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1. Introduction

Some stylized facts

The global income distribution has been and still is characterized by strong disparities. In the 1960s the bulk of the world's countries had an average per capita income far below the per capita income of the high-income OECD countries[1]. While Sub-Sahara Africa, South Asia, East Asia and the Pacific had a per capita income level of around one tenth of that prevailing in high-income OECD countries, other regions such as Latin America and the Caribbean were with an income level around 30 to 50 percent of that in high-income OECD countries slightly better off. While the East Asian and the Pacific region managed to substantially lower the income gap from to 10 to 20 percent of the OECD countries' level by the turn of the century, most region's relative income level more or less stayed the same (Latin America and the Caribbean, South Asia) while others' fell even further behind. By 1998 the income level in Sub-Sahara Africa was only 5 percent of that in high-income OECD countries (UNDP 2001:16).

The disparities regarding innovative activities are even wider. In 2000, 14% of the world's population took out 94% of the U.S. patents, while on the other hand 63% of the world's population, living in 128 countries, took out just 0.75% of all U.S. patents in that year. These patterns are not specific to U.S. patenting (Sachs 2003:132). For example in 2006 four countries (Germany, Japan, Korea, and U.S.A.) received 73% of the patents granted worldwide (WIPO 2008:7). An analogue picture emerges from R&D expenditures. In 2007 the U.S., the European Union and Japan alone accounted for almost 70% of worldwide R&D expenditure, developing countries[2] accounted for 23.9% and less developed countries did not account for more than 0.1% (UNESCO 2009).

Eaton and Kortum (1996) highlighted in their work the enormous importance of knowledge diffusion for productivity growth. They find that in OECD countries – except for the U.S. – 50% of productivity growth stems from foreign innovation. Thus, even countries that have a viable R&D sector are highly dependent on foreign ideas. While this study focuses only on OECD countries, developing countries with their considerably weaker innovative capabilities

[1] OECD countries excluding the Czech Republic, Hungary, the Republic of Korea, Mexico, Poland, Slovakia and Turkey (UNDP 2001: 259).
[2] Excluding less-developed countries

are arguably even more dependent on knowledge diffusion from the centres of innovative activity.

Technological Change and Growth

Solow's (1956) growth model was not able to account for the majority of growth by its input factors labour and capital leaving a large residual. While neoclassical growth models attributed this residual to technological change, new growth theory endogenised human capital formation and technological change. Instead of assuming that technological progress occurs automatically and unintentionally, new growth theory includes the deliberate production of knowledge – through investment in Research and Development (R&D) – into their models.

Increasing returns to scale in the production of new knowledge at the aggregate are then possible via spillovers to other firms. Thus, while sustained per capita growth was impeded in the long-run in Solow style models by diminishing returns to capital, new growth theory enables sustained growth by modelling production functions with increasing returns due to knowledge investment in the aggregate (see Romer 1986 and Lucas 1988).

While the importance of technological progress for sustained economic growth is widely accepted in economic theory nowadays, the means of stimulating innovation are not without controversy. It is the nature of technology as a good that poses the problem. Without government intervention, R&D investors have only limited possibilities to appropriate the returns from their investment, and this can thus lead to R&D investment levels that may be too low. One solution to this appropriability problem is the granting of temporary monopoly rights for the new product or in other words to provide intellectual property (IP) protection. However, while this allows innovators to reap the returns from their investment and thus fosters innovation, strong Intellectual Property Rights (IPRs) can also encourage monopoly by hindering the entrance of rivals, impeding the diffusion of knowledge, and can even reduce incentives for further innovation by successful innovators.

Changes in the international Intellectual Property Regime

Until 1995, the international Intellectual Property Regime consisted of various voluntary conventions under the stewardship of the World Intellectual Property Organisation (WIPO). The establishment of the World Trade Organization (WTO) and the associated Agreement on

Trade-Related Aspects of Intellectual Property Rights (TRIPS) were a major change from this practice however. For the first time, a variety of conventions were put together into one agreement, which not only specifies a minimum standard of rights but also their enforcement (Liebig 2001:43-46). It was the developed countries, foremost the U.S., who pushed for a new, more comprehensive agreement on IP protection. The 'sudden' interest of the North in IP protection has to be seen in the wider context of a changing global economic system. Numerous reasons have been put forward to explain why developed countries increasingly perceived the contemporary intellectual property regime as insufficient: amongst others, 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, increasingly open markets due to a continuous reduction of trade barriers and the perception of developed countries that they are losing their technological lead to countries who caught up by imitating (Correa 2000:3-4).

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 IP protection (Liebig 2001:43-44, 52).

A development perspective

The subject matters raised above constitute along very general lines the main reasons why developing countries take a rather critical position towards the TRIPS Agreement.

New growth theory highlights the importance of technological change for sustainable growth. Since the vast majority of intellectual property is produced and held in industrialized countries, developing countries are dependent on spillovers or formal technology transfer from these centres of R&D activity. TRIPS however, by – at least for most developing countries – raising the IP protection level reduces the possibility to free-ride on technological knowledge produced in the North and limits the South to formal channels of technology transfer, which might be associated with substantial costs[3]. This as well as potential price increases or reduced product availability in the South and substantial implementation and enforcement costs associated with TRIPS have raised objections from the developing world. On the other hand however, stronger IP protection can increase FDI, as well as trade and licensing flows, which are potential vehicles of technology transfer and hence can foster

[3] This does not imply that informal technology transfer comes free of charge. Imitation of advanced technology can also be cost and time intensive.

growth. This aspect has been taken account of by Article 7 of the TRIPS agreement which outlines the objectives of the agreement and emphasizes the importance of technology transfer and dissemination.

The brief outline of the main concerns of developing countries above is not meant to create the impression that developing countries are a homogeneous group which pursue the same interests. There are considerable differences among as well as within developing countries. The terms 'developing country' or 'South' on the one hand and 'developed country', 'North', or 'industrialized country' on the other hand are used interchangeably in this work as general terms to crudely embrace their polarity in many respects. Terms like "Least Developed Countries" (LDCs) or "lower middle income countries" are used following the UN or World Bank definitions respectively in cases where it is necessary and insightful to further differentiate within the group of developing countries. Whilst being well aware of the crude simplification of terms like 'the North' and 'the South', these terms are used in the absence of any other convenient terminology. However, they are not meant to conceal the different interests prevalent among and even within these countries. To name just one example for the latter, the interests of the Indian elites especially in the sector of electronically delivered services presumable contravene those of the Indian farmers' rights movement (May 2007:17). Thus, the conflict of interest regarding the level of IP protection is not simply one of North versus South but rather runs along more complex lines.

These conflicts between different interest groups within a country have until the establishment of the WTO been subject to a social bargain at the national level. As May (2007) points out:

> "At the level of national policy as regards intellectual property, history demonstrates a continual political conflict (mediated by the state) between the interests of commercial operators and the interests of what (for ease) might be termed the public domain (or public interest). Indeed the history of IPRs is in many ways a series of national settlements as regards the balance between private rights to reward and public-regarding interests in access and dissemination" (May 2007:20)

However, the TRIPS Agreement 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 new level of IP protection for the vast majority of countries (May 2007:20-22).

These developments raise an array of political questions for developing countries regarding the global power relations among countries as well as the fact that many developing countries,

especially LDCs, lack the financial and professional capacities to formulate and promote their position in international negotiations at the WTO. However, the focus of this paper is on the effect of the recent changes in the global IPR regime. Thus political aspects are, at best, only briefly touched on.

As outlined above the main concerns of the South regarding TRIPS is that it impairs their access to knowledge and thus their potential for growth. However, proponents of TRIPS argue that the stronger protection of IP can increase formal channels of technology transfer and thus foster growth. The research questions of this paper follow directly from the above considerations:

Does IPR protection affect economic growth in developing countries? If it does so, in which way does it affect it and through which channels (e.g. trade, licensing, FDI) does it predominantly work?

The remainder of the work is organized as follows. The next section discusses the historical context of the development of national IPRs as well as the movement towards a global intellectual property regime. Thus, this section further motivates the subject and the reasons for the current paper by emphasizing the historical changes which led to the contemporary intellectual property regime. It also contributes to the main question of this paper by studying from a historical perspective the level of IP protection of at that time developing countries which have now successfully industrialized.

The third section focuses on theoretical considerations. Thus, the theoretical grounds for granting IPRs are outlined as well as theories about the impact and effectiveness of IPRs at a national and international level. Section four summarizes the existing empirical literature on this topic and together with the previous section provides necessary and valuable insight for the development of the regression model of the fifth section. The final section draws conclusions from the historical, theoretical and empirical findings, as well as emphasising the limitations of the results.

2. Historical review

The intention of this chapter is twofold. First, there is a rather prescriptive purpose, namely to outline the origins of contemporary intellectual property rights and their evolution from national to almost global rights. Second, there is a more analytical purpose, namely to highlight what a historical perspective can contribute to the central question of this paper. A reasonable first step is to take a closer look at the patent provisions of nowadays developed countries during their phase of industrialization in order to analyse whether any obvious pattern exist. Anticipating the main result, while some tentative patterns seem to emerge, insights from a purely historical perspective are limited.

2.1. A short review of the evolution of national IPR regulations

The name patent derives from the Latin words "litterea patentes" which can be literally translate as open letters. These "letters" entitled the holder to certain rights, titles, or privileges. During the 14th and 15th century the main purpose of those 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 1993:44-46). The first formal patent law[4] 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 apply their genius, would discover, and would build devices of great utility to our commonwealth." (cited in Kaufer 1989:5)

The Republic of Venice though was not the only one to grant these kinds of privileges. There is evidence that this practice informally existed as well in Electoral Saxony, the Austrian Archduchy, England under Edward III and even the Republic of the Seven United Netherlands (Silberstein 1961: III, Kurz 2000: 146), while France started to use this practice on a regular base during the middle of the 16th century as a part of its mercantilist policy. (Kaufer 1989:7) The purpose of these practices was the same in all countries: the introduction of devices or processes unknown in their respective countries.

[4] There is evidence that the Venetian Senate had been granting similar rights long before the formal recording in 1474 (Kaufer 1989:4-5).

During this time most of the technological knowledge was still 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[5]. 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: 44-47)

2.1.1. The experience of Western European countries and the United States

Despite some differences among the European countries the fact that patent privileges were typically granted by the sovereign without the possibility of interference from a control entity led to substantial abuses of the monopoly privileges.

In early 17th century England the misuse of monopoly privileges hindered the development of whole sectors (paper industry) and considerably raised prices since the Crown handed out monopolies for products like salt, soap, vinegar and coal. (Kurz 2000: 156-157) 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 grant 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 (Kurz 2000: 168-171). The "true and first inventor and inventors" only referred to those from England (Kaufer 1989:6). Thus, patents on new manufactures developed and protected abroad could be patented by the person merely by 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 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

[5] It comes from this tradition that the length of patents do not vary among branch or industry (David 1993: 45).

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 mercantilistic policies played at least an equally important role. An inventor lost his right to his invention if she/he 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: 15-16).

The first patent laws on the American continent were passed during the second half of the 17th century[6] (Kaufer 1989:7-8). These early versions drew heavily on the British model and granted patents for "such new inventions that are profitable for the Country"[7] (David 1993: 48). The next decisive event for the American patent system did not come until 1782 when the first Article of the U.S. 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 1989:7-8). 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 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-, transparent and predictable. The American patent law recycled the phrase used in the British patent law about the "true and first inventor" just that this time it was used literally. As a consequence Americans could not apply for "import patents". However, the American patent law discriminated against foreign inventors too. While foreigners were in the beginning not allowed to obtain a patent at all, later on they could place claims but had to pay patent fees that were about one hundred times as high as for nationals[8] and were subject to a working requirement (Khan 2002:21-23).

The views among the German states about patent protection differed a lot. While Prussia[9], under a free-trade oriented government, dismissed patents as mercantilistic policy, other

[6] Massachusetts (1641), Connecticut (1672), South Carolina (1691) (Kaufer 1989:7)
[7] Patent law passed by the General Court of Massachusetts Bay in 1641 (David 1993: 48).
[8] British nationals were an exception, they faced even higher fees (Khan 2002: 23).
[9] In spite of its free trade position - which it followed roughly since its defeat by Napoleon in 1806 - Prussia had possesed a patent law since 1815. But the law was designed to minimize the potential threat of monopolies by the inclusion of an examination of newness, working requirements, the exclusion of agricultural machinery and

countries, mostly the territories close to the Rhine, adopted a French style patent system. The increasing dominance of Prussia over the other German territories further added 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, especially from industrialists and inventors, Germany implemented a national patent law in 1877[10], which was one of the most business friendly of its times (Khan 2002: 19-20, Heggen 1975: 90-91). 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 (Heggen 1975:135). In 1891 the possibility to obtain a utility model[11] was introduced, which especially suited the needs of inventors without much capital (Kurz 2000:385). The coexistence of a rather business friendly patent law and utility models on a registration basis reasonably complemented each other (Khan 2002:20).

While this patent law was one of the most stringent of its time, it still tolerated the infringement of foreign intellectual property rights 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 measure, however, did not achieve the anticipated effect (Chang 2001: 292-293, Khan 2002: 20).

While the anti-patent movement in Germany was defeated due to the intensive lobbying of industrialists, the movement in other countries was more successful. The Netherlands abolished its patent law, which admittedly suffered from substantial flaws, in 1869, while Switzerland simply refused to implement a patent law in the first place until 1907. Despite some similarities in the argumentation there were also substantial differences between the discourse in the Netherlands and Switzerland on the one side and Germany on the other side. Most importantly while in Germany the industrialists lobbied for a patent law, the industrialists in the Netherlands and Switzerland clearly took an anti-patent position.

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pharmaceuticals, an obligation to disclose the patent information, and a short patent length (Heggen 1975: 31-33, Seckelmann 2006: 95, Kaufer 1989:8).

[10] A factor favouring the introduction of a federal patent law was that by that time Prussia had already abandoned its free trade position (Kaufer 1989:9).

[11] Utility Models (Gebrauchsmuster) were granted on registration base for three years (with a maximum length of six years) and required a lower degree of novelty than ordinary patents (Kurz 2000:385).

Due to their lack of patent protection Switzerland and the Netherlands are especially interesting countries for this analysis. Schiff (1971) analysed the economic development of the Netherlands and Switzerland in the time when they had no patent law and compared this time to a period when they possessed such a law. Further, he compared their period without a patent law to the experience of other European countries development of that time. His comparisons of the number of patents held by Swiss and Dutch nationals in other countries during the patentless time 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 patentless time industrial progress in the Netherlands rested to a greater degree on foreign inventions than afterwards, there is no similar evidence for Switzerland (Schiff 1971: 51). Swiss inventors have been – measured by patent application in other countries – among the most productive before and after the introduction of a patent system (p. 113-120). Among the important inventions made without a national patent system are the Honegger loom, Sulzer Steam engine, milk chocolate, and instant soup to name just a few (Schiff 1971: 108-111). Regarding the industrial progress of the two countries a similar picture appears. While the progress of industrialization was rapid in Switzerland during its patentless phase, and the absence of a patent law did not even deter foreign investment, the case of the Netherlands is less decisive. The progress of industrialization in the Netherlands was rather moderate but still steady and could stand comparison 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 special case the absence of patent protection was a supporting rather than hindering factor (Schiff 1971: 32, 122-123). So while for the Netherlands Schiff at least 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 does not focus on the rate but on the direction of innovation. Analysing data from 19th century World's 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, like secrecy, exist. Moser (2005) suggests that in the long run the lack of IP protection did have a negative effect on economic development since it stirred innovation

away from the future leading sector, 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 IP protection since this would only redirect their innovative activity towards sectors with harsh competition from developed countries (Moser 2005: 1231-1233).

In sum Schiff (1971) and Moser's (2005) findings seem to 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, combined with the fact that both countries are rather small, could have been a sufficient incentive for invention.

Still, one should not simply dismiss the questions the history of these two countries raise. Especially, as the experiences of the other countries reviewed here point in a similar direction, that at an early stage of economic and industrial development the possibility to "learn", in other words 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 1989:48).

Before any premature conclusions are drawn, more recent examples of successful industrialisation by latecomers will be investigated. Attention is therefore drawn to the experience of Japan, Taiwan and South Korea.

2.1.2. The experience of Japan and first tier NIEs

A large amount of research has been undertaken investigating the "growth miracle" of some East Asian countries. Many factors have been identified as being important for the rapid growth of countries such as Japan, Taiwan and South Korea. While there is still much disagreement about this topic it is widely accepted that the ability to adapt advanced technology was a crucial aspect (Kumar 2002:21).

The first Japanese patent law was launched in the course of the modernisation and industrialisation fostered by the Meji-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 for the Protection of Industrial Property a new revision, which acknowledged the rights of foreigners too, 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: 149, Kurz 2000: 486). Japan, as with many countries in their early phase of industrialisation excluded pharmaceutical products, chemical compounds, and food and beverages from patentability until 1975 (Kumar 2002:22). 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 exhibited other abnormalities (Kotabe 1991:153,157). 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: 561). This was shrewdly used by Japanese firms to slow down the actual grant of the patent (Kotabe 1992:152). This procedure both lowered the protection term, which started with the filling out of the application and fostered technological diffusion by allowing the 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: 562, Kotabe 1992: 151, 155) and in point of fact Kotabe (1992) found some empirical evidence that foreign firms were indeed discriminated against.

While the operation of the patent system in Japan is important, of more importance to us is the question of whether the system was suited to advance the countries' technological and economic development. Both Ordover (1991) as well as Maskus and McDaniel (1999) address this question. Ordover (1991) analyzed 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 1991:48). A narrow patent breadth and weak novelty

requirements tended to favour reverse engineering and small modifications on existing inventions over "major technological breakthroughs". Furthermore narrow scope, weak novelty requirement and pre-grant disclosure foster technological diffusion. Therefore Ordover (1991:53-54) states that the Japanese patent system was especially suited for a technology importing country. Still, the system had some drawbacks as well. It created substantial incentives for cross-licensing which can produce entry barriers for competitors.

Maskus and McDaniel (1999) came to a similar conclusion in their empirical investigation of the effect of the patent system on total factor productivity in post-war Japan. Their findings too suggest that the narrow breadth and pre-grant disclosure stimulated technological diffusion. Especially important in this regard were utility models which allowed for protection of follow-on inventions with relative low novelty level. 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. Hence it seems that domestic invention was more important than the imitation of foreign inventions for Japanese growth in total factor productivity between 1960 and 1993 (Maskus and McDaniel 1999: 558, 572).

South Korea's first patent law was introduced in 1961 and was revised in 1981 in order to comply with the 1967 Stockholm revision of the Paris Convention[12]. This version drew heavily on the Japanese Patent system from before 1975, for example regarding the range of product groups excluded from protection: food stuffs, luxury consumer goods, nuclear devices, chemicals and pharmaceuticals. Further the revision allowed for foreigners to take out patents, 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 Korea again revised its patent law in response to increasing U.S. government pressure. This time product protection for pharmaceuticals and chemicals was introduced and the protection term expanded from 12 to 15 years. Enforcement remained a problem well after the revision of 1986 (La Croix and Kawaura 1996:111-112). Kim (1997) points out that in the early phase of Korea's industrialization reverse engineering and imitation played a crucial role (p. 38), while only at a later stage of development did FDI and licensing become of primary importance. It is in the wake of this development that IP protection also became an issue for local firms (Kim 2003:3). Kumar (2002) highlights another aspect of Korea's patent law. Utility models

[12] The Paris Convention is dealt with later on in more detail.

and industrial designs seemed to have served as a viable mechanism to foster local adaptation of foreign technology. This becomes evident from a look at the patent statistic: 92-95% of all design patents and utility models are held by Korean nationals (p. 24).

Taiwan established IP protection in 1949. This patent law already distinguished between three different types of protection: invention patents, utility models and design patents, where the first one granted protection for 10 years and the latter two for 5 years. It only provided protection for manufacturing processes and manufacturing products though. The Taiwanese patent law passed through several revisions (1959, 1960, 1979, 1986 and 1994). The revision of 1979 allowed for IP protection on agricultural and extractive industries possible. However, chemicals and pharmaceutical remained unprotected, working requirements and comprehensive provisions for compulsory licensing were maintained, and the maximum fine for patent infringement was approximately U.S. $1,300. In addition to the rather weak protection on the statute books even less attention was paid to the enforcement of the law (Lo 2004:8-9). 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: 268). The 1994 revision finally extended patent protection to among others beverages, food and micro-organisms and expanded the protection term to 20 years for patents, 12 years for utility models and 10 years for design patents. While there have been further advances regarding the enforcement issue as well, there are still concerns left (Kumar 2002:26).[13]

Taiwan and South Korea both managed to upgrade their technological capabilities and switch from imitation to innovation within roughly one generation (Hu and Jaffe: 2001: 1). It is evident that the role of the level of patent protection in these countries, as well as in Japan, was, if anything, just one of the many aspects that facilitated this process of catching-up. These countries put deliberate effort into the mastering of advanced technology through policy actions in many different fields including education, taxation, and investment. But even if the relative importance of the level of patent protection in this process is more than 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. Further it seems that all three countries intentionally designed their patent law to best suit their economic needs. At

[13] 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 2002:26).

least that is what some of these countries' "special provisions", which admittedly often violated the property rights of foreigners (e.g. in the case of Japan the pre-grant disclosure or in the case of Taiwan which provided stronger punishment for the infringement of the kinds of patents that were primarily held by nationals) indicate. Furthermore, all three countries provided some incentives for local firms to conduct adaptive innovation of foreign products (for example, utility models). Finally, all three countries provided rather weak protection in the initial stages of industrialization and later on gradually increased their protection level. Compared to the developing countries of today, Korea and Taiwan, at an early stage of industrialization, enjoyed considerable freedom regarding the design of their IP protection, even though they did not increase their protection solely on their own initiative (Kim 1997: 239).

Before the recent changes in IP protection are discussed some aspects from this section are highlighted.

First, in the case of the reviewed Western European countries and the United States one has to be careful when interpreting the findings. While the patent law in these countries played an important role for industrialization, one has to keep in mind that these early versions of patent laws normally did not protect foreign intellectual property. Actually, rather the opposite was true; the patent law was used to acquire foreign technologies (e.g. import patents) to spur technology transfer at an early stage of industrialization. Thus, while industrialisation in these countries was surely facilitated by reducing the risk for entrepreneurs via intellectual property rights provision, many features of their modern patent law were severely underdeveloped at the time of rapid industrialization in both Europe and northern America.

Second, at an early stage of industrialization some countries decided to pick a low to non-existing level of IP protection, as for example Switzerland, the Netherlands and to some extent Germany. Again the implication of these facts has to be kept in perspective for numerous reasons. First and foremost two issues should be mentioned, the general deficiencies of patent protection, and the size of the technological gap between these countries and the technological leader at that time. These findings have also been highlighted 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 1989:48, emphasize added)

Third, more recent examples point in a similar direction. At an early stage of industrialization Japan's, South Korea's and Taiwan's IP protection included some unusual provisions in their patent laws, which indicate that informal technology transfer was considered an important issue.

There are however substantial caveats to these findings. Most importantly the technological gap between developed countries and developing countries has grown substantially, even since the start of the catching-up process of Taiwan and South Korea. While such countries have been able to master some parts of advanced technology by reverse engineering, this might not be possible for late-comer countries nowadays. Therefore these countries might be dependent on formal transfers of technology, 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, like FDI and licensing however, are probably influenced by the level of IP protection. On the other hand though, 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 IP protection would not have been so fierce.

In the next section we focus on this rising pressure and its consequence, namely the evolution of TRIPS as well as its implications for developing countries. Before that however, the intellectual property regime that prevailed before TRIPS is briefly outlined in order to emphasize the substantial changes.

2.2. From internationalisation to globalisation

Due to the lack of any international agreements prior to the second half of the 19th century, most advanced countries turned to other instruments, for example the prohibition of emigration of skilled workers or the exportation of machinery, in order to sustain their technological lead. Another option to protect intellectual property was bilateral commercial

agreements, which existed mainly among European countries (UNCTAD-ICTSD 2003: 35)[14]. By the end of the 19th century however these measures were deemed to be insufficient. It was at the wake of the Vienna World Fair in 1873 that serious concerns about the protection of intellectual property were raised by mostly American inventors. The Vienna Congress held in 1873 as a consequence of these concerns was a rather unsuccessful gathering though. The moot point at this Congress was the question of "compulsory working requirements"[15], which was strongly objected to by the United States. 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, who 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: 291-292). 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 latter WIPO became a specialized 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 1998:7-8). The main provisions of the Paris Convention were "national treatment" and "preferential filling". "National treatment" simply implies that nationals and foreigners were treated equally. "Preferential filling" 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. 1990:11).

Thus, the "international phase", as Drahos (1998) refers to this time, was characterised by substantial freedoms for the signatory countries. This was among other things 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 principle, the option to appeal to the International Court of Justice, this never happened (Dinwoodie 2007:67)

[14] Most of these agreements focused on trademarks and at the time the Paris Convention came in to force 69 treaties of such kind existed. This indicates that the subject had become a relevant matter of concern for many countries by that time (Drahos 1998: 6)

[15] Working requirements were part of the national patent law in Austria and some other countries.

2.2.1. Trade Related Intellectual Property Rights – TRIPS

In the decades following World War II most colonies became independent. As already mentioned in most cases their intellectual property system reflected those of their respective colonizers even long after their independence. Some of them however started to reassess their intellectual property systems to better suit their national objectives. Further, an increasing number of these newly independent countries joined the Paris and Bern Convention and thereby substantially shifted the power structure in these Conventions[16]. Developing countries tried to make both the Paris and the Bern Convention subject to revision talks 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[17] their push for revision was successful, in the case of the Paris Convention no understanding could be reached (Drahos 1998: 8-9, May 2000: 83). Whatever the reason for the failure to revise the Paris Convention was, the consequent reactions of the developed countries, above all the United States were not anticipated by any of the developing countries. As May (2000:84) 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 [...]".

Among these shortcomings were, on the one hand, the many different agreements, with sometimes only a scarce number of signatories[18] and on the other hand the lack of enforcement mechanisms to ensure compliance of those countries that actually signed (May 2000: 84). This gave developing countries the freedom to exclude some product groups (e.g. pharmaceuticals, food stuff, chemicals, plant varieties and other biotechnological inventions) entirely from protection, to provide only rudimentary and poor protection for copyrights, trademarks and trade secrets, and finally to reserve their right to compulsory licensing even with inadequate compensation (Maskus 1998: 193).

The factors listed above, were perceived by Western countries as substantial shortcomings of the IP regime. The increasing inability of developed countries to push their choice of IP protection through in WIPO based agreements (Drahos 1998:9), as well as changes in economic activity that made knowledge based industries a keystone of a countries' competitiveness also gave rise to pressure groups who pushed for a fundamental change in the international intellectual property regime (May 2000:84).

[16] WIPO conventions - like all UN organizations - worked under a "one country, one vote" system.
[17] The Stockholm Protocol was signed in 1967.
[18] See appendix A Tabel 1.

2.2.1.1. Forum Shifting – towards the trade-relatedness of IPRs

It was mostly American companies, dissatisfied with the current system, who lobbied for internationally recognised and enforced IPRs. The film, software and pharmaceutical industries in particular have a vested interest in the protection of their IP. These well organized and often oligopolistic industries made IP protection 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 (Liebig 2001: 48-49). This amendment was followed by the Omnibus Trade and Competitiveness Act (1988) which extended the 301 provision by differencing between 'Regular 301', 'Special 301' and 'Super 301' processes. These regulations obligated 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: 9-10).

At the launch of the Uruguay Round in 1986 the USA pushed for the introduction of intellectual property issues as one of the negotiating topics, despite the protests and reservations of many developing countries (e.g. Argentina, Brazil, India, and Nigeria amongst others) (Drahos 2002: 13-14).

There are two non-exclusionary perceptions about the inclusion of intellectual property issues in the Uruguay Round trade talks. While the one side interprets this move as a mere effort to shift the topic to a forum where the power relations are more favourable for the IP advocates than in the WIPO forum, others emphasize the fact that IPRs do affect trade flows and a lack of IPRs does distort trade[19] (Commission on Intellectual Property Rights 2002: 159-160). One of the strongest supporters of the first position is Drahos (2002):

> 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. (Drahos 2002:10)

[19] "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: 229).

Both points of view have their justification. 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[20] 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 IP issues to the WTO negotiation gave advanced countries the possibility to include the TRIPS agreement in a broader bargaining package (UNCTAD-ICTSD 2003: 45).

While it is quite evident why developed countries sought to include IPRs in the new world trade regime, the question remains why developing countries accepted this move, since they displayed an attitude which ranged from concerned to hostile towards its incorporation in the beginning (UNCTAD-ICTSD 2003: 44).

As Yu (2006: 371-379) points out there a four different narratives as an answer to this question: the 'bargaining', the 'coercion', the 'ignorance', and the 'self-interest narrative'. The 'bargaining narrative' highlights that developing countries agreed to TRIPS as a broader bargaining package, in which the developed countries in return made concessions regarding lower tariffs on agriculture and textiles – subjects that were by many developing countries considered far more important than intellectual property rights. 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' emphasizes that developing countries did not understand the full impact and the importance of the issue. This narrative, while it cannot be entirely dismissed since the full impact of stronger IPRs is not even a clear-cut story today, might exaggerate the ignorance of developing countries. If this heterogeneous country group was so ignorant about the relevance of IP protection, it would not have tried to reverse the Paris and Bern Convention in the 1960s and 1980s. And finally the last narrative suggests that developing countries agreed to TRIPS simply because it was in their own interest. But, if this is the case 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 rather contradictory to the 'bargaining narrative'. This is also true for the other

[20] 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 finalization of the Uruguay Round in 1995.

two narratives. Hence, 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[21] (Yu 2006: 371-379). While it is unlikely that any of the narratives tells the whole story, and reservations exist in all cases, the 'self-interest narrative' is not only the most contradictory to the other narratives but also does not quite fit into the historical development of the TRIPS agreement if one keeps its origin in mind. The first three narratives on the other hand are not a priori contradictory and may all contribute to some degree to the motivation of developing countries for accepting TRIPS as a keystone of the World Trade Organization.

2.2.1.2. Important aspects of TRIPS for developing countries

As the narratives about 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[22] others emphasize 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 criticized 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 recognizes that TRIPS can have beneficial effects for those countries if implemented with care (Gervais 2007: 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

[21] 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 (1989). 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.

[22] "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 2005:658)

until then constituted the international intellectual property regime, into one agreement[23]. 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, therapeutical and surgical methods (Art. 27.3 (a)), and plants and animals. However all members are obligated 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 impossibility to exclude some matters from patentability constituted a major change for many developing countries. As Correa (2000:50, 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[24]. 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: 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)[25] is new to the intellectual property framework (UNCTAD-ICTSD 2003: 48).

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

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

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

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[26] (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 1999:14). 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 2005:248). 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 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*" (WTO 1994: preamble, emphasis added). The relevance of the dissemination and transfer of technology is further strengthened in Article 7, where the objectives are outlined[27]; in Article 8, which refers to the principles of the agreement[28]; 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

[26] Article 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 2000:90).

[27] „The 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 and in a manner conducive to social and economic welfare, and to a balance of rights and obligations" (WTO 1994, Art. 7, emphasis added).

[28] Art. 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 (WTO 1994, Art. 8.2).

viable technological base" (Art. 66.2). However, there has been disagreement concerning 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: 2). Moon (2008) and Correa (2007) recently investigated to what extent this 'obligation'[29] 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/ and 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 2003:48-49).

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: 89-99).

As briefly outlined above TRIPS does substantially alter the global intellectual property regime and the minimum standards it introduces constitute a considerable strengthening of the intellectual property 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 harmonizes the national intellectual property laws. As pointed out there is still room left for manoeuvres in order to generate IP laws that suit a countries' level of economic development. And there are potential gains especially from dynamic effects for developing countries. On the other

[29] 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).

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 2003:49). 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).[30] Its membership[31] 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[32]. 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.

2.2.2. BIT's, BIP's and TRIPS-Plus

As already emphasized TRIPS generates a minimum level for intellectual property protection and nothing impedes countries from implementing higher standards of IP 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 [as TRIPS]; or which eliminates an option for a member under a TRIPS standard" (Drahos 2006:91). 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; however there are provisions in the 'standard agreements'[33] that do further strengthen IP protection. An example of this 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

[30] 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).
[31] 40 of the currently 67 Members (Status on May 2009) of UPOV have joined the Agreement after 1994 (UPOV 2009).
[32] 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).
[33] Since bilateral negotiations are cost and time consuming, the US negotiators stick to a prototype of agreement that has been approved by congress. If they do not deviate to far from this standardization the approval of these treaties by congress is very likely (Drahos 2006:92).

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: 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, the signatories (of a BIT, BIP or FTA) have to provide higher standards of IP protection to all WTO members. Therefore these agreements introduce TRIPS-PLUS standards country by country into the WTO (Drahos 2006:100).

A few noteworthy aspects should be emphasized before the next section. First, the coming into force of TRIPS is a major change in the global intellectual property regime. It is the most comprehensive international agreement on IP protection ever passed and thus substantially lessens the freedom of choice for all signatory countries. However, as already outlined there is still substantial scope of action left. And while TRIPS surely reduces the differences among developed and developing countries, it by no means provides the same level of protection in all countries. It is the South however, which will have to make the bulk of changes. Second, having traced the process of origin and its main proponents, it is apparent that the TRIPS is, in the first place, in the interests of developed countries. Further, it seems as if some developed countries, first and foremost the US and the European Union are not yet satisfied with the global level of protection, since they are again turning to bilateral agreements to further raise levels of protection.

Still, these points do not imply that there is nothing to be gained for developing countries. From a theoretical point of view there are many aspects which can be of great importance for developing countries today, such as enhanced FDI inflows or the development of products better suited to developing countries' needs. This aspect has not yet been considered at all in this chapter but bears the possibility of substantial benefits for the South. Thus before even a preliminary conclusion can be drawn theoretical considerations need to analysed. The next chapter will focus on these issues.

3. The economics of intellectual property

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: 80)

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. Still, many questions remain unanswered. The following section will quickly review the reason for market failure in knowledge production, possible solutions to this inefficiency, and their respective economic consequences. Section 3.2 focuses on the trade-off for society between knowledge production and diffusion. While the last section draws attention to special issues arising from IPRs in a North-South context.

3.1. Knowledge production and market failure

Knowledge, as Arrow (1962) already 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[34]. 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: 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 1999:309).

The public good characteristics of knowledge generate some problems regarding the production and dissemination of innovations. If inventors do not get the chance to profit from their invention, since everybody can and should use the knowledge produced, the only knowledge that would be produced is knowledge with zero production costs. This of course

[34] 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: 309).

leads to an insufficient level of R&D and innovation from an economic point of view (Stiglitz 1999:309).

Further one can distinguish between local and global public goods. While the benefits of national defence are geographically limited other public goods like the international environment affect the entire world population. Knowledge in most respects can be considered a global 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 1999:310-311). It is the *global* public good[35] character 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 2005:9).

3.1.1. Patents - trade-off between diffusion and appropriability in a closed economy[36]

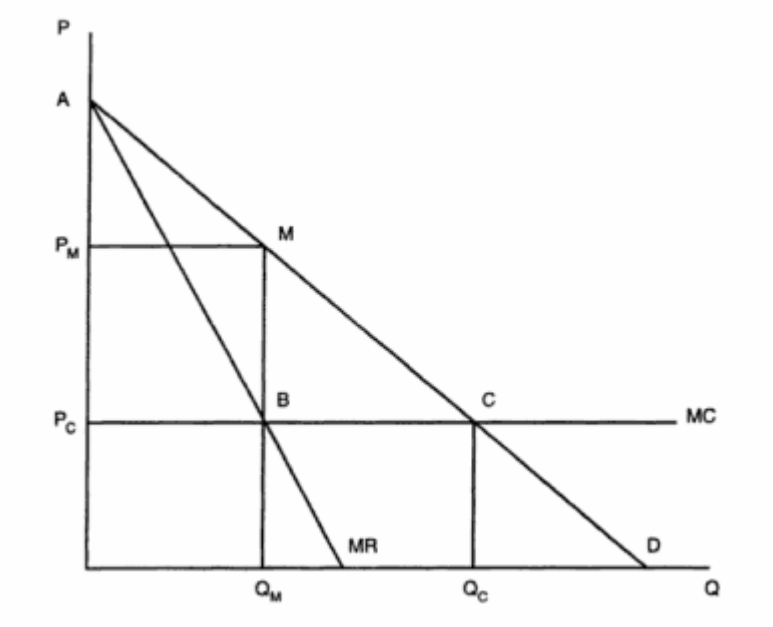
A private market solution for knowledge production henceforth is destined to lead to an insufficient level of invention and innovation. Consequently some kind of government intervention is necessary to stimulate research investment. One possible solution is the provision of intellectual property rights. However, granting property rights to one party to ensure appropriability of research investment at the same time 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. On the one hand extensively strong IPRs provide powerful incentives for research. However, they also generate distortion through insufficient access and may transfer surpluses from consumers to inventors. On the other hand, weak IPRs while satisfying the static goal, namely diffusion, do not create the necessary incentives for firms to invest into research. Welfare considerations suggest therefore that it is necessary to find the best balance between these two efficiency requirements.

[35] 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).

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

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 in order to cover the 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_MMBP_C as rents and the consumer surplus would 'shrink' to AMP_M compared to the competitive (but not attainable) price. Without IP protection the entire consumer benefits would be lost - if it is assumed that in this case the product remains undeveloped - but under a system of IPRs society would gain the monopoly profits P_MMBP_C minus R&D expenditures plus the consumer surplus AMP_M (Maskus 2000:28-30).

Figure 1 Trade-off in IPRs



(Source: Maskus 2000:30)

The costs associated with granting IPRs due to the temporary monopoly are therefore justified by the necessity of creating incentives for invention and innovation. This implies of course that patents should only be granted as long as the benefits outweigh the costs (Mazzoleni and

Nelson 1998:275). Besides the deadweight loss associated with the temporary monopoly, there is another shortcoming of IP protection as a mechanism to stimulate research. Ideally the IP system would be shaped to create exactly those innovations for which R&D costs just do not exceed the ex-post consumer surplus. However, it is not possible to create a system that is so precise. Thus, IPRs remain a second-best solution to the problem of inappropriability (Maskus 2000:30).

3.1.2. Other possible solutions: awards and contract research

The costs associated with granting IP protection poses the question of whether there are other incentive mechanisms with superior properties than IPRs. Awards and contract research can also theoretically generate the necessary incentive mechanisms. Just like 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 1983:704). Just like contract research, awards are under some conditions able to generate the same research incentives as intellectual property rights while at the same time having the virtue of avoiding the deadweight loss generated by monopoly pricing. However, awards and research contracts produce some market distortion too 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 innovations, property rights 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[37]. In this case property rights have the advantage that the decision 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 research investment. Further, instead of imposing the costs on the general public intellectual property protection charges the actual users of knowledge. (Gallini and Scotchmer 2002:54-55, Liebig 2005: 64-66)

Therefore intellectual property rights, in a closed economy and working under the realistic assumption that the information about the social value and costs of an invention are not

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

generally available seem to be a reasonable albeit second-best solution[38], despite the deadweight loss associated with them.

3.2. The properties and function of the patent system in a closed economy

As stated above granting IPRs can stimulate invention 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 IP protection[39]. If no other mechanisms of appropriating returns from research investments 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 returns from investment (Scherer 2005: 3)

There have been a handful of empirical studies which tried to evaluate the relevance of patent protection for different industries. Taylor and Silberston (1973), Mansfield (1986), and Levin et al. (1987) are among the earlier studies of this kind. Their rather similar findings are not very supportive of the effectiveness of patent protection. Levin et al. (1987) find that - with exceptions to a few industries, predominantly pharmaceuticals and chemicals[40] - 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 IP protection would have only small effects on innovative efforts in most industries, again pharmaceuticals and chemicals are the main exceptions[41]. These results are supported by a more recent study by Cohen et al. (2000). Consistent with the previous studies they find that, in the majority of industries secrecy and lead time are the most effective appropriability mechanisms. Further they find evidence that firms not only patent to directly profit from the

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

[39] It should be noted that there are other reasons for granting IPRs than fostering innovation, which will be considered later on in this section.

[40] 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 2000:50).

[41] For four industries (textiles, rubber, motor vehicles, office equipment) the absence of IP protection would have made no difference for 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 industry (65%) a major part of products would have been undeveloped (Mansfield 1986: 175).

inventions through licensing or commercialization but also for "strategical" reasons (patent blocking, prevention of suits, use of patents in negotiations).

These findings about the limited effectiveness of patents pose some questions about the usefulness of a patent system. However, the results of these studies should not be overstated and have to be interpreted with care for two reasons. First, all these studies focused on large established firms and there are a number of reasons why the situation might be different for small firms and new entrants. Second, in addition to inducing invention IP protection also serves other purposes which have not been considered in these studies (Mazzoleni and Nelson 1998:274).

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 resources necessary to commercialize inventions. These firms may find it more convenient to license their invention to larger companies who then carry on the product development and commercialization of the product. Furthermore, in cases where small firms or new entrants decide to commercialize their invention themselves patents can play a crucial role. These firms will very likely find it necessary to turn to the capital market to raise funds. In this case holding a patent can be the decisive asset (Mazzoleni and Nelson 1998:277).

The argument that IP protection 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) IP protection might play an important role for commercialisation. In this case, the "commercialisation argument" is in a way contradictory to the "incentive for invention" argument, since it argues for the granting of IP protection, which poses some costs to society, 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. This argument is subject to two reservations. First, in many areas it is possible to obtain patents on the development work. Second, the same reservations as for the "incentive to invent" argument hold, namely that there are other market mechanisms to appropriate returns from research investment (Mazzoleni and Nelson 1998: 277-278).

Another line of argumentation - the prospect theory **-** has been put forward by Kitch (1977). He argues that the absence of a broad patent on an invention leads to duplicative and wasteful R&D efforts for follow-on inventions, since many people actually 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 rather suggest that many people see many different prospects. Consequently a single rights holder might underdevelop the original invention. Kitch's notion that different ideas can still be realized by licensing poses some problems as well. In general licensing can be associated with substantial transaction costs, which seem to further increase in the case of major inventions or tailored licensing (e.g. to a particular licensee for the development of one specific prospect) (p. 873-875). Furthermore tailored licensing does not seem to be common. Merges and Nelson (1990) do not find evidence of tailored licensing in their study, to the contrary en masse cross and pooled licensing seem to be more common (p. 908-909).

Information disclosure as an argument for patent protection has been around for a long time. It implicitly assumes that inventors can keep the relevant part of their invention secret - at least for a while - even when the invention is commercially exploited. But the possibility of protecting the relevant information through property rights induces the inventor to reveal the information to the public and in doing so adds to the public stock of knowledge (Mazzoleni and Nelson 1998:278). The sooner the patent application is released to the public the sooner possible 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 2000:41).

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 IP protection. On

the other hand IPRs are subject to a range of downsides as well (e.g. common pool problems or impeding follow-on inventions). Thus a considerable amount of research has been focused on the properties of the "optimal" patent system. The next section will briefly review this work in order to get a more precise picture of the aspects that can influence the impact of an IPR regime on the economy.

3.2.1. Length, breadth, and height of the "optimal patent"

There are numerous studies which have focused on the optimal design of a patent system, which maximizes 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 (novelty requirements for protection) (Verspagen 2003: 498).

One of the earliest studies of this kind was the work of Nordhaus (1967) on the optimal patent life. The study focuses on "run-of-the-mill" inventions under perfect competition, which are cost reducing inventions[42] and which leave the pre-invention price and quantity unaltered[43]. 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 1972:423). Maximizing the benefits to producers and consumers subject to any given patent term, Nordhaus obtained the welfare-maximizing 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 (Kaufer 1989:29, Nordhaus 1967:8). These are fairly intuitive results. Furthermore he found that, optima patent life is shorter for more important inventions[44], since they have greater social impact and thus produce a greater deadweight loss, and optimal patent life decreases with a higher price elasticity of demand. (Nordhaus 1967:9).

[42] His findings can be applied to the more general case of product inventions as well (Kaufer 1989:25)
[43] 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 1972:23).
[44] 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 1967:9).

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 1999:23). In the case of an "independent single invention" the analysis of patent scope does not differ a lot 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 however, an innovative 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 can also deter the rate of invention (Jaffe 1999:23).

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 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. On the one hand 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, while on the other hand Klemperer shows that a wider patent by reducing the possibilities for consumers to switch to unpatented, competitively provided varieties of the product reduces the second form of distortion. Thus he concludes: "(...), infinitely lived, narrow patents are 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 1990:127). In short, Klemperer's results indicate how the optimal combination of patent length and breadth varies with product classes.

While Gilbert and Shapiro (1990) as well as Klemperer (1990) both advocate the idea that the optimal patent system should include some kind of trade-off between length and breadth[45], Gallini's (1992) work is, to some extent, in contrast to these findings. 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 and henceforth, imitation is always a problem for the inventor independent of patent policy, 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 though, where patent length and breadth are considered, which is measured by the flow of profits acquired by the inventor (following Gilbert and Shapiro), 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 (p. 52-53).

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

In this setting a third characteristic in addition to the length and breadth of a patent comes into play, namely the height of 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 2002:66). Regarding the height of protection Scotchmer and Green (1990) argue with some reservations for weak novelty requirements.

[45] 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 the elasticity of demand.

Fairly recent studies by Green and Scotchmer (1995), O'Donoghue (1998) and O'Donoghue et al. (1998) are mostly consistent with Kitch's[46] 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 maximizes the reward for the initial inventor.

Several researchers however have raised doubts about this favouritism for broad patent protection. 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 field. Mazzoleni and Nelson argue that the risk of this effect is higher than most studies anticipate since they do not account for the possible high transaction costs of licensing agreements (p. 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" (p. 908-909). Especially the last point seems to raise doubts about the theory that licensing agreements can substitute patent protection for the second inventor.

To sum up this section in one sentence, even in the setting of a closed economy the effect of IP protection on the economy is not clear from the outset, due to the various trade-offs at play.

3.3. IPRs in a North-South context

In an open economy where extensive differences in economic development and innovation capabilities among countries exist, IP 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[47], which is if anything a question of distribution. In contrast, in the case of an open economy and of a technology importing country the monopoly rents

[46] 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.
[47] Leaving the deadweight loss aside for a moment, since it will be suffered in any case.

($P_M MBP_C$; see Figure 1) are awarded to a foreign firm and thus can 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 2000:33).

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 2005:5). Furthermore the effect on the quantity served to the market is not clear from the outset. On the one hand, IP protection strengthens the market position of the exporting firm since illegitimate local competitors are driven out of the market thus raising demand for the IP protected good. Maskus (2000) refers to this effect, which leads to an expansion of the quantity of goods exported to the country, as the *market-expansion effect*. On the other hand however, the firm might cut down the provided quantity, since the lower elasticity of demand due to increased market power allows the firm to curtail it sales (p. 112). Whether the *market-power* or the *market-expansion effect* prevails is not clear from the outset 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 large countries with strong imitative capabilities the opposite is likely to be the case (p.230).

Apart from potential negative effects due to market power, there are potentially positive effects which have to be considered. First, stronger IPR protection can stimulate invention and innovation in the developing country itself. However, this argument is very likely only true for a small number of relatively advanced developing countries, who have gained substantial experience and technological knowledge at least in some fields of production. In all other countries simply raising the level of IP protection will not be enough to foster innovation (Verspagen 2003:503-504). For example Lerner (2002) finds in his study, which examines 177 patent reforms over the past 150 years in 60 nations, that reforms increasing IP protection had no effect on innovation in developing countries, where innovation is measured by patent fillings in the reform country and Great Britain. (p. 30-31)[48]. Second, strong IP protection in developing countries may induce 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 1989:2). Again, this is presumably of greater

[48] Brandstetter et al. (2004) and Schneider (2005) do not find an impact of IPRs on innovation for developing countries. Chen and Puttitanun (2005) though do find a positive impact.

relevance for large developing countries with considerable purchasing power. Third, as long as innovative firms do not see their intellectual property protected they might be unwilling to either license their knowledge to firms in that country, to engage in FDI, or in cases where the potential threat of imitation is especially high even refuse to serve the market through exporting to that country. Thus, stronger IP protection might increase any of these three potential channels of technology transfer (Verspagen 2003:503). Due to developing countries limited innovation capability, this effect is probably of greater importance for the South as a means of technological advance than the potential stimulation of local innovation.

Enhanced formal technology transfer is one of the most promising potential positive effects for developing countries. However, the impact stronger IPRs have on the market serving decision is not clear from the outset, since there are considerable interactions at work.

3.3.1 The role of trade, FDI, and licensing

Trade, FDI and licensing can be important channels of technology transfer[49] (Maskus 2004: 24). However nothing has been said about the effectiveness of these channels yet.

While there are some empirical studies, where no or only weak evidence for an impact of imports on technology diffusion are found[50] further empirical research has established a fairly robust link[51]. Furthermore the empirical evidence summarized by Keller (2001) suggests that the degree to which countries can take advantage of imports as a device of technology transfer can be influenced by other aspects, for example by geographical and technological distance (p.35-44). The further a countries' technological capabilities lag behind the technological frontier the more cost and time intensive imitation, adaptation, or follow-on innovation will be. Thus human capital, technical skills, local R&D programmes, and the like are important determinants for a country's absorptive capability (Maskus 2004:17-18). This is supported by the findings of Eaton and Kortum (1996) which shows that the higher the level of human

[49] 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: 9-13).

[50] The results obtained by Keller (1998) do not support the notion that imports and technology diffusion are linked. Eaton and Kortum (1996) conclude in their study that: "imports are not an important vehicle for technology diffusion" (p. 265).

[51] Coe and Helpman (1995) find that the composition and the level of imports influence technological diffusion. Xu and Wang (1999) find a significant effect of import composition and Lumega-Neso et al. (2005) find an important role for trade on technology diffusion once indirect spillovers are considered.

capital (which is used to measure the technological gap) and the lower the geographical distance the larger the technology flows.

Regarding FDI as a device of technology transfer there are two important aspects. On the one hand FDI internalizes the transfer of technology. Thus, the fact that knowledge is kept inside the source firm may limit the potential for diffusion to the host country. On the other hand a number of arguments have been put forward that underline the potential positive spillovers through labour training and turnover, potential facilitation of imitation through local production, access to high-quality intermediate goods, and potential gains for local exporters who might benefit from the distribution networks and transport infrastructure established by TNCs (Falvey and Foster 2006:29-30). After surveying the literature regarding spillover effects of FDI Görg and Greenaway (2003) conclude that, while there are several theoretical reasons for spillovers the empirical evidence on the subject is, at best, mixed. However, at firm level there seems to be evidence that geographic distance and the absorptive capability of the local firms have an important role in determining the effect of FDI in the same industrial sector (p.14-15).

The impact of licensing is even more complex. Licensing is not a simple transaction and difficult to characterize. 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 regarding 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, a successful transfer again very likely depends on the host countries technological capacities (Maskus 2004:20).

Thus, it can be argued from the brief review above that there is no a priori preferred channel of technological transfer and that countries' technological capabilities are decisive in all three cases. Markusen (2001) examines in his study the welfare effects different entry modes have. He concludes that welfare increases in those cases where higher levels of IP protection lead the foreign firm to alter their serving mode from exporting to local production but decreases if production were local anyway.

It is reasonable to assume that the entry mode a firm chooses (licensing, FDI, or exports) is influenced by the level of IP protection. The OLI framework from Dunning (1981) is a relevant approach to consider the simultaneity of the serving decision firms. 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 the intangible assets it holds. It can exploit location advantages by shifting production to a location with lower labour costs while the question of internalization refers to whether or not to produce within or outside the firm. Thus in the context of IP protection, ownership advantages (e.g. intellectual property that is protected) can, depending on the respective strength of the market-power and market-expansion effects, increase or decrease "bilateral exchange"[52]. Regarding the location decision, strong IP protection in a country can constitute a location advantage and thus increase local production (FDI and licensing) relative to exports. And finally since internalization is preferred when the threat of imitation is very high, internalization favours exports and FDI (Smith 2001: 414-418). Thus, apart from a fairly strong theoretical case for a positive influence of IP protection on licensing, no conclusion can be drawn about the net effect of higher levels of IP protection 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 IP protection but also on the vintage of the technology to be transferred. Maskus et al. (2005) find that the effect of stronger IP protection depends on whether the decrease in contracting cost or the decrease in imitation threat prevails. In the first case licensing increases relative to FDI. The second case is ambiguous however. With high rates of global innovation an increase in IP protection yields the same results as in the first case. FDI is likely to increase relative to licensing at a low global innovation rate however. Consequently the effect of higher levels of protection is in this case affected by the rate of innovation in the respective industry. In general, the effect of stronger IP protection on the serving decision is not clear from the outset.

[52] The term "bilateral exchange" is used to refer to all three serving decisions (trade, FDI and licensing). (See Smith 2001)

3.3.2. Theoretical welfare considerations (local and global welfare)

This section deals with the theoretical considerations regarding welfare effects of stronger IP protection in the South from a local and global point of view. Chin and Grossman (1988) were among the first to formulate a theoretical model in order to investigate the impact of extending IP protection to the South on local and global welfare. In their product-cycle model with a single Northern and a single Southern firm, they assume that only the northern firm can innovate, while the Southern firm can imitate at zero costs if no patent protection is available. They find that the North always gains from patent protection in the South while the South only gains from protecting the intellectual property of the Northern firm if the cost saving from innovation is very high or Southern consumption makes up the bulk of global consumption. For global welfare they find that only if productivity gains are high will it increase with Southern IP protection. However, in the case of licensing, global IP protection always enhances global welfare. But Northern and Southern interests also conflict in this case since the results for Southern welfare in the absence of licensing remain more or less the same under licensing. Thus the market share of Southern consumers and the amount of cost saving through innovation in the end determine welfare loss or welfare gain for the South, while global welfare additionally depends on licensing possibilities as well.

Similar results are found by Deardorff (1992); while the North in his model always benefits the South, except when using unrealistic parameter specifications, suffers a welfare loss and the effect on global welfare is uncertain. He shows that, as more and more people move from a country without protection to a country with protection, which is equivalent to expanding patent protection to a larger number of countries, a point is reached where extending IP protection further reduces global welfare. Thus, he argues that while some extension of patent protection is likely to increase global welfare, worldwide protection is not desirable from a welfare point of view, and hence the poorest countries should be excluded from protection.

Diwan and Rodrik (1989) picked up on one of the issues raised by Chin and Grossman's (1988) work. At first glance it seems rather unrealistic that Southern consumers have a market share of around 80% of the world market, as would be necessary in order to achieve a welfare gain for the South in Chin and Grossman's model. However, if one assumes, as Diwan and Rodrik do, that the North and the South have different preferences, it becomes at least somewhat realistic[53]. In this case patent protection in the South can contribute to inducing

[53] For example in the case of drugs for tropical diseases.

firms to invest part of their scarce research capital into the development of technologies better suited for the South. This gain in new appropriate products for the South now has to be weighed against the benefits of free-riding. Furthermore, in contrast to the findings in the previous model IP protection in the South need not always be beneficial for the North, since it might steal away limited R&D resources (pp. 2-3). They find that increasing patent protection either in the South or the North always increases innovation and skews the technological fit of the innovations towards the patent protecting region. From a utilitarian point of view, which assigns equal weight of welfare to both regions, the North and the South should provide the *same* protection level. From an egalitarian point of view, laying greater weight on Southern welfare[54], the levels of protection should differ, in what way, however is not clear from the outset[55]. Even though introducing possible utility differences between the North and the South is a valuable and reasonable step, it generates further ambiguity, since now the global welfare effect strongly depends on value judgements, namely the amplitude of the weight difference assigned to Northern and Southern welfare.

All three models listed above are partial equilibrium models. Helpman (1993) was the first to investigate the effect of enhanced IP protection in the South on local and global welfare in a general equilibrium setting. He splits the potential effect on welfare into four different items: production location, terms of trade, intertemporal allocation of consumption, and product availability. Then he considers the potential effects on welfare with and without the possibility of FDI. He finds that the South loses from increased IP protection in all cases considered in the model with and without FDI. In the case of the North however, loss or gain depend on the rate of innovation, the rate of imitation, the relative population size of the South and whether or not FDI is possible. One especially striking result from the array of possible outcomes is that in the absence of FDI it is possible that stronger IP protection actually lowers the rate of innovation. Not considering FDI a welfare loss for the North is also possible. However, once FDI is included, the North is very likely to gain in all cases. Even though Helpman's inclusion of FDI into the model is rather simplistic, the results still highlight the importance of considering FDI in this kind of analysis.

[54] Scherer (2004) makes a similar point in his model regarding pharmaceutical patenting. He finds that if one assumes that there exists a utility differential between the North and the South then in the bulk of cases free-riding of the South is locally and globally optimal.

[55] While in the purely theoretical case there is ambiguity regarding which region should provide higher levels of protection, in the numerical simulation however they find that the North should provide a higher level of protection.

Lai (1997) more thoroughly examines the effect of FDI in the case of stronger IP protection in the South. In his dynamic general equilibrium model he allows for two channels of technological advance in the South, namely imitation and FDI[56], where in the latter case imitation is only possible after the transfer of production to the South by a Northern firm has occurred. Innovation is in both cases determined endogenously[57]. His findings point in a similar direction as Helpman's model results. In the case where imitation is the only channel of technology transfer, increased IP protection in the South reduces the rate of innovation, however, in the case of FDI the opposite is true. This finding also holds for a mixture of both channels as long as the fraction of multinationalisation remains high enough.

Yang and Maskus (2001) include the possibility of licensing into their general equilibrium product cycle model. After successful innovation the Northern firms decides whether or not to license its new technology, which is on the one hand encouraged by lower labour costs in the South and on the other hand constrained by rising costs, due to contract negotiation and the share of rents which has to be given to the licensee in order to deter imitative activities. The level of IP protection not only influences the total economic return but also its distribution between the licensee and the licenser. They find that enhancing IP protection in the South increases innovation in the North as well as the rate of licensing. Regarding the effects on relative wages the findings are ambiguous. If a large amount of production is shifted to the South, then wages in the South increase. However in the case of only a small shift, wages would decrease. Thus, aside from an inexplicit effect on Southern wages, Yang and Maskus' findings are supportive of stronger IP protection.

Glass and Saggi (2002) further advance this issue by endogenising imitation as well. In contrast to Helpman (1993) and Lai (1997) the effect of stronger IP protection in the South on innovation does not depend on the channel of technology transfer (imitation or FDI) anymore. Instead they find that stronger protection always reduces innovation. Stronger IP protection in the South makes imitation more costly and forces the South to use up more resources for imitation, which have to be drawn from production. Thus FDI declines and production in the North has to rise. This however causes innovation to decline since fewer resources are available for research.

[56] Which Lai refers to as "multinationalization".
[57] Helpman (1993) only addresses endogenous innovation in the case without FDI.

In short, this section can be summarized with a statement from Maskus and Reichman (2005): "(…) there is even less consensus among economists about how to regulate the global market for knowledge goods than exists in successful national markets, and that these uncertainties are aggravated by inequalities between rich and poor nations." (p. 18).

Essentially, it is the public good character of knowledge that causes the market solution of knowledge production to be inefficient, thus making some kind of government intervention necessary. In the realistic case of asymmetric information IPRs are in most cases preferable to the other possible mechanisms of appropriation like awards or contract research, since IPRs decentralise the research decision. In general IPRs involve an unavoidable trade-off between access to knowledge on the one hand and stimulating research investment on the other. While from a static point of view everybody should have access to knowledge at its marginal costs, from a dynamic point of view inventors must be compensated for their research expenditure, since otherwise no research would have been conducted in the first place. In the case of cumulative research the trade-off becomes even more complex. In this case stronger protection of intellectual property may lead to lower research investments since strong initial patents might impede further research. There have been numerous theoretical studies focusing on the question of how to balance these trade-offs. However, the complexity of the issue avoids clear-cut answers and the results of these studies depend very much on model specifications and parameters. This is even more pronounced when open economies with different levels of economic development are considered. However, while the insights from a purely theoretical point of view are limited, there are valuable results to guide further research. The inclusion of one or more channels of technology transfer next to imitation tends to alter the results obtained from some models considerably. Thus, these aspects should be considered in empirical studies. However, for this work the most important findings are that from a theoretical point of view the effect of expanding strong IP protection to the South on technology transfer and welfare are not at all clear from the outset. Thus, the question is mainly an empirical one.

4. Empirical evidence

This section summarizes the relevant empirical studies addressing the impact of IP protection on different channels of technology transfer such as trade, FDI and licensing and on growth in general.

4.1. IPRs and trade

In the 1980s the growth in exports for the first time exceeded output growth and between 1980 and 1994 the share of exports of high technology products rose from 12% to 24% (Primo Braga et al. 2000:16). Developing countries were mainly excluded from these developments however. While upper middle-income countries[58] were able to slightly increase their share in capital-intensive, skill-intensive and high-technology imports from OECD countries, the shares of low income and lower-middle income countries as well as for Sub-Saharan states[59] has been decreasing since the 1970s. In 2001 for example the share of low income, lower-middle income and Sub-Saharan countries in capital-intensive OECD exports was 2%, 11.2%, and 0.6% respectively (Maskus 2004: 11).

As outlined in the theoretical section, stronger IP protection 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. Thus, the net effect is in the first place an empirical question. There are a number of studies which have focused on this issue and there seems to be a rough trend towards the notion that stronger IP protection increases trade flows.

Maskus and Penubarti's (1995) study is designed to investigate the prevalence of market-power and market-expansion effects in more detail. They augment a Helpman-Krugman model for bilateral gross imports by a measure of patent protection, preferences and trade distortions in importing countries. They correct the Rapp and Rozek (1990) index through an instrumental variable regression in order to account for, on the one hand, the possibility of endogeneity, since trade flows and level of economic development may influence legislation and on the other hand, to account for measurement errors and subjectivity of the index. By interacting the patent variable with a dummy variable for small and large developing countries

[58] As defined by the World Bank.
[59] Sub-Saharan countries, South Africa excluded.

in order to capture market size and technological capabilities, they find that weak patent protection in large developing countries does seem to negatively affect exports from OECD countries. The findings for small developing countries however are ambiguous. Thus, they argue that, it indeed seems to be the case that the market-expansion effect is predominant in larger countries while the market-power effect is stronger in smaller countries which possess a lower threat of imitation. Furthermore by splitting the industry sectors in to three groups depending on their presumed patent sensitivity[60] they find that patent protection is more important for industries which are less patent-sensitive (low-technology goods). This, surprising result can be explained if it is considered that the patent protection variable might proxies for trademark protection. As a consequence low-technology goods which are easily copied (clothing or consumer items) under weak trademark protection strongly react to changes in patent protection. Trade in products which are demanding to imitate, like most products in the first group[61], are less sensitive to patent protection.

Smith (1999) estimates various bilateral trade equations in a gravity and Helpman-Krugman model. She uses data on exports of U.S. states to a large sample of developed and developing countries, with data collected at the two-digit industry level. Her findings are in general consistent with Maskus and Penubarti (1995). By including dummies for different levels of economic development, the study finds that the market-expansion effect is dominant in the lower middle income group, while the market-power effect seems to prevail in the other groups. It is intriguing that other things being equal the richest and the poorest are affected in the same way. However, what high, upper-middle and lower-income countries have in common is their low imitation threat, which is in the case of the first two groups due to high levels of IP protection and in the last group due to the lack of imitative abilities. Thus, the imitation threat seems to be crucial in determining whether market-power of market-expansion effect dominates. Smith explicitly investigates this topic by including dummies for threat of imitation and interacting them with the IP variable. The findings are supportive of the previous results. The market-power effect dominates in countries with the lowest imitation threat, while the market-expansion effect dominates in countries with the highest imitation threat.

[60] The first group includes industries which have been reported to depend heavily on patent protection following the studies of Mansfield (1986), Levin et al. (1987) and the Reports of the US International trade commission which reports the sector which obtained most damages from foreign patent infringement. The second group includes those industries who are the least sensitive to differing levels of IP protection, while the third group includes all remaining industries. Pharmaceuticals are not included in any of the groups (Maskus and Penubarti 1995:241)

[61] This group includes amongst others electrical machinery, metal products, industrial chemicals and machinery.

Fink and Primo Braga (2005) estimate a gravity model for bilateral trade flows. They cope with the problem of zero trade flows between some countries in the sample by estimating a bivariate probit model. Furthermore they distinguish between non-fuel trade flows and high-technology trade flows in order to test whether knowledge-intensive goods are more responsive to differing levels of IP protection, which they measure with the Ginarte and Park index. While they find a statistically significant positive effect of the patent index on the probability of non-fuel trade between countries and on total non-fuel trade flows this is not the case for high-technology goods. In this case there is a statistically significant negative effect on the probability of trade flows and an insignificant effect on positive high-technology trade. There are a number of possible explanations for these findings. First, market-power effects are stronger than market-expansion effects in these goods. Second, stronger protection alters the serving decision of high-technology firms and third the aggregate for high-technology goods may contain many goods for which alternative mechanisms of appropriation are decisive (p. 28).

Lesser (2002) also investigates the effect of IP protection on trade. To measure IP protection Lesser develops a new index of IP protection, based on scope, efficiency and transparency[62]. Using a dataset which covers up to 44 developing countries for 1998, the study finds a statistically significant effect of the IPR score on trade.

Lippoldt and Park (2003) regress trade flows as well as FDI inflows and outflows on GDP per capita, country risk, the average 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[63] positive effect for developing countries and an insignificant one in the case of least developed countries[64]. As the authors point out, these findings are in line with the results of Maskus and Penubarti (1995) that market size is important in determining the effect of patent protection. In addition Lippoldt and Park point to the fact that in many developing and least developed countries

[62] Scope and efficiency are measured by membership to various treaties. For example PCT (Patent Cooperation Treaty) membership is assumed to imply efficient application processes. Enforcement is determined through the Corruption Perception index (CPI). The three components are then weighted by the weights obtained from a factor analysis (Lesser 2002: 4-8).

[63] Lippoldt and Park speak of a statistically modest effect if the p-value lies between 5% and 20% (p.37).

[64] However, for the sample of least developed countries some control variables (country risk, tariff rate) had to be dropped due to insufficient data availability, this limits the informative value of the regression analysis for this country group (Lippoldt and Park 2003: 18, footnote 24).

substantial trade barriers remain as another possible explanation for their findings. Furthermore they suggest that it may also be due to the production cost advantages of developing and least developed countries which induce foreign firms to switch from exporting to FDI, when IP protection is sufficiently high. This notion is supported by their findings that IP protection has an economically stronger effect on FDI in poorer countries.

To quickly sum up this section, when trade flows alone are considered, IPRs seem to have a significant positive effect on them, however, it seems to be more definite in low-technology goods than in high-technology goods. Keeping in mind the ambiguous theoretical considerations, the studies reviewed here are surprisingly consistent in their findings.

However, it remains ambiguous 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 IP protection, though impedes competition and may shift production to the North, which may face higher production costs than the South[65]. On the other hand however, if an insufficient level 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. The empirical studies though could not find a significant effect of IP protection for these products (Liebig 2001:17).

These reservations are just mentioned to outline that there exist some ambiguity regarding the effect of increased trade flows on IP protection, though this has to be kept in perspective since there are still other significant positive externalities associated with trade.

4.2. IPRs and licensing

Royalty flows have been in the past and still are mostly a domain of high income countries. In 1970 99.7% and in 2001 96.7% of royalty flows passed between OECD countries. In 2001 the only income group that made up a small share of worldwide royalty flows (2,4%) towards OECD countries other than high income countries were the upper middle income countries (Maskus 2004:11).

[65] 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.) (Liebig 2001:17)

As in the case of trade flows, the empirical literature concerning the effect of IPRs on licensing is limited. Contractor (1980) carried out one of the first studies on this subject. His study, which covers 102 technology licenses, focuses on the level and composition of compensation for licenses. Regarding patent protection, he shows that licensing returns are higher for patented technology. In Yang and Maskus (2005), the authors test their theoretical model (see Yang and Maskus 2001) on the basis of a panel dataset (1985, 1990, 1995 and 23 countries) for U.S. firms' receipts of license fees and royalties. As explanatory variables they include a measurement for openness, total labour endowment of the technology importing country, the skilled labour to total labour ratio, real GDP per capita and the Ginarte and Park index as well as its squared term. This equation is estimated for four different dependent variables: 'unaffiliated royalties and license fees', 'unaffiliated fees for using industrial processes', 'affiliate royalties and license fees' and the 'ratio of unaffiliated license fees to U.S. exports'. The study finds that stronger protection of IP favours unaffiliated over affiliated transfer of technology. Furthermore, unaffiliated license fees and royalties are at a lower level of protection negatively and at a higher level of protection positively influenced by IPRs. Countries with a low level of protection are likely to have limited skilled-labour endowments and thus pose a limited imitation threat. Yang and Maskus thus assume that in these countries the *market-power effect* dominates the *economic-returns effect*[66].

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) on industry level The study finds substantial differences in licensing structure between the analysed industries (chemicals, industrial and commercial machinery, and electronic and electrical equipment and components[67]). Anand and Khanna act on the assumption that IP protection is not only defined by policy choice but also by bounded rationality. Since it is rather easy to precisely describe chemical inventions and inventing around an existing patent is difficult in the chemical industry[68], patent protection can be considered rather strong in this case. By contrast the electronics industry is suffering from difficulties of making an exhaustive verbal

[66] Yang and Maskus (2005) refer to the positive effect of stronger IP protection on licensing returns as the economic-returns effect. This can on the one hand be attributed to enhanced licensing flows since licensing is preferred over trade and FDI and on the other hand to the greater rent share the licenser receives since the rents do not have to be used to deter imitation by the licensee (p. 113-114).

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

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

description of e.g. a circuit layout. Thus, there is substantial room left for inventing around and reverse engineering. Consequently, patent protection is stronger in the chemical industry than in the others (p. 126-128). 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 find a statistically significant impact of IPRs on licensing, neither regarding the volume of licensing nor the serving decision[69]. Fosfuri argues that firms might react to lower protection levels by transferring older technology, however this cannot be tested from his data set. 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's (2005) paper is the most recent one on the effect of strengthened IP protection on international licensing. They use firm level data to investigate the relationship, on the one hand between IPRs and licensing receipts and on the other hand between the volume of licensing and IPR strength. As control variables, country risk, corruption and mean tariff rate are included. The variables of interest are IPR, which is the equally weighted sum of a patent right index from Ginarte and Park (1997) and Park and Wagh (2002), a copyright index, and a trademark index, or alternatively each of these indices on their own as well as enforcement effectiveness, which is based on reports from the U.S. Trade Representative (USTR). Overall the empirical findings support the proposition that stronger IP protection positively affects international licensing. In the context of this paper though, the results regarding patent protection are the most interesting. The study finds that stronger patent protection 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 patent protection, while for the groups 'food and kindred', 'chemicals', 'metals', 'machinery' and 'wholesale' no statistically significant impact is found[70]. Regarding different levels of income[71] the study finds that

[69] Fosfuri (2003) only distinguishes between technological transfer that includes the transfer of production since the data set does not include export data (p.5).
[70] The findings regarding industry groups have to be interpreted with care since some firms may be involved in multiple industry activity and thus the industry classification may lead to some bias (Park and Lippold 2005:41).
[71] For this purpose the sample is split into countries with GDP per capita > 18000$ and GDP per capita < 18000$.

patent protection positively influences licensing in both relatively rich and poor countries, where the effect is economically more important in relatively richer countries. Park and Lippoldt (2005) also explore whether IP protection influences the serving decision by including the ratio of unaffiliated licensing to trade or FDI as dependent variable. They find that when patent protection increases, 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 IP protection is stronger (p. 29-30). Why this does not hold for richer countries in the case of trade remains unclear.

The results of the reviewed papers are in general consistent with the theoretical arguments outlined in the previous chapter. While most theoretical considerations were inconclusive, the case for a positive effect of stronger IP protection on licensing was the most unambiguous. Moreover, the bulk of the empirical studies on this subject finds a positive influence of IP protection on license fees and royalty payments. Thus, there is a fairly strong case for a positive influence of IP protection on licensing behaviour.

4.3. IPRs and FDI

In general, FDI outflows from OECD countries increased from 1970 to 2001. The share of high income countries in FDI, while still very high, has decreased from 79.9% to 71 %. The income group that experienced the strongest increase in FDI flows from OECD countries are the lower middle income countries, this is presumably due to increasing OECD FDI flows to China, which is in this country group. Low income and Sub-Saharan countries again had to face a decrease in their shares, from 3.2% to 1.2% and from 1.2% to 0.8%, respectively. However, the absolute values did increase from 0.3 to 8.1 and 0.1 to 5.5 ($bn) respectively (Maskus 2004:11). The relative importance of FDI for developing countries in general increased. Inward FDI stock as a share of GDP almost doubled between 1985 and 1995 (Primo Braga et al. 2000: 21).

Many early studies of the impact of IP protection on FDI provided rather mixed evidence. Maskus and Eby-Konan (1994) [72] do not find a statistical significant influence of patent protection, measured by the index of Rapp and Rozek, on FDI. The same is true for Kondo

[72] Fink and Primo Braga (2005) have raised doubts regarding the reliability of their results (p. 30).

(1995), who develops his own index of IP protection and Ferrentino (1993), who simply uses membership in international agreements and duration of protection as a proxy for patent protection. Seyoum (1996) finds an overall positive effect of different IPR measures[73] on FDI but then again an insignificant effect of patent protection in LDCs and a significant negative effect of patent protection in developed countries.

Lee and Mansfield (1996) however find a positive effect of IP protection on FDI. They use the perceived weakness of IP protection, which they obtain from survey data from U.S. firms as a variable for IP protection. When controlling for market size, stock of FDI, degree of industrialization, openness, and for being Mexico[74] they find a significant influence of perceived weakness if IP protection on the volume of FDI flows and on the composition. Weak IP protection is found to decrease FDI flows in general, and alters the composition of FDI by affecting wholly-owned subsidiaries more strongly than minority or majority owned subsidiaries. There are however some methodological shortcomings with this study. The authors picked the 14 countries for their sample because they have been regularly cited in controversies over weak IP protection (Lee and Mansfield 1996:181). All of these countries[75] possess some technological capability in general and some imitative capability in particular. Consequently, IP protection is likely to be relevant for the investment decisions and the study by Lee and Mansfield (1996) may overstate the importance of IP protection. Primo Braga and Fink (1998) further express concerns that the survey results implicitly capture other aspects that can influence the investment decision (e.g. presence of imitators). Thus, while a survey has the advantage that it can take account of non-recorded factors, like enforcement weakness or corruption, it obviously suffers from subjectivity (p. 177, 182-183).

Nicholson (2003) uses count data to analyse the joint impact of industry characteristics and IPRs on U.S. FDI and licensing. The basic results from their cross-country, cross-sector panel data model support the notion that both FDI and licensing are positively influenced by IP protection, which is measured by the Ginarte and Park index. Furthermore they test the hypothesis that capital intensive industries are more likely to engage in FDI under a weak IP regime, while R&D intensive industries are less likely to engage in FDI in this case. The

[73] Seyoum includes in his regression variables for patents, trademarks, trade secrets, and copyrights, which he obtains from questionaires handed out to IP experts and practitioners in the respective countries.
[74] The study focuses on U.S. direct investment. It is presumable that due to geographic and political reasons Mexico receives a greater share of U.S. investment.
[75] Argentina, Brazil, Chile, Hong Kong, India, Indonesia, Mexico, Nigeria, Philippines, Singapore, South Korea, Taiwan, Thailand, Venezuela (Lee and Mansfield 1996:181).

findings generally support the hypothesis. They use count data since less aggregated industry data is available on count data (3-digit) than on dollar value data (2-digit). However, count data limits the possibilities of investigating a potential substitution effect from FDI and licensing as IP levels rise. What can be stated though is that the study finds evidence that an increase of the Ginarte and Park index by one unit has a lower marginal effect on FDI counts than on licensing counts.

Javorcik (2005) uses industry level data from an EBRD survey to test the hypotheses that IP protection affects IPR sensitive sectors (defined by Mansfield 1995) more heavily and that IP protection influences the foreign firms' choice between simple distribution activities and setting up production facilities. The collected data contains information on FDI projects in 24 Eastern European countries and the former Soviet Union. Two alternative measures of IP protection are employed, the Ginarte and Park index and an index based on the recommendations for IIPA (International Intellectual Property Alliance) Special 301 Watch list countries[76]. In general, both measurements yield very similar results. With regard to the first hypothesis a probit model yields very supportive results, IPRs positively affect FDI in the high technology sector but are insignificant in the other sectors[77]. In the case of the second hypothesis two equations are estimated: The first addressing the question of whether or not to engage in FDI, and the second the purpose of this investment. Again the findings are supportive of the hypothesis. Local production is favoured over distribution facilities when IPRs are stronger. These findings are not limited to IPR sensitive industries but apply to all sectors. Javorciks' study is especially interesting as the region was virtually closed to FDI until 1989. Thus, the findings of this paper are not obscured by investment history and past policy variables.

The bulk of the studies find a significant positive effect of IP protection on one of the channels of technology transfer. In the case of licensing the positive effect is the most unambiguous. Regarding trade flows the picture is still rather consistent and points towards a significant positive impact. The findings for FDI are the least definitive. Earlier studies in particular, often fail to find a significant effect. Nevertheless, more recent studies do find a

[76] It was solely the descriptions in these reports (e.g. about enforcement issues) that were used for the index and not the placement on the Watch list, since the latter also depends on a country's importance for U.S.' interests.
[77] These findings are supported by an industry survey from Mansfield (1994), who points out that in the case of high-technology industries the level of IPR protection is especially important for firms' decision to invest (FDI).

positive effect[78]. If the ambiguous results of the theoretical part are considered, the findings of the bulk of studies which consider one way of serving a market at a time are rather consistent. However, even though some of these studies focus on more than one way of technology transfer, the simultaneity of the serving decision is in most cases not taken into account.

There are a limited number of 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, intrafirm exports and arm's length exports. The level of IP protection 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 IP agreements regarding U.S. exports or foreign production. Transfer exports[79] however, are higher under a weak IP regime. Unsurprisingly, under a weak IP regime U.S. parent firms are less willing to transfer production processes to the foreign affiliate and thus export more to these affiliates. Still, these findings need to be interpreted with caution due the crude measure of IP protection employed.

Fink (2005), who investigates the effect of different levels of IP protection on U.S. and German foreign production, exporting, and licensing behaviour, also finds only weak evidence for an impact of IP protection on these channels of technology transfer. His approach is similar to Ferrentino's, but improves on it by using a more precise IPR measure (Ginarte and Park index) and taking account of the possibility that data availability may affect the randomness of the sample. Furthermore, Fink not only considers the modes of delivery individually but also the sum of international transactions (p. 79). His findings about the U.S. indicated that there is no or at best a weak negative impact of IP patent protection. In the case of Germany though, exports as well as receipts for processes, inventions and patents seem to be positively influenced. However, the last finding does not indicate whether this is due to an increase in technology transferred, or whether it is a consequence of the stronger bargaining power of German firms associated with stronger patent protection. In the case of foreign FDI stock[80] the study found no significant impact.

[78] Furthermore recent studies which find a positive effect are Lippoldt and Park (2003) (see 4.1), who not only investigate trade flows but also FDI, and Brandstetter et al. (2004), who analyse the effect of IP policy reform in host countries on intrafirm royalty payments.
[79] U.S. exports from the parent firm to a foreign affiliate.
[80] FDI stock had to be used due to a lack of data on other more preferable variables (Fink 2005: 97).

Maskus (2000) estimates a simultaneous set of equations for 46 countries from 1989-1992 for 'applications', 'sales', 'exports', and 'assets'[81]. Thus this system of equations can take account of four possible options of MNEs, exporting, increasing sales from operative foreign activities, direct technology transfer, or an increase in FDI. Furthermore, in addition to a range of control variables a dummy for developing countries is interacted with the IPR variable. Interestingly the interaction term always has the opposite sign than the IPR variable, pointing to a different influence on developed and developing countries. He finds that, while IP protection has a significant positive impact on affiliate exports, affiliate sales and FDI, there is only a negligible effect on patent applications (Maskus 2000: 131-133).

A study even more important for this paper, which takes account of the simultaneity of the serving decision is Smith's (2001), since she focuses not only on transfer forms to affiliates but also more generally on exports and licensing. Smith jointly estimates a gravity model for U.S. exports, affiliate sales and licensing to unaffiliated firms. She derives three hypotheses about the effect of IP protection on these channels of technology transfer based on the OLI framework. By controlling for GDP per capita, population size, distance, openness, and taxes she obtains results which are in general supportive of her hypothesis. In particular her findings support the notion that ownership advantages (through stronger patent protection) foster bilateral exchange in general. Second, due to internalization effects licensing is preferred over exports and FDI. Third, in countries with strong imitative capabilities the market expansion effect prevails. In sum the study finds that strong patent protection has a relatively strong positive impact on knowledge transfer outside the host country and an even stronger positive impact on knowledge transfer outside the source firm.

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. Furthermore, the nature of the transferred technology is found to be an important determinant, in addition to country characteristics, such as imitation threat.

[81] "Applications is number of U.S. patent applications filed in host country; Sales is total sales of foreign affiliates of U.S. parents (...), Exports is U.S. exports shipped to affiliates (...), Assets is total assets, foreign affiliates of U.S. parents (...)" (Maskus 1998:199). The last variable is measured in US$ billions the two previous ones in US$ millions (Maskus 1998:199).

4.4. IPRs and economic growth

There are a small number of studies that examine the effect of the level of IP protection on growth. This approach though, while having the advantage of pointing out an overall effect, has some drawbacks since the effect of IPRs on growth presumably is not straightforward. For example, IPRs may enhance innovation and invention, which in turn enhances growth. In countries without an own R&D sector where the effect on local innovation may be negligible however, IP protection might affect trade, FDI and licensing, which in turn affect growth. So if an insignificant effect on growth was to be found this does not imply that IP protection has no effect at all, it might just be the case that some effects offset each other (Kanwar and Evenson 2003:240).

Gould and Gruben (1996) were among the first to examine the effect of IP protection on growth. They use cross-country data to regress yearly GDP per capita growth on patent protection, measured by the Rapp and Rozek index (IPROP) and control variables[82]. They obtain a positive though only marginally significant coefficient on IPROP. The authors turn to an instrumental variable approach[83] in order to take account of possible measurement errors and endogeneity. Thereby IPROP becomes significant at a 5% level. However, the inclusion of ancillary variables lowers the significance level. They move on to examine whether the findings so far depend on the trade regime of a country. Gould and Gruben employ three measures to capture the openness of a country: black market premium (BMP), real exchange rate distortion (RERMED), and a trade index. For all three measures of openness they find that the significant positive impact of IPROP is stronger in relation to more open economies.

Ginarte and Park (1997) employ a system of equations to examine the impact on factor accumulation. They estimate an augmented Mankiw, Romer, and Weil model. They obtain a system of four equations: one for GDP growth, and the others for gross investment rates in physical, human and research capital. The data is averaged over the period 1960 to 1990 and split at the median income level before the system is estimated by SUR. While the measure for IP protection remains insignificant in all growth equations, it has a significant positive impact on the accumulation of physical and research capital in the whole sample. The sample

[82] All variables are the average over the period 1960-1988. The control variables include initial GDP per capita, the investment share of GDP, rates of secondary school enrolment and the initial literacy rate (Gould and Gruben 1996:330-331).

[83] For the first stage regression they regress IPROP on the initial literacy rate, the number of coups and revolutions per year, patent duration, dummies for Africa, patents of chemical products and microorganisms, the existence of petty patents, and membership of Berne Convention and UPOV (Gould and Gruben 1996: 337).

split by income reveals that this effect only works in the richer economies. Ginarte and Park suggest two explanations for these findings. First, a bigger part of R&D in developing countries is imitative or adaptive and thus IPRs are less important. Second, the IP protection level is so low in these countries that R&D reacts to other incentives.

Thompson and Rushing (1999) also estimate a system of equations but contrary to Ginarte and Park (1997), they do not focus on factor accumulation but on factor productivity growth. In essence they try to find evidence for the hypothesis that IP protection positively influences innovation, which subsequently encourages total factor productivity (TFP). The system of equations is estimated by SUR, where the Rapp and Rozek index (1990) is used to capture patent protection. The sample is split in two with regard to the initial income level[84]. They find a significant positive impact of TFP on GDP growth in the whole sample as well as in the split samples. Furthermore they find a significant positive impact of patent protection on TFP in the case of high-income countries but an insignificant effect for the whole sample and the low-income countries. Thus, patent protection does not seem to stimulate TFP in low-income countries.

Kanwar and Evenson (2003) do not focus on economic growth directly but on technological change, which is proxied for by R&D investment as a share of GNP. They employ a cross-country panel data set for the period 1981-1995. Their random effects estimation indicates a strong effect of IP protection, measured by the Ginarte and Park index on R&D investment.

Falvey et al. (2004) use threshold regression techniques in order to examine non-linearities in the relationship between growth and IP protection. They use a panel data set for 80 countries from 1975-1994, where four five year averages are formed. The estimated threshold for the level of IP protection, measured by the Ginarte and Park index, though significant, cannot contribute much to the issue, due to the large size of the confidence interval. In contrary to the IP level the thresholds found for initial GDP per capita are more insightful. The authors find two thresholds regarding income levels. The estimation results for the respective income groups show a positive and significant impact of IP protection on growth in low and high income countries but an insignificant effect in the middle income group. The significant positive impact on high income countries was to be expected, considering that these countries conduct the bulk of worldwide R&D. By contrast the significant positive impact in low

[84] The sample is split at an income level of U.S. $4000 (in 1985 constant $).

income countries arguably does not stem from increased R&D investment incentives. There have to be other mechanisms at work which are responsible for the positive impact (e.g. enhanced technology diffusion via trade and FDI). Finally the insignificant impact of IP protection on middle income countries could be due to offsetting effects, namely the positive impact of increase trade, FDI and licensing flows and the negative impact of impeded imitative activities.

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. Smith suggests that this can be attributed to the fact that innovative activities in developing countries are often adaptive or imitative. Smith points out that, instead of turning away from IP 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, Smith argues that the impact of IPRs on growth might not be fully captured in a traditional growth regression, due to its indirect nature.

The limited empirical literature on this subject indicates that a growth enhancing effect of IP protection depends once again on country characteristics. Other things equal there seems to be a stronger positive effect of IPR protection in more open economies. Furthermore, the countries' income levels seem to be an important aspect as well. While most studies which focus on income differences in the effect of IPR protection on growth – but also those studies which focus on trade, FDI, and licensing- only differentiate between two country groupings, namely developed and developing countries, the threshold analysis by Falvey et al. (2004) as well as the study by Smith (1999) indicate that it might be necessary to distinguish at least between high, middle and low income countries. Both studies suggest that high and low income countries are the most likely to gain from IPR strengthening, while the effect for middle income countries is ambiguous, probably due to the impeding effect of IPRs on their imitative activities.

5. Econometric analysis

The review of the theoretical and empirical literature suggests that both the direct and indirect effects of IPR protection should be considered when the overall impact of IP protection is the subject of interest. Thus, the regression analysis will not only focus on the direct impact of IP protection on growth but also on the effect of IP protection on different channels of bilateral exchange. Furthermore, the theoretical as well as the empirical literature emphasizes the importance of country characteristics especially regarding the level of economic development. It is exactly this aspect which poses the central question of this work, namely whether the level of economic development influences the impact of IP protection. This section further explores this subject by panel data analysis.

5.1 Model specification and variable description

5.1.1 Growth specification

A vast array of variables has been found to significantly affect growth in the past[85]. Levine and Renelt (1992) as well as Sala-i-Martin (1997) give some guidance about which standard variables to include in growth regressions. These standard independent variables are augmented by the variables of particular interest for this work: a measure for IPR protection (IPR), the average ratio of imports to GDP (IMP), the average ratio of FDI inflows to GDP (FDI), and the average ratio of royalty and licensing fees outflows to GDP (ROY). Thus, economic growth is modelled as a function of a measure of the initial level of GDP (IGDP), the average gross fixed capital formation (GCF), the average population growth rate (POPG), the average number of secondary school years in the population older than 15 (SYR), inflation (INF) included as a control variable for economic stability, a dummy variable for openness (OPEN), which is one in the case of open economies and zero otherwise, and the variables of particular interest. $GROWTH_{it}$ denotes the average GDP per capita growth rate for country i in period t.

$$GROWTH_{it} = \beta_1 IGDP_{it} + \beta_2 GCF_{it} + \beta_3 POPG_{it} + \beta_4 SYR_{it} + \beta_5 INF_{it} + \beta_6 OPEN_{it} + \beta_7 IPR_{it} + \beta_8 IMP_{it} + \beta_9 FDI_{it} + \beta_{10} ROY_{it} + u_{it} \quad (1)$$

[85] The number of variables that have been found to be significant in at least one growth regression seems to be between 50 and 60. Levine and Renelt (1992) speak of more than 50 variables, while Sala-i-Martin (1997) finds about 60 variables.

However, the variables capturing the serving decision are at risk of being subject to endogeneity in the economic sense. For example, including any kind of investment measure (e.g. FDI) into a growth regression can merely reveal whether or not investment and growth are associated but does not clarify the direction of causation, since both arguments – that investment enhances growth and that growth fosters FDI – are equally reasonable. Consequently the estimated coefficient will be inflated by capturing these two effects and henceforth will be inconsistent. In cases where there is a strong argument for endogeneity in the economic sense it is reasonable that the variables are also endogenous in the statistical sense, namely that they are correlated with the error term[86] (Durlauf et al. 2005:637-638). One way to deal with endogeneity is by explicitly modelling the potentially affected variables and then jointly estimate a system of structural equations. While this method, used for example by Tavares and Wacziarg (2001), has the advantage of revealing the underlying mechanisms and yielding efficiency gains, it suffers from the fact that potential misspecifications in one of the structural equations also affect the estimates of the other equations. The approach most commonly used in literature is to employ instrumental variables estimation for a single structural equation. While a variety of instruments have been used in growth studies, lately some scholars have raised doubts about the validity and strength of the instruments commonly employed (Brock and Durlauf 2001). Section 5.4, which focuses on the estimation methods, will deal with the problems of estimating growth equations of the above form in greater detail.

5.1.2 Bilateral exchange specification

For the specification of the bilateral exchange equations the guidance from the theoretical and empirical literature is less extensive than in the case of growth equations. However the variables affecting imports, FDI and licensing presumably resemble each other since the dependent variables are determined by the very same decision, namely the serving decision.

Foreign direct investment

There exists a variety of theoretical approaches, including neoclassical models, the OLI framework, risk diversification models, or the knowledge-capital model which attempt to explain FDI flows (Faeth 2008:165). Accordingly, a multitude of variables have been employed in empirical studies analysing the determinants of FDI. While in the context of

[86] Next to the problem of 'reverse causality' there are of course other aspects that can cause a variable to be correlated with the error term, for example measurement errors and omitted variables.

growth regressions a set of standard variables has emerged, in the case of FDI regression the choice of control variables is a less clear cut case. Faeth (2008) therefore suggests a broad approach, which is not based on a single theoretical model but instead takes into account a variety of factors suggested by different theoretical approaches, amongst others, market characteristics and market size, risk factors, policy variables, transport costs, and ownership advantages. Following Lippoldt and Park (2003) we include GDP per capita, the mean tariff rate and country risk as control variables, GDP per capita (*GDP*), openness (*OPEN*) to capture the tariff regime and inflation (*INF*) to capture the economic country risk in the regression analysis. Furthermore average schooling (*SYR*) is included in order to capture the skill level of the population while rule of law (*LAW*) is included in order to avoid the possibility of the IPR index picking up more general aspects of property rights and the legal system of a country. Finally, squared GDP per capita (GDP^2) is included to capture potential non-linearities.

Royalty and licensing fees

In the case of the royalty equation specification, the empirical model of Yang and Maskus (2005) and Park and Lippoldt (2005) are roughly followed. Yang and Maskus include the following control variables in their empirical model: an openness index from Sachs and Warner (1995), real GDP per capita, a measure for human capital, and total labour endowment (p. 118-120). The last control variable is not, however, included in the reported estimates since it always remains insignificant and since it would reduce the number of observations considerably because of data unavailability. Park and Lippoldt (2005) include control variables for tariff level, corruption and country risk (p.19). Thus, following Yang and Maskus (2005) GDP per capita (*GDP*), a measure for human capital (*SYR*) and the openness index from Sachs and Warner (*OPEN*) are included. These control variables are augmented by the variables suggested by Park and Lippoldt (2005), namely inflation (*INF*) in order to capture economic country risk and rule of law (*LAW*), which on the one hand roughly captures the author's corruption variable and on the other hand is included in order to avoid the IPR variable picking up the more general effects of property rights or other institutions of the legal system.

Imports

Again following Lippoldt and Park (2003), GDP per capita (*GDP*) and openness (*OPEN*), which captures the tariff regime, are included in the regression analysis. Furthermore, the rule

of law (*LAW*) is included in order to avoid the IPR index picking up more general aspects regarding the functioning and provision of the legal system.

Thus, the basic models for the bilateral exchange equations are:

$$FDI_{it} = \beta_1 GDP_{it} + \beta_2 GDP_{it}^2 + \beta_3 SYR_{it} + \beta_4 OPEN_{it} + \beta_5 INF_{it} + \beta_6 LAW_{it} + \beta_7 IPR_{it} + u_{it} \quad (2)$$

$$ROY_{it} = \beta_1 GDP_{it} + \beta_2 SYR + {}_{it}\ \beta_3 OPEN_{it} + \beta_4 INF_{it} + \beta_5 LAW_{it} + \beta_6 IPR_{it} + u_{it} \quad (3)$$

$$IMP_{it} = \beta_1 GDP_{it} + \beta_2 OPEN_{it} + \beta_3 LAW_{it} + \beta_4 IPR_{it} + u_{it} \quad (4)$$

Except for *GDP* and *LAW* all variables have been defined in the previous section. *GDP* denotes the average logged GDP per capita and *LAW* is an index measuring the rule of law, which takes judicial independence, impartial courts, protection of property rights, military interference in rule of law and the political process, integrity of the legal system, legal enforcement of contracts, and regulatory restrictions on the sale of real property into account (Gwartney et al. 2008).

5.1.3 Measuring IPRs

In order to empirically investigate the impact of IP protection on growth and the serving decision one has to find a way to measure IPR protection. However, there is no straight forward way of measuring a country's level of IPRs in an internationally comparable way. Thus, various different approaches have been taken in the empirical literature in order to capture the differences in IP protection across countries. These approaches range from surveys about the perceived weakness of protection to a dummy variable approach that is based on crude input measures, and finally to more sophisticated approaches based on indices as developed by Rapp and Rozek (1990) and Ginarte and Park (1997)[87].

The first approach was taken by Lee and Mansfield (1996), which used survey data from U.S. firms[88] about the perceived weakness of protection to measure IPRs. While this approach has the advantage of taking into account enforcement issues and corruption, it suffers from subjectivity and additionally might pick up other aspects related to the subject, such as the prevalence of imitators (Primo Braga and Fink 1998: 182-183). Ferrentino (1993) for example

[87] A number of other indices have been developed, such as those of Kondo (1994), Seyoum (1996), and Lesser (2002).
[88] They draw on the survey results from Mansfield (1994).

took the second approach by including dummy variables for the existence or absence of certain features of patent laws (e.g. adherence to international treaties).

Rapp and Rozek (1990) were the first ones to develop an index of patent protection (Primo Braga and Fink 1998). Their index rates the compliance with the 'Guidelines for Standards for Protection and Enforcement of Patents' from the U.S. Chamber of Commerce Intellectual Property Task Force for 159 countries on a scale from zero, indicating no patent protection, to five, which implies full compliance with the U.S. minimum standards[89] (Rapp and Rozek 1990:79). While widely used in literature the RRI is not suitable for this study since it is not available for different time periods. Furthermore the RRI possess rather limited cross-country variability, since it only allows for five distinct levels of protection. And as pointed out by the authors themselves, the index is based on the law in the books and does not account for enforcement issues (p.79, footnote 11).

Ginarte and Park (1997) took a more elaborate approach. They considered five categories ('extent of coverage', 'membership in international patent agreements', 'provisions for loss of protection', 'enforcement mechanisms', and 'duration of protection'), which were further broken down to account for important determinants of these categories. Each of the five categories can score a value between zero and one. For example, in the case of coverage a country scores one if its patent law provides protection for chemicals, pharmaceuticals, plant and animal varieties, food, micro-organisms, surgical products and utility models (p.284-286)[90]. Just like the RRI, the GPI is based on the law in the books and does not consider the actual enforcement of the laws. Thus, both indices probably overstate the level of protection in countries with weak enforcement. However, since a country can score any value between zero and five the GPI exhibits more cross-country variation than the RRI. Furthermore, it is available quinquennially from 1960 onwards. Thus the GPI is used to proxy for IPR protection. However, it has to be kept in mind that this index only accounts for the law in the books.

[89] A scale score of 0 indicates 'no patent protection laws', a score of 1 'inadequate protection laws, no law prohibiting piracy', a score of 2 'seriously flawed laws', a score of 3 'flaws in law, some enforcement laws', a score of 4 'generally good laws', and a score of 5 'protection and enforcement laws fully consistent with minimum standards proposed by the U.S. Chamber of Commerce' (Rapp and Rozek 1990:83).
[90] A full description of the structure and categories of the GPI is given in appendix A.

5.2 Data source and description

The panel dataset covers 64 countries[91] and the time period covered is from 1975 to 2004. The data is averaged over five year periods[92]. These are taken in order to remove short-term variation that may obscure the long-term effects and because the variable of main interest – the Ginarte and Park index for IPR protection – is only available quinquennially. The data on GDP per capita and GDP growth, as well as the data on population growth, gross capital formation, inflation, imports and FDI is obtained from the World Bank's World Development Indicators. The data on schooling is obtained from the Barro and Lee dataset (2000). The data on royalties and licensing outflows is drawn from the Balance of Payments (BOP) statistic (IMF). The measure of openness is from Sachs and Warner (1995) and Wacziarg and Welch (2003)[93]. The rule of law variable is the second component of the 'Economic Freedom of the World' index from the Fraser Institute, which is available quinquennially from 1970 onwards (Gwartney et al. 2008).

In the appendix A, summary statistics and the correlation matrix for all included variables are provided. It is useful however to explore the properties of the main variable of interest, the Ginarte and Park index for IPRs in greater detail, especially with respect to different income levels.

Table 1 indicates that the level of IPR protection as measured by the Ginarte and Park index does vary by income group. Furthermore it suggests that IPR protection rises with a country's income level, lower middle income countries which have a lower average protection level than the world's poorest countries are an exception.

Table 1. Average IPR index score by income groups

	LOW	LOWER MIDDLE	UPPER MIDDLE	HIGH
IPR mean	1.84	1.60	2.09	3.43
Std. Dev.	0.39	0.68	0.92	0.88
Nr. of Obs.	n=54	n=96	n=90	n=144

[91] The countries included in the sample, as well as their World Bank classification are listed in the Appendix. Countries are grouped according to their GNI per capita (2008): low income GNI per capita < $975; lower middle income, $976-3,855; upper middle income countries, $3,856-11,905; and high income GNI per capita > 11,906.

[92] Thus the time periods are: 1975-1979, 1980-1984, 1985-1989, 1990-1994, 1995-1999, and 2000-2004.

[93] Wacziarg and Welch (2003) updated the openness measurement from Sachs and Warner (1995) for the nineties.

Table 2 takes a closer look at the evolution of the average IPR scores for the different income groups over time. While all income groups exhibit a consistent rise in their average index score over time, upper-middle income countries followed by lower-middle income countries exhibit the biggest increase in their average index score. Apart from that three out of four income groups exhibit an erratic increase in their average protection level from 1995 onwards. While the average index score for low income countries rose by 0.26 index points during the period from 1975 to 1990, it again rose by 0.27 index points in the next five year period alone. In the case of lower-middle income countries this sharp increase becomes even more apparent. While the IPR score index for both of these country groups rose by about 0.1 index points from 1975 to 1990, it rose by 0.48 index points for lower-middle income countries and by 0.83 index points for upper-middle income countries in the next period. These two country groups also maintained this higher rate of growth of IP protection level for the last reported period. In the case of high income countries this pattern is less distinct. These relatively large changes in the IPR index in the recent past might reflect changes in the law to meet TRIPS minimum requirements.

Table 2. Average IPR index score by income group and time period

IPR mean	**LOW**	**LOWER MIDDLE**	**UPPER MIDDLE**	**HIGH**
1975	1.53	1.26	1.59	2.60
1980	1.65	1.31	1.63	2.97
1985	1.72	1.35	1.68	3.13
1990	1.79	1.36	1.70	3.40
1995	2.06	1.84	2.53	4.09
2000	2.31	2.50	3.39	4.37

5.3 Estimation methods

The data for the bilateral exchange equations is fitted to a two-way error component, fixed effects model of the following form:

$$y_{it} = \beta' \mathrm{X}_{it} + u_{it} \qquad u_{it} = \mu_i + v_t + \varepsilon_{it} \qquad i = 1,...,N \quad t = 1,...,T$$

where *y* denotes the dependent variable (e.g. GDP growth), β is a $K \times 1$ vector and X_{it} denotes the *it*th observation on *K*, where *K* denotes the numbers of explanatory variables included in the model. *N* denotes the number of countries and *T* the number of years included in the data set. Thus, *NT* gives the maximum number of observations. The disturbance term u_{it} is composed of μ_t ,which denotes the country-specific fixed effects and thus is invariant to time; v_t, which denotes the unobservable time effect and thus is country-invariant and accounts for time-specific effects not explicitly captured in the model; and finally ε_{it}, which is the stochastic disturbance term (Baltagi 2008: 15, 35).

The fixed effects model[94] is applied since μ_i is assumingly correlated with some of the X_{it}. While this approach is costly in regard to degrees of freedom lost, a random effects model may suffer from inconsistent estimates since it depends on the assumption that explanatory variables are uncorrelated with possible omitted heterogeneity (Greene 2008:208-209). Thus, any potential bias stemming from possibly omitted time invariant variables does not bias the fixed effects estimation, since the country-specific intercepts capture the effects of these variables. However, it has to be considered that by eliminating the effects of omitted heterogeneity through fixed effects estimation, the valuable information stemming from the variation between countries is lost as well. Higher standard errors and thus imprecise parameter estimates are the consequence of ignoring the variation between countries. In short, while the fixed effects estimator eliminates the bias from unobserved heterogeneity it is imprecise since it ignores the between information and is exclusively based on the within information. Thus, if the explanatory variables exhibit weak within–country variation, identification problems can arise (Durlauf et al. 2005: 629-631). In the case of the variables used in this work the problem does not seem to be too severe since all variables exhibit a reasonable amount of variation. However it should be noted that many variables exhibit greater between variations than within variation, indicating that a significant amount of valuable information is indeed lost. Appendix A reports the decomposed standard deviations for the variables included in the model.

[94] A Hausman specification test rejects the null hypothesis of random effects in all cases.

While these drawbacks have to be kept in mind, fixed effects estimation still has the advantage that it yields consistent estimates whether or not some explanatory variables are correlated with unobserved time-invariant effects. Thus, even in the case where the random effects model is the valid model, the fixed effects estimates are not inconsistent but merely imprecise. (Johnston and DiNardo 2007:400-403).

The two-way error component model has been chosen in order to be able to take account of time-specific effects as well as country-specific effects. This is preferable since the long time span is likely to make unobservable time-effects (e.g. oil crisis) an issue[95].

Since the particular interest of the paper lies in potential differences regarding the various ways IPRs can foster growth it is desirable to be able to test cross equation restrictions. One possibility is to use a "stacked estimator". *Seemingly unrelated estimation* allows for testing cross- and intra-model hypotheses by combining the parameter estimates and the covariance matrices of a set of equations into a parameter vector and a simultaneous covariance matrix. More precisely, in order to be able to test cross equation restrictions a Huber-White-sandwich covariance estimator is applied to the bilateral exchange equations, which are estimated by fixed effects dummy variable regression[96] (Stata Corp. 2007:347-364, Stata Corp. 2005:326-327).

However, while the fixed effects estimator is able to deal with omitted heterogeneity and thus is a suitable estimator for the bilateral exchange equations, the potential endogeneity problems regarding the growth equation persist. A common approach in literature to deal with endogenous variables is to employ instrumental variables.

[95] Both an F-test on the joint significance of the time dummies as well as on the joint significance of time and country dummies strongly support this notion.

[96] The set of equations has also been estimated by Zellner's *seemingly unrelated regression* (1962), which also allows to test cross equation restrictions while in addition having the potential for efficiency gains if the error terms of the different equations in the system of equations are correlated. The SUR estimator, which exploits these correlations of the error terms, obtains the best results – regarding an increase in efficiency – when the error terms are highly correlated and the regressors of the different equations are not. It is estimated in two stages. Where the first stage simply estimates the variance-covariance matrix of the residuals from an OLS regression and the second stage uses these results for the calculation of the GLS estimator (p.348-353). While for regressions with correlated error terms, OLS is asymptotically unbiased, but inefficient, applying SUR to regressions with uncorrelated error terms yields exactly the same results as OLS (Greene 2008: 254-258). The later seems to be the case here. A Breusch-Pagan test for independence of the residuals does not reject the null hypothesis of independence indicating that there are actually no potential efficiency gains from applying SUR to the set of equations. This notion is supported by the fact that the estimation results from the OLS and the GLS estimator are very similar (although not exactly the same).

In order for instrumental variable regression to be consistent and to yield more precise estimates two properties have to hold for the data matrix of the instruments (**Z**). Namely, the instruments have to be relevant, thus in the limit correlated with the explanatory variables (**X**); and they have to be exogenous, thus in the limit uncorrelated with the error term. More technically, the following properties have to hold:

1. plim (1/n) $\mathbf{Z'X = Q_{zx}}$, where $\mathbf{Q_{zx}}$ is a nonzero, finite matrix with full rank
2. plim (1/n) $\mathbf{Z'u = 0}$ (Greene 2008:314-316)

In contrast to the first condition, well founded theoretical and empirical arguments for the compliance of the second condition are often difficult to establish. Especially in the context of growth regressions, finding instruments which arguably fulfil both properties can be difficult. As for example pointed out by Durlauf et al. (2005):

> "(...) the belief that it is easy to identify valid instrumental variables in the growth context is deeply mistaken. We regard many applications of instrumental variable procedure in the empirical growth literature to be undermined by the failure to address properly the question of whether these instruments are valid, i.e. whether they may be plausibly argued to be uncorrelated with the error term in a growth regression." (p.638)

Bazzi and Clemens (2009) furthermore argue that many of the instruments used in literature necessarily fail to satisfy the second condition, since the instruments used in one application are rendered invalid by their other applications. In other words, assume that a variable z has been shown by existing research to be a strong instrument for x_j. Hence, z cannot be a valid instrument for x_i in a regression[97] where x_j is not included and $\beta_j \neq 0$. An example given by Bazzi and Clemens (2009) is the use of "legal origins" as instrument for various different variables in growth regressions. Thus, if the second stage is specified correctly in one of the applications, "legal origins" is rendered invalid as instrumentation in the other applications. In short the authors state that at best one of the specifications is correct and at worst none (p. 4-5).

Another option is to use lagged variables as instruments. Arellano and Bond (1991) developed a dynamic panel data estimator which uses lagged levels of the endogenous variables as

[97] For example of the following form: $g = \beta_0 + \beta_i x_i + u_i,\ i = 1,...,k$; where g denotes growth, u_i is the error term, and x_i are k potentially endogenous explanatory variables.

instruments for the current-period first differences of the series. This approach generates a set of moment conditions which can be exploited by GMM estimation. Furthermore, by the nature of the estimator it allows for lagged dependent variables. Thus, equation (1) can be written as:

$$y_{it} = \gamma y_{it-1} + \beta' \mathrm{X}_{it} + u_{it} \tag{5}$$

where the error term u_{it} is split up into country specific fixed effects (v_t) and a stochastic disturbance term ε_{it}. Rewriting equation (5) makes the presence of a lagged dependent variable explicit.

$$y_{it} = \gamma y_{it-1} + \beta' \mathrm{X}_{it} + v_i + \varepsilon_{it} \qquad \gamma = \alpha + 1$$

To eliminate the country specific effects (eq. 6), Arellano and Bond first difference all variables – hence the estimator is also called difference GMM estimator – and then use the lagged values of the variables as instruments:

$$(y_{it} - y_{it-1}) = \gamma(y_{it-1} - y_{it-2}) + \beta'(X_{it} - X_{it-1}) + (\varepsilon_{it} - \varepsilon_{it-1}) . \tag{6}$$

For t=3, the first period equation (6) can be observed, $y_{i,1}$ is a valid instrument since, as long as the error terms are not serially correlated, $y_{i,1}$ is not correlated with $(\varepsilon_{i,3} - \varepsilon_{i,2})$ while it is highly correlated with $(y_{i,2} - y_{i,1})$. Although in this case there is one instrument available for period t=3, for the next period (t=4) two instruments are available, namely $y_{i,1}$ and $y_{i,2}$. Thus, the number of available instruments increases with T so that for the last time period ($y_{i,1}$, $y_{i,2}$, $y_{i,3}$, ... , $y_{i,T-2}$) instruments are available (Baltagi 2008: 149).

More generally, under the assumption of serially uncorrelated errors, the moment condition for the lagged dependent variable can be written as:

$$E[y_{it-s} * (\varepsilon_{it} - \varepsilon_{it-1})] = 0 \tag{7}$$

Furthermore, for the potentially endogenous explanatory variables[98], the ratio of imports to GDP, the ratio of FDI inflows to GDP and the ratio of royalty and licensing fees to GDP, the following moment conditions apply:

[98] All other explanatory variables are not assumed as endogenous, but predetermined.

$$E[x_{it-s} * (\varepsilon_{it} - \varepsilon_{it-1})] = 0 \tag{8}$$

Since the validity of the lagged levels as instruments for the first differences rests on the assumption that the errors are serially uncorrelated a number of tests have been developed in order to verify this assumption, e.g. the Arellano and Bond test for second order serial correlation in the residuals of the differenced equation.

The advantages of the difference GMM estimator are that it can take account of potentially endogenous right-hand side variables, omitted variable bias due to fixed effects, and lagged dependent variables. Furthermore it is designed for "short T, large N" panel data sets. However, when the number of time series observations is low, the estimator can suffer from significant finite sample bias in the case of persistent time series since in these cases the lagged variables are only weak instruments for the first differences. In other words the lagged levels are barely correlated with the first differences and hence are only weak instruments. This potential drawback deserves some consideration in the context of growth regressions. First, output can be a highly persistent series. Second, many growth regressions, including this one, consider a rather small number of time series observations, as they work with e.g. five year averages in order to circumvent modelling cyclical dynamics (Bond et al. 2001:3).

Blundell and Bond (1998) proposed an alternative estimator, which exploits further moment conditions and for which superior finite sample properties hold in the case of persistent series and short time dimensions. Building on the work of Arellano and Bover (1995), Blundell and Bond (1998) additionally use lagged first differences as instruments for the level equations. The additional information this estimator exploits comes at the cost of further assumptions. Under the assumption that the first-differences of the right-hand side variables are uncorrelated with the unobserved country-specific effects, the additional moment conditions

$$E[u_{it}(y_{it-1} - y_{it-2})] = 0 \quad \text{for } i = 1, \ldots, \text{N and } t = 3, \ldots, \text{T} \tag{9}$$

$$E[u_{it}(x_{it-1} - x_{it-2})] = 0 \quad \text{for } i = 1, \ldots, \text{N and } t = 3, \ldots, \text{T} \tag{10}$$

are available. The system GMM estimator uses a stacked system of the first-difference and the level equations, exploiting both sets of moment conditions (7) and (8) as well as (9) and (10). The validity of this estimator rests on the assumption that the differences are uncorrelated

with the country specific fixed effects. A difference Sargan or Hansen test of overidentifying restrictions can be used to test the validity of the additional instruments employed (Bond et al. 2001:8-9, 12-13).

Blundell, Bond and Windemeijer (2000) consider endogenous regressors in their Monte-Carlo simulation of different GMM estimators for dynamic models. Their findings support previous studies considering AR(1) models, indicating that, in the case of highly persistent series, system GMM estimation can reduce the finite sample bias considerably.

5.4 Empirical results

5.4.1 Growth estimation

Table 3 reports the results for the growth equation from different estimators. In the presence of a lagged dependent variable, OLS and LSDV estimates are biased. However, the results from these estimators are included since the coefficient on the lagged dependent variable provides valuable information on the credibility of the results from the GMM estimation. While in the presence of a lagged variable OLS estimates are biased upwards, LSDV estimates on the lagged variable are biased downwards. Thus, any credible estimate for the lagged variable should lie between the OLS and LSDV estimates (Bond et al. 2001:7). Column (3) reports the one-step, robust, difference GMM[99] results and the associated test statistics. As expected, the Arellano/Bond test for first-order serial correlation in differences rejects the null-hypothesis of no autocorrelation, since $\Delta\varepsilon_{i,t}$ is related to $\Delta\varepsilon_{i,t-1}$ by differentiation[100]. Thus, in order to test for first–order autocorrelation in the levels, second-order correlation in the differences needs to be examined. The null hypothesis of no second-order serial correlation in the differences is not rejected. The Sargan and Hansen test support the validity of the estimation. Both tests however are subject to some limitations. While the Sargan test is inconsistent under heteroscedasticity the Hansen test can be weakened by too many instruments. The p-value for the Hansen test of 1.000 and the fact that the number of instruments exceeds the number of groups by far indicates that, in this case, the Hansen test statistic is indeed weakened by too many instruments. Furthermore, the estimated coefficient for the lagged dependent variable lies outside the range of credibility.

[99] All GMM estimations (first-difference and system) include year dummies.
[100] Both share the term $\varepsilon_{i,t-1}$.

Table 3: Comparing estimators

	(1) OLS [a]	(2) LSDV [a]	(3) diff. GMM [a,b]	(4) diff. GMM [a,b]/ lim	(5) syst. GMM [a,b]/ coll	(6) syst. GMM [a,b]/ lim	(7) syst. GMM [a,b]/ coll. lim	(8) syst. GMM [a,b,c]/ coll. lim
$Y_{i, t-1}$	-0.004	-0.079***	-0.086***	-0.096***	-0.003	-0.003	-0.030**	-0.020**
	(-1.474)	(-5.939)	(-6.132)	(-4.086)	(-0.995)	(-0.756)	(-2.195)	(-1.991)
GCF	0.124***	0.085**	0.067	-0.069	0.150***	0.169***	0.245***	0.206***
	(4.315)	(1.984)	(1.609)	(-0.765)	(4.470)	(4.191)	(2.895)	(3.129)
POPG	0.289	1.152***	1.231***	1.610***	0.556	0.919***	1.417***	1.457***
	(0.748)	(4.549)	(6.850)	(13.143)	(1.218)	(2.794)	(5.602)	(7.407)
SYR	0.003**	0.010**	0.014***	0.006	0.003	0.004	0.026**	0.021***
	(2.495)	(2.300)	(2.606)	(0.521)	(1.553)	(1.322)	(2.511)	(2.813)
OPEN	0.009**	-0.002	-0.003	0.003	0.009**	0.014***	0.019**	0.018***
	(2.489)	(-0.430)	(-0.578)	(0.335)	(2.117)	(3.101)	(2.510)	(3.036)
INF	-0.001**	-0.000	-0.000	0.000	-0.001**	-0.001	-0.001	-0.001
	(-2.227)	(-0.052)	(-0.206)	(0.533)	(-2.487)	(-1.289)	(-0.959)	(-0.706)
IMP	0.004	0.017**	0.011	0.016	0.004	0.003	-0.020	-0.004
	(1.373)	(2.324)	(1.374)	(1.082)	(0.968)	(0.511)	(-1.336)	(-0.338)
FDI	0.000	0.000	-0.001	0.004	-0.001	-0.002	-0.004	-0.001
	(0.092)	(0.284)	(-0.436)	(1.115)	(-0.505)	(-0.671)	(-0.576)	(-0.198)
ROY	0.003***	0.002	0.002	-0.001	0.004***	0.004**	0.004	0.004
	(3.611)	(1.000)	(0.794)	(-0.234)	(2.794)	(2.172)	(1.019)	(1.123)
IPR	-0.003	0.003	0.003	0.003	-0.003	-0.002	0.009	0.004
	(-1.570)	(0.852)	(1.028)	(0.535)	(-1.105)	(-0.515)	(1.311)	(0.680)
cons					-0.021	-0.045	0.031	0.020
					(-0.780)	(-1.475)	(0.349)	(0.328)
N	248	248	178	178	248	248	248	248
R^2	0.533	0.785						
# of instruments			128	44	174	90	25	39
# of groups			61	61	63	63	63	65
AB test for AR (1)			0.001	0.003	0.002	0.001	0.005	0.004
AB test for AR (2)			0.136	0.172	0.756	0.343	0.250	0.466
Sargan			0.182	0.042	0.008	0.000	0.732	0.049
Hansen			1.000	0.120	1.000	0.990	0.749	0.228
Difference Hansen					1.000	0.204	.	0.070

t-statistic in parenthesis, * p<.1; ** p<.05; *** p<.01. All models include unreported time dummies.
All estimates with robust standard errors. For all tests p-values are reported.
[a] Full set of country dummies included.
[b] One-step estimates.
[c] Lags for endogenous variables only collapsed and not limited, lags for predetermined variables limited and collapsed.

Its bias towards the LSDV results can be an indication of weak instrumenting due to persistent series combined with short T panels (Bond et al. 2001:7). In these cases system GMM can perform considerably better than difference GMM, since it exploits additional moment conditions. In other words, while identification in the case of difference GMM rests solely on the within variance, system GMM additionally exploits the between information. Limiting the number of instruments to t-2 for endogenous variables and t-1 for predetermined variables yields a more reliable Hansen statistic, which still does not reject the null of exogeneity of the instruments. However, the coefficient on the lagged dependent variable decreased further. Column (4) reports the one-step robust system GMM results and the above mentioned test statistics as well as the difference Hansen test in order to test the additional assumptions. P-values for the Hansen and difference Hansen test of 1.000 as well as the high number of instruments are again tell-tale signs for overfitting the equation. Thus, the number of lags included as instruments is limited again. However, due to the additional moment conditions exploited by system GMM, the number of instruments is considerably higher than in the difference GMM case. Since limiting the lags for instruments cannot circumvent over-fitting the equation the instruments are, in this case, additionally collapsed. The collapse option produces one instrument per variable instead of creating one instrument for each period and variable (Roodman 2006:24). The results for the limited and collapsed one-step system GMM estimates are reported in column (7). Since the equation now is exactly identified the difference Hansen test cannot be performed. Thus, while in the previous equations the Hansen test was unreliable due to the high number of instruments, in this equation it cannot be obtained and the additional assumptions needed for system GMM to be viable remain untested. In order to be able to test this assumption, equation (8) only limits the lags for predetermined variables and thus generates additional instruments while preventing overfitting the equation. The reported difference Hansen test supports the application of system GMM. Finally for equation (7) and (8) the coefficient for the lagged dependent variable lies well within the range of credibility.

Table 4 examines the impact of IPRs on growth for different income levels and through different channels using the specification from equation (7) of Table 3. Column (1) reports the results from the basic equation. While, except for inflation, all the standard variables included in the growth regression are significant and carry the expected sign, the variables of particular interest, namely the bilateral exchange variables and the Ginarte and Park index are not significant at any conventional level. In order to evaluate whether the effects of IP protection

Table 4: Effects of IPRs on growth

	(1)	(2)	(3)	(4)
$Y_{i, t-1}$	-0.030**	-0.019	-0.026	-0.017**
	(-2.195)	(-1.631)	(-1.478)	(-2.222)
GCF	0.245***	0.266***	0.264***	0.179**
	(2.895)	(3.349)	(2.810)	(2.192)
POPG	1.417***	1.438***	1.457***	1.373***
	(5.602)	(5.182)	(5.643)	(4.068)
SYR	0.026**	0.019**	0.028***	0.018***
	(2.511)	(2.250)	(2.645)	(2.660)
OPEN	0.019**	0.018***	0.017**	0.017**
	(2.510)	(2.754)	(2.034)	(2.574)
INF	-0.001	-0.001	-0.001	-0.000
	(-0.959)	(-0.824)	(-0.946)	(-0.531)
IMP	-0.020	-0.015	-0.021	-0.008
	(-1.336)	(-1.039)	(-1.414)	(-0.312)
FDI	-0.004	-0.000	-0.004	0.007
	(-0.576)	(-0.075)	(-0.484)	(0.611)
ROY	0.004	0.000	0.004	0.002
	(1.019)	(0.074)	(0.922)	(0.284)
IPR	0.009		0.025	0.005
	(1.311)		(1.132)	(0.293)
IPR*LOW		0.001		
		(0.060)		
IPR*LOWER		0.013		
		(1.583)		
IPR*UPPER		0.010*		
		(1.912)		
IPR*HIGH		0.012*		
		(1.770)		
IPR*GDP			-0.002	
			(-0.601)	
IPR*IMP				0.005
				(0.543)
IPR*FDI				-0.003
				(-0.599)
IPR*ROY				0.000
				(0.109)
cons	0.031	-0.011	-0.008	0.023
	(0.349)	(-0.118)	(-0.069)	(0.337)
N	248	248	248	248
# of instruments	25	31	27	31
# of groups	63	63	63	63
AB test for AR (1)	0.005	0.005	0.005	0.004
AB test for AR (2)	0.250	0.284	0.236	0.354
Sargan	0.732	0.217	0.760	0.075
Hansen	0.749	0.297	0.700	0.562
Difference Hansen	.	.	.	.

t-statistic in parenthesis, * p<.1; ** p<.05; *** p<.01. All models include unreported time dummies. Specification as in equation 7 table 1. All estimates with robust standard errors.

vary with a country's income level the IPR variable is interacted with dummy variables indicating their income level as defined by the World Bank[101]. The respective results are reported in column (2). While the interaction terms for low and lower middle income countries with the GPI are again insignificant, the interaction terms for upper middle and high income countries are positive and significant at a 10% level. While a significant positive effect for high income countries was expected, the findings for upper middle income countries are especially interesting. At least some of the countries in this group (for example Brazil, South Africa, Malaysia, and Turkey are in this income group) are suspected of having some form of an imitative industry. Thus, a trade-off between positive effects on growth through innovation and negative effects due to the loss or reduction of its imitative industry can be expected. Still, the results suggest that even if these contrary effects might be at play, in the end the positive effects prevail. For low and lower middle income countries no significant effect can be found. In the case of lower income countries this might be the case due to the above mentioned trade-off between potentially positive and negative effects. Alternatively, the absence of evidence for a growth effect of IP protection in low and lower middle income countries might simply indicate that intellectual property protection is not a decisive factor for growth in countries at the lower end of the global income distribution.

While the World Bank country characterization has the advantage of covering all World Bank members and all other economies with more than 30,000 inhabitants, it has only been available from the beginning of the nineties onwards. Thus, the income dummies exhibit no variation across time. This is problematic as they cannot correctly capture the development of countries which have been moving to higher (or in rare cases to lower) income groups. Thus equation (3) includes an interaction term with a continuous and time varying measure, namely the average logged GDP per capita (GDP). However, the results from equation (2) are not supported. This is surprising since the averaged logged GDP per capita was expected to be a more precise measure than the crude dummy variables and thus to be better able to reveal potential differences in the effect of IP protection regarding income.

As outlined in the previous chapters IP protection might also affect economic growth indirectly via fostering bilateral exchange. Thus, in equation (4) interaction terms between the GPI and the bilateral exchange variables are included. However, while again all standard explanatory variables – except for inflation – are significant, the variables of particular

[101] Also see footnote 7.

interest are once again insignificant. Since it can be argued that the potential indirect effect of IPRs on economic growth is more important for countries with lower income levels, as they are less likely to gain from an increase in local innovation, the sample is split in half at the median income. However, for both income groups the interaction terms remain insignificant.

In short, while there is some weak evidence that IP protection has a positive impact on economic growth in high and upper middle income countries, no effect for low and lower middle income countries – direct or indirect – can be found.

5.4.2 Serving decision

In order to examine whether IP protection has an impact on the market serving decision equation (2), (3), and (4) are jointly estimated by seemingly unrelated estimation[102].

Table 5 reports the results for the import equation. Except for rule of law all control variables are significant and have the expected signs. The coefficient on IPR is also significant and has a positive sign. When this effect is evaluated with respect to different income levels, it turns out that IP protection has in particular a positive impact on the ratio of imports to GDP for countries with lower income. While the size of the economic effect of IP protection is about the same for the middle income country groups, it is three times as big for low income countries. These findings are supported by column (3), where the IPR index is interacted with the averaged logged GDP per capita. The positive IPR coefficient and the negative interaction term imply that the positive effect of a marginal increase in IP protection decreases with income. The turning point, where the effect turns negative is not of any significance since it lies outside the sample. Column (4) investigates whether there are any non-linearities by including a quadratic term. Since the OLI framework suggests that a firm alters its location and internalization decisions as its intellectual assets become better protected. For example, as IP protection rises the threat of imitation decreases and thus might favour other forms of serving a market since internalization becomes less important. Thus, the positive effect of IP protection on imports might decrease with higher protection levels as other ways of serving the market become more profitable. However, no evidence of such an effect can be found since the coefficient for the squared GPI is not significant.

[102] Thus, for example equations (1) from table (5), (6) a (7) are jointly estimated.

Table 5: Ratio of imports to GDP

	(1)	(2)	(3)	(4)
GDP	0.230**	0.314***	0.347***	0.239**
	(2.746)	(3.557)	(3.560)	(2.835)
OPEN	0.140**	0.110*	0.106*	0.128**
	(3.251)	(2.475)	(2.505)	(2.801)
LAW	0.024	0.022	0.019	0.022
	(1.870)	(1.798)	(1.574)	(1.732)
IPR	0.087**		0.411**	0.143*
	(2.939)		(3.013)	(2.061)
IPR*LOW		0.374*		
		(2.065)		
IPR*LOWER		0.111**		
		(2.671)		
IPR*UPPER		0.120**		
		(3.164)		
IPR*HIGH		0.039		
		(1.148)		
IPR*GDP			-0.038*	
			(-2.489)	
IPR²				-0.011
				(-0.941)
cons	-3.280***	-3.321***	-3.307***	-3.279***
	(-27.078)	(-32.458)	(-28.701)	(-27.090)
N	354	354	354	354

t-statistic in parenthesis, * p<.1; ** p<.05; *** p<.01. All models include unreported country and time dummies. All estimates with robust standard errors.

Table 6 reports the results for the FDI equation. Except for inflation and rule of law all explanatory variables, including IPR and the interaction terms, are insignificant in the first two specifications. In column (3) however, averaged logged GDP, squared average logged GDP, the GPI and the interaction term turn significant. The signs of the coefficients indicate that the positive effect of IP protection on FDI increases with income. At an averaged logged GDP per capita of 7.9, which is slightly below the mean averaged logged GDP per capita of upper middle income countries (≈8.0), the effect of IPR's turns positive. It is exactly this income group which arguably poses the highest imitation threat. However, the positive effect at the mean income level of this country group is rather small (≈0.02). Only for the high income group[103] is a positive effect of considerable size (0.37) found. While the substantial negative effect for low and lower-middle income countries is difficult to explain, the direction of the effect, namely that it increases with income may be explained by the different natures

[103] Evaluated at the mean averaged logged GDP of the income group.

of FDI. In a nutshell, while for a number of reasons (e.g. low productivity, a lack of infrastructure, or intransparent government regulations) least developed countries hardly attract any FDI inflows , less developed countries mostly attract vertical FDI due to their low labour costs. As countries develop further, vertical FDI is eventually replaced by horizontal FDI as on the one hand the labour costs rise and on the other hand the higher income levels create a market for high-quality capital and consumer goods. It is, however, horizontal FDI for which IP protection matters most (Maskus 2000:122-123). Thus, the more important horizontal FDI becomes the more important IP protection and hence the greater the positive effect.

Table 6: Ratio of FDI inflows to GDP

	(1)	(2)	(3)	(4)
GDP	0.206	1.856	4.359*	3.457*
	(0.145)	(1.063)	(2.277)	(2.045)
GDP²	-0.001	-0.118	-0.311*	-0.217*
	(-0.010)	(-1.058)	(-2.384)	(-2.045)
SYR	0.155	0.143	0.138	0.150
	(0.930)	(0.864)	(0.857)	(0.947)
OPEN	0.022	0.057	0.086	0.122
	(0.139)	(0.339)	(0.534)	(0.763)
INF	-0.058***	-0.058***	-0.062***	-0.063***
	(-3.951)	(-4.016)	(-4.449)	(-4.454)
LAW	0.120**	0.121**	0.131**	0.129**
	(2.678)	(2.709)	(2.903)	(2.865)
IPR	0.081		-1.718**	-0.779**
	(0.760)		(-2.940)	(-2.632)
IPR*LOW		-0.481		
		(-1.296)		
IPR*LOWER		-0.031		
		(-0.187)		
IPR*UPPER		0.043		
		(0.370)		
IPR*HIGH		0.232		
		(1.486)		
IPR*GDP			0.217**	
			(3.173)	
IPR²				0.171**
				(3.243)
cons	-0.549***	-0.549***	-0.572***	-0.571***
	(-5.959)	(-6.057)	(-6.189)	(-6.101)
N	354	354	354	354

t-statistic in parenthesis, * p<.1; ** p<.05; *** p<.01. All models include unreported country and time dummies. All estimates with robust standard errors.

The results of equation (4) which introduces a quadratic IPR term are intriguing. IPR and IPR squared are both significant. The signs suggest that a country cannot gain from IP protection – by increased FDI – unless it reaches a particular protection level, in this case 2.27. Below this, the level of protection seems to be too weak to have a positive impact on the FDI decision. Hence, the effect of IP protection does not only depend on a country's income level but also on the actual level of protection. These results are in contradiction to the OLI framework, which suggests that as protection rises, internalization and hence FDI becomes less important. However Smith (1999) and Yang and Maskus (2005) find similar results for international trade and licensing respectively. Yang and Maskus argue that countries with low initial protection levels are presumably characterized by a low skilled labour endowment and hence weak imitative abilities. Since the imitation threat is weak anyway the market power effect of raising the protection level dominates the economic returns effect. Thus, the firm exploits its monopoly power and reduces supply.

Table 7 reports the result for the royalty and licensing fees equation. Except for averaged logged GDP per capita, which is highly significant and has a coefficient of considerable size, all other explanatory variables are insignificant in the first two specifications. Equation (3) again includes an interaction term with GDP. Similarly as in the imports equation the positive effect of IP protection on royalty and licensing fees decreases with income. The effect is stronger than in the import equation. At an averaged logged GDP per capita of about 8.74 the effect of IP protection turns negative. Thus for most countries in the high income group[104] a marginal increase in IP protection has a negative impact on royalty and licensing fees. For the majority of countries though, IP protection has a significant and positive effect on royalty and licensing fees. These results have to be interpreted with care. The dependent variable measures the fees paid for licenses in US$. Thus, one cannot distinguish between a rise in the price for licenses due to better protection and an increase in the number of licenses. In other words, the positive impact of IP protection on the dependent variable can either imply that more licenses are issued, and hence a higher inflow of technology occurs, or that those countries are now simply paying more for their licenses. It would be reasonable to assume that both effects are at work. The negative effect of IP protection on licenses once an averaged logged GDP per capita level of 8.74 is reached remains difficult to interpret. The negative sign of the coefficient[105] can either be interpreted as a reduction in licenses issued or a

[104] Hungary, Korea, and Trinidad & Tobago are the only high income countries that at some point in time had a (logged) GDP per capita lower than 8.74.
[105] At the average logged GDP for the high income country group the coefficient is -0.11.

reduction in the price of the issued licenses. Furthermore, the countries affected by the negative coefficient are in the first place high income countries. Thus cross-licensing may offer an explanation for the results. Innovative firms are predominantly located in high income countries. Hence cross-licensing arguably takes place among these countries in the first place. Cross-licensing may reduce the price for licenses and thus cause the negative sign of the coefficient. Equation (4) explores potential non-linear relationships. The coefficients on IPR's and squared IPR's are significant but carry surprising signs, which suggest that there exists a level of IP protection for which a further increase in protection would yield a negative impact on royalty and licensing fees. The turning point is calculated at 2.76, which lies well within the sample as the IP index ranges from 0 to 5.

Table 7: Ratio of royalty and licensing fees to GDP

	(1)	**(2)**	**(3)**	**(4)**
GDP	2.288***	2.438***	2.635***	2.268***
	(4.633)	(4.880)	(5.029)	(4.542)
SYR	-0.217	-0.176	-0.129	-0.132
	(-1.535)	(-1.229)	(-0.895)	(-0.917)
OPEN	-0.231	-0.351	-0.362*	-0.385*
	(-1.407)	(-1.870)	(-2.111)	(-2.189)
INF	-0.004	-0.001	0.001	0.002
	(-0.189)	(-0.036)	(0.030)	(0.100)
LAW	0.024	0.031	0.020	0.016
	(0.613)	(0.770)	(0.505)	(0.399)
IPR	0.046		1.110**	0.690**
	(0.383)		(2.695)	(2.757)
IPR*LOW		0.883		
		(1.197)		
IPR*LOWER		0.133		
		(0.824)		
IPR*UPPER		0.115		
		(0.778)		
IPR*HIGH		-0.096		
		(-0.677)		
IPR*GDP			-0.127**	
			(-2.713)	
IPR²				-0.125**
				(-2.639)
cons	-0.781***	-0.782***	-0.801***	-0.803***
	(-6.202)	(-6.420)	(-6.544)	(-6.599)
N	354	354	354	354

t-statistic in parenthesis, * p<.1; ** p<.05; *** p<.01. All models include unreported country and time dummies. All estimates with robust standard errors.

The results reported are not in line with the findings of Yang and Maskus (2005), since they find a significant negative effect for their IPR measure and a significant positive effect for the squared variable.

The results from the serving decision equations suggest that IP protection affects the three bilateral exchange variables in different ways. For example, in the case of FDI the effect of IP protection increases with income, while in the case of royalty and licensing fees it decreases, which is also the case for imports, where the turning point lies outside the sample. The stacked estimator used allows to test cross equation restrictions in order to investigate whether these differences are statistically significant[106]. While this seems obvious in the case of FDI, the effects of IP protection on imports and licensing resemble each other much more. Indeed, when the results from the FDI equations are included all Wald tests for equality of coefficients reject the null at a 1% level; this is not the case when the impact of IP protection on imports and royalties is compared. Consider equation 3. Even though the coefficient on IPR in the licensing equation is almost three times the size of the IPR coefficient in the import equation, the null hypothesis of equality cannot be rejected. Thus, it cannot be argued that IP protection has a stronger positive impact on royalty fees than on imports. The same is true for the interaction term in this equation. For equation (4) the results are different. For both coefficients which include IPR's the null of equality of coefficients between the import and the licensing fee equation cannot be rejected at a 5% level. Thus, the considerable difference in size of these coefficients is indeed statistically significant. This indicates that while raising IP protection has a positive impact on both imports and licensing fees (in particular at rather low protection levels), the effect is stronger for licensing fees than for imports.

5.5. Concluding remarks

This section investigated the effect of IP protection on growth and the serving decision. While the dynamic panel data estimation finds some evidence for a positive effect of IP protection on growth for high and upper middle income countries, this is not the case for low and lower middle income countries. However, these results are weak in the sense that they are not supported by an alternative way of controlling for income levels. Furthermore no indirect effect of IP protection on growth via bilateral exchange is found. But it is indeed, this indirect effect from which less developed countries are most likely to gain, since most of these

[106] The bilateral exchange equations (3) and (4) are used for cross equation testing, since most of the IPR coefficients are significant in these specifications.

countries have rather limited innovation abilities. Thus the effect of IP protection on the bilateral exchange variables has been explored in greater detail. The results from the import equation support the notion that IP protection has a positive impact on imports especially for developing countries. Only for the highest income group no significant effect can be found. The effect of IP protection on FDI is quite different. Unless a certain income level is reached IP protection has a negative impact on FDI inflows. Most low and lower middle income countries face a negative effect, while for upper middle and high income countries a significant positive effect is found. This may be attributed to the different types of FDI and their varying dependence on IP protection. The introduction of a quadratic term yields a minimum at a protection level of 2.2, which implies that unless this level is exceeded there are no gains from IP protection. One has to take into account that by the end of the time period covered the majority of countries had a protection level higher than 2.2[107]. In the case of the licensing fees equation the positive effect of IP protection diminishes with income. For the majority of high income countries the effect of IP protection is negative. Since the data does not allow one to distinguish between a change in the price for licensing and a change of the number of licenses issued this may be interpreted as a reduction in the price of licenses due to cross licensing. Similarly, taking into account the ambiguity regarding the interpretation of the coefficient, the positive effect for low and lower middle income countries can either be construed as an increase in the price or the quantity. Most likely both effects are at work.

Thus, while IP protection does not have a positive impact on all channels of bilateral exchange, there is some evidence that it facilitates bilateral exchange, at least via trade and licensing.

[107] Bangladesh, Benin, Egypt, Guatemala, Guyana, Nicaragua, Niger, Senegal, Togo, and Zambia are exceptions.

6. Conclusion

This work analyses whether IP protection affects growth in developing countries and through which channels it predominantly works.

From a historical perspective, when considering the developed countries of today and their rapid phase of industrialization it is noticeable that most of these countries developed an IP system during that time. While this points towards an important role of IP protection for industrialisation, it should not be overstated. Eighteenth century IP protection differed greatly from modern IP systems and in particular took at best a very relaxed stand on foreign intellectual property. In many cases IP law deliberately discriminated against foreigners in order to facilitate technology transfer. Thus, on the basis of the historical experience of these countries recommending a level of IP protection to the South which more or less resembles the protection level of the North is inappropriate.

From another point of view, yet in a similar vein, arguing for no or a fairly low level of IP protection based on the historical experience of Switzerland and the Netherlands on the one hand and the Asian Tigers on the other hand is equally flawed. In both cases it can be argued that the situation of these countries differed greatly from the situation of nowadays developing countries'. While this argument is certainly stronger in the first case, it is also viable in the case of Japan, South Korea, and Taiwan, especially if compared to the least developed countries of today. It is arguably very difficult - if not impossible - for this country group to catch up via reverse engineering.

Apart from general limitations in making an inference from a limited number of observations, above arguments further question the transferability of the historical experience of the reviewed countries. Keeping all these limitations regarding the different situations of the countries, the number of observations and the deficiencies of early patent provisions in mind, it can at least be stated that at an early stage of economic development foreign intellectual property protection was in many nations the weakest point of their IP laws. The consequences of this practice for technology transfer and economic development and the implications for nowadays developing countries' are difficult to assess from a historical perspective.

Due to the trade-offs at work both in an open economy and in a closed economy the insight from a theoretical economic perspective is likewise limited. The handful of theoretical papers which focus on the global and local welfare effects of expanding IP protection on the South remains rather inconclusive. In many cases though including a formal mechanism of technology transfer into the model notably alters the results, thus indicating the importance of considering formal channels of technology transfer (e.g. FDI and licensing) next to imitation. Apart from this finding, the welfare effect for the South is, in most cases, unsettled, an ambiguity that is further enhanced if an egalitarian approach is applied and utility differences between the South and the North are assumed. While assigning different weights to northern and southern welfare is a sensible step, any results from this analysis should be interpreted with caution as they might be driven by assumptions about the size of the weight difference.

In the empirical analysis the effect of IP protection – as measured by the Ginarte and Park index – on economic growth and bilateral exchange is investigated. In the case where the effect of IP protection on economic growth is considered, the potential channels through which IP protection works are of particular interest. Thus FDI, trade and licensing as well as interaction terms between these three serving decision variables and IP protection have been included in the estimation. In order to be able to take account of potential endogeneity problems, dynamic panel data estimation is employed. The results from the growth regressions are at best mixed. Only for upper middle and high income countries can a significant positive effect of IP protection be found. For the other income groups as well as for the whole sample no effect can be found. In addition after treating the bilateral exchange variables as endogenous neither the variables themselves nor the interaction terms are significant at any conventional level. It is indeed this indirect effect from which developing countries are most likely to gain. Thus, since in this case no evidence for the indirect channel via trade, FDI and licensing can be found it is furthermore examined whether IP protection has an impact on the bilateral exchange variables in the first place. For developing countries rather strong evidence for a positive effect of IP protection on trade and to a weaker extent on licensing is found, while in the case of FDI the effect is again significant but negative.

In a nutshell, while no growth effects of IP protection for low and lower-middle income countries can be found a significant positive effect of IPR's on the ratio of imports to GDP and the ratio of licensing fees to GDP is observed. Thus the results support the notion that IP

protection is a valuable asset for less developed countries when trying to encourage bilateral exchange via trade and licensing.

The results from the licensing equation have to be interpreted with caution, since the data employed makes it impossible to distinguish between an increase in the number of licensing contracts and a simple increase in prices of licensing. In the case of the growth equation the results for IP protection are very limited. Only in the case of two country groups there is some evidence for an effect of IP protection on growth, which is not supported by an alternative, theoretically more precise measure of income though. Whereas in the growth equation no effect of IP protection –either direct or indirect – can be found for low and lower-income countries, there is a significant positive effect on trade and licensing. While this indicates that IP protection has a positive impact on bilateral exchange it defers the issue of whether or not growth effects can materialize from IP protection for low and lower middle income countries to the question of whether or not trade (licensing) does cause growth.

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Appendix A

A.1. Number of signatory countries

IP Protection Treaties	1990	2000
Paris Convention (1883)	97	160
Bern Convention (1886)	83	147
Madrid Agreement (1891)	29	32
Rome Convention (1961)	34	67
Phonograms Convention (1971)	42	64
Brussels Convention (1974)	12	24
Nairobi Treaty (1981)	32	40
Trademark Law Treaty(1994)	6*	26
WCT (1996)	---	37**
WPPT (1996)	---	37**

* 1996, ** 2002

Source: WIPO (n.d.)

A.2. Income groups:

LOW	LOWER MIDDLE	UPPER MIDDLE	HIGH
Bangladesh	Bolivia	Algeria	Australia
Benin	Cameroon	Argentina	Austria
Ghana	Ecuador	Botswana	Belgium
Kenya	Egypt, Arab Rep.	Brazil	Canada
Niger	El Salvador	Colombia	Finland
Rwanda	Guatemala	Costa Rica	France
Togo	Guyana	Dominican Rep.	Germany
Zambia	Honduras	Jamaica	Greece
Zimbabwe	India	Malaysia	Hungary
	Nicaragua	Mexico	Ireland
	Pakistan	Peru	Israel
	Paraguay	South Africa	Italy
	Philippines	Turkey	Japan
	Senegal	Uruguay	Korea, Rep.
	Thailand	Venezuela, RB	Netherlands
	Tunisia		New Zealand
			Norway
			Portugal
			Spain
			Sweden
			Switzerland
			Trinidad & Tobago
			United Kingdom
			United States
n=9	n=16	n=15	n=24

A.3. Summary of Ginarte and Park index (GPI):

(1) Coverage	Yes	No
Patentability of pharmaceuticals	1	0
Patentability of chemicals	1	0
Patentability of food	1	0
Patentability of plant and animal varieties	1	0
Patentability of surgical products	1	0
Patentability of microorganisms	1	0
Patentability of utility models	1	0
(2) Membership in international treaties		
Paris convention and revisions	1	0
Patent cooperation treaty	1	0
Protection of new varieties (UPOV)	1	0
(3) Loss of protection measures against losses		
Working requirements	1	0
Compulsory licensing	1	0
Revocation of patents	1	0
(4) Enforcement		
Preliminary injunctions	1	0
Contributory infringement	1	0
Burden-of-proof reversal	1	0
(5) Duration	Value	
Application-based standard:		
$x \geq 20$ years	1	
$0 \leq x < 20$	x/20	
Grant-based standard:		
$x' \geq 17$ years	1	
$0 \leq x' < 17$	x/17	

Source: Ginarte and Park 1997: 300

A.4. Summary statistics

	Mean	Standard Deviation	Minimum	Maximum
GROWTH	0.014	0.03	-0.11	0.08
IMP	-1.26	0.53	-2.79	0.21
FDI	-4.63	1.29	-9.66	-1.17
ROY	3.95	2.91	-3.22	9.85
GDP	8.00	1.53	5.10	10.56
GCF	0.22	0.06	0.05	0.46
POPG	0.02	0.01	-0.05	0.06
SYR	1.62	1.25	0.03	5.09
INF	0.52	2.85	-0.06	38.59
OPEN	0.60	0.50	0	1
IPR	2.44	1.11	0.59	4.88
LAW	5.82	2.38	1.19	9.89

A.5. Correlation matrix

	GROWTH	IMP	FDI	ROY	GDP	GCF	POPG	SYR	INF	OPEN	IPR	LAW
GROWTH	1											
IMP	0.15	1										
FDI	0.15	0.38	1									
ROY	0.29	-0.12	0.18	1								
GDP	0.17	0.01	0.15	0.77	1							
GCF	0.37	0.23	-0.01	0.20	0.22	1						
POPG	-0.21	-0.07	-0.18	-0.66	-0.77	-0.19	1					
SYR	0.19	0.03	0.14	0.72	0.79	0.08	-0.66	1				
INF	-0.17	-0.22	-0.08	-0.08	-0.07	-0.11	0.08	-0.10	1			
OPEN	0.29	0.21	0.32	0.48	0.52	0.16	-0.49	0.48	-0.16	1		
IPR	0.16	0.13	0.20	0.71	0.71	0.08	-0.58	0.74	-0.21	0.52	1	
LAW	0.26	0.04	0.18	0.72	0.78	0.17	-0.68	0.75	-0.16	0.46	0.66	1

A.6. Decomposed standard deviations

		Standard Deviation
GROWTH	overall	0.026
	between	0.015
	within	0.020
IMP	overall	0.525
	between	0.485
	within	0.209
FDI	overall	1.288
	between	0.900
	within	0.9569
ROY	overall	2.909
	between	2.808
	within	1.051
GDP	overall	1.525
	between	1.524
	within	0.185
GCF	overall	0.058
	between	0.045
	within	0.037
POPG	overall	0.011
	between	0.010
	within	0.006
SYR	overall	1.250
	between	1.189
	within	0.408
INF	overall	2.850
	between	1.509
	within	2.424
OPEN	overall	0.491
	between	0.357
	within	0.340
IPR	overall	1.115
	between	0.927
	within	0.628
LAW	overall	2.377
	between	2.202
	within	0.964

Appendix B

B.1. English summary

Next to directly affecting economic growth by fostering innovation, IP protection can also indirectly affect growth by increasing technology inflows via trade, FDI and licensing. Arguably, developing countries, which are characterized by rather limited local innovative capabilities, mainly depend on technology transfer, may it be formal or informal (e.g. reverse engineering) for technological progress.

This thesis examines the impact of IP protection on economic growth and in particular attempts to identify the channels through which IPRs influence growth. The historical analysis outlines that nowadays developed countries often took a rather relaxed stand on foreign intellectual property in order to facilitate technology transfer during their own industrialisation and that the coming into force of TRIPS for all signatory countries substantially reduces the freedom of choice regarding their IP laws. The literature review presents the arguments in the respective theoretical and empirical literature. The insights from a theoretical perspective on the global and local welfare effects of expanding IP protection to the South remain limited, due to the various trade-offs at work. The theoretical models nevertheless emphasize the importance of considering formal channels of technology transfer. The analysis of the existing empirical literature finds some evidence for an overall positive impact of IPR protection on trade, FDI and licensing The results for growth regressions are more ambiguous and emphasize the importance of considering differences regarding the countries' income levels.

In the econometric analysis conducted in this work, both the direct effect of IP protection on economic growth and the potential channels of technology transfer are investigated. In the estimation of the direct effect dynamic panel data estimation is used in order to be able to take account of potential endogeneity problems. While neither direct nor indirect growth effects of IP protection – as measured by the Ginarte and Park index – for low and lower-middle income countries can be found, a significant positive effect of IPR's on the ratio of imports to GDP and the ratio of licensing fees to GDP is observed. Thus the results support the notion that IP protection is a valuable asset for less developed countries when trying to encourage bilateral exchange via trade and licensing. However, the notion that IP protection fosters growth for this country group cannot be supported on the basis of this analysis.

B.2. German summary

IPRs können einerseits durch ihre innovationsfördernde Wirkung Wachstum direkt beeinflussen und andererseits durch ihren potentiell positiven Einfluss auf Handelsflüsse, ausländische Direktinvestitionen (FDI) und Lizenzvergabe Technologietransfer fördern und dadurch auch indirekt das Wirtschaftswachstum befördern. Da die meisten Entwicklungsländer kaum die Voraussetzungen für eine nennenswerte innovationsfördernde Wirkung haben sind sie daher für ihren technologischen Fortschritt auf formelle oder informelle Formen des Technologietransfers angewiesen.

In dieser Diplomarbeit wird der Einfluss geistiger Eigentumsrechte (IPRs) auf Wirtschaftswachstum untersucht, wobei im Speziellen die Kanäle, durch die IPRs Wachstum beeinflussen können, untersucht werden. Der historische Teil dieser Arbeit stellt einerseits die häufig durch ihre Patentgesetzgebung geschützte Praxis heutzutage entwickelter Länder dar, zur Zeit ihrer Industrialisierung auf informelle Formen des Technologietransfers zurück zu greifen. Andererseits wird die Veränderung des globalen Regimes der geistigen Eigentumsrechte beschrieben, welche zur Folge hatte, dass der Handlungsspielraum der Länder bezüglich der Gestaltung ihrer Patentgesetzgebung erheblich eingeschränkt wurde. Die theoretischen ökonomischen Modelle zur Analyse des globalen und lokalen Wohlfahrtseffektes einer Ausweitung des Patenschutzes auf den Süden bleiben zwar aufgrund der vorhandenen trade-offs ohne eindeutiges Ergebnis, weisen aber darauf hin, wie wichtig es ist, formelle Formen des Technologietransfers zu berücksichtigen. Empirische Studien finden einen tendenziell positiven Effekt geistiger Eigentumsrechte auf Handelsflüsse, ausländische Direktinvestitionen (FDI) und Lizenznahmen. Die Ergebnisse der Studien die den Effekt auf Wachstum untersuchen sind uneindeutiger, zeigen jedoch die Bedeutung der Berücksichtigung unterschiedlicher Einkommensniveaus auf.

Der ökonometrische Teil der Arbeit untersucht daher sowohl den Effekt geistiger Eigentumsrechte auf Wachstum als auch auf Handelsflüsse, FDI und Lizenzvergabe. Die Wachstumsregression wird mit einem dynamischen Paneldatenschätzer geschätzt, um potentielle Endogenitätsprobleme zu berücksichtigen. Während für die beiden unteren Einkommensgruppen der Länder in der Wachstumsregression weder direkte noch indirekte Effekte von IPRs – gemessen mit dem Ginarte und Park Index – auf Wirtschaftswachstum festgestellt werden können, lässt sich ein signifikanter und positiver Einfluss von IPRs auf Importe und Lizenzgebühren für diese Ländergruppen feststellen.

B.3 Curriculum vitae

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