimilated mature technologies in order to undertake duplicative imitation of existing foreign products with cheap skilled labour. Relatively few foreign firms patented technologies in the Republic of Korea because of its small market size and limited imitative threat. In addition to maintaining weak IPR standards, he argues that the role of government was to promote exports and to encourage the development of technical and engineering skills.

Kumar (2002) argues that IPR protection in Taiwan was weak to encourage the diffusion of knowledge, with the government openly encouraging counterfeiting as a means of developing local industries. Taiwan implemented legislation on IPRs in 1949. The patent law distinguished between three different types of protection: invention patents, utility models and design patents, with the former granting protection for 10 years and the latter two for 5 years. The patent law provided protection for manufacturing processes and products only however. The Taiwanese patent law passed through several revisions (in 1959, 1960, 1979, 1986 and 1994). The revision of 1979 introduced IPR protection for agricultural and extractive industries. Chemicals and pharmaceuticals remained unprotected however, while working requirements and comprehensive provisions for compulsory licensing were maintained. Moreover, the maximum fine for patent infringement was approximately 1,300 U.S. dollars. In addition to the relatively weak IPR protection on the statute books enforcement of the laws was also lax (Lo, 2004). As an unattributed government document suggests the design of the patent law was a deliberate decision: "The R.O.C [Republic of China] government has viewed imitation as a necessary process in the evolution of human civilization and believed that commercial counterfeiting is an inevitable phenomenon in most developing countries" (quoted in Wade, 1990). The 1994 revision of the patent law extended patent protection to beverages, food and micro-organisms among other things and expanded the protection term to 20 years for patents, 12 years for utility models and 10 years for design patents. While there has also been progress on the issue of enforcement, concerns still remain.[18]

Both Taiwan and South Korea managed to upgrade their technological capabilities and switch from imitation to innovation within roughly one generation (Hu and Jaffe, 2001). It is evident that the role of IPRs in these countries as well as in Japan was, if anything, just one of the

[18] For example prison penalties are only possible in the case of infringement of utility models or design patents, which are mostly held by Taiwanese nationals. (Kumar, 2002).

many aspects that facilitated this process of catching-up. These countries made a deliberate effort to master advanced technology by directing their policies in many different fields, including education, taxation, and investment. While the relative importance of IPRs in this process is unclear it can be argued that a level of protection which is considered too weak from a developed country's point of view need not impede economic growth. Moreover, it appears that all three countries intentionally designed their patent law to best suit their economic needs. In addition, these three countries provided incentives for local firms to conduct adaptive innovation of foreign products, in particular the use of utility models. Finally, all three countries provided rather weak protection at the beginning of their industrialisation phase, gradually increasing their protection level as industrialisation advanced. Compared to the developing countries of today, the Republic of Korea and Taiwan in the early stages of their industrialisation enjoyed considerable freedom regarding the design of their patent laws (Kim, 1997).

Further case-study examples include Kumar (2002) who documents the experience of India. While inheriting a relatively strong IPR regime from colonial times that provided protection for most industries, considerable pressure built up from Indian firms in the 1960s that were unable to develop their own technology due to foreign patent holders who were restricting entry. This was particularly the case in the chemicals and pharmaceuticals industries and led to a new patent act that reduced the scope of patentability in food, chemicals and pharmaceuticals to processes and not products. It is widely accepted that these changes helped facilitate the development of local technological capability in chemicals and pharmaceuticals[19]. Kumar argues that the experience of India indicates the importance of weak IPR protection in building up local capabilities, even in countries at very low levels of development.

Maskus (2000c) examines the likely effects of introducing stronger IPR protection in the Lebanon, using survey data on 117 manufacturing and services firms. IPRs are seen as unimportant in many industries, and where patents are applied for they tend to be for minor improvements and disclosure does not provide for effective technology transfer. Whilst acknowledging their shortcomings, Maskus uses partial equilibrium models to calculate the impact of stronger IPR protection in different industries. For most industries he finds that the static effects of stronger IPR protection on prices, employment and output are likely to be negative. He goes on to suggest that dynamic gains from stronger IPR protection are possible, however, through increased FDI, increased product development by local firms (particularly in cosmetics, food products, software applications, publishing and film production), and the increased ability to enter into joint ventures or product licensing. Further, to the extent that

[19] Fink (2001) simulates the effects of the introduction of IPR protection on two therapeutic drugs in India. The results suggest that the impact of offering IPR protection can be higher prices and significant welfare losses, but that non-patented therapeutic substitutes to a patented drug can limit the extent of price increases and reduce welfare losses.

these lead to additional technology transfer and local product development, the average quality of local products should rise.

Survey evidence from China reveals that managers of foreign enterprises are reluctant to locate R&D facilities in China for fear of misappropriation and patent infringement (Maskus et al., 2005). Enforcement problems and weak penalties were also a concern. These factors led firms that transferred technology to China not to use the latest technology, but technologies that were at least five years behind the frontier. Chinese firms were also found to suffer from trademark infringement, which in the long run is likely to be particularly damaging to enterprise development.

To summarise, in the cases of Western European countries and the United States the patent law in these countries played an important role in their industrialisation. One should keep in mind that these early versions of patent laws normally did not protect foreign intellectual property, and in reality the patent law was used to acquire foreign technologies to spur technology transfer at an early stage of industrialisation. Thus, while industrialisation in these countries was surely facilitated by reducing the risk for entrepreneurs via IPRs provision, many features of their modern patent law were severely underdeveloped at the time of rapid industrialisation in both Europe and northern America. More recent examples point in a similar direction. At an early stage of industrialisation the patent laws in Japan, the Republic of Korea's and Taiwan included some unusual provisions, which indicate that informal technology transfer was considered an important issue. Other countries at an early stage of industrialisation opted for no or negligible IPRs, examples being Switzerland and the Netherlands. The experiences of these countries are summarised by Kaufer (1989):

> "The historical experience with industrialization in Holland, Germany, and Switzerland shows that it may be advantageous not to have a patent law, assuming that domestic inventive capabilities are sufficient to "free-ride" by imitating the technologies already developed by foreign enterprise. Only after industrialization has progressed further and technical skills have developed to a higher level does the nation introduce a national patent system to guide its domestic inventive activity away from imitation and towards more original work." (Kaufer, 1989).

There are substantial caveats to these findings. Most importantly, the technological gap between the developed and developing world has grown substantially since the start of the catching-up process of Taiwan and the Republic of Korea. While these countries have been able to master some parts of advanced technology by reverse engineering, this might not be possible for late-comer countries today. These countries might be dependent on formal transfers of technology therefore, which have the advantage that they not only include the codified knowledge but also tacit knowledge and in some cases even some assistance on how to master it. These formal channels of technology transfer, which include FDI and licensing, are likely to be influenced by the level of IPRs. On the other hand, it seems to be the case that at least the more advanced developing countries are still able to master foreign technology by reverse engineering, since otherwise the pressure for stronger IPRs would not have been so fierce.

2.2. Development of a Global Intellectual Property Rights Regime

In the 19th century the lack of international agreements on IPRs led most advanced countries to turn to other instruments in order to sustain their technological lead, examples being the prohibition of emigration of skilled workers or of machinery exports. Some European countries also protected intellectual property through bilateral commercial treaties (UNCTAD-ICTSD, 2003)[20]. By the end of the 19th century however these measures were deemed insufficient. The Vienna Congress was held in 1873 with the aim of creating an international agreement on patent rights, but ended in failure largely due to the objections of the United States to "compulsory working requirements"[21]. It was not until 1883 that the first convention on that subject was ratified. The "Paris Convention of the International Union for the Protection of Industrial Property" was ratified by 11 countries – among them the Netherlands and Switzerland, which at this time did not even possess a patent law – and covered patents and trademarks. In 1886 a subsequent Convention on Copyrights was signed in Bern (Chang, 2001). The secretariats for the Paris and the Bern Conventions were merged in 1893 and were replaced by the World Intellectual Property Organization (WIPO) in 1967. Seven years later WIPO became a specialised agency of the United Nations. The Paris and the Bern Conventions, which were both revised numerous times, constituted the basic principle of the international IPR regime for more than 100 years (Drahos, 1998). The main provisions of the Paris Convention were "national treatment" and "preferential filing". "National treatment" simply implies that nationals and foreigners were treated equally, while "preferential filing" or "priority rights" give inventors the exclusive right to file a patent on their invention in any member country within one year of the first application. Apart from that the signatory countries mostly retained control over the design of their national patent laws, for instance regarding the issue of compulsory licensing or the general exclusion of certain product groups from protection (Siebeck et al., 1990). The "international phase", as Drahos (1998) refers to this time, was thus characterised by substantial freedom for the signatory countries. This was partly due to the fact that there were no actual enforcement mechanisms in place. While in later versions of the agreements countries had, at least in

[20] Most of these agreements focused on trademarks. By the time the Paris Convention was implemented 69 such treaties existed (Drahos, 1998).
[21] Working requirements were part of the national patent law in Austria and some other countries.

principle, the option to appeal to the International Court of Justice this never happened in practice (Dinwoodie, 2007).

In the decades following World War II most colonies became independent. Long after independence the IPR regime in these countries often reflected those of their respective colonisers. Some countries however started to reassess their intellectual property systems to better suit their national objectives. Moreover, an increasing number of these newly independent countries joined the Paris and Bern Convention, shifting the power structure within these Conventions[22]. These and other developing countries made attempts to revise the Paris and the Bern Conventions to generate an international system of intellectual property protection that was more in line with their specific perceptions. While in the case of the Bern Convention[23] their push for revision was successful, in the case of the Paris Convention no agreement could be reached (Drahos, 1998 and 2000).

Whatever the reasons for the failure to revise the Paris Convention, the consequent reactions of developed countries – and the United States in particular – were not anticipated by developing countries. As May (2000, p. 84) points out; "The pressure to further weaken international IPR protection regimes may well have alerted developed states to actual problems caused by WIPO's stewardship [...]". These problems included the many different agreements that in many cases had few signatories and the lack of enforcement mechanisms to ensure compliance of those countries that actually signed (May, 2000). These and other problems with the existing conventions gave developing countries the freedom to exclude some product groups (including pharmaceuticals, food stuff, chemicals, plant varieties and other biotechnological inventions) from protection, to provide only rudimentary and poor protection for copyrights, trademarks and trade secrets, and to reserve the right to compulsory licensing (Maskus, 1998b).

Problems with the existing IPR regime along with the increasing inability of developed countries to push through their choice of IPRs in WIPO based agreements (Drahos, 1998) and changes in economic activity that made knowledge based industries key to a country's competitiveness generated considerable pressure in developed countries for a fundamental change in the international IPR regime (May, 2000). The major pressure for change came from American companies, and in particular firms in film, software and pharmaceutical industries, which lobbied for internationally recognised and enforced IPRs. These well organised and often oligopolistic industries made the strengthening of IPRs one of the most important topics of U.S. commercial policy. In the 1980s the Office of the U.S. Trade Representative used Section 301, an amendment to the Trade Act of 1974, to pressure countries to strengthen their IPRs. This amendment was followed by the Omnibus Trade and

[22] WIPO conventions, as with all UN organisations, operated under a system of "one country, one vote".
[23] The Stockholm Protocol was signed in 1967.

Competitiveness Act (1988) which extended the 301 provision by differentiating between 'Regular 301', 'Special 301' and 'Super 301' processes. These regulations obliged U.S. trade representatives to identify countries with insufficient IP protection and engage in bilateral negotiations with those countries. In the case of an unsatisfactory outcome trade sanctions could be imposed (Drahos, 1998).

At the outset of the Uruguay Round of trade negotiations in 1986 the U.S. pushed for the introduction of IPRs as one of the negotiating topics, despite the protests and reservations of many developing countries, including Argentina, Brazil, India, and Nigeria (Drahos, 2002). The move to include IPRs in the Uruguay trade talks can be seen as an effort to shift the topic to a forum where the power relations are more favourable for IPR advocates than the WIPO forum. As Drahos (2002, p. 10) writes;

> "In fora such as WIPO, UNCTAD and UNESCO, the US faced the problem that developing country blocs could defeat its proposals on intellectual property or advance their own. The US began to argue the issue of intellectual property protection should become the subject of a multilateral trade negotiation within the General Agreement on Tariffs and Trade (GATT). The GATT was a forum in which the US was the single most influential player."

Others argue that IPRs belong in the trade sphere, emphasising the fact that IPRs do affect trade flows and a lack of IPRs does distort trade[24] (Commission on Intellectual Property Rights, 2002, pp. 159-160). While there is increasing evidence that IPRs do significantly influence trade flows, there are apparent advantages for Western countries from shifting the issue of IPRs to the WTO too. Aside from more favourable power relations, the WTO did possess a dispute settlement mechanism[25] and hence better enforcement mechanisms than WIPO. Furthermore making TRIPS an integral part of the WTO accelerated the spread of the higher standards since a country striving to become a WTO member had no option to opt out from TRIPS and finally shifting IPR issues to the WTO negotiation gave advanced countries the possibility to include the TRIPS agreement in a broader bargaining package (UNCTAD-ICTSD, 2003).

[24] "Thus, a firm making export decisions across different markets faces an array of effective levels of patent protection. If the firm takes this array into account, trade will be "distorted" in the sense that policy parameters will influence its international distribution". However the authors further point out that this is a rather uncommon definition of distorted as "there is no clear standard for defining global optimality against which to assess the trade impacts" (Maskus and Penubarti, 1995: p. 229).

[25] Strictly speaking the WTO did not exist at that time but the preceding agreement, the GATT, did possess a dispute settlement mechanism. The WTO was established with the finalisation of the Uruguay Round in 1995.

While it is quite evident why developed countries sought to include IPRs in the new world trade regime, the question remains as to why developing countries accepted this move, since they displayed an attitude to its incorporation which ranged from concerned to hostile in the beginning (UNCTAD-ICTSD, 2003). Yu (2006) argues that there are four answers to this question, namely; (i) 'bargaining', (ii) 'coercion', (iii) 'ignorance' and (iv) 'self-interest'. The 'bargaining narrative' emphasises that developing countries agreed to TRIPS as a broader bargaining package, in which developed countries made concessions regarding lower tariffs on agriculture and textiles in return – subjects that were by many developing countries considered far more important than IPRs. The 'coercion narrative' considers TRIPS a neo-imperialistic document that was forced upon the developing countries by threatening to exclude them from the global trading system or by using 'Section 301' processes. The 'ignorance narrative' emphasises that developing countries did not understand the full impact and the importance of the issue. While this argument cannot be entirely dismissed since the full impact of stronger IPRs is not even clear today, it may exaggerate the ignorance of developing countries. If this heterogeneous country group was so ignorant about the relevance of IPR protection, it would not have tried to reverse the Paris and Bern Convention in the 1960s and 1980s. The last narrative suggests that developing countries agreed to TRIPS simply because it was in their own interest. If this were the case however, developed countries were rather ill-advised to make concessions to the developing countries in order to make them accept TRIPS. In other words the 'self-interest narrative' seems to be contradictory to the 'bargaining narrative'. While the first three narratives are in no way mutually exclusive the 'self-interest narrative' does not fit well with any of the other narratives[26] (Yu, 2006: pp. 371-379). While it is unlikely that any of the narratives tells the whole story, the first three narratives may all contribute to the motivation of developing countries to accept TRIPS.

3. On the Economics of IPRS

In a thorough study of the US patent system conducted in 1958 for the US congress Machlup concluded:

> "If we did not have a patent system, it would be irresponsible, on the basis of our present day knowledge of its economic consequences, to recommend instituting one. But since we have had a patent system for a long time, it would be irresponsible, on the basis of our present day knowledge, to recommend abolishing it." (Machlup, 1958: p. 80).

[26] However the 'self-interest narrative' raises an important aspect. If the technological necessities of developing countries are different from those of developed countries, IP protection in the South is necessary to stimulate research in these areas. In this case the South does have a self-interest in protecting intellectual assets. This issue has been investigated in greater detail by Diwan and Rodrik (1993). However the negotiation history of TRIPS suggests that, while this is a potentially important aspect, the South at least did not consider it as such.

Since then an extensive amount of research on the economics of the patent system has been conducted and more light has been shed on the issue. In what follows we briefly review the reasons for market failure in knowledge production, possible solutions to this inefficiency, and their respective economic consequences. We further discuss the trade-off for society between knowledge production and diffusion.

3.1. Knowledge Production and Market Failure

Knowledge, as Arrow (1962) pointed out in his essay "Economic Welfare and the Allocation of Resources for Invention" has the properties of a public good. First, it is non-rivalrous in consumption. It stems from this property that an efficient allocation of knowledge requires that nobody is excluded from its use since the marginal cost of providing knowledge to an additional individual is zero[27]. Further it is non-excludable in use or as Arrow pointed out: "The very use of information in any productive way is bound to reveal it, at least in part" (Arrow, 1962: p. 615). So while it follows from the first property that "no one should be excluded" from the use of knowledge the second property states that "no one *can* be excluded" from its use (Stiglitz, 1999: p. 309). The public good characteristics of knowledge generate problems regarding the production and dissemination of innovation. If inventors do not get the chance to profit from their invention, since everybody can and should use the knowledge they produced the only knowledge that would be produced is knowledge with zero production costs. This of course leads to an insufficient level of invention and innovation from an economic point of view (Stiglitz, 1999: p. 309).

Knowledge in most respects can also be considered a global – as opposed to a local – public good. Even though the value of some forms of knowledge (e.g. knowledge about a country's legal system) is limited to a specific country, knowledge that is embodied in patents and henceforth relevant in this context is most of the time valid worldwide (Stiglitz, 1999: pp. 310-311). It is the *global* public good[28] characteristic of knowledge that makes the theoretical case for the *international* regulation of knowledge usage and dissemination, since national provisions will not take account of cross-border externalities and thus, will not be globally optimal (Maskus and Reichman, 2005).

[27] This does not imply that there are no costs for the transmission of knowledge. The marginal costs of knowledge transmission may be significant. However, this does not have an effect on the public good properties of knowledge (Stiglitz, 1999).
[28] Maskus and Reichman (2005) define global public goods as: "those goods (including policies and infrastructure) that are systematically underprovided by private market forces and for which such under-provision has important international externality effects" (p. 8).

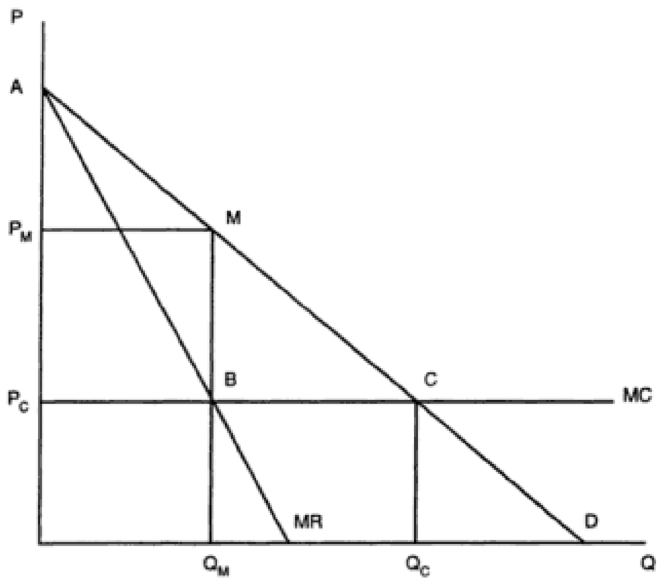
3.2. Patents – A Trade-Off between Diffusion and Appropriability in a Closed Economy[29]

A private market solution for knowledge production is destined to lead to an insufficient level of invention and innovation. Consequently some form of government intervention is necessary to stimulate research investment. One possible solution is the provision of IPRs. However, granting property rights to one party to ensure that they gain the fruits of their research investment by definition excludes others from the usage of this knowledge. This creates an inescapable trade-off between static and dynamic efficiency considerations. From a static point of view everybody should have access to knowledge at marginal cost, which is close to zero. From a dynamic point of view however, an incentive mechanism is required to encourage innovation. Strong IPRs provide powerful incentives for research. However, they also generate distortions through insufficient access and may transfer surpluses from consumers to inventors. Conversely, weak IPRs while satisfying the static goal, namely diffusion, may not create the necessary incentives for firms to invest in research. Welfare considerations imply that one must find the optimal balance between these two efficiency requirements.

Figure 1 illustrates the basic trade-off between static and dynamic efficiency requirements. Static efficiency requires that a newly invented product is made available at its marginal costs (MC) which is associated with the price P_C, the quantity Q_C and a consumer surplus ACP_C. At this price the innovator does not earn any rents, implying that the firm earns no return on its research expenditures. Consequently no research would be conducted, the product would not be developed in the first place and the entire consumer benefits would not accrue. Therefore, the solution C associated with the competitive price is not attainable. Alternatively, if IPRs are granted the product would be available at the monopoly price P_M, the inventor would earn $P_M MBP_C$ as rents and the consumer surplus would 'shrink' to AMP_M compared to the competitive (but not attainable) price. Without IPRs the entire consumer benefits would be lost - assuming that in this case the product remains undeveloped - but under a system of IPRs society would gain the monopoly profits $P_M MBP_C$ minus R&D expenditures plus the consumer surplus AMP_M (Maskus, 2000a: pp. 28-30).

[29] The following basic theoretical discussion does not consider the effects of any *market mechanisms* (lead-time, moving down the learning curve quickly and so on) that can have an impact on the ability of firms to appropriate the returns from their research investment.

Figure 1: Trade-off from IPRs



(Source: Maskus 2000a: p. 30)

The costs due to the temporary monopoly provided by the granting of a patent are therefore justified by the necessity of creating incentives for invention and innovation. This implies that patents should only be granted as long as the benefits outweigh the costs (Mazzoleni and Nelson, 1998: p. 275). In addition to the deadweight loss associated with the temporary monopoly, there is another shortcoming of IPRs as a means of stimulating R&D and innovation. Ideally the system of IPRs would be designed to create just those innovations for which R&D costs are just below the ex-post consumer surplus. It is not possible to create a system that is so precise however. Thus, IPRs remain a second-best solution to the problem of inappropriability (Maskus, 2000a: p. 30).

3.3. Other Solutions: Awards and Contract Research

The costs associated with granting IPRs lead to the question of whether there are other incentive mechanisms with superior properties than IPRs. Awards and contract research can theoretically generate the necessary incentive mechanisms. As with patents, awards have a long tradition as an incentive for innovation. In 1713 the British Board of Longitude offered a prize for a special chronometer, which was awarded to John Harrison in 1762 (Wright, 1983: p. 704). Similar to contract research, awards are under some conditions able to generate the same research incentives as IPRs whilst at the same time having the virtue of avoiding the deadweight loss generated by monopoly pricing. However, awards and research contracts also produce market distortions since the prizes have to be financed through public taxes. It follows from the general theory of taxation though that the broader the tax base the smaller the distortion. Therefore, in the case of symmetric information, where firms and the social planner both know the values and costs of innovation, IPRs are not preferred over other mechanisms of appropriability. In general however, this is not the case. Neither costs nor social value are known beforehand to the social planner and thus the "correct" prize for an innovation cannot be evaluated[30]. In this case IPRs have the advantage in that the decision over whether or not to invest in R&D is left to firms who can be expected to have better information about the costs and benefits of R&D investment. Moreover, rather than imposing costs on the general public IPRs charge the actual users of knowledge (Gallini and Scotchmer, 2002: pp. 54-55).[31]

3.4. Properties and Function of the Patent System in a Closed Economy

Granting IPRs can stimulate innovation but creates costs to society. Consequently in an 'ideal' world IPRs should only be granted for inventions that would have not been made in the absence of IPRs.[32] If no other mechanisms for appropriating the returns from R&D exist and perfect competition prevails, as in the theoretical discussion above, this is very likely to be the case. However, in a more realistic setting firms may have other possibilities (secrecy, lead time, rapidly moving down the learning curve, image advantages for first-movers, sales or service efforts, non-patent barriers to market entrance) to appropriate the returns from investment (Scherer, 2005: p. 3). A number of studies have attempted to evaluate the relative importance of IPRs for different industries. Taylor and Silberston (1973), Mansfield (1986), and Levin et al. (1987) are among the earlier studies of this kind. Their findings are rather similar and are not very supportive of the effectiveness of patent protection. Levin et al. (1987) find that with the exception of a few industries, predominantly pharmaceuticals and chemicals[33] lead time, sales or service efforts, and moving down the learning curve are considerably more effective than patents in product protection. In a similar vein Mansfield (1986) finds that the absence of IPRs would have only minor effects on innovative efforts in most industries, with

[30] There are some cases where the social planner knows the value of an investment, e.g. in the case of military equipment where the social planner actually determines its value (Gallini and Scotchmer, 2002: p. 55).

[31] Wright (1983) in one of the first formal studies on these three incentive mechanisms came to the conclusion that IPRs were the preferred second-best option. However his analysis suggests that for a number of reasons (e.g. common pool problem, nature of research process and so on) "(...) the range of situations in which a practical patent system dominates other feasible alternatives may be narrower than is commonly believed (...)" (p. 704).

[32] It should be noted that there are other reasons for granting IPRs than fostering innovation, which will be considered later.

[33] The problems of appropriability are especially high in these industries, since the composition of pharmaceuticals and chemicals is easily revealed once the product is on the market (Maskus, 2000a: p. 50).

pharmaceuticals and chemicals again being the main exceptions[34]. These results are supported by the more recent study of Cohen et al (2000) who find that in the majority of industries secrecy and lead time are the most effective appropriability mechanisms. Moreover, they find evidence that firms patent not only to directly profit from their innovation through licensing or commercialisation but also for strategic reasons (for example, patent blocking, prevention of suits, use of patents in negotiations).

While these findings on the limited effectiveness of patents pose some questions about the usefulness of a patent system, the results should not be overstated and have to be interpreted with care. Firstly, all of these studies focused on large established firms and there are a number of reasons to suggest that the situation might be different for small firms and new entrants. Secondly, in addition to encouraging innovation IPRs serve other purposes which were not considered in these studies (Mazzoleni and Nelson, 1998: p. 274). For small firms and new entrants the ability to protect their intellectual property might be considerably more important than for large established firms which may have other mechanisms of appropriability at their disposal. Many small firms may lack the necessary resources to commercialise their innovation. These firms may find it more convenient to license their invention to larger companies who then carry on the product development and commercialisation of the product. Even where small firms or new entrants decide to commercialise their innovation themselves patents can play a crucial role. Such firms will very likely find it necessary to turn to the capital market to raise funds, in which case holding a patent can be a decisive asset (Mazzoleni and Nelson, 1998: p. 277).

The argument that IPRs induces commercialisation of new products is, in the case of large established firms that both invent and commercialise new products, very similar to the basic argument for generating incentives for R&D investments. However, as already outlined in the case of small firms and new entrants the focus on commercialisation of an invention makes a relevant difference. Furthermore, in cases where the original invention would have been made with or without patent protection (e.g. by universities or government research) IPRs might play an important role for commercialisation. In this case the "commercialisation argument" is contradictory to the "incentive for invention" argument, since it argues for the granting of IPR protection even when the invention has already been made. However, under the assumption that further research investment is needed to develop the original invention into a commercial product and that no patent can be filed for further development work (e.g. since the inventive step is too small to meet the necessary conditions) no private firm will be willing to make the investment unless some property rights over the initial invention can be obtained.

[34] For four industries (textiles, rubber, motor vehicles, and office equipment) the absence of IPRs would have made no difference to their inventive efforts. For the bulk of other industries the percentage of products that would have been undeveloped ranges from 4% to 18%, while only in the chemical (30%) and pharmaceutical (65%) industries would a major portion of products been undeveloped (Mansfield, 1986: p. 175).

This argument is subject to two reservations. Firstly, in many areas it is possible to obtain patents on the development work. Secondly, as for the "incentive to invent" argument there are alternative market mechanisms to appropriate the returns from research investment (Mazzoleni and Nelson 1998: 277-278).

Kitch (1977) proposes a further argument that has been termed prospect theory, which argues that the absence of a broad patent on an invention is likely to lead to duplicative and wasteful R&D efforts for follow-on inventions, since many people see the same possibilities. In this case only a broad patent on the initial invention can assure the orderly development of follow-on inventions either by the patentee or their licensors (p. 266-271). Merges and Nelson (1990) however raise doubts about the assumption that many people see the same prospects and suggest that many people see many different prospects. Consequently a single rights holder might under-develop the original invention. Indeed, one of the basic arguments for patent protection is information disclosure. The possibility of protecting relevant information through patents induces the inventor to reveal the information to the public and in doing so adds to the public stock of knowledge (Mazzoleni and Nelson, 1998). Once the patent application is released to the public competitors can gain access to the information and, depending on the scope of patent protection, can invent around the original patent and thereby raise long-term competition (Maskus, 2000a).

So while empirical studies have raised doubts about the importance of a patent system as the most important incentive mechanism for invention for large established firms and the majority of industries, there are a range of other potential positive effects of granting IPR protection. At the same time IPRs have considerable disadvantages, which have resulted in a significant amount of research focussing on the properties of the "optimal" patent system.

3.5. Length, Breadth, and Height of the "Optimal Patent"

There are numerous studies which have focused on the optimal design of a patent system that maximises social welfare by optimally balancing negative and positive effects. Earlier studies often focused solely on patent life (duration of protection) while later studies included considerations about the optimal patent breadth (scope of protection) as well. A minority of studies investigate the height of patent protection (i.e. novelty requirements for protection).

One of the earliest studies of this kind was Nordhaus' work on the optimal patent life (Nordhaus, 1967). The study focuses on "run-of-the-mill" inventions under perfect competition, which are cost reducing inventions,[35] and which leave the pre-invention price

[35] His findings can be applied to the more general case of product inventions as well (Kaufer 1989: p. 25).

and quantity unaltered[36]. Furthermore Nordhaus assumed that during the patent term the patentee gains the entire monopoly profit while immediately after expiration of the patent term competition eliminates any rents (Scherer, 1972, p. 423). Maximising the benefits to producers and consumers subject to any given patent term, Nordhaus obtained the welfare-maximising patent term, which depends on the price elasticity of demand, the "importance of the invention", the discount rate, and on the elasticity of cost reduction with respect to R&D investment. Furthermore he found that the optimal patent life is shorter for more important inventions[37], since they have a greater social impact and thus produce a greater deadweight loss.

Gilbert and Shapiro (1990) and Klemperer (1990) expanded the analysis of the optimal patent system by including patent scope in their models. Patent scope corresponds to "the size of the region of technology space from which a patentee may exclude others from operating" (Jaffe 1999, p. 23). In the case of an "independent single invention" the analysis of patent scope does not differ a great deal from the analysis of patent length. The broader the patent scope the higher the incentives for research and the higher the welfare loss from market power. In the case of cumulative research however, there are further aspects that have to be considered. On the one hand a broader patent promises higher returns to investment and thus stronger research incentives. On the other hand, an inventive firm anticipates that its potential invention might infringe on an existing patent and thus research becomes riskier and less valuable. Consequently broader patents can not only spur but also deter the rate of invention (Jaffe 1999, p. 23).

Gilbert and Shapiro (1990) and Klemperer (1990) both focus in their work on the optimal combination of patent length and breadth. While Gilbert and Shapiro (1990) come to the conclusion that a longer patent life and a narrow breadth are optimal as long as broader patents are associated with increasing costs to society through deadweight losses for any given size of reward for the inventive firm, Klemperer (1990) identifies a case where exactly the opposite is the case. Klemperer identifies two sources of social costs: Firstly, consumers who substitute to another product class, and secondly consumers who substitute within the product class to less preferred products. A wider patent increases the first form of distortion by permitting higher prices, which leads consumers to switch to other product classes and thus increases deadweight loss, but a wider patent also reduces the possibilities for consumers to switch to unpatented, competitively provided varieties of the product thus reducing the second form of distortion. Thus he concludes that "..., infinitely lived, narrow patents are

[36] This is due to the fact that the cost reduction is not big enough to induce a decrease in prices and an associated output increase (Scherer 1972: p. 23).

[37] This is quite contradictory to the conventional argument, which would award longer patent lives to more important inventions since they are arguably riskier and probably require higher research investments. However, this surprising result of Nordhaus' model only holds for run-of-the-mill inventions and not in the case of drastic inventions (Nordhaus 1967: p. 9).

typically desirable when substitution costs between varieties of the product are similar across consumers, but very short-lived, wide patents are desirable when valuations of the preferred variety relative to not buying the product at all are similar across consumers" (Klemperer 1990, p. 127). In short, Klemperer's results indicate how the optimal combination of patent length and breadth varies with product classes.

While both Gilbert and Shapiro (1990) and Klemperer (1990) advocate the idea that the optimal patent system should include some kind of trade-off between patent length and breadth,[38] Gallini (1992) produces somewhat contrasting results. This is attributable to the fact that Gallini introduces imitation costs to the model. While Gilbert and Shapiro (1990) and Klemperer (1990) both assume that the imitation cost is zero, Gallini (1992) by introducing imitation costs endogenised the imitation decision. Since longer patent terms increase the incentives for imitation Gallini finds that if only patent length is considered, it should be short in order to discourage imitation. In the case where both patent length and breadth are considered however, Gallini (1992) finds that the scope of protection should be broad while the length can be adjusted in order to reach the requested level of patent rewards (pp. 52-53).

All three papers are however subject to limitations. In particular, their focus on a single independent invention implies that the potential negative effects of a broad patent on the rate of invention are not considered. In the case of cumulative research the question of the best way to distribute the rewards for inventing between the initial inventor and the follow-on inventor arises. An invention can be stimulated by an earlier invention in three different ways. The initial invention can spur the development of the second invention, in which case society profits by getting the second invention sooner. Alternatively the initial invention can reduce the research costs of the second invention in which case society profits by getting the second invention cheaper. The initial invention may also make inventions possible that could not have been developed otherwise. These externalities are not considered by the initial inventor's research decisions unless they can appropriate some of the returns of the follow-on inventions however. The second inventor also needs to be rewarded in order to induce research investment in the follow-on invention (Scotchmer, 1991, p. 31).[39]

[38] Gilbert and Shapiro (1990) find the optimal patent to be narrow and long, while Klemperer (1990) finds the optimal patent to be either narrow and long or broad and short depending on elasticity of demand.

[39] In this setting a third characteristic in addition to patent length and breadth becomes important, namely the height of IPR protection. The height of protection determines the novelty requirements and thus together with patent breadth determines the level of protection for the initial invention from follow-on inventions (Gallini and Scotchmer, 2002, p. 66). Regarding the height of protection Scotchmer and Green (1990) argue with some reservations for weak novelty requirements.

Recent studies by Green and Scotchmer (1995), O'Donoghue (1998) and O'Donoghue et al. (1998) are mostly consistent with Kitch's[40] conclusion that strong patent protection should be awarded to the initial inventor in the case of cumulative research. Scotchmer (1996) even claims that patent protection for follow-on inventions is not necessary at all to induce their development if there is no impediment to ex-ante licensing, since this maximises the reward for the initial inventor. Several researchers have raised doubts about this support for broad patent protection however. Merges and Nelson (1990) as well as Mazzoleni and Nelson (1998) expressed their concerns about a broader patent scope with regard to the danger of blocking up the entire research field. Mazzoleni and Nelson argue that the risk of this effect is higher than most studies anticipate since they do not account for possible high transaction costs for licensing agreements (pp. 280-282). Merges and Nelson (1990) argue on the basis of historical evidence from the radio, aircraft and pharmaceutical industries that in the case of cumulative research broad patents can lead to blockages. Further they conclude that: "[t]here is no evidence [...] that firms coordinate the development of a prospect by licensing the cultivation of particular applications of a broad technology to particular licensees; indeed, patents were often pooled and cross licensed en masse to all firms seeking to enter the field" (pp. 908-909).

3.6. IPRs in the North-South Context

In an open economy where extensive differences in economic development and innovation capabilities among countries exist, IPR protection raises further questions. From a static point of view in a closed economy granting temporary monopoly rights merely involves a transfer of consumer surplus to producers,[41] which is if anything a question of distribution. In the case of an open economy however and of a technology importing country in particular the monopoly rents ($P_M MBP_C$ in Figure 1) are awarded to a foreign firm and can thus be considered as a static loss for the country. If, in addition, the country is rather small and thus unlikely to stimulate the research of foreign firms towards products that better suit the local demand a straightforward welfare loss is the consequence (Maskus, 2000, p. 33).

Moreover, losses can arise if the country possesses an imitative industry. This can impose further costs for the country through higher unemployment rates and higher prices (Fink and Maskus, 2005). In addition, the impact of IPRs on the quantity supplied to the market is not clear a-priori. On the one hand, IPR protection strengthens the market position of the exporting firm since illegitimate local competitors are driven out of the market which thus raises the demand for the protected good. Maskus (2000a) refers to this effect, which leads to

[40] Kitch (1977) argues in the case of sequential invention for a broad initial patent in order to prevent over investment and wasteful duplication and thus secure orderly development of the follow-on invention. Licensing could assure the consideration of other research ideas and capabilities for follow-on invention.
[41] Leaving the deadweight loss aside for a moment, since it will be suffered in any case.

an expansion in the quantity of goods exported to the country, as the *market-expansion effect*. On the other hand, the firm might reduce supply since the lower elasticity of demand due to increased market power allows the firm to curtail it sales, which Maskus (2000a) refers to as the *market-power* effect (p. 112). Whether the *market-power* or the *market-expansion effect* prevails is not clear a-priori and likely depends on other characteristics of the economy. Maskus and Penubarti (1995) suggest that in small countries with low imitation capabilities the *market-power effect* probably outweighs the *market-expansion effect*, while for larger countries with strong imitative capabilities the opposite is likely to be the case (p.230).

In addition to potential negative effects due to market power, there are potentially positive effects which also have to be considered. First, stronger IPR protection can stimulate invention and innovation in the developing country itself. This argument is likely to be relevant for a small number of relatively advanced developing countries however, who have gained substantial experience and technological knowledge in some fields of production at least. In all other countries simply raising the levels of IPRs is unlikely to be enough to foster innovation (Verspagen, 2003, pp. 503-504). Lerner (2002) for example finds in his study of 177 patent reforms in 60 countries over the past 150 years that reforms aimed at increasing the levels of patent protection had no effect on innovation in developing countries, where innovation is measured by patent fillings in the reform country and in Great Britain. (p. 30-31).[42] A second benefit of strong patent protection in developing countries would result if a high level of IPRs induces research by firms from developed countries that better suit the needs and demand of developing countries. This can be especially important in the case of pharmaceutical products (Diwan and Rodrik, 1991, p. 2). Once again however this is likely to be of greater relevance for large developing countries with considerable purchasing power. A third benefit of patent protection would arise if in the absence of patent protection innovative firms that do not see their intellectual property protected are unwilling to either license their knowledge to firms in that country, engage in FDI, or export to that country. Stronger IPR protection may increase any of these three potential channels of technology transfer therefore (Verspagen, 2003, p.503). Such a benefit is likely to be of more relevance to developing countries, since they may not gain from the stimulation of local innovation due to their limited innovation capability. Formal technology transfer is likely to be one of the most promising potential positive effects for developing countries from stronger IPRs. The impact of stronger IPRs on the market serving decision is not clear from the outset however, since there are considerable interacting effects at work.

[42] Brandstetter et al. (2004) and Schneider (2005) find no impact of IPRs on innovation for developing countries. Chen and Puttitanun (2005) find a positive impact however.

4. Intellectual Property Rights and Innovation

The main benefit claimed for strong IPR protection is that by allowing innovators to appropriate a share of the benefits of their creative activities, R&D is encouraged which leads to innovation and higher long-run growth. In this section we examine the cross-country evidence linking IPRs to domestic innovation, with its impact on (long-run) growth discussed later. As mentioned above, there is some literature often using survey data that finds IPR protection to have only a limited impact on innovation, with studies suggesting that with the exception of some industries IPRs are not a particularly effective means of appropriating the returns to R&D (see for example, Mansfield, 1986).[43] Other studies consider more aggregate data to examine the relationship between IPRs and innovation, often looking at the relationship between indices of the strength of IPR protection and either R&D spending (a measure of the input into innovative activity) or patent applications (a measure of the output of innovative activity).[44] A selection of results from such studies are summarised in the upper part of Table 2, which summarises the literature linking IPR protection to innovation, technology diffusion and growth.

At the aggregate level Kanwar and Evenson (2003) examine directly whether stronger IPR protection (measured by the Ginarte and Park (1997) index of IPRs, hereafter GPI) results in increased R&D expenditure[45]. They estimate a panel model for up to 32 countries for the period 1981-1995, and find that stronger IPR protection has a positive and significant impact on the share of R&D investment in GDP. Given that it has been shown elsewhere that R&D spending impacts positively upon TFP and output growth (see for example Coe and Helpman, 1995), these results provide indirect evidence of the importance of IPR protection in growth. There are also a small number of econometric studies using data on domestic patent applications to examine the role of IPRs in promoting innovation. Many such studies suggest that stronger IPR protection results in little or no measured increase in domestic innovation, at least as measured by patent applications (Lerner, 2001, 2002; Branstetter et al., 2004).[46]

[43] Other studies reaching similar conclusions include Scherer et al. (1959), Taylor and Silberston (1973), Arundel and van de Paal (1995) and Cohen et al. (1997).

[44] Both measures have advantages and disadvantages. Data on R&D for instance fails to take into account that innovation is risky, so that a significant portion of R&D projects are unsuccessful, and there is the possibility of discovering new technology by chance, while there exists substantial variation in the value of patents, with the majority worth very little (though more than the cost of patenting), as well as the fact that many innovations are not patented.

[45] Note the potential for reverse causality in the relationship between R&D spending and IPR protection. Not only may IPR protection stimulate R&D and innovative activities, but we may also expect that the demand for IPR protection is stronger in countries that are more innovative.

[46] Whilst finding that domestic innovation does not respond significantly to IPR protection, both Lerner (2001, 2002) and Branstetter et al (2004) find that *foreign* patent applications respond to IPR reforms suggesting that one benefit of increased IPR protection is through technology transfer. This channel is further discussed below.

A recent paper by Chen and Puttitanun (2005) however shows that stronger IPR protection has a positive impact upon innovation – as measured by patent applications – in developing countries. Chen and Puttitanun develop a model that has both an import and a local sector, with a local and a foreign firm in the import sector and two local firms in the local sector. In the import sector the foreign firm has a patented technology, while one of the local firms has the ability to develop patentable technology in the local sector. Stronger IPR protection by reducing the ability to imitate can lead to lower competition and higher prices in the import sector, but may encourage innovation in the local sector. The theoretical model suggests that domestic innovation in a country increases in its protection of IPRs and its level of development, and that a country's level of IPR protection may at first increase and then decrease in its level of development. The model is tested empirically on a sample of 64 developing countries using panel data over the period 1975-2000. The empirical model is a system of two equations, one for IPRs and one for innovation. IPRs are measured using the GPI index, while innovation is measured using patent applications filed at the US patent office by developing country residents. Empirical results confirm the U-shaped relationship between IPRs and a country's level of development and that stronger IPR protection encourages innovation. Including interaction terms between IPRs and the level of development suggest that IPR protection has a stronger impact on innovation in countries with higher levels of development.

In a related paper, Schneider (2005) examines the importance of IPR protection, high-tech imports and FDI on innovation and on per capita GDP growth. Once again innovation is measured using the number of US patent applications made by residents of a given country. The model is estimated on panel data for 47 developed and developing countries over the period 1970-1990. The results again suggest that innovation responds positively to IPR protection. Splitting the sample into developed and developing countries, Schneider finds that while IPRs have a positive impact on innovation in developed countries, the impact in developing countries is negative, and often significant.

5. Technology Diffusion and Intellectual Property Rights

Technology may be transferred through a number of formal and informal channels with Trade, FDI and licensing being potentially some of the most important.[47] As we saw above, the impact of stronger IPR protection on technology diffusion is ambiguous in theory and will depend on a country's circumstances. On the one hand, stronger IPR protection can restrict the diffusion of technology with patents preventing others from using proprietary knowledge

[47] Other potential channels of international technology transfer include: joint ventures, cross-border movement of skilled workers, test data and patent applications, and temporary migration of scientists, students and managerial personnel (Maskus 2004: pp. 9-13).

and the increased market power of IPR holders potentially reducing the dissemination of knowledge due to lower output and higher prices. On the other hand, IPRs can play a positive role in knowledge diffusion, since the information available in patent claims is available to other potential inventors. Moreover, strong IPR protection may encourage technology transfer through increased trade, FDI, technology licensing and joint ventures. Despite this theoretical ambiguity, the diffusion of technology from countries at the technological frontier is considered to be one of the main potential benefits of the TRIPS Agreement, particularly for developing countries that tend not to innovate significantly.

Most studies considering the impact of IPRs on technology diffusion tend to take one of the channels through which technology might be diffused and to examine whether IPRs impacts upon the volume of activity in this channel. If it does, then it is inferred that IPR protection affects technology flows (via a specific channel). This literature is reviewed below, the general conclusions of which are summarised in the lower part of Table 2.

5.1 Intellectual Property Rights and International Trade

The available evidence suggests that trade is an important channel for technology diffusion (see for example Keller, 2004), the question that remains is to what extent are trade flows influenced by IPRs. Maskus (2000a) discusses the problems faced in trying to identify the effects of IPR protection on international trade. Firstly, the effects of patent strength are partly embedded in the prices at which goods are traded, and these effects cannot be separated from other components of pricing behaviour. Secondly, the decision to export may be but one of the options available. The effects of stronger IPRs on exports will also depend on whether FDI and licensing are viable alternatives and how stronger IPRs affect the choice among them (Ferrantino, 1993). Thirdly, IPR protection creates market power in the distribution and sale of new goods and technologies, implying that market structure also matters.

As outlined above, stronger IPRs can, depending on whether the market-expansion or the market-power effect prevails and whether the firm chooses to substitute trade by FDI or licensing, expand or reduce trade flows. Maskus and Penubarti (1995) argue that of the two countervailing effects, the ‘market expansion’ effect is likely to dominate in larger countries with strong imitative abilities, while the ‘market power’ effect would dominate in smaller countries with weak imitative abilities. As Maskus (2000a) notes however, the ‘market power’ and ‘market size’ effects may be moderated by other circumstances. Weak IPR protection need not remove an innovative firm’s market power since imitation in the local market is likely to be costly and take time. Similarly strong IPR protection need not create a monopoly because legitimate substitutes are likely to be available in the domestic economy. Taylor (1993) argues that a third factor may be important for larger markets with significant imitative abilities at least, with stronger IPR protection encouraging exports by reducing the need for firms to try and deter local imitation, thus reducing costs for exporting firms. This discussion suggests that the impact of IPR protection on trade is likely to depend importantly upon the level of development and upon the imitative ability of the importing country. In countries with little capacity to imitate advanced goods, stronger IPR protection may lead to market power effects, whereas in countries with the ability to imitate advanced goods strong IPR protection may be important for exporters in advanced countries, with such protection reducing the risk of imitation and encouraging trade.

Given the theoretical ambiguity of the IPR-Trade relationship, a number of studies have examined the question empirically. Maskus and Penubarti (1995) use an augmented version of the Helpman-Krugman model of monopolistic competition to estimate the effects of patent protection on 1984 bilateral trade for 28 manufacturing sectors. They examined trade from 22 OECD countries to a sample of 71 countries at all stages of development. Their explanatory variables include the importing country's per capita Gross National Product (GNP) and trade restrictions (BMP and tariff revenue as a percentage of dutiable imports) alongside an index of IPR protection developed by Rapp and Rozek (1990) (RRI hereafter). They also include the interaction between the IPR index and dummies indicating whether the importing developing country has a small or a large market to account for market size effects and technological capacity. Their results indicate that higher levels of IPR protection have a positive impact on bilateral manufacturing imports into both small and large developing economies, though the impacts were statistically weaker in the smaller economies. Whilst suggestive of the importance of technological capacity or imitative ability for the relationship between IPR protection and trade, their results find little support for a positive impact of IPR protection in the most patent sensitive industries.

Adding a measure of IPR protection to a standard equation explaining trade flows is a clear first step to determine if this channel is important for technology diffusion. Fink and Primo Braga (2005) add the GPI measure of IPR protection to a standard gravity equation[48] explaining either total non-fuel or high-tech trade flows for a large cross-section of countries for the year 1989. The rationale for using high-tech trade in addition to total non-fuel trade is based on the *a priori* expectation that the effects of IPR protection are stronger for knowledge-intensive trade. To deal with the econometric problem of zero trade flows, their model consists of one equation explaining the probability of zero observations and a second equation explaining the magnitude of positive trade flows. They find that stronger IPR protection has a small but significantly positive impact on the probability that countries trade with each other and a significantly positive impact on bilateral trade flows for both total non-fuel imports and

[48] Including the GDP and populations of both trade partners, distance between trade partners and dummies for common border, common language and various Preferential Trading Arrangements (PTAs) as standard explanatory variables.

exports. For high-tech trade however, stronger IPR protection is found to have a significantly negative impact on the probability that two countries trade with one another and a negative and insignificant impact on bilateral trade flows. This latter result is contrary to what one might have expected, and Fink and Primo Braga suggest several possible explanations, based on the considerations noted above. Firstly, strong market power effects in the case of high technology goods may offset positive market expansion effects caused by stronger IPR protection. Secondly, stronger IPR regimes may cause high-tech firms to serve foreign markets by FDI, partly substituting for trade. Thirdly, the high-tech aggregate may include many goods that are not sensitive to the destination country's patent regime, as other means of appropriating the benefits of the investment in R&D may be more important. Fourthly, they were unable to include tariff and non-tariff barriers, which may be important determinants of trade flows for some industries.

In a similar gravity equation exercise, Smith (1999) examines the impact of IPR protection on exports from the 50 US states plus the District of Colombia to 96 countries. Smith splits her sample of importing countries into four groups depending on their imitative ability defined according to their strength of patent rights[49] and R&D spending as a percentage of GNP[50]. Dummies for these four groups were then interacted with the IPR measure. She finds a negative relationship between IPR protection and exports from the US to those countries with the weakest threat of imitation. For those countries with the strongest threat of imitation however a positive relationship between IPR protection and trade exists. Overall, she concludes that US exports depend upon IPR protection in importing countries, but that the direction of the relationship depends on the threat of imitation. Weak IPRs are a barrier to US exports, but only for countries that pose a strong threat of imitation.

Falvey et al (2009) consider the impact of the strength of IPRs in a sample of 69 countries on imports from the five countries conducting the vast majority of the world's innovation (i.e. France, Germany, Japan, the UK and the U.S.). After confirming a positive impact of IPRs on imports the authors use threshold regression methods to examine whether a country's imitative ability and market size impact upon the relationship between IPRs and imports. The results indicate that the impact of IPRs on imports is increasing in both imitative ability and market size. Unlike Smith (1999) there is little evidence supporting market power effects.

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[49] Both the Rapp and Rozek and the Ginarte and Park indices are used with similar outcomes.

[50] The four groups are defined (in increasing order of imitative ability) as: 1. Countries with weak imitative abilities and strong IPR protection: 2. Poor countries that have low technological capabilities and thus a low threat of imitation, but that also have low levels of IPR protection: 3. Industrial countries that tend to have strong technological capabilities leading to a strong imitation threat, but that at the same time tend to have high IPR protection, which dampens this threat, and: 4. Industrialising countries that have an effective threat of imitation and that also have low levels of IPR protection. Maskus (2000a) suggests caution is warranted in interpreting Smith's results since, "in the developing economies R&D data are highly suspect and not comparable to those in developed countries" (p. 118). In addition, the division of countries into four groups is somewhat subjective, with a number of anomalous designations.

Recently, studies have considered *how* trade is affected by IPRs. Foster (2011) for example examines whether IPRs impact upon trade by changing the volume of products traded (i.e. the intensive margin) or by changing the variety of products traded (i.e. the extensive margin). The results indicate that stronger IPRs have a positive impact upon imports, and that this effect works mainly along the extensive margin. For the intensive margin market power effects are often found. The results thus indicate that stronger IPRs can enhance trade by increasing the variety of products traded, but that firms may act monopolistically in countries with stronger IPRs by reducing the volume of goods traded. Ivus (2011) conducts a similar exercise using data on U.S. exports and again finds that stronger IPRs in developing countries have impacted positively upon imports from the U.S. and that this effect has occurred largely along the extensive margin.

The results of these studies suggest that stronger IPR protection can lead to significantly higher trade flows, though not necessarily in goods and industries considered high-tech or patent sensitive. Fink and Maskus (2005) draw the following conclusions from this empirical literature. Firstly, they argue that transnational trading firms do not base their export decisions on IPRs in the poorest countries, where the local threats of imitation and reverse engineering are weakest. Secondly, patent rights matter importantly in middle-income, large developing countries, where such imitation is more likely. Stronger IPR protection in these countries encourages foreign firms to expand their trade volumes by reducing the threat of imitation. Thirdly, the products of many high-tech industries are difficult to imitate, so trade flows in these industries are in fact less sensitive to IPR protection than in other medium-technology industries[51]. Fourthly, high-tech firms may decide to serve foreign markets through FDI and licensing, so that exports in such industries may be little affected by variations in the degree of IPR protection. Moreover, while stronger IPR protection may increase imports of high-tech goods, it also increases imports of low-tech consumer goods and may lead to the decline of indigenous industries relying on imitation.

Despite these conclusions ambiguity remains over how these increased trade flows affect welfare in the South. The general explanation for the welfare enhancing properties of international trade is related to a more efficient division of labour and enhanced competition. Stronger IPRs however impede competition and may shift production to the North, which may face higher production costs than the South[52]. On the other hand, if an insufficient level

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[51] Cohen (1995) argues that in many high-tech industries, such as aerospace and robotics, the complexity of the technology makes imitation via reverse engineering extremely difficult, rendering IPR protection unnecessary.

[52] For example the decision of Pfizer not to serve the Indian market with a new drug because there are already generic equivalents on the market is one example where the lower trade flows cannot be per se associated with a welfare loss for the Indian consumer. (Under the assumption that the generic product has about the same quality as the brand name product.)

of protection impedes the import of products that cannot be imitated, and thus no equivalent substitutes exist, national welfare is negatively affected. This is probably most important in the case of high-technology goods and capital goods, despite empirical studies tending not to find a significant effect of IPRs for these products.

5.2. Intellectual Property Rights and FDI

Foreign Direct Investment (FDI) occurs when a Multinational Corporation (MNC) has a sufficient cost or technological advantage over firms in the host country to offset the higher costs of operating internationally. FDI can be vertical, in which case the subsidiary produces inputs or undertakes assembly from components that are likely exported within the MNC, or horizontal, in which case the subsidiary produces products and services similar to those produced by the parent firm. Increasingly, FDI is undertaken in industries in which knowledge and technology are important. This is because technology advantages can be transferred relatively easily across borders, and because technology acts as a public good within the firm, where it can be employed in several locations without reducing its availability for others. The decision on where to invest will depend on locational considerations that include local market size, resource availability, distance from markets and production costs. Where technology is relevant to the FDI decision an adequate supply of labour with the appropriate skills will also be important.

While FDI can be an important channel for technology diffusion when firm-specific technology is transferred across borders, one important advantage of FDI relative to licensing or joint ventures from the TNC's perspective is that FDI keeps the technology internal to the firm. This may limit the diffusion of technology within the host country. Even so a number of considerations suggest that the presence of TNCs in a country will provide spillover benefits to domestic firms[53]. Fosfuri, Motta and Ronde (2001) for example argue that such benefits may appear through labour training and turnover, while Rodriguez-Clare (1996) suggests that the provision of high-quality intermediate inputs may provide an important externality when they also become available to domestic firms. Imitation through reverse engineering may also be facilitated when the product is produced locally (Das, 1987). Domestic firms may find it easier to export once foreign TNCs establish distribution networks, a transport infrastructure and satisfy the relevant regulatory arrangements (Aitken, Hanson and Harrison, 1997).

Empirical evidence linking FDI to technology diffusion is mixed. In general, there is little evidence of substantial FDI spillovers for developed or developing countries.[54] Xu and Wang (2000) extend the approach of Coe and Helpman (1995) for a sample of up to 21 OECD countries over the period 1971-1990, by adding both inward and outward FDI flows as

[53] See Blomstrom and Kokko (1998) and Saggi (2002) for a detailed discussion of the potential benefits of FDI.
[54] See the review by Görg and Greenaway (2004).

weights on foreign knowledge stocks. They find little evidence of spillovers through inward FDI, but some evidence of spillovers through outward FDI. Globermann, Kokko and Sjöholm (2000) using data on patent applications by Swedish TNCs and non-TNCs also find evidence that outward FDI is the more important source of technology transfer. An alternative approach has been to consider patent citations as an indicator of the extent of spillovers. Using data on Japanese FDI into the United States, Branstetter (2001) finds evidence that FDI encourages technology spillovers through subsidiaries bringing technology from their countries of origin and through TNCs facilitating learning of foreign technologies.

Görg and Greenaway (2004) summarize the results from several studies of FDI spillovers at the firm or industry level. Here firm or industry productivity is regressed on control variables plus a variable which proxies the presence of foreign firms in the sector, usually the share of employment in TNCs or the share of total sales by TNCs. The results are mixed with positive, negative and insignificant impacts of foreign investment all being found. One explanation put forward for the negative impact is that increased competition in product and factor markets can have a negative impact on a domestic firm's productivity (Aitken and Harrison, 1999). Görg and Greenaway do note that there is some evidence of spillovers for firms that have a certain level of absorptive capacity.

Like the other channels, economic theory is unable to draw unambiguous conclusions on the impact of IPRs on FDI. TNCs are more likely to undertake FDI rather than licensing or joint ventures when they have a complex technology and highly differentiated products and when the costs of transferring technology through licensing are high (Davidson and McFetridge, 1984; Teece, 1986; Horstmann and Markusen, 1987). In such circumstances stronger IPRs, by reducing the risks of technology leakage through "arms-length" trade, may increase the extent of licensing and joint ventures, thus reducing the need for FDI (Yang and Maskus, 2001a). On the other hand, it has been argued that weak IPR protection tends to affect the general investment climate adversely, hence discouraging FDI (Smith, 2001). The importance of IPR protection is also likely to vary across sectors, being of secondary importance for FDI in low-tech industries, or where the product or technology is difficult to imitate. For TNCs with technology that is easy to copy however we would expect more attention to be paid to the strength of IPR protection. Regardless of these arguments it is clear that strong IPR protection is not a necessary condition for firms to invest in particular countries. If it were, then large countries with high growth rates but weak IPR regimes, such as Brazil and China, would not have received the large foreign investment inflows that they have. While flows of FDI into these countries have been large, some evidence indicates that TNCs are unwilling to locate R&D facilities in such countries and that they may transfer older technology (see for example Maskus et al., 2005).

The empirical evidence linking IPR protection to inward FDI is mixed. Mansfield (1994) used survey evidence for 100 major US firms in six industries, and asked whether IPR protection was a concern in the location of various facilities. He found that while IPR protection was of little concern in the location of sales and distribution outlets, it became more important at higher stages of production. Many firms were concerned about IPR protection when deciding on the location of components manufactures, while the majority were concerned about IPR protection in the location of complete product manufactures. The greatest concern about IPR protection was in deciding the location of R&D facilities, which were less likely to be located in countries with weak IPR protection[55]. Across industries IPR protection was found to be very important for chemicals and pharmaceuticals, but was of secondary importance in other industries. This it has been argued is because FDI in many low-tech goods is likely to depend more on input costs and market opportunities, rather than IPR protection (Maskus, 2000d). IPRs are also likely to be of secondary importance for FDI in products that are difficult to imitate.

The early econometric research found little evidence of links between IPR protection and the volume of FDI. Ferrantino (1993) found no statistically significant relationship between a country's membership of international patent or copyright conventions (or the length of its patent grant) and the extent of US affiliate sales in that country; Mansfield (1993) found that there was no significant correlation between the extent of FDI by US firms in a country and the perceived strength of its intellectual property protection; and Maskus and Eby-Konan (1994) found an insignificant impact of the RRI on FDI by US TNCs. More recently, Primo Braga and Fink (1998) found no evidence of a relationship between either FDI flows or stocks and the GPI in a gravity model of FDI. But Maskus (2000b) cautions that these studies should be discounted somewhat, since they were "limited in specification and plagued by poor measurement" (p. 10).

There is stronger evidence that the strength of IPRs affects the type of activities TNCs are willing to conduct in host countries. Lee and Mansfield (1996) consider the relationship between a country's protection of IPR and the volume and composition of US FDI in that country. Using the same survey of 100 US firms as Mansfield (1994) they explain the volume of US FDI into each of 14 countries using control variables and a variable which measures the average percentage of firms who considered patent protection in this country to be too weak to either transfer their newest technology to a wholly owned subsidiary there or to invest in a joint venture with a local partner. The results suggest that FDI is lower in countries with weaker perceived IPR protection, and that the percentage of FDI that was devoted to final production and to R&D facilities was significantly lower in countries with perceived weak IPR protection, suggesting that not only the volume but also the quality of investment is affected

[55] Mansfield (1995) conducted a similar exercise for German and Japanese firms, reaching similar conclusions.

by the strength of IPR protection. Kumar (2002) argues that these results should be treated with caution due to the small sample size, the subjective measure of IPR protection and the low t-values on coefficients. He goes on however to discuss evidence by Seyoum (1996) who found that IPR protection is significant in explaining inward FDI, particularly in emerging markets and Maskus (1998b) who found that the strength of IPR protection was positively related to affiliate sales and assets in developing countries.

The question of whether the strength of local IPRs is important for the location of overseas R&D activity of TNCs is taken up by Kumar (2001). Economies of scale in innovation, agglomeration economies and the need to protect firm-specific technology all discourage undertaking R&D abroad. But this may be partly countered by the need to adapt goods to local market conditions, to take advantage of cheap inputs, and to benefit from trained R&D personnel and localised knowledge. While investment in R&D overseas is the least globalised of TNCs activities, Kumar shows that it has grown over time, especially since the 1980s. He then relates the ratio of R&D expenditure to affiliate sales by US and Japanese TNCs to control variables and the GPI in a sample of up to 77 countries, but finds that R&D spending overseas is not affected by the strength of IPR protection in the destination country.

Smarzynska (2004) examines whether stronger IPR protection affects the composition of FDI flows for 24 transition economies. She estimates a Probit model of the decision to invest in a country and in the decision to invest in production facilities abroad. She finds that weak IPR regimes deter FDI in high-tech sectors (i.e. drugs, cosmetics and health care products, chemicals, machinery and equipment and electrical equipment) with some evidence suggesting that FDI is deterred in other industries also. She also finds evidence to suggest that stronger IPR protection encourages firms to set up local production facilities rather than focusing solely on distribution networks, with this latter effect not restricted to high-tech sectors.

Branstetter et al (2004) use affiliate level data on US TNCs and aggregate patent data to test whether legal reforms that strengthen IPRs increase the transfer of technology by TNCs to reforming countries. The results suggest that technology transfer is higher following IPR reforms, with an increase in technology transfer, as measured by intra-firm royalty payments from parent firms to affiliates located in IPR reforming countries. They also distinguish affiliates between those whose parent companies patent in the US above and below the median. They find that technology transfer is concentrated among affiliates of parents that use patents extensively (i.e. those that patent above the median).

In conclusion, while there are many reasons to expect inward FDI to be an important channel for technology diffusion, the evidence of this to date at both the aggregate and firm level is mixed. If anything at all, the evidence indicates that FDI is an important source of diffusion in countries that have reached a certain level of absorptive capacity. To the extent that FDI is an important source of diffusion, IPR protection can affect the extent of technology diffusion through its impact on FDI flows. Again however, the evidence linking IPRs to FDI is mixed. Stronger IPR protection has been found to encourage FDI in certain industries, most notably chemicals and pharmaceuticals. As with trade, IPRs may play less of a role in high-tech industries due to the difficulty in imitating these industries products, while in low-tech industries other factors may be more important in determining FDI flows. Stronger IPR protection has also been found to affect FDI flows at certain production stages. In particular, IPRs can affect FDI flows in component manufactures, final production and R&D facilities, reflecting the fact that patenting is more important at some stages of production than at others.

5.3. Intellectual Property Rights and Licensing

The role of licensing as a means of technology diffusion is complex. Licensing is not a simple transaction and difficult to characterise. Licensing transactions range from turnkey projects to technical assistance, codified knowledge and IPRs. Furthermore they can differ regarding the rights transferred (e.g. distribution rights, production rights, and limits regarding the time and geographical territory the rights are granted for), the compensation mode (e.g. fixed fees, share of profits, franchise fees) and other specifications (e.g. provisions for performance requirements, "no-compete" clauses, non-disclosure mandates and grant-back provisions for adaptations). While licensing can be an important device for technology transfer, successful technology transfer again very likely depends on the host countries technological capacities (Maskus 2004: p. 20).

Economic theory suggests that firms that own a complex technology, produce highly differentiated products and face high licensing costs are more likely to undertake FDI than licensing (Horstmann and Markusen, 1987). FDI is more efficient in these circumstances as it allows the costs of technology transfer to be internalised. The reasons that technology and product licensing should be particularly sensitive to IPR protection are evident however. Stronger IPRs should reduce the costs of licensing by reducing the licensor's expense of deterring defection from contracts. They should expand security over the protection of proprietary information in licensing deals. Stronger IPR protection gives the licensor greater ability to set and monitor terms under which licensees operate. A stronger IPR regime is also likely to increase the rents accruing to the licensor, since it does not need to offer the licensee a higher share of the rents to deter imitation. At the same time stronger IPR protection provides the licensor with greater monopoly power, which as discussed above can reduce innovation, which in turn may lead to reduced licensing.

Little empirical literature on licensing and on the importance of IPRs exists. Contractor (1980) carried out one of the first studies on this subject. His study, which covers 102 technology licenses, mainly focuses on the level and composition of compensations however. Regarding patent protection, he shows that licensing returns are higher for patented technology. Mansfield (1994) in his study of IPR protection and FDI found that US TNCs were less likely to transfer advanced technologies to unaffiliated firms in countries with weak patent rights. More recently, Yang and Maskus (2005) estimate the impact of international variations in IPR protection on the volume of unaffiliated royalties and licensing fees (a measure of arms-length technology transfer) paid to US firms in a panel of 23 largely developed countries in 1985, 1990 and 1995. Included alongside the GPI (and its square) are measures of human capital (representing imitative ability), real GDP, the labour force and a measure of openness. The results often indicate a non-linear relationship between licensing and IPR protection, with stronger IPR protection reducing licensing at low levels and increasing licensing at higher levels. This it is argued is because countries with the lowest levels of IPR protection also have the weakest imitative ability. As such an increase in IPR strength in these countries, while reducing the risk of imitation slightly, would also increase the monopoly power of the licensor. This latter effect is likely to dominate and lead to lower licensing. Most observations in the sample however are above the turning point, suggesting that IPR protection has a positive impact upon licensing.

Anand and Khanna (2000) investigate the structure of licensing agreements (e.g. prevalence of cross-licensing and exclusive licensing, the decision between ex-ante and ex- post technology transfer as well as between related and unrelated parties) for a number of different industries (chemicals, industrial and commercial machinery, and electronic and electrical equipment and components[56]). The study finds substantial differences in licensing structure between industries. Anand and Khanna assume that IPRs are defined not only by policy choice but also by bounded rationality. Patent protection is considered strong in the case of chemicals since it is relatively easy to precisely describe chemical inventions and inventing around an existing patent is difficult in the chemical industry,[57] while making such a verbal exhaustive description of an innovation in the electronics industry is much more difficult (e.g. a circuit layout). In this latter case there is substantial room left for inventing around a patent and reverse engineering. Consequently, patent protection is stronger in the chemical industry than in the others. Their study finds that the structural differences in licensing patterns of industries can be explained by these variations in IP protection.

Fosfuri (2003) focuses in his paper on the effects of country risk on international technology flows in the chemical industry. In contrast to the other studies reviewed here, Fosfuri does not

[56] These industries will from now on be referred to as chemicals, computers and electronics, respectively.

[57] This is only the case if product protection is available. If only the process can be protected, inventing around is considerable less challenging.

find a statistically significant impact of IPRs on licensing, neither regarding the volume of licensing nor the serving decision[58]. Fosfuri argues that firms might react to lower protection levels by transferring older technology, though this cannot be tested in his data. Park and Lippoldt (2005) propose another explanation for Fosfuri's findings. They point out that process innovations, which make up the main part of innovations for the firms included in the sample, are better protected by other mechanisms than patent protection (p.15).

Park and Lippoldt (2005) use firm level data to investigate the relationship between IPRs and licensing receipts and between the volume of licensing and IPR strength. As control variables, country risk, corruption and the mean tariff rate are included. The empirical findings support the proposition that stronger IPR protection positively affects international licensing. In particular, the study finds that stronger IPRs increase licensing flows for industrial processes, pre-recorded performances, and software. Furthermore the industry groups electrical and electronics, transportation, finance, and services are positively affected by IPRs, while for the food and kindred, chemicals, metals, machinery and wholesale industries no significant impact is found. The study further finds that IPRs positively influences licensing in both rich and poor countries, with the effect being economically more important in relatively richer countries. Park and Lippoldt (2005) also explore whether IPRs influence the serving decision by using the ratio of unaffiliated licensing to trade or FDI as dependent variables. They find that when IPRs increase, licensing is favoured over trade in poorer countries while it is insignificant in richer countries. In the case of licensing compared to FDI, licensing is favoured in both income groups. Theoretical considerations also suggest that licensing is favoured over the other channels of technology transfer when IPRs are stronger (p. 29-30).

5.4. Intellectual Property Rights and Foreign Patenting

A further formal channel of international technology diffusion that is relevant is the patenting of innovations in a country by non-residents. When applying for a patent the innovator must submit a written description of the innovation, which is then available for all to see. As such, non-resident patent applications provide domestic residents with details of foreign technology, which can then be used in further domestic innovative activities (to the extent that domestic innovative activity doesn't infringe upon the patent at least). This channel shouldn't be seen in isolation to the channels discussed above however: if the innovating non-resident firm was not going to supply a particular market through trade, FDI or licensing then it would have little incentive to patent its technology there. Eaton and Kortum (1996) argue that the decision to serve a market will be driven largely by market size. They further argue that firms would find it unnecessary to patent an innovation in a foreign market with little imitative ability, since the risk of their innovation being imitated would be small. As such, firms would

[58] Fosfuri (2003) only distinguishes between technological transfer that includes the transfer of production since the data set does not include export data (p.5).

find it most necessary to patent their inventions in countries with large markets and with relatively high levels of imitative ability. To test this Eaton and Kortum (1996) include the RRI measure of IPR protection in their regression explaining the decision to patent abroad in OECD countries. They find that countries providing stronger IPR protection are more attractive destinations for foreign patents. They further show that productivity growth was significantly related to foreign patents, and that except for the major innovators (France, Germany, Japan, UK and the USA), countries in the sample obtained over 90 percent of their productivity growth from foreign patenting.

Other studies also consider developing countries. Park (1999) conducts a similar exercise to that above relating the decision to patent inventions abroad for 16 source countries and 40 destination countries for four periods between 1975 and 1990. He regresses the fraction of inventions in each source country that are patented in each destination on the market size of the destination (i.e. GDP per capita), the number of scientists and engineers per 10000 of the workforce, the cost of filing patents and the GPI. The results indicate a strong positive impact of IPR protection on the decision to patent, suggesting that a 1 percent increase in IPR protection leads to a greater than 1 percent increase in the rate of foreign patenting.

Xu and Chiang (2005) consider three channels of technology diffusion. These are: international trade (following the approach of Coe and Helpman, 1995); foreign patenting (following Eaton and Kortum, 1996); and disembodied spillovers (following the approach of Benhabib and Spiegel, 1994). Using data over the period 1980-2000, they split their sample of 48 countries into developed and developing countries and also into three groups based on real GDP per capita (low, middle and high-income countries). They show that, with few exceptions, TFP growth is positively and significantly related to all three channels of technology diffusion. They go on to examine the determinants of the patenting decision, finding that the level of IPR protection is positively and significantly related to foreign patenting across country groupings, suggesting that strengthening IPR protection may have a positive indirect upon TFP growth by increasing foreign patent applications.

5.5. Multiple Channels of Diffusion

While valuable and informative, the accumulation of studies of individual channels of technology diffusion is unlikely to provide full information on the effects of increased IPR protection on international technology transfer for several reasons. Firstly, the decisions to export, undertake FDI or license are made jointly, implying that studies considering a single channel may produce biased results. Secondly, there are some channels that are very difficult to measure - imitation and reverse engineering for example – and, consequently, analysis of the impact of these channels does not exist. Thirdly, as noted above, there are likely to be interactions between direct channels and indirect channels, such as imitation. In view of these considerations, some authors have looked either at multiple channels simultaneously or attempted to model the overall costs and benefits of stronger IPR protection.

It is reasonable to assume that the entry mode a firm chooses (licensing, FDI, or exports) is influenced by the level of IPRs. The Ownership-Location-Internalisation (OLI) framework from Dunning (1981) is a valuable approach to illustrate the simultaneousness of the serving decision facing the firm. It distinguishes three possible aspects that influence a firm's serving decision, ownership, location, and internalisation advantages. For example a firm can have ownership advantages due to intangible assets it holds. It can exploit location advantages by shifting production to a location with lower labour costs while the question of internalisation refers to whether or not to produce within or outside the firm. Thus in the context of IPRs ownership advantages (e.g. intellectual property that is protected) can, depending on the respective strength of market-power and market-expansion effect, increase or decrease "bilateral exchange"[59] in general. Regarding the location decision, strong IPRs in a country can constitute a location advantage and thus increase local production (FDI and licensing) relative to exports. And finally since internalisation is preferred when the threat of imitation is very high, internalisation favours exports and FDI (Smith, 2001: pp. 414-418). Thus, apart from a fairly strong theoretical case for a positive influence of IPRs on licensing, no conclusion can be drawn about the net effect of higher levels of IPRs on the serving decision from these considerations.

Other aspects that can influence the serving decision in conjunction with IPRs have been put forward in the literature. Fosfuri (2000) finds that the decision on the entry mode not only depends on the level of IPRs but also on the vintage of the technology to be transferred. Maskus et al. (2005) find that the effect of stronger IPRs depends on whether the decrease in contracting cost or the decrease in imitation threat prevails. In the first case licensing increases relative to FDI, while the second case is more ambiguous. At a high rate of global innovation an increase in IPRs yields the same results as in the first case, but with a low global innovation rate FDI is likely to increase relative to licensing. Consequently the effect of stronger IPRs is in this case affected by the rate of innovation in the respective industry.

There are a limited number of empirical studies which take account of the simultaneity of the serving decision. Ferrentino (1993) uses a gravity model estimated by SUR for sales by foreign affiliates, intra-firm exports and arm's length exports. The level of IPRs is simply measured by membership in international IP conventions (Paris, Berne and UPOV) and the duration of protection. The study does not find an effect of adherence to IPR agreements regarding U.S. exports or foreign production. Transfer exports[60] however, are higher under a weak IPR

[59] The term "bilateral exchange" is used to refer to all three serving decisions (trade, FDI and licensing) (See Smith, 2001).
[60] U.S. exports from the parent firm to a foreign affiliate.

regime. Unsurprisingly, under a weak IPR regime U.S. parent firms are less willing to transfer production processes to the foreign affiliate and thus export more to these affiliates.

Fink (2005), who investigates the effect of different levels of IPRs on U.S. and German foreign production, exporting and licensing behaviour also finds only weak evidence for an impact of IPRs on these channels of technology transfer. His approach is similar to Ferrentino's, but improves on it by using a more precise IPR measure (the GPI) and takes account of the possibility that data availability may affect the randomness of the sample. His findings for the U.S. indicate that there is no or at best a weak negative impact of IPRs, while for Germany exports as well as receipts for processes, inventions and patents are positively influenced by IPRs. This last finding however does not indicate whether this is due to an increase in technology transferred or a consequence of the stronger bargaining power of German firms due to stronger IPRs.

Maskus (1998b) considered the joint decision of TNCs, examining the impact of patent rights on patent applications, affiliate sales, exports and affiliate assets using a four equation simultaneous equation model. The model was estimated with data on the foreign operations of US majority-owned manufacturing affiliates in 46 destination countries over the period 1989-1992. As independent variables Maskus included the RRI, distance from the US, investment incentives, market size, tariff protection and the level of local R&D. Also included was the interaction between the IPR index and a dummy for developing countries. The results suggest that patent applications are strongly affected by IPR protection, though less so in developing countries. Stronger IPRs also impact positively upon exports, affiliate assets and affiliate sales in developing countries.

In a similar vein, Smith (2001) considers the simultaneous impact of IPR protection on US exports, affiliate sales and licenses to unaffiliated foreign firms in a sample of 50 developed and developing countries using a variant of the gravity equation. As in her previous study, the IPR variable is interacted with dummies for weak and strong imitative ability. The results suggest that stronger IPRs increase bilateral exchange across all countries. At the same time, stronger IPRs increase the benefits of locating abroad and lead to increases in affiliate sales and licensing relative to exports, particularly in countries with strong imitative abilities. Strong IPRs also reduce the need to internalise knowledge assets within the firm thus increasing US licenses relative to both affiliate sales and exports. The evidence in favour of stronger IPRs increasing US exports is weak once multiple channels of exchange are allowed.

McCalman (2005) seeks to quantify the impact of TRIPS, by estimating an endogenous growth model for 27, mostly developed, countries[61]. He finds that in the short-run (i.e. when

[61] See also McCalman (2001) who estimates the value of income transfers between countries in response to TRIPS.

the level of technology is held constant) the majority of countries lose due to a redistribution of wealth to foreign owners of technology. But in the long run, when research efforts can respond to the enhanced incentives provided by TRIPS, all countries benefit. McCalman shows that the increase in income levels due to enhanced innovation are sufficient to offset the redistributive impact of TRIPS, though under certain plausible parameter values India was found to lose. Given this last result, one might conjecture that countries with lower technological capability than India, but which were not covered in this study, may also suffer under TRIPS.

In an interesting case study, McCalman (2002) examines the behaviour of Hollywood film studios with respect to IPR protection in different countries. Given the large fixed costs and relatively low duplication costs of new films, IPR protection is likely to be of great importance to film studios. McCalman studies the speed of diffusion of 60 Hollywood films to 37 countries. The results suggest that increasing IPR protection from a relatively low level to a moderate level increases the speed of diffusion, but further increases to a high level reduce the speed of diffusion. The release of a film is likely to be delayed in countries with weak IPR protection because of the risk of piracy that will reduce returns on that film. In countries with relatively high IPR protection studios may be less worried about piracy, but more worried about competition with their existing products, and so may also delay the release of a film. Overall, the results suggest that while some IPR protection can speed the diffusion of new products (films in this case), very strong IPR protection may in fact reduce the speed of diffusion.

Lippoldt and Park (2003) regress trade flows as well as FDI in- and outflows on GDP per capita, country risk, mean tariff rate and the Ginarte and Park index (1997). Their results regarding imports are rather ambiguous. While there is a significant positive impact of IPRs on imports for all countries, there is only a statistically modest positive effect for developing countries and an insignificant one in the case of least developed countries. These findings are in line with the arguments of Maskus and Penubarti (1995) suggesting that market size is important in determining the effect of patent protection.

6. Economic Growth, Welfare and Intellectual Property Rights

In the modern literature on economic growth, technological progress is viewed as the prime determinant of long-run growth. This technological progress arises from the activities of economic agents carried out in order to profit from the introduction of new products (Romer, 1990; Grossman and Helpman, 1991, Ch. 3) or the improvement of existing ones (Grossman and Helpman, 1991, Ch. 4; Aghion and Howitt, 1992). Agents invest in R&D in the expectation of profiting from the resulting inventions. But besides creating new products, innovative activity adds to society's stock of knowledge, upon which subsequent innovations are based. This process is assisted where the information that IPRs protect is made available to other potential inventors as in patent claims.[62] The global rate of growth then depends upon the rate of innovation and the stock of knowledge, and IPRs can increase growth by encouraging both.

When it comes to exploring these issues in a multi-jurisdiction context, the most relevant analyses are those that examine a world composed of two types of countries: a developed, innovating "North" and a developing, imitating "South". The main concerns have been whether increased IPR protection in the South would increase (i) the rate of (global) growth, (ii) the rate of technology transfer from the North to the South, and, (iii) welfare levels in both locations. A straightforward partial equilibrium analysis reveals that while the North always benefits from stronger IPR protection in the South, the South itself is found to benefit only when R&D is highly productive, such that the R&D induced by stronger IPR protection in the South results in significant cost reductions, and when the South comprises a large share of the overall market for the good (Chin and Grossman 1990). In these circumstances the additional monopoly profits available in the South provide a significant additional incentive for northern investment in R&D, and the welfare of the South increases due to the increased benefits in consumption resulting from northern R&D. But as Deardoff (1992) shows, the benefits of increased innovation through stronger IPR protection become weaker as more and more countries strengthen their IPR regimes, since the extra market covered and the extra innovation that can be stimulated by such protection diminishes. Since IPR holders engage in monopoly pricing that distorts consumer choice, strengthening IPR protection can lead to welfare reductions, particularly in a country that undertakes little or no R&D and would otherwise be able to free ride on foreign innovations[63]. Countering this is the notion that the North and the South may have different requirements and priorities when it comes to technology (Diwan and Rodrik, 1991). The South may then have an incentive to provide IPR protection in order to facilitate the invention of the particular technologies that meet its needs, which might otherwise be neglected.

More recent work has considered dynamic general equilibrium models of innovation and growth. Several aspects are then shown as potentially important. One is the competition for

[62] Mansfield (1985) provides evidence suggesting that the learning process from patent claims is relatively rapid, taking 10-12 months in the US. These benefits should not be overstated however since patents do not necessarily disclose sufficient information for the invention to be manufactured and many developing countries lack the capacity to adopt and adapt new techniques.

[63] Results such as these have led many commentators to argue that the main impact of TRIPS will be to shift wealth from developing countries to firms in developed countries. Rodrik (1994) for example states that "irrespective of assumptions made with respect to market structure and dynamic response, the impact effect of enhanced IPR in LDCs will be a transfer of wealth from LDC consumers and firms to foreign mostly industrial-country firms" (p. 449).

scarce resources between R&D (investments in innovation) and the production of the new and improved goods that arise from the innovation. The channels through which technology can be transferred from one country to another then become significant. In the simplest case, where only goods are traded, successful southern imitation results in the competitive advantage for the production of imitated products shifting to the South. Stronger IPR protection in the South then decreases southern imitation and increases northern innovation in the short-run, as innovation becomes more profitable. But, as Helpman (1993) notes, in the long-run innovation in the North may fall, because if new products are produced for a longer time span in the North fewer resources are available for innovation there. Stronger IPR protection in the South may then reduce global growth. But weak IPR protection in the South may have effects besides reducing the incentive for innovation in the North. Northern exporters may be able to 'mask' their production technologies, thereby limiting the extent to which it can be imitated through traded goods (Taylor 1993). The potential gains from technology transfer through weak IPR protection in the South might then be offset by increases in northern masking.

Where FDI is an option, the resource competition effect noted by Helpman is moderated (Lai 1998). The innovator can now shift production of new goods to the South, reducing the competition for resources in the North. Stronger IPR protection in the South may increase the speed of foreign investment and the return to innovation further. This analysis becomes more complicated, however, if one assumes, as seems reasonable, that southern firms can more easily imitate the products of TNCs when they are produced in the South than products produced in the North. Stronger IPR protection in the South then makes "imitation" more costly, and southern firms find themselves devoting greater resources to imitation, but with a lower rate of success. The additional resources drawn into imitation in the South leave less available for production, causing FDI to contract. In response production is shifted back towards the North leaving fewer resources in the North available for innovation, which lowers the rate of innovation overall (Glass and Saggi, 2002).

Extending the options further, the impact of stronger IPR protection in the South on incentives for firms in the North to innovate and to license advanced technologies to firms in the South has also been examined (Yang and Maskus 2001a). Licensing has the advantage of higher profits due to lower production costs in the South, but involves other costs in terms of contract negotiations, transferring the necessary technology and in the rents that the innovator must give to the licensee to discourage imitation. By reducing the risk of imitation, stronger IPR protection in the South reduces the costs of licensing (and its policing), thus encouraging licensing to the South and freeing up resources for innovation in the North.

Perhaps the most important conclusion that follows from this brief review of the relevant theoretical literature is that the implications of stronger intellectual property protection in the

South on either the incentives for innovation in the North or the rate of technology transfer from the North to the South are not clear cut. Much depends on the channels of transmission available and the ability of the South to take advantage of the technology to which it is exposed. For individual countries the impact of IPR protection on growth is likely to depend upon country characteristics, most notably factor endowments. This leads to a further consideration. Many models of endogenous growth have one dynamic sector that exhibits learning by doing externalities or spillover effects and another traditional sector that does not. Then, depending on whether opening up to trade shifts resources toward or away from the dynamic sector, a country's rate of economic growth may increase or decrease with globalisation. The reallocation of resources will depend upon a country's initial factor endowments, amongst other things. While IPR protection would be expected to enhance growth in countries that move toward free trade and have a comparative advantage in the dynamic sector, its impact on countries with a disadvantage in this sector is less clear.

There is a small empirical literature that directly tests whether stronger IPRs are likely to result in higher growth. The results from this literature are summarised in Table 3. This literature is not generally concerned with testing for the specific channels through which technology is being transferred among countries, or for the mechanisms through which growth might be enhanced, but simply whether, where and when a positive effect is discernable. The approach adopted is to include a measure of the strength of IPR protection in a standard cross-country empirical growth framework.

While issues remain over the direction of causality[64] the results of the various studies lead to fairly consistent conclusions. Gould and Gruben (1996) employ the RRI to examine the importance of stronger IPR protection for growth in a sample of up to 95 countries with data averaged over the period 1960-1988. They also examine whether the impact of IPR protection on growth depends upon the degree of openness to trade, the underlying argument being that in closed economies stronger IPR protection may not have the desired effect of encouraging innovation and higher growth, as firms may not have the incentive to innovate if their market is guaranteed[65]. The model of Rivera-Batiz and Romer (1991) provides a theoretical rationale for this hypothesis, with firms in closed economies finding it more profitable to copy foreign technology than develop new technology.

Gould and Gruben regress the average growth of real GDP per capita on the RRI and a number of standard explanatory variables, including initial GDP per capita, the investment to

[64] The level of IPR protection is highly correlated with a country's level of economic development. Ginarte and Park (1997) examine the determinants of their index and find that higher levels of GDP per capita, shares of R&D in GDP, openness and levels of human capital are positively related to the strength of IPR protection.
[65] Their hypothesis is based on firm-level evidence from Brazil by Braga and Willmore (1991) who found a negative relationship between the degree of trade protection and a firm's propensity to develop new technology or purchase it abroad.

GDP ratio, the secondary school enrolment ratio and initial levels of literacy. They find that stronger IPR protection has a positive impact on growth, which is marginally statistically significant. Gould and Gruben then go on to examine the relationship between IPR protection and growth in open versus closed economies. Openness is measured using three variables. The first two are the Black Market Premium (BMP) and distortions in real exchange rates. Countries with high BMPs and high real exchange rate distortions tend to be highly distorted and inward oriented (De Long and Summers (1991) and Dollar (1992) respectively). The third measure is a composite index of a country's trade regime developed by Gould and Ruffin (1993) comprising a number of existing trade orientation indices as well as a country's BMP, real exchange rate distortions and the ratio of import taxes to imports. Each of these are interacted with the RRI and included in the growth regression. From their results, Gould and Gruben conclude that IPR protection has a slightly larger effect on growth in more open economies. These last conclusions are tentative, however, since, as Gould and Gruben acknowledge, openness is multifaceted, which makes using a single measure problematic, particularly since the measures of openness that have been employed in the empirical literature tend not to be highly correlated (Pritchett, 1996)[66].

Thompson and Rushing (1996) conduct a similar exercise, regressing the average growth of real GDP per capita between 1970 and 1985 on the ratio of investment to GDP, the secondary school enrolment ratio, population growth, initial GDP per capita and the RRI for 112 countries. While they find a positive relationship between the RRI and growth, it is not statistically significant. They then go on to consider whether IPR protection may have an impact upon a country's growth rate, but only once a country has reached a certain (but unknown) level of development, as measured by initial GDP per capita. For this they employ threshold regression techniques finding a threshold at an initial level of GDP of $3400 (in 1980 dollars). For countries below this value there is no significant relationship between IPR protection and growth, but above, the relationship is positive and significant.

In a later paper (Thompson and Rushing, 1999), they extend their analysis to a system of three equations. The three dependent variables are: the growth rate of real GDP per capita, the ratio of total factor productivity (TFP) in 1971 to that in 1990 and the RRI. The system is estimated using Seemingly Unrelated Regression (SUR) techniques for 55 developed and developing countries. They once again split their sample in two depending on the initial level of GDP per capita. It is found that increases in TFP have a positive and significant impact on GDP growth. The IPR index is found to have an insignificant impact on TFP for the full sample of countries, but a positive and significant impact for the richest sub-sample. The results suggest that in the most developed countries stronger IPR protection impacts upon growth by enhancing TFP.

[66] Rodriguez and Rodrik (2000) provide a critique of the most popular measures of openness.

Falvey, Foster and Greenaway (2004a) extend and update the single equation analysis by employing recently developed threshold techniques of Hansen (1996, 1999 and 2000). These allow the positioning and significance of a threshold (i.e. a structural break) to be identified, as well as the possibility of having more than one threshold. They use the GPI and a panel of up to 80 countries with data averaged over four five-year periods between 1975 and 1994. They follow the approach of Thompson and Rushing, arguing that the impact of IPR protection is likely to depend upon the level of development of a country as well as the structure of its economy. They use initial GDP per capita and manufacturing value added (since manufacturing tends to be the most R&D intensive sector) as alternative indicators of imitative/innovative ability. The two measures of imitative ability yield consistent results, indicating a three-regime model. For countries in either the low or the high regimes a positive and significant impact of IPR protection is found. But for countries in the middle regime no significant relationship between IPRs and growth appears to exist.

Schneider (2005) examines the effect of high technology trade, IP protection, and FDI on innovation and growth. She uses a panel data set from 1970 to 1990, which contains data on up to 19 developed and 28 developing countries. Regarding innovation (measured by U.S. patent applications by respective foreign residents) she finds that IPRs (measured by the Ginarte and Park index) have a statistically significant positive impact on innovation in developed countries but a statistically significant negative impact in developing countries. Schneider suggests that this can be attributed to the fact that innovative activities in developing countries are often adaptive or imitative. Schneider points out that, instead of turning away from intellectual property protection in developing countries, innovative activities should be fostered, if necessary with support from developed countries. In the growth regression IPRs are significant and positive for the sample of all countries but insignificant in the split samples. Thus, it is difficult to draw any conclusions from these findings. However, Schneider argues that the impact of IPRs on growth might not be fully captured in a traditional growth regression, due to its indirect nature.

Finally, there has been at least one attempt to explore the way in which IPR protection can influence the factors that directly contribute to the growth of GDP per worker. Park (1999) uses SUR methods to estimate a system of four equations. The four dependent variables are output growth, the fraction of GDP invested in the capital stock, the fraction of GDP invested in human capital and the fraction of GDP invested in R&D. The latter three variables are included as explanatory variables in the output growth equation, while the GPI is included as an explanatory variable in all four equations. The model was estimated for 60 countries with data averaged over the period 1960-1990. The results suggest that, while IPR protection has an insignificant direct impact on output growth, it does have a significant indirect effect through its impact on physical capital and R&D investment. Splitting the sample in two based on the average level of GDP per worker, Park finds that IPR protection affects growth indirectly through these inputs in the richest half of the sample only, with no significant impact found for the poorest half.

7. TRIPS and Developing Countries

As the narratives concerning the coming into force of TRIPS vary, so does the way TRIPS is perceived. While some observers, especially from the developing world, condemn TRIPS as a neo-imperialistic document[67] others emphasise the possible gains from TRIPS, for example via an increase in technology inflows through formal channels as FDI and licensing. Accordingly, the first group recommends a minimalistic implementation of the agreement and call for a more 'development friendly' interpretation of TRIPS. This point of view has been sharply criticised by the proponents of the 'self-interest theorists'. Lately a more sophisticated point of view has gained ground, which on the one hand acknowledges that simply implementing TRIPS into a developing countries legal framework will not yield huge developmental benefits and can even cause welfare losses in some cases, and on the other hand recognises that TRIPS can have beneficial effects for those countries if implemented with care (Gervais, 2007: pp. 13-17).

Keeping this in mind different aspects of the TRIPS Agreement and their implications for developing countries will be addressed in the following section. As already mentioned, TRIPS represents a significant change in the global intellectual property regime. The TRIPS Agreement for the first time combined the mosaic of intellectual property conventions, which until then constituted the international intellectual property regime, into one agreement[68]. Another major change from the Paris Convention to TRIPS regards the subjects of patentability. While the first provided the opportunity to omit certain matters the TRIPS Agreement requires that "patents shall be available for *any inventions, whether products or processes*, in all fields of technology, provided that they are new, involve an inventive step and are capable of industrial application" (Art. 27.1, emphasis added). The only exceptions are diagnostic, therapeutic and surgical methods (Art. 27.3 (a)), and plants and animals. However all members are obliged to provide patent protection for microorganisms and patent or *sui generis* protection for plant varieties (Art. 27.3 (b)). Further "[m]embers may exclude from patentability inventions, the prevention [...] of which is necessary to protect *ordre public* or morality [...]" (Art. 27.2). In particular the obligatory protection of plant varieties as well as the

[67] "The intent of the TRIPS Agreement is perfectly clear. From the start of the industrial revolution, every country that became economically great began by copying: the Germans copied the British, the Americans copied the British and the Germans, and the Japanese copied everybody. The thrust of the TRIPS Agreement is to ensure that this process of growth by copying and learning by doing will never happen again" (Kingston 2005: p. 658)

[68] The Agreement covers Copyright and Related Rights, Trademarks, Geographical Indications, Industrial Designs, Patents, Layout-Designs (Topographies) of Integrated Circuits, Protection of Undisclosed Information, and Control of Anti-Competitive Practices in Contractual Licences (WTO 1994, TRIPS Part II)

impossibility to exclude some matters from patentability constituted a major change for many developing countries. As Correa (2000: p. 50, p. 68) points out only a few developing countries provided for plant variety protection before TRIPS and 65 countries, the vast majority of them developing countries, excluded pharmaceutical products from patentability in 1980. Still, while the room for manoeuvre has been limited by TRIPS, it has not vanished. There is no clear definition of the requirements for patentability, namely the inventive-step, the capability of industrial application and for newness[69]. There have been and probably will continue to exist substantial differences among countries regarding the interpretation of these terms - even among developed countries (Correa 2000: pp. 57-61). Thus, in this aspect TRIPS does provide for some scope of action for signatory countries. For example countries are free to establish utility model patents with a low inventive step, which in the past successfully increased local adaptive innovation in Germany, Japan, Taiwan, and South Korea.

Besides the subjects of patentability there are a couple of other provisions that require relevant legal changes for many countries. While the provision of 'national treatment' is not new - the Paris Convention was based on that principle - the principle of 'Most Favoured Nation' (MFN)[70] is new to the intellectual property framework (UNCTAD-ICTSD 2003: p. 48). The length of patent protection must last for 20 years from the date of completion (Art. 33), in process infringement cases the burden of proof is reversed (Art. 34), a provision that considerably strengthens the position of the patentee, working requirements are not allowed[71] (Art. 27.1), and finally compulsory licensing, while not entirely banned, is subject to severe restrictions (Art. 31). Compulsory licensing has been pointed out as a viable policy tool to address development issues (e.g. to foster technology transfer). However, it should be kept in perspective that a country's ability to effectively use a patented technology depends to a great degree on its technological capacity. Hence more advanced countries may benefit from compulsory licensing, while least-developed countries may lack the ability to do so (Juma 1999: pp. 14). Further, the possibility to request the revision of compulsory licensing when the circumstances that led to the granting no longer exist intensifies the insecurity for the licensee and may discourage a company from seeking compulsory licensing in the first place since it may not be able to recover its investment (Correa 2005: pp. 248). These aspects, among others, vitally constrain the developmental possibilities of compulsory licensing in general.

In order to account for the concerns raised by many developing countries that their access to technology would be locked up by TRIPS, several passages of the Agreement refer to the

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[69] "[...] patents shall be available for any inventions [...] provided that they are new, involve an inventive step and are capable of industrial application" (Art.27.1)

[70] Any "advantage, favour, privilege or immunity" accorded by one Member to another must "immediately and unconditionally" be granted to all other members (Art. 4).

[71] Art 27.1 states that "patents shall be available and patent rights enjoyable without discrimination [...]whether products are imported or locally produced". This has been interpreted as ban on any requirements to produce an invention locally (Correa 2000: p. 90).

unique situation of developing countries. Already the preamble to the agreement recognises "the underlying public policy objectives of national systems for the protection of intellectual property, *including developmental and technological objectives*" and "the special needs of the least-developed country members in respect of maximum flexibility in the domestic implementation of laws and regulations in order to enable them *to create a sound and viable technological base*" (TRIPS preamble, emphasis added). The relevance of the dissemination and transfer of technology is further strengthened in Article 7, where the objectives are outlined; in Article 8, which refers to the principles of the agreement[72]; and in Article 66.2 , which calls upon developed countries to "provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least-developed country members in order to enable them to create a sound and viable technological base" (Art. 66.2). However, there has been disagreement upon the question of whether this article actually *obligates* developed countries to do so and which countries are in fact referred to with the term "developed country members" (Moon 2008: p. 2). Moon (2008) and Correa (2007) recently investigated to what extent this 'obligation'[73] has been met by developed countries. Both studies focus on the mandatory annual reports on Article 66.2 activities by developed countries and come to the conclusion that in general developed countries have not met their obligations, since they either failed to submit their reports at all or their reported activities did not focus on LDCs, did not qualify as technology transfer, or their activities should be rather classified as traditional Official Development Aid (ODA).

TRIPS provided for a range of transitional periods for countries to bring their national IPR laws into TRIPS compliance. Except for least-developed countries who still have time until 2016 to introduce "patent protection for pharmaceutical products", all other transition periods have by now expired (UNCTAD ICTSD 2003: pp. 48-49).

All controversies among members are subject to the Dispute Settlement Mechanism. On the one hand this, as already mentioned, has the advantage, especially for developed countries, that contrary to the WIPO Convention, there is an enforcement mechanism to apply in the case of non-compliance to the Agreement. On the other hand, it also has advantages for developing countries since unilateral actions by any member are unlawful. This in fact can prevent developing countries from 'section 301' procedures under the US Trade Act. However, there has been evidence that the unilateral actions by the US did not cease with the introduction of TRIPS (Drahos 2006: pp. 89-99).

[72] Article 8.2 allows for measures "to prevent the abuse of intellectual property rights by right holders or the resort to practices which unreasonably restrain trade or adversely affect the international transfer of technology". However these measures have to be consistent with the provisions of the TRIPS Agreement (TRIPS, Article 8.2).

[73] Due to concerns from developing countries, that developed countries do not comply with article 66.2 the WTO Ministerial Conference in Doha reaffirmed that "[...] the provisions of Article 66.2 of the TRIPS Agreement are mandatory [...]" (WTO 2001).

TRIPS substantially alters the global intellectual property regime and the minimum standards it introduces constitute a considerable strengthening of IPR protection in most developing countries. There is no question that developed countries are the ones to gain most from TRIPS and that imitation and reverse engineering are increasingly restricted under TRIPS. However, TRIPS in no ways harmonises the national intellectual property laws. As pointed out there is still room left for manoeuvres in order to generate intellectual property laws that suit a country's level of economic development. And there are potential gains especially from dynamic effects for developing countries. On the other hand, whether these gains can be realised remains to be seen. The costs of implementing, administering and enforcing TRIPS have to be borne beforehand (UNCTAD-ICTSD 2003: p. 49). Despite the attempt to bring all relevant intellectual property issues into one agreement, there are still subjects regulated outside of this framework by other agreements. The most important probably is the International Union for the Protection of New Varieties of Plants (UPOV).[74] Its membership[75] has substantially benefited from TRIPS, since Art. 27.3 (b) commits TRIPS members to either protect plant varieties by patents or *sui generis* systems, where UPOV is the only agreement that provides *sui generis* protection for plant varieties at the moment[76]. Besides the very few choices countries have if they decide to protect plant varieties by *sui generis* systems, some developing countries joined UPOV because it was a concession made in bilateral free trade agreements with the US or the European Union (UNCTAD-ICTSD 2003:53). These bilateral agreements on trade and investment increasingly incorporate intellectual property issues.

As already emphasized TRIPS generates a minimum level for intellectual property protection and nothing impedes countries from implementing higher standards of intellectual property protection as long as they are not contrary to any provisions of TRIPS. Thus, TRIPS-Plus standards are possible. A TRIPS-PLUS standard bilateral agreement "requires a Member to implement a more extensive standard [than TRIPS]; or which eliminates an option for a member under a TRIPS standard" (Drahos 2006: p. 91). Bilateral investment treaties (BITs) often do not include explicit references to intellectual property; many however do protect the rights of investors, whereas intellectual property is included in the definition of investment. In other cases the BIT is used to bribe countries into signing bilateral intellectual property agreements (BIPs). Both do not generate a TRIPS-Plus standard per se, though there are provisions in the 'standard agreements'[77] that do further strengthen IPRs. An example of this

[74] The Treaty on Plant Genetic Resources, and the Convention on Biological Diversity should also be mentioned in this respect. The first one is in some respects controversial (UNCTAD-ICTSD 2003:52, 54).

[75] 40 of the currently 67 Members (Status on May 2009) of UPOV have joined the Agreement after 1994 (UPOV 2009).

[76] There have been attempts to develop alternative systems, e.g. by the Organization of African Unity, South Korea, and India (UNCTAD-ICTSD 2003: 53, footnote 40 and 41 at p. 60).

[77] Since bilateral negotiations are cost and time consuming, the U.S. negotiators stick to a prototype agreement that has been approved by congress. If they do not deviate too far from this standardisation the approval of these treaties by congress is very likely (Drahos 2006:92).

proceeding is the bilateral investment treatment between the United States and Nicaragua (1995), which among other things committed Nicaragua to join the UPOV or the Agreement on the Establishment of a Free Trade Area (FTA) between the United States and the Hashemite Kingdom of Jordan, which also obligated Jordan to ratify UPOV and narrowed the exceptions from patentability. Another example is the FTA between the European Union and Mexico, which included TRIPS-PLUS standards (Drahos 2006: pp. 92-101).

The combination of multilateralism and bilateralism has a noteworthy consequence. Since Article 4 of the TRIPS Agreement obligates a country to make any concessions granted to one Member available to all the other Members too, the signatories (of a BIT, BIP or FTA) have to provide higher standards of IPR protection to all WTO members. Therefore these agreements introduce TRIPS-PLUS standards country by country into the WTO (Drahos 2006:100).

8. Concluding Remarks

The main purpose of IPRs is to encourage innovation by granting innovators a temporary monopoly over their innovations, thus allowing them to earn a positive return on the potentially large investments in R&D undertaken. While benefitting the individual innovators, by encouraging innovation IPRs are also expected to add to the overall stock of knowledge, which according to recent theories of growth will make future innovation easier and lead to sustained economic growth. While few would consider IPR protection to be a panacea for countries, and developing countries in particular, views on the importance of IPR protection tend to be polarised. On one side, it is believed that stronger IPR protection can encourage innovation, technology diffusion and enhance growth. On the other it is thought that stronger IPR protection leads to monopoly power for patent holders, reduces the incentive to innovate and limits the diffusion of knowledge. The evidence reviewed here supports neither claim.

In the past, countries have been able to adapt their IPR regimes to facilitate technological transfer and to promote their own industrial policy objectives. Evidence exists to suggest that many current innovators operated lax IPR systems in the past designed to encourage technology diffusion through imitation. Until recently, IPR policy was largely set at the national level which allowed countries to do this. The TRIPS Agreement however has shifted the conflict and the social bargain from the national level to a supranational domain. Consequently it was international power relations which played an important role in setting the level of IPRs for the vast majority of countries (May, 2007). It can be argued that industrialised innovators benefitted most from this change. Since the vast majority of intellectual property is produced and held in industrialised countries, developing countries are dependent on spillovers or formal technology transfer from these centres of R&D activity. TRIPS however, by increasing the strength of IPRs reduces the possibility to free-ride on technological knowledge produced in the North for most developing countries and limits the South to formal channels of technology transfer, which might be associated with substantial costs.[78] This, along with potential price increases and/or reduced product availability in the South and substantial implementation and enforcement costs associated with TRIPS have raised objections from the developing world.

Despite the above costs of IPRs for technology borrowers, stronger IPRs can increase FDI, trade and licensing flows, which are potential vehicles of technology transfer and hence can foster growth. There seems to be some evidence for an overall positive impact of IPR protection on bilateral exchange. While the findings for trade and foremost licensing are fairly consistent, the case of FDI seems to be the most ambiguous. The impact of IPR protection on growth, innovation and technology diffusion in non-innovating countries is likely to depend upon a number of factors. While stronger IPR protection in the poorest countries is not likely to lead to substantial benefits in terms of innovation or technology diffusion, the administrative cost of developing a patent system and the enforcement of TRIPS, along with the potential abuses of market power in small closed markets suggests that such countries could lose out from TRIPS. Stronger IPR protection in the poorest countries may also inhibit or lengthen the imitative stage of development that seems to be necessary in order to develop innovative capacity in many industries. In other developing countries however the potential for benefits from TRIPS is stronger. Existing firms engaging in imitation for example could be encouraged through stronger IPR protection to shift resources towards adaptive innovation, while stronger IPR protection is likely to increase trade and FDI flows into countries with existing imitative ability, thus enhancing technology transfer. Countries such as China, which have seen relatively large increases in innovative activity in recent years, are also likely to benefit increasingly from stronger IPR protection by encouraging domestic innovation, as well as through increased technology diffusion through formal channels and potentially through the offshoring of R&D activities from advanced countries.

Looking forward, while there is little enthusiasm in the developing world to see ever stronger IPR regimes firms in the developed world are keen to see stronger IPRs enforced internationally and to see an ever wider variety of innovations patentable (particularly in the area of bio-technology). Developing countries are however keen to get access to rich country markets and are likely to be willing to accept higher IPR levels as the price of such access. Combined with the Most Favoured Nation clause of the WTO this process of regional integration and bilateral agreements is therefore likely to result in a further increase in IPR levels for many countries in the near future. The impact of these changes on technology diffusion is unclear. On the one hand, we would expect formal channels of diffusion to expand, both because of the higher IPR levels and because of the increased integration

[78] This does not imply the informal technology transfer comes free of charge. Imitation of advanced technology can be cost and time intensive as well.

achieved through these bilateral and regional agreements. On the other, we would expect informal channels that have been used as a means of developing an innovative sector in the past to diminish in importance. Countries will still have some means at their disposal to influence the extent of diffusion through patent application and renewal fees, as well as through their definition of the "inventive step" required to make an innovation patentable and the breadth of the allowable patent claims. Other policies, such as those towards education, R&D investment and policies to attract FDI are also likely to play a role for a number of countries as a means of developing a technological base.

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Box 1: Substantive Requirements of TRIPS in the WTO

General obligations	*Comments*
1. National treatment	Applied for persons
2. Most favoured nation	Reciprocity exemptions for copyright; prior regionals / bilaterals allowed
3. Transparency	
Copyright and related rights	
4. Observes Berne Convention	Does not require moral rights
5. Minimum 50-year term	Clarifies corporate copyrights
6. Programmes protected as literary works	A significant change in global norms
7. Data compilations protected similarly	
8. Neighbouring rights protection for phonogram producers, performers	
9. Rental rights	A significant change in global norms
Trademarks and related marks	
10. Confirms and clarifies Paris Convention	
11. Strengthens protection of well-known marks	Deters use of confusing marks and speculative registration
12. Clarifies non-use	Deters use of collateral restrictions to invalidate marks
13. Prohibits compulsory licensing	
14. Geographical indications	Additional protection for wines and spirits
Patents	
15. Subject matter coverage	Patents provided for products and processes in all fields of technology
16. Biotechnology	Must be covered but exceptions allowed for plants and animals developed by traditional methods
17. Plant breeder's rights	Patents or effective *sui generis* system required
18. Exclusive rights of importation	
19. Severe restrictions on compulsory licensing	Domestic protection can no longer be required; nonexclusive licenses with adequate compensation
20. Minimum 20-year patent length from filing date	
21. Reversal of burden of proof in process patents	
22. Industrial designs	Minimum term of protection: 10 years
Integrated circuits designs	
23. Protection extended to articles incorporating infringed design	A significant change in global norms
24. Minimum 10 years protection	
Undisclosed information	
25. Trade secrets protected against unfair methods of disclosure	New in many developing countries
Abuse of IPRs	
26. Wide latitude for competition policy to control competitive abuses	Cannot contradict remainder of WTO agreement
Enforcement measures	
27. Requires civil, criminal measures and border enforcement	Will be costly for developing countries
Transitional arrangements	
28. Transition periods	5 years for developing and transition economies; 11

	years for poorest countries
29. Pipeline protection for pharmaceuticals	Not required but a provision for maintaining novelty and exclusive marketing rights
Institutional arrangements	
30. TRIPS Council	Agreement to be monitored and reviewed
31. Dispute settlement	Standard approach with 5-year moratorium in some cases

Source: Maskus (2000a)

Table 1: Instruments and Agreements for Protecting IPRs

Type of Intellectual Property	*Instruments of Protection*	*Protected Subject Matter*	*Primary Fields of Application*	*International Agreements*
Industrial Property	Patents and utility models	New, non-obvious inventions with industrial utility	Manufacturing, agriculture	Paris Convention Patent Cooperation Treaty Budapest Treaty Strasbourg Agreement TRIPS
	Industrial designs	Ornamental designs of products	Manufacturing, clothing, automobiles, electronics, etc.	Hague Agreement Locarno Agreement TRIPS
	Trademarks	Identifying signs and symbols	All industries	Madrid Agreement Nice Agreement Vienna Agreement
	Geographical indications	Identifying place names	Wines, spirits	Lisbon Agreement TRIPS
Artistic and literary property	Copyrights and neighbouring rights	Original expressions of authorship	Publishing, electronic entertainment, software, broadcasting	Berne Convention Rome Convention Geneva Convention Brussels Convention WIPR Copyright Treaty WIPO Performance and Phonograms Treaty Universal Copyright Convention TRIPS
Sui generis protection	Integrated circuits	Original designs	Computer chip industry	Washington Treaty TRIPS
	Database protection	Databases	Information processing	EC Directive 96/9/EC
	Plant breeder's rights	New, stable, distinct varieties	Agriculture, food	UPOV TRIPS
Trade secrets	Laws against unfair competition	Business information held in secret	All industries	TRIPS

Source: Primo Braga, Fink and Sepulveda (2000)

Box 2: Aspects of TRIPS and Their Impact on Innovation and Technology Diffusion

Included in the TRIPS Agreement are the following aspects of intellectual property protection:

- Patents – give their owners the right to exclude all others from making, selling, importing, or using the product or process named in the patent without authorisation for a fixed period of time. Three forms of patents may be applied for; (i) Invention patents require significant non-obviousness and as such a discrete advance in technology; (ii) Utility models tend to be awarded for incremental improvements of existing products and technologies; (iii) Industrial designs protect the aesthetic or ornamental aspects of a commercial article.
- Copyrights – protect the rights of creators of literary and artistic works to communicate, display, or perform those works in some medium, plus the rights to make and sell copies.
- Trademarks and service marks – protect rights to use a particular distinctive mark or name to identify a product, service or company.
- Geographical indications – are related to trademarks and certify that a consumer product was made in a particular place and that it embodies physical characteristics of that location.
- Trade Secrets – are proprietary information about production processes, including items such as customer lists and organisational methods. Standard liability laws guard against unauthorised disclosure through commercially unfair means.
- Layout Designs of Integrated Circuits – covers the layout design of integrated circuits, the chips on which they are masked, and products that incorporate the chip. TRIPS specifically permits reverse engineering of integrated circuits.

The importance of these different aspects of IPR protection for innovation and technology diffusion are likely to vary. Here we discuss some of these differences.

Patents are expected to increase both innovation and technology diffusion. By providing an incentive to undertake R&D and the associated costs of inventing a new technology or product, patents should encourage innovation. The empirical evidence suggests that the relationship between patent rights and innovation is not strong however (see Section 3). Through the publication of claims, patents add to the stock of public knowledge and can encourage technology diffusion. The evidence in favour of such diffusion is stronger (see Section 4).

Literary and artistic ideas protected by copyrights are without industrial applicability. While not encouraging industrial innovation, copyright protection is aimed at encouraging creative works that provide social, cultural and economic benefits to society. On the other hand, copyright protection limits the dissemination of literary works and raises the static costs of education, research and education.

Trademarks and geographical indications do not protect the creation of additional knowledge nor in theory do they restrict imitation or copying of protected goods as long as they are sold under a different mark. Like copyrights therefore they are unlikely to directly raise innovation or encourage technology transfer. Similar arguments can be made for the protection of integrated circuit designs, though TRIPS specifically allows for the reverse engineering of such designs. Trademarks are however likely to lower search costs, protect consumers from fraud regarding the origin of a product and safeguard commercial reputations for quality. Since trademarks and geographical indications are used as a signal of quality, they may also encourage firms to maintain or improve quality over time, as well as generating further product differentiation. There is also some anecdotal evidence that under the right circumstances trademarks can contribute to business development among low- and middle-income producers in the developing world (see for example Maskus et al., 2000c; Maskus, 2005).

continued…

Trade secrets are rationalised as a mechanism to foster innovations that do not comply with the strict requirements for the patentability of products and processes. Firms may choose not to patent an innovation for a number of reasons; (i) the innovator may judge their creation to be unpatentable in legal terms, but hard to imitate; (ii) a firm may prefer not to disclose its processes, as required by patents, because disclosure could reduce expected profits; (iii) firms may wish to avoid the costs of patenting. Trade secrets do not incur costs in the form of application and grant procedures, yet they also do not add to the base of knowledge available to the public. As such trade secrets would not be expected to raise the diffusion of technology significantly, though the potential exists for trade secrets to be reverse-engineered. Trade secrets may however encourage innovation, especially of the small, incremental type.

Source: Based on Maskus (2000a, pp.20-23 and 36-50).

Table 2: Summary of Effects of Stronger Intellectual Property Rights on Innovation, Technology Diffusion and Growth

	Domestic Intellectual Property Rights	**Technology Spillovers**
Domestic Innovation		
Domestic R&D	Stronger IPRs increase domestic R&D spending	Evidence that higher R&D spending facilitates technology transfer and raises growth
Domestic Patenting	Evidence mixed in general. But threshold analysis shows stronger IPRs (1) increase domestic patenting in countries with innovative/imitative capacity; (2) reduce domestic patenting in more open economies	Evidence relating domestic patenting to growth is mixed. In developing countries there is little evidence of a positive impact of domestic patenting on growth
Channels of International Technology Diffusion		
Foreign Direct Investment	Evidence mixed in general, but strong IPRs seem to be important for some TNC activities (production and R&D) and in industries where products can be imitated (chemicals, pharmaceuticals). Some evidence that TNCs more willing to transfer technology to countries with stronger IPRs	Evidence generally mixed on whether inward FDI provides technology spillovers, although some evidence of spillovers to host country firms with absorptive capacity. Some evidence of spillovers from outward FDI
Technology Licensing	Limited evidence, but what evidence there is suggests stronger IPRs increase licensing, particularly in countries with innovative/imitative capacity	Little evidence
Foreign Patenting	Positive effect stronger in more open economies and in countries with higher innovative/imitative capacity	Evidence of positive (negative) spillovers from foreign patenting for developing countries with strong (weak) IPRs, high (low) innovative/imitative capacity and large, open (small, closed) markets
Trade	Impact of IPRs on trade flows depends upon market size and the imitative ability of the importing country. Positive effect of IPRs on trade in manufacturing goods (except goods difficult to imitate) in countries that have imitative capacity. Possible negative effects in small markets with weak imitative ability	Trade has been found to promote technology spillovers both between developed countries and from developed to developing countries
Domestic Growth	Evidence that stronger IPRs increase growth in developed countries and developing countries with low innovative/imitative capacity. No effect evident for developing countries with high innovative/imitative capacity	

Table 3: Summary of Research on IPRs and Growth

Study	Sample and Method	Dependent Variable(s)	IPR Index	Results
Gould and Gruben (1996)	95 countries; cross-section with data averaged over the period 1960-1988	Growth of real GDP per capita	Rapp and Rozek Index	IPR protection has a positive impact on growth, which is slightly stronger in more open economies
Thompson and Rushing (1996)	112 countries; cross-section with data averaged over the period 1970-1985	Growth of real GDP per capita	Rapp and Rozek Index	IPR protection has a positive impact on growth only in countries that have reached a certain initial level of GDP per capita
Thompson and Rushing (1999)	55 countries; Seemingly Unrelated Regression techniques on a cross-section of data over the period 1971-1990	Growth of real GDP per capita; Ratio of Total Factor Productivity (TFP)[79] in 1971 to that in 1990; the Rapp and Rozek Index of IPRs	Rapp and Rozek Index	IPR protection has a positive impact on TFP in relatively rich countries, which in turn impacts positively upon output growth
Park (1999)	60 countries; Seemingly Unrelated Regression techniques on a cross-section of data over the period 1960-1990	Growth of real GDP, Fraction of GDP invested in physical capital, fraction of GDP invested in human capital, fraction of GDP invested in R&D	Ginarte and Park Index	IPR protection has no direct impact on growth. IPR protection has an indirect positive impact on growth through physical capital investment and R&D in the most advanced countries
Falvey, Foster and Greenaway (2004)	80 countries; five-year averages over the period 1975-1994.	Growth of real GDP per capita	Ginarte and Park Index	Positive impact of IPR protection on growth in countries with low and high GDP per capita. No impact of IPR protection in middle-income countries

[79] Total Factor Productivity (TFP) is a derived measure of technology change.