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TECHNICAL REPORT

Intellectual Property and Developing Countries

A review of the literature

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Prepared for the UK Intellectual Property Office and the
UK Department for International Development

RAND EUROPE

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Preface

This report supports the UK Intellectual Property Office (IPO) and the Department for International Development (DfID) in assessing the impact of intellectual property rights (IPRs) in developing countries, in the context of the World Trade Organization's Agreement on Trade-Related Intellectual Property Rights (TRIPS) and the development of TRIPS-plus standards.

Detractors of TRIPS highlight the negative effects of strengthening intellectual property rights on economic development in developing countries, and the unfair gains for developed countries. Conversely, supporters of TRIPS stress the benefits emerging from the international harmonisation of intellectual property rights regimes for both developed and developing countries.

This report assesses the effects of intellectual property rights in developing countries in five main areas proposed by the IPO: foreign direct investment, trade, innovation, public health, and genetic resources and traditional knowledge. In order to examine the effects of intellectual property rights in developing countries in these areas, available relevant evidence was collected from scholarly and grey literature.

The report is divided into five chapters corresponding to the areas proposed by the IPO. Each chapter reviews the theoretical arguments and empirical evidence for and against strong intellectual property rights in developing countries from the perspective of both developed and developing countries. The report concludes with a discussion of the knowledge gaps that exist in the literature and suggests directions for future research.

This report was produced with funding support from the IPO. The report will be of interest to government officials dealing with intellectual property rights and development. In particular, it will be of interest to the IPO and DfID, and will contribute to the development of the UK Government's intellectual property policy in relation to its development objectives.

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Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
DfID	Department for International Development
FAO	United Nations Food and Agriculture Office
FDI	Foreign direct investment
GI	Geographical indication
HIV	Human Immunodeficiency Virus
IP	Intellectual property
IPO	Intellectual Property Office
IPRs	Intellectual property rights
PVP	Plant variety protection
R&D	Research and development
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights
UPOV	International Union for the Protection of New Varieties
WTO	World Trade Organization

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Executive summary

Introduction

The debate concerning the economic implications of intellectual property rights (IPRs) has gained considerable attention over the past two decades in the context of the World Trade Organization's (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), and the subsequent increase of regional and bilateral free trade agreements in the TRIPS-plus era. TRIPS aims to narrow the gaps in the way that IPRs are protected around the world, and to bring them under common international rules. It establishes minimum levels of protection that each WTO Member State must provide. The following rapid proliferation of regional and bilateral free trade agreements include elements of IPRs building on and raising minimum standards defined by TRIPS. These agreements indeed integrate TRIPS-plus norms, including undertakings by developing countries not to use specific TRIPS flexibilities. Developing countries are under increasing pressure to strengthen their national intellectual property (IP) regimes, in order to harmonise them with those of developed countries.

The movement towards strengthening IPRs in the laws of developing countries was initiated by developed countries under the belief that this would generate additional profits leading to more research and development (R&D), and it would be necessary to fuel economic growth in those countries. However, such belief attracted many critics, particularly researchers, who stressed that this movement was initiated against developing countries, underscoring the absence of empirical evidence to justify the socio-economic benefits for developing countries from strengthening IPRs.

Encouraged by this controversy, researchers have undertaken growing work to better understand the socio-economic effects of strengthening IPRs in developing countries, both from theoretical and empirical perspectives. In particular, researchers have tried to assess the effects of stronger IPRs on various economic variables, such as foreign direct investment (FDI), trade and innovation, as well as key areas such as public health and traditional knowledge.

This report presents the results of studies examining the effects of strengthening IPRs in developing countries. It reviews the results of the recent grey and scholarly literature on the positive and negative effects of stronger IPRs in developing countries, with a focus on five areas: FDI, trade, innovation, public health, genetic resources and traditional knowledge. The report also suggests future research directions.

Main findings from past research

The main findings from the literature review are presented below. The empirical literature on the effects of strengthening IPRs in developing countries has grown substantially over the past decades. However, it remains surprisingly scarce, despite the passionate debate generated by the implementation of TRIPS and the subsequent development of bilateral and regional free agreements creating higher standards for IPRs in developing countries. Consequently, the main findings presented in this report should be interpreted with caution.

Intellectual property rights, foreign direct investment and international trade

Commonly, FDI and trade are seen as key determinants for economic development and poverty reduction in developing countries. Inward FDI can generate important spillovers for developing economies, resulting in the upgrading of domestic innovative capacity, increased R&D employment, better training and support to education. For most developing countries, international trade allows them to acquire high value-added goods through importation that are necessary for economic development, but which are not produced domestically. In turn, exports allow developing countries to transform under-utilised natural resources and surplus labour into foreign exchange, in order to pay for imports to support economic growth.

Consequently, a central aim of the literature has been to examine how stronger IPRs in developing countries can give incentives to firms in developed countries to undertake cross-border investment in, and to export their goods to, these countries. Recalling the ambiguous relationship between IPRs and the individual strategies of single firms from a theoretical point of view, researchers have investigated empirically the effects of stronger IPRs on inward FDI in developing countries and exports from developed to developing countries.

The empirical evidence suggests that stronger IPRs may positively affect the volume of FDI and exports, particularly in countries with strong technical absorptive capabilities where the risk of imitation is high. When such risk is weak, particularly in the poorest countries, firms in developed countries do not seem to be sensitive to the level of protection in developing countries.

Using disaggregated data on FDI and trade, the empirical literature also shows that stronger IPRs impact on the composition of FDI and trade. First, stronger IPRs seem to encourage FDI in production and R&D rather than in sales and distribution. Second – and more surprisingly – stronger IPRs do not have any effect on the exports of high-technology products. There are at least two explanations for this somewhat surprising result. Many high-tech products are difficult to imitate, thereby international trade for these products is less sensitive to the level of protection than for other products. Furthermore, firms in developed countries may choose to distribute their high-tech products through FDI or licensing, instead of exporting them directly.

Intellectual property rights, international technology transfer and domestic innovation

Increasingly, harnessing technological progress is viewed by policymakers as a key priority to boost economic growth and improve living standards. In an open economy, technological progress can be driven either by technology diffusion or technology creation.

In less advanced economies, technology absorption can drive economic growth because countries at the forefront of technology act as a driver for growth by expanding the stock of scientific and technological knowledge, pulling other countries through a 'catch-up' effect. However, the strength of this 'catch-up' effect at the technology frontier decreases with the level of technological development, to the benefit of technology creation. Indeed, technology creation by domestic firms becomes progressively more important as a country moves closer to the technology frontier, because catching up with the frontier translates into increasingly smaller technological improvement.

The empirical literature has examined the effects of IPRs on technological progress through these two main channels: technology absorption (i.e. international technology transfer) and technology creation (i.e. domestic innovation).

The empirical evidence suggests that stronger IPRs in developing countries may encourage international technology transfer through market-based channels,[1] particularly licensing, at least in countries with strong technical absorptive capacities. In the context of strong IPRs, firms in developed countries are more inclined to transfer their technologies to developing countries through licensing rather than through exports and FDI, since such rights allow them to retain control over their technologies. In the presence of weak IPRs, multinationals in developed countries seem to prefer to retain control over their technologies through intra-firm trade with their foreign affiliates in developing countries or FDI. Nevertheless, the historical evidence shows that many developing countries have benefited from international technology transfer through non-market-based channels, especially reverse engineering and imitation, thanks to weak IPR regimes.

The empirical literature also shows that stronger IPRs can encourage domestic innovation, at least in emerging industrialised economies. Nevertheless, the empirical literature suggests the existence of a non-linear function (i.e. a U-shaped curve) between IPRs and economic development, which initially falls as income rises, then increases after that.

Intellectual property rights and public health

One-third of the world's population does not have access to essential medicines. The proportion reaches 50 per cent in the poorest parts of Africa and Asia. In addition, pharmaceutical R&D on health problems specific to poor countries is often perceived as inadequate. Moreover, fewer than 10 per cent of global health research is directed towards diseases that afflict 90 per cent of the world's population.

IPRs in pharmaceuticals have two principal areas of impact which affect public health. First, there is the issue of access, where discussion focuses on the links between IPRs, the exclusion of competitors, and the availability and pricing of new medicines. Second, there is the issue of incentivising innovation, where discussion focuses on the role of IPRs in motivating the discovery and development of new drugs, and the effect of these rights on R&D expenditure and its allocation across diseases, countries and organisations.

These two areas are at the heart of the empirical literature on the effects of IPRs on public health in developing countries. Overall, the literature suggests that strong IPRs can hamper

[1] Other market channels include trade and FDI.

access to medicines in developing countries and does not necessarily encourage pharmaceutical innovation that responds to developing country needs.

Generic medicines are central to providing healthcare at prices affordable to developing countries. However, strong IPRs in only a select few countries that export generic medicines have far-reaching consequences for the developing world. This is because countries that rely heavily on imports of generic medicines may find themselves with a sudden shortage of suppliers.

Some have suggested that developing countries may benefit from differentiated prices, provided that strong IPRs are allowed to set high prices in the developed world and measures are taken to minimise parallel importing from developing countries where prices will be lower. However, the evidence suggests that even under such favourable IP and importing conditions, price differentiation is unlikely to be large – certainly not large enough to be of benefit to the very poor.

The argument that strong IPRs will benefit developing countries through future innovation is not borne out by the evidence. Strong IPRs are important for pharmaceutical innovation, but only where there is a strong market, as is often the case for health problems prevalent in the developed world. However, pharmaceutical industries in countries such as India, which have seen their IPR regimes strengthened, are not responding to developing country needs. Instead they too are focusing on developed country markets.

So, for health issues of particular relevance to developing countries, IPRs are of value to commercial product and technology developers only if a viable market can be created (for example, through an advanced market commitment).

Intellectual property rights, genetic resources and traditional knowledge

Genetic resources from plants, animals and micro-organisms are widespread in developing countries, amounting to 90 per cent of the world's genetic resources. Communities and individuals in developing countries have exploited these genetic resources through the generations. Their use is embodied in what often is referred to as traditional knowledge.

However, the use of such knowledge and resources is not limited to local contexts, and many innovations relate to and draw on them. The broader use of traditional knowledge and genetic resources raises the prospect that they may play an important role in driving growth in developing countries. Therefore, the main issue is how this prospect might be best realised, particularly when the exploitation of traditional knowledge and genetic resources is coming increasingly under the governance of various, and sometimes conflicting, IPR frameworks.

The empirical evidence shows that IPRs can facilitate diversity in access to knowledge and benefit-sharing from innovation in developed countries. However, the effectiveness of IPRs in this regard depends on local capabilities in developing countries, in particular capabilities to engage in market production and exchange, and negotiate and establish the right legal infrastructure and enforcement.

Tailored IP laws are a necessary condition for knowledge protection systems to engage a wider range of people in accessing and sharing the benefits of knowledge in developing countries.

Although evidence about implementation is scarce, this could be facilitated by using the provisions in TRIPS for *sui generis* protection and geographical indications. Empirical studies have found that *sui generis* IP systems can facilitate increased influence in innovation on the part of local communities in developing countries. Geographical indications can be used to protect diversity in access and benefit-sharing in developing countries by making provisions for a price premium for goods produced in a specific locality.

Finally, in isolation, plant variety protection might impede diversity in access and benefit-sharing; however, these measures could be combined with provisions for farmers' rights, so as to promote diversity in knowledge systems in agriculture. However, at present, the empirical evidence about the impact of plant variety protection and farmers' rights in developing countries is thin.

Future research directions

Throughout the literature review, the report identifies several knowledge gaps that deserve attention for future research.

Intellectual property rights, foreign direct investment, trade and licensing

The bulk of the empirical literature on the effects of IPRs on FDI, trade and licensing has relied on data covering the period preceding the establishment of TRIPS and subsequent development of increases in the strength of IPRs through regional and bilateral free trade agreements in the TRIPS-plus era. Research is needed to assess the effects of these agreements on economic development in developing countries.

The majority of empirical studies have used indicators of IP protection constructed by researchers to proxy the level of protection in both developed and developing countries. However, many studies do not consider explicitly the effects of stronger IPRs in developing countries. Instead, they focus on examination of the differentials of protection across countries, whether developed or developing countries. Future research should concentrate explicitly on the effects of stronger IPRs in developing countries, and even distinguish between different groups of developing countries (e.g. fast-growing countries, least-developed countries).

Most of the empirical evidence of the effects of stronger IPRs on FDI, trade and licensing has been based on econometric methods. Although these methods are useful to examine whether there is a statistically significant relationship between IPRs and development, they are not able to explain fully the fundamental reasons behind the statistical results. For example, the limits of these methods are striking when the focus of the analysis is at industry level. Case study methods can provide useful insights in order to explain the different impacts of IPRs on economic variables such as FDI and trade at industry level.

Many studies using firm-level data to assess the effects of stronger IPRs on FDI, trade and licensing have used data on American (US) multinationals. More research is needed on European and Asian multinationals.

The empirical literature on the impact of stronger IPRs has considered the strategies of single firms in a partial-equilibrium framework without considering the impact on the whole economy. It is important to consider broader efficiency aspects in a general-equilibrium setting, particularly from a North–South perspective. Future research should investigate how IPRs impact on the dynamic allocation of resources devoted to the generation of knowledge and how the former influences the international division of labour devoted to the manufacture of protected goods. Furthermore, it is not clear from a dynamic perspective whether strong IPRs in developing countries encourage innovation in developed countries or whether some benefits from innovation in developed countries accrue to developing countries. These issues are of considerable importance and deserve further empirical research.

Intellectual property rights, international technology transfer and domestic innovation

The empirical literature on IPRs and international technology transfer has concentrated mainly on market-based channels of technology transfer, i.e. licensing. However, little is known on the effects of stronger IPRs on non-market channels of international technology transfer, i.e. reverse engineering and imitation. Future research should examine in particular how stronger and well-structured property rights regimes can foster the diffusion of free technical information, and thereby innovation.

The empirical literature on IPRs and domestic innovation has established the existence of a U-shaped relationship between IPRs and economic development at the country level, suggesting that weak protection may ease economic development. Further research should seek to better explain the reasons behind this U-shaped relationship.

Intellectual property rights and public health

Due to the convergence of economies, it is possible that IPRs may have a more important role to play in the future in dealing with the health problems common to both developed and developing countries. There is evidence that many problems are converging. Future research should investigate how the convergence of economies – and thereby the growing similitude of health problems between northern and some southern countries – are likely to impact on IPR regimes.

The review of the literature also reveals a knowledge gap in understanding the role of IPRs in public–private partnerships. Since these types of arrangements have emerged as the dominant paradigm for addressing neglected diseases, further research on this issue is needed urgently.

Several IP-related policy measures (such as government patent buy-outs, bifurcated patent systems, orphan drug legislature that extends patents, and transferable IPRs) have been put forward, based on theoretical grounds or indirect empirical evidence. These require careful policy analysis in order to determine their feasibility and implications with more confidence.

Intellectual property rights, genetic resources and traditional knowledge

The review of the literature on genetic resources and traditional knowledge has shown that there is a need for further research in order to assess the relative impact of different tailored IP laws on diversity in access and benefit-sharing. Specifically, more empirical evidence is required to better understand the impact of existing national *sui generis* systems and specific measures in the agricultural sector.

CHAPTER 1 Introduction

Systems to govern intellectual property and promote social welfare through innovation and knowledge creation are not new. Despite their existence through the past decades and centuries, intellectual property was relatively absent from the public debate. Recent changes in international legal and trade structures altered this situation. The negotiations to ratify the World Trade Organization's (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) acted as a catalyst to bring discussions of intellectual property (IP) to the forefront of policy debates. Signed in 1994, TRIPS provides a minimum standard of protection for intellectual property and provides a dispute resolution system for entities to challenge breaches of these standards. Subsequently, new deals have formed through bilateral, regional and international agreements to strengthen these minimum standards of protection. These agreements are accompanied further by a growing number of institutions which refer to intellectual property questions in their programmes, including, but not limited to, the World Health Organization (WHO), United Nations Educational, Scientific and Cultural Organization (UNESCO) and other United Nations (UN) programmes.

Amid this plethora of institutions and agreements discussing IPRs, debates have ensued about the influence of such rights in diverse areas such as trade and industrial policy, public health, food and agriculture and biodiversity and biotechnology. These debates have become increasingly complex, involving arguments from the perspectives of international law, human rights and social and economic development. This complexity is coupled with controversy, as critics challenge the existing intellectual property regimes based on their implications for developing countries, in particular their impact on a development agenda, whether positive or negative. The relationship between IPRs and development is indeed quite complex from a theoretical point of view. On one hand, there are theoretical arguments suggesting that stronger IPRs can have positive effects on development. On the other hand, there are theoretical arguments against stronger IPRs in developing countries.

Amid this complexity and controversy about the impact of intellectual property on developing countries, RAND Europe was commissioned to review the empirical evidence about how the strength of IPRs affects economic and social development in developing countries. As such, this report reviews the empirical evidence about the relationship between the strength of IPRs (see Box 1) and each of the following areas in developing countries: foreign direct investment (FDI), trade, innovation, public health, and traditional knowledge and genetic resources. The empirical evidence of the effects of IPRs on these areas varies considerably in terms of the research methods used. The empirical literature on

FDI, trade and innovation has used mainly econometric studies to test theoretical assumptions based on economic arguments. Instead, the empirical evidence on public health and traditional knowledge is based on more qualitative approaches and other disciplines than economics. This explains why the approach followed by the review varies across these areas.

The review finds that, in fact, the relationship is viewed better from an alternate perspective, where the broader levels of economic and social development have a strong effect on how IPRs affect developing countries. In this way, the report helps to reposition the initial question on the roles of IPRs in developing countries and to clarify its related evidence base.

Box 1: Characterising, measuring and comparing intellectual property rights

Any attempt to quantify the impact of IPRs needs to appreciate the variable nature of the legal framework that supports IPRs. The enforcement of IP can turn on subtleties in the language of IP statutes as interpreted by courts, administrative agencies and other participants in the IP system. This variation has major implications for the strength of IPRs, such that IP protection is felt quite differently across different sectors of the economy. Thus, the context of IPRs is important: they are interwoven with other domestic laws and institutions governing competition policy and anti-trust, international trade, labour relations, privacy and many other issues, as well as multilateral or bilateral agreements with other countries.

Clearly, this makes characterising, measuring and comparing IPRs across countries and over time extremely difficult. Early efforts by Gadbaw and Richards (1988) and Rapp and Rozek (1990) to develop indices of national IPRs were based on analysing legislation in various countries. Lee and Mansfield (1996) and Seyoum (1996) developed similar indices, but based these on questionnaire results. A more ambitious and standard-setting study by Ginarte and Park (1997) constructed an index of the strength of patent protection for 110 countries over the period 1960–1990, now extended to 2005 (Park, 2008), by coding national patent laws according to the extent of coverage of different technologies, membership in international treaties, potential to lose protection, presence of enforcement mechanisms and duration. These data have been used widely in studies of growth, development and IPRs.

Notwithstanding the very significant effort required to construct such indexes, they pose a number of problems. Composite indices tend to focus almost exclusively on patents, ignoring copyright, trade marks and other appropriability mechanisms such as secrecy and speed to market. Composite ranking or rating schemes often bury important features of the IP regime, obscure important sectoral differences and do not control for the complementary aspects of a country's legal regime (Lerner, 2002). Perhaps most significantly, these indices reflect the formal status of patent protection as indicated by law, rather than an empirical assessment of the conditions facing IPR holders (or prospective holders) at ground level (Ostergard, 2000).

More comprehensive attempts have been made to examine other factors that affect the strength of IPRs (Sherwood, 1997; Pugatch, 2006). These include patent breadth and length, what objects and processes can be patented, and the obviousness of the inventive step. However, quite understandably, the colossal effort required to collect data on all of these items means that Pugatch (2006) has computed his 22-factor index with an assortment of weightings for only eight countries over five years.

CHAPTER 2 Intellectual property and foreign direct investment

2.1 Introduction

Traditionally, attracting FDI in general, and in R&D in particular, has been high on the policy agenda of many countries, as inward flows of R&D are believed to provide net benefits for the host country (Organisation for Economic Co-operation and Development (OECD), 2008).[2] Acquiring modern technology may generate important spillovers for the host country economy, which result in more and better competition, upgrade domestic innovative capacity, increase R&D employment, give better training and support to education, and reverse 'brain drain' effects (Caves, 1974; Borensztein et al., 1998; Veugelers and Cassiman, 2004). However, inward FDI may have negative effects on the host country, such as loss of control over domestic innovative capacity, potentially impacting the technological competitiveness of domestic firms and leading to job loss. In addition, outward direct foreign investment has negative effects on the home country, such as loss of jobs and technological capacity (OECD, 2008).

The impact of outward FDI in R&D on the home country is an aspect of the R&D internationalisation process which has been considered less frequently in the literature on FDI, but continues to receive considerable policy attention. Several benefits of outward FDI for the home country have been identified. Such investment allows foreign firms to tap into other sources of expertise, enhance their access to foreign markets and benefit from reverse technology transfer (Griffith et al., 2006; OECD, 2008). In contrast, outward FDI may generate costs for the home country through loss of jobs, loss of technical capability, deindustrialisation and loss of economic benefits, if results are exploited locally (OECD, 2008).

Despite the possible costs of FDI for the home country and the host country, FDI is perceived often by policymakers to be an important engine for economic growth, especially in developing countries. This perception has attracted increasing attention over the past decades, especially during the negotiations preceding the ratification of the TRIPS

[2] A foreign direct investment enterprise is an incorporated or unincorporated enterprise in which a direct investor resident in another economy owns 10 per cent or more of the ordinary shares or voting power (for an incorporated enterprise) or the equivalent (for an unincorporated enterprise).

Agreement and subsequent use of bilateral agreements on IPRs in the TRIPS-plus era. This attention compels the question: how do agreements aimed at strengthening IPRs in developing countries impact on FDI decisions by multinationals?

This chapter will help to provide tentative answers to this key question by looking at the results of the literature on the relationship between IPRs and FDI. The chapter is structured as follows: the first section examines the relationship between IPRs and FDI from a theoretical perspective. The second section reviews the empirical literature on the effects of strengthening IPRs in developing countries on FDI decisions. Finally, the chapter concludes by summarising the key findings from the empirical literature and suggesting future research directions.

2.2 Intellectual property and foreign direct investment: the theory

Over the past two decades, there has been a growing scholarly literature on the relationship between IPRs and FDI inflows in developing countries. From a theoretical viewpoint, the relationship between IPRs and FDI decisions is complex. The following paragraphs briefly review the theoretical arguments for and against stronger IPRs in developing countries in their influence on FDI decisions.

2.2.1 The case for stronger intellectual property rights

Stronger intellectual property rights can create ownership advantages

Investment by firms can be more likely when host countries have strong IP protection, as this protection reduces the risks of imitation and leads to a relatively larger net demand for protected products (Primo Braga and Fink, 1998a). Therefore, IPRs positively affect the volume of FDI by enabling foreign firms to compete effectively with indigenous firms that possess ownership advantages (Smarzynska Javorcik, 2004).

Stronger intellectual property rights can create location advantages

Not only can IPRs positively affect the volume of FDI, but they can also influence where multinationals decide to locate that investment. IPRs are territorial in nature and hence differ across national boundaries.

In this regard, stronger IPRs in some developing countries can be a location advantage that will positively affect multinationals' decisions (Primo Braga and Fink, 1998a). On the contrary, developing countries characterised by weak IPRs can be less attractive locations for foreign firms. However, in the context of TRIPS, it is reasonable to think that the trend toward harmonisation of IPRs within TRIPS would offset such location advantages. In this sense, countries with weaker protection can become more attractive as they strengthen their IPRs, and the relative attractiveness of those with strong IPRs already in existence can fall (Maskus, 2004).

Stronger intellectual property rights can increase quality of foreign direct investment

IPRs affect the composition of FDI. Strong protection may encourage FDI in high-technology sectors, where such rights play an important role. In addition, it may shift the focus of FDI projects from distribution to manufacturing (Smarzynska Javorcik, 2004).

2.2.2 The case against stronger intellectual property rights

Strengthening intellectual property rights can increase market power

Strong IPRs negatively influence FDI by providing rights holders with increased market power. As a result, strong IPRs, at least theoretically, cause firms to divest and reduce their service to foreign countries (Maskus and Penubarti, 1995; Primo Braga and Fink, 1998a). The market power effect can reduce the elasticity of demand facing the foreign firm, inducing them to invest – or produce – less of its patentable product in the host country, or products made by a patentable process in the market with the stronger IPRs. Stronger IPRs can allow the practice of higher prices by foreign firms because IPRs reduce competition among firms. Therefore, stronger prices can compensate for lower investment or production.

Stronger intellectual property rights can deter foreign direct investment by encouraging licensing

Not only can strong IPRs increase the market power of foreign firms, but they also can cause multinationals to switch their preferred mode of delivery from foreign production and R&D to licensing (Primo Braga and Fink, 1998a). Ferrantino (1993) argues that firms prefer FDI over licensing when protection is weak, as firms are more able to maintain direct control over their proprietary assets through internalised foreign production or in-house foreign R&D. In this case, strengthening IPRs diminishes the incentive for FDI at the margin for R&D-intensive industries (Primo Braga and Fink, 1997).

2.3 Intellectual property and foreign direct investment: the empirical evidence

Empirical evidence comes from surveys of foreign investors in industrial countries, or from econometric work evaluating the impact of different IPR regimes on a cross-section of countries. The empirical literature has intended to test the somewhat contradictory theoretical assumptions on the effects of IPRs on FDI. The bulk of the empirical literature has concentrated on the effects of IPRs on FDI from the perspective of developed countries: only a small part of the literature examines the effects of these rights from the perspective of developing countries.

2.3.1 Evidence from the perspective of developed countries

Intellectual property rights positively impact on foreign investment under certain circumstances

Early studies focusing on the decisions made by US multinational enterprises did not find any statistical significant relationship between IPRs and FDI (Ferrantino, 1993; Mansfield, 1993; Maskus and Konan, 1994). However, as Maskus (2004) noted, these studies suffer from methodological weaknesses, including poor measurement of the strength of IPRs.

Further studies carried out in the 1990s continue to present mixed conclusions. Lee and Mansfield (1996) examined the relationship between a developing country's system of IP protection and the volume and composition of US FDI in that country, by using a new index of weakness of IPRs. This study was carried out in 14 destination countries including several South American, Latin American and Asian countries and one African

country.[3] Based on data obtained from almost 100 US firms regarding their perceptions of the strength of such protection in the various countries, Lee and Mansfield (1996) found that the level of intellectual property protection influenced the volume of US FDI.

Maskus (1998) further corroborated Lee and Mansfield's (1996) results. Maskus investigated the impact of IPRs on FDI decisions from US multinationals in a panel of 46 developing countries. Using the index of patent strength developed by Maskus and Penubarti (1995), he found that the strength of IPRs positively affected FDI decisions only for more developed countries. According to the econometric results, when other things were equal, a 1 per cent rise in the extent of patent protection expanded the stock of US investment in developing countries by 0.45 per cent.

Nevertheless, empirical studies do not universally find that IPRs positively affect FDI decisions. This is evident in a study by Primo Braga and Fink (1997), in which the effects of IPRs on FDI decisions with respect to manufacturing from US multinationals were examined using a larger set of developing countries than Lee and Mansfield (1996). To proxy the strength of IPRs, they used the index developed by Rapp and Rozek (1990a): the Rapp-Rozek index. The authors found a positive significant relationship between the strength of IPRs and FDI for total manufacturing in developing countries. However, their results at the sectoral level are less statistically robust.

Other empirical studies have disaggregated these previous findings so as to understand better the effects of IPRs on FDI decisions according to the level of development of recipient countries and their imitative abilities. For example, Smith (2001) analysed how IPRs affect US affiliate sales and licences in a sample of 50 countries from Africa, Asia, Europe, Latin America and the Middle East, measuring the strength of IPRs by using the Rapp-Rozek index and the index developed by Ginarte and Park (1997): the Ginarte-Park index. Smith found that strong IPRs increase both US affiliate sales and licences, particularly among countries with strong imitative abilities, as measured by R&D and education statistics.

Similar to the Smith (2001) study, Nair-Reichert and Duncan (2008) used panel data from US multinationals over the period 1992–2000 to show that affiliate sales are impacted negatively and significantly when a host country poses a risky environment for firms due to high imitation abilities. Strong IPRs increase affiliate sales in countries with a high ability to imitate, suggesting that the positive market expansion effect dominates the negative monopoly power effect.

Park and Lippoldt (2003) confirmed that the effects of IPRs on FDI tend to vary by a country's level of economic development. For example, the authors found that developing nations which are WTO members generally have greater inward stocks of FDI than developing nations which are not. However, they found that this does not hold true among the least developed nations: among these countries, WTO members do not have significantly more FDI than non-members. Nevertheless, Park and Lippoldt's econometric results suggest overall that an increase in the strength of IPRs will tend to have a significant

[3] Argentina, Brazil, Chile, Hong Kong, India, Indonesia, Mexico, Nigeria, Philippines, Singapore, South Korea, Taiwan, Thailand and Venezuela.

positive effect on the inward and outward FDI of both developing and least developed countries.

More recently, Awokuse and Yin (in press, 2009) investigated the role of IPR protection in the surge in FDI in China. Using panel data from 38 source countries, they found that the strengthening of IPRs in China has had a positive and significant effect on FDI.

Blyde and Acea (2002) empirically examined the effects of IPRs and FDI in Latin American countries. Their results nuance the influence of the level of development of countries on FDI decisions, affirming a positive relationship between IPRs and FDI. They found that IPRs affected bilateral inflows of investment from OECD countries, even after controlling for variables such as infrastructure and human capital levels.

Intellectual property rights affect the composition of foreign direct investment

Although while they considered the level of development of countries and their strong technical capabilities, the previous studies on direct investment drew on aggregate FDI data rather than data disaggregated by industry. In contrast, a growing number of empirical studies have begun to consider the effects of IPRs on FDI by industry and by its composition.

In their pioneer study Lee and Mansfield (1996) show empirically, through a sample of US chemical multinational firms, that the proportion of FDI devoted to final production of R&D facilities was negatively and significantly associated with weak IP protection.

In another study comprising a survey on US manufacturing firms, Mansfield (1994) determined that the importance of IPRs for investment depended on the purpose of the investment project. For example, only a minor share of the respondents was concerned about IPRs for investment in sales and distribution. The share of those concerned rose when looking at investment in rudimentary production and assembly facilities. The share further increased for investment in manufacturing components, complete products and R&D facilities (Mansfield, 1994).

Similarly, Park and Lippoldt (2003) found that the importance of IPRs to FDI differed across industries. For example, the influence of the strength of foreign patent regimes was insignificant for US outward FDI in metals, machinery, electronics, transportation and wholesale trade. In addition, patent rights were found to affect modestly US outward FDI in chemicals and pharmaceuticals.[4] In contrast, the strength of foreign patent regimes significantly influenced US outward FDI in petroleum, finance and services (including computer-related services) industries in all countries. According to the authors, the sectors are sensitive to patent protection due to the emergence of new energy-related technologies and the complementarity between finance and technology. Finally, patent rights moderately affected US FDI in these same sectors in developing nations (except in the computer-related services industry, where this depended strongly on patent rights).

[4] The authors recognised that this result is surprising especially for pharmaceuticals. Nevertheless, they stressed that their sectoral study does not distinguish between chemicals and pharmaceuticals, the latter being a sub-category of the former. Moreover, they pointed out that their data on foreign direct investment do not include only R&D investment, but also other types of investment.

Looking specifically at investment projects in Eastern Europe and the former Soviet Union by using unique firm-level data from 24 economies, Smarzynska Javorcik (2004) found that investors in sectors relying heavily on IP protection were deterred by weak IPRs in a potential host country. Moreover, weak rights deterred investors from undertaking local production and encouraged them to focus on distribution of imported products.

Using sectorally-disaggregated data on FDI for a large sample of host countries, Nunnenkamp and Spatz (2004) concluded that IPRs were a significant determinant of US outward FDI, particularly in developing countries. Their results also revealed that weaker IPRs were associated with lower quality of FDI, as judged by the small increases in local R&D, employment and added value that accompany the investment.

2.3.2 Evidence from the perspective of developing countries

Following the literature review from the perspective of developed countries, the question remains as to what the existing evidence shows about the effects of strengthening IPRs on FDI in the developing countries. In this respect, the empirical evidence is limited. Predominantly, this literature has examined first, whether increased FDI from developed countries has impacted economic development, and second, whether IPRs affect the outward FDI of developing countries.

Intellectual property rights seem to impact positively on economic development through foreign direct investment

Branstetter et al. (2007) provide recent empirical insights about the effects of increased FDI on industrial development. Using firm-level panel data on US multinational firms, they examined how US firms responded to a series of intellectual property reforms undertaken in 16 countries in Asia, Europe, Latin America and the Middle East.[5]

Their findings showed that US multinationals expanded the scale of their activities in countries after these countries implemented IPR reforms. The increase in use of inputs in the host countries was disproportionately higher among multinationals that made extensive use of IPRs. More importantly, industrial activity expanded overall after rights reform. This expansion of multinational activity more than offset any decline in the imitative activity of indigenous firms.

Intellectual property rights positively affect outward foreign direct investment

Concerning outward FDI from developing countries, Park and Lippoldt (2003) empirically showed that that an increase in the strength of patent rights tended to significantly and positively affect the outward FDI of developing and least developed countries, suggesting that the latter could gain from the harmonisation of IPRs (Park and Lippoldt, 2003).

[5] Argentina, Brazil, Chile, China, Colombia, Indonesia, Japan, Mexico, Philippines, Portugal, South Korea, Spain, Taiwan, Thailand, Turkey and Venezuela.

2.4 Conclusions and future research directions

This chapter has examined the relationship between IPRs and FDI, and concludes the following.

- There are theoretical arguments showing that strengthening IPRs can have positive effects on FDI. Strong rights can create ownership advantages that allow firms to invest abroad. They can also represent a location advantage, which can be used by developing countries to attract new cross-border investment. Moreover, stronger IPRs can provide incentives for multinationals to increase the quality of their investment dedicated to developing countries.
- However, there are theoretical arguments against strong IPRs. Strong IPRs can increase the market power of multinationals in developing countries, giving them incentives to increase the price of their products and to decrease their investment and sales abroad. Moreover, strengthening IPRs can reduce FDI to the benefit of licensing.
- Empirical evidence shows that stronger IPRs positively affect the volume of inward FDI in developing countries, especially those with strong technical absorptive capabilities. Additionally, they may influence the composition of FDI by encouraging investment in production and R&D rather than in sales and distribution.
- The empirical literature suggests that developing countries may benefit from the international harmonisation of IPR regimes. Strong IPRs increase inward FDI and contribute further to industrial development. Moreover, international harmonisation may impact positively on the outward FDI of developing and least developed countries.

Examination of the empirical evidence of the effects of IPRs on FDIs suggests several gaps in the literature. Among the most striking ones is the need to extend research on multinationals to others than those only in the United States of America (USA), since multinationals' decisions might differ across home countries. Equally important is a better understanding of the extent to which IPRs affect FDI at the industry level and, above all, the type of cross-border investment (e.g. sales versus R&D).

CHAPTER 3 Intellectual property and trade

3.1 Introduction

Increasing and enhancing trade flows through liberalisation remains a priority for policymakers in many countries, mainly industrialised ones (Sundaram and von Arnim, 2009). A common view assumes that trade liberalisation is an engine for economic development (Krueger, 1997). Empirical evidence confirms the importance of trade for economic growth (Greenaway et al., 1997; Edwards, 1998), except in countries which have suffered from political instability, adopted contractionary macroeconomic policies or undertaken efforts to counteract trade reform (Wacziarg and Welch, 2008). More generally, international trade is viewed as an important instrument to reduce poverty in developing countries (United Nations Conference on Trade and Development (UNCTAD), 2004) by facilitating a process of sustained economic growth, developing productive capacities and expanding employment opportunities. For most developing countries, exports allow them to acquire goods through importation that are necessary for economic growth and poverty reduction, but are not produced domestically. In turn, exports can make it possible to transform underutilised natural resources and surplus labour into foreign exchange, in order to pay for imports to support economic growth. However, this process requires speed and stability in export growth so as to meet growing import demand sufficiently.

Despite the results of these empirical studies showing the potential benefits of trade for developing countries, several prominent economists (Stiglitz, 2003; Samuelson, 2004) have argued that, as guided by the rules set out in recent multilateral and bilateral agreements, international trade remains unfair to developing countries, as the majority of gains from trade are accrued to developed countries. Moreover Chang (2002) shows that many developed countries did not pursue trade liberalisation when they were climbing the economic ladder of success in the nineteenth century.

The TRIPS Agreement and increases in the strength of IPRs through bilateral agreements in the TRIPS-plus era have raised concerns for policymakers about the effect of IPRs on trade. This raises the question: how do agreements aimed at the reinforcement of IPRs in developing countries affect trade between developed and developing countries?

By reviewing the literature on the relationship between IPRs and international trade, this chapter will address this question, synthesising the existing evidence. The chapter is structured as follows: first, it outlines the main findings of the theoretical literature on the

relationship between IPRs and international trade. Second, it reviews the empirical literature on the effects of strengthening IPRs in developing countries on international trade. Finally, the chapter summarises the key findings from the empirical literature and suggests future research directions.

3.2 Intellectual property and trade: the theory

A growing body of scholarly literature examining the relationship between IPRs and international trade developed through the 1990s and 2000s. However, within this body of work, the relationship between IPRs and trade remains ambiguous from a theoretical viewpoint. The following paragraphs briefly present the main theoretical arguments supporting and challenging the view that stronger IPRs increase and enhance international trade.

3.2.1 The case for stronger intellectual property rights

Stronger intellectual property rights can create ownership advantages

Stronger IPRs confer ownership advantages to firms serving foreign markets by providing legal recourse against violation of their assets. In this regard, stronger IPRs expand the markets served by firms.

In addition, strong IPRs can increase bilateral exchange to foreign markets by reducing the costs associated with preventing loss of knowledge assets. Such costs consist of foregone revenues resulting from reduced bilateral exchange and/or expenses incurred to make knowledge assets difficult to imitate. Thus, under market expansion conditions, strengthening IPRs can positively affect trade (Maskus and Penubarti, 1995), especially when the destination country has strong imitative abilities (Smith, 2001).

International harmonisation of intellectual property rights regimes can reduce the transaction costs associated with trade

Discrepancies among national IPR regimes create effects that are comparable to non-tariff barriers (Primo Braga and Fink, 1997). Exporting firms in developed countries face additional costs when exporting to developing countries, when they must engage in activities designed to inhibit local imitation.

International harmonisation of IPR regimes can diminish the transaction costs of operating in different regulatory environments. In this regard, it can represent a location advantage for the participating countries.

3.2.2 The case against stronger intellectual property rights

Strengthening intellectual property rights can increase market power

Although strong IPRs enhance ownership advantage, this enhanced ownership can increase or decrease bilateral exchange. The market power concept holds that strong rights reduce bilateral exchange by ensuring a temporary monopoly over the protected knowledge. This market power is attributed to the patent (grant) holder, whether domestic or foreign.

Firms that secure strong patent protection in foreign markets can exercise their market power by restricting quantity and increasing the unit price of bilateral exchange to that market (Maskus and Penubarti, 1995; Fink and Primo Braga, 2004).

Firms' behaviour depends on a variety of conditions. For example, market power can be generated by relatively modest strength of IPRs when markets are segmented, when few close substitutes are available and technical absorption capacities are weak. Concomitantly, strong IPRs can reinforce market segmentation and reduce the ability to substitute products. As a result, a negative relationship can emerge between the strength of IPRs and bilateral flows under market power conditions, especially when technical absorptive capacities are weak (Smith, 2001). Firms are likely to reduce the quantity supplied and increase the protected products' prices.

Stronger intellectual property rights can deter trade and encourage licensing

A further source of ambiguity stems from the fact that differing levels of IPRs can affect a firm's decision about its preferred mode of serving a foreign market.

In an environment characterised by strong rights, a firm may choose to serve a foreign market by FDI, or by licensing its intellectual assets rather than through direct export. In this respect, strengthening intellectual property protection can have negative effects on trade flows (Fink and Primo Braga, 2004).

3.3 Intellectual property and trade: the empirical evidence

The empirical literature on the effects of IPRs on trade has grown over the past two decades. The empirical evidence comes mainly from econometric studies and, to a lesser extent, from case studies.

The empirical evidence can be divided into two main bodies of work: first, examining the impact of IPRs on trade flows from the perspective of developed countries; and second, investigating how IPRs can affect economic growth in developing countries through trade.

3.3.1 Evidence from the perspective of developed countries

Intellectual property rights positively affect trade, at least with countries with high technical absorptive capabilities

Early studies based on aggregate trade data suggested that firms in developed countries were influenced by the strength of importing countries' IP regimes when engaging in export activities. Using bilateral data for US exports from 1989 and covering 35 partner countries, either developed or developing, Primo Braga and Fink (1997) estimated the impact of the strength of IPRs as measured by the Rapp-Rozek index on arm's-length trade, intra-trade and establishment trade for US companies. They suggested that market expansion dominates market power effects, after finding a positive, statistically significant relationship between the strength of IPRs and arm's-length trade.

Primo Braga and Fink's results were confirmed by Maskus and Penubarti (1995). By using a dataset of 22 OECD countries and 77 additional developing countries from Africa, Latin America and the Middle East based on 1984 data, the authors revealed that increasing IPRs, as measured by the Rapp-Rozek index, had a positive impact on bilateral

manufacturing imports in both small and large countries (Maskus and Penubarti, 1995). However, this positive relationship between trade flows and stronger IPRs was conditioned slightly by a further study by Primo Braga and Fink using a different dataset, which found that the impact of IPRs on trade flows was weaker in large developing countries and stronger in small developing countries (Primo Braga and Fink, 1997; Fink and Primo Braga, 2004).

As with FDI, more recent empirical research has examined the relationship between the strength of IPRs and trade flows according to the level of development of countries and their imitative abilities. For example, Smith (1999) examined the sensitivity of US exports to the strength of national IPRs in countries, grouped by threat of imitation. The measure for threat of imitation reflected an importing country's ability to imitate the technologies embodied in imported goods without penalty from patent law. The strength of IPRs was measured using the Rapp-Rozek and Ginarte-Park indexes. Smith found that US exports were affected by IP protection in importing countries, but the significance of the relationship depended on the level of threat of imitation. Indeed, weak patent rights were a barrier to US exports, but only to countries that posed a strong threat of imitation. These countries tended to be those with emerging economies, and unsurprisingly, countries that experienced substantial US pressure to raise IPR standards. Moving on from this work, Smith (2001) found in a later study that international trade flows, especially in patent-sensitive industries, responded positively to increases in patent rights among middle-income and large developing countries.

Rafiquzzaman (2002) took the exports of 10 provinces in Canada to 76 countries in 1990 as a sample in order to analyse the relationship between IPRs and exports. The findings showed that exports increase with improvement in IPRs, no matter what the degree of development of the importing country. Rafiquzzaman also found similar results to Smith (1999), in that when IPRs improved, the change in exports depended on the importing country's type of imitative threat.

Park and Lippoldt (2003) determined that IPRs played a significant role in attracting total imports in a sample of developed and developing countries during the past decade. However, this effect was not distributed evenly. IPRs tended to have a modest role in attracting total imports to developing nations, and an insignificant role in bringing imports to the least developed countries.

Intellectual property rights affect trade differently across industries

The previous studies mainly drew on aggregate trade data. However, a number of empirical studies have investigated the effects of IPRs on trade by industry.

Maskus and Penubarti (1995) analysed sector exports by clustering industries in three different categories of expected sensitivity to patent laws: high sensitivity (R&D-intensive industries and those industries that have reported significant damages from piracy); low sensitivity; and other industries. They found that the effects of IPRs were larger and more significant for those categorised as low sensitivity industries than those clustered as high sensitivity industries. They interpreted this result as related either to larger-market power effects or to the interplay between trade and FDI decisions in highly sensitive industries. In addition, Maskus and Penubarti argued that the patent index they used may have captured

other dimensions of the IPR regime (for example, copyright and trademark protection) that are relevant for the low patent-sensitivity group.

Using a sample of 89 countries in 1989, Fink and Promo Braga (2004) found a positive relationship between IPRs and trade flows for total non-fuel trade. However, the strength of this relationship differed by industry, and was found to be weak between IPRs and high-tech trade such as chemical, electrical and office machinery and telecommunications apparatus. Fink and Promo Braga give several explanations for this surprising result. First, market power effects in the case of high-tech goods may offset positive market expansion effects caused by stronger IPRs. In addition, the latter may encourage firms to service foreign markets through direct investment rather than trade. Finally, some high-trade goods may not be sensitive to the destination country's IPR regime, since other means may be used to appropriate returns on investment (e.g. first-mover advantage, learning curve).

Park and Lippoldt (2003) examined the role played by IPRs in attracting imports by industry in a large sample of developed and developing countries. For example, they found that patent rights are important to the import of textiles,[6] drugs and industrial chemicals for both developed and developing countries. In addition, patent rights are important in the textile imports of the least developed countries. Computer and office equipment imports are affected modestly by patent rights, and insignificantly so in the case of imports by developing and least developed nations. Developing country imports of drugs and industrial chemicals are affected moderately by patent rights, and least developed country imports (other than textile imports) are affected insignificantly by patent rights.

The previous section presented the results of the empirical literature on the impact of IPRs on trade from the perspective of developed countries. From this follows the question: what is the empirical evidence of the effects of strengthening IPRs on trade flows in the developing countries?

3.3.2 Evidence from the perspective of developing countries

The empirical literature has investigated whether increased imports from developed countries affect economic development and whether harmonisation of IPRs has affected their export behaviour. However, even within these areas, the empirical evidence from the perspective of developing countries is rather limited, especially regarding the affect of imports from developed countries on economic development.

International harmonisation of intellectual property rights may encourage exports from emerging industrialised countries

A small but growing empirical literature has investigated the effects of IPRs on exports from newly-industrialised countries and developing countries. Liu and Lin (2005) carried out a consecutive pooled data analysis from 1989 to 2000 in order to investigate the relationship between IPRs and the exports of three high-tech industries in Taiwan: semiconductor, information and communication equipment.

[6] According to Park and Lippoldt, patent rights are important to the textile imports of least developed countries, where the threat of imitation of fabric patterns and other designs is high and could discourage foreign producers from selling in these markets.

Their empirical results showed that improvement in IPRs had a positive impact on Taiwan's exports if the importing country had a stronger R&D ability than Taiwan. Moreover, Liu and Lin found that when an importing country exhibited a strong threat of imitation, the improvement in IPRs in that country increased Taiwan's exports through the market expansion effect. These results were corroborated further by Yang and Huang (2009).

Harmonisation has not increased exports from other developing countries

Smith et al. (2009) explored whether TRIPS generated gains for developing countries in the form of increased pharmaceutical exports. They found that TRIPS had not generated substantial gains for developing countries, but instead increased pharmaceutical trade in developed countries.

In a more comprehensive econometric study, Park and Lippoldt (2003) analysed the effects of IPRs on exports from a large set of developing and least developed countries. According to their results, patent rights tend to influence insignificantly the total exports of developing and least developed countries. However, two industries in which exports in developing countries were moderately affected were pharmaceuticals and computer and office equipment. In contrast, in the case of the least developed countries, exports were affected negatively and significantly by patent rights.

3.4 Conclusions and future research directions

This chapter has looked the relationship between IPRs and trade. Its main conclusions are as follows.

- There are theoretical cases showing that strengthening IPRs can have positive effects on international trade. As with FDI, strong IPRs can theoretically create ownership advantages that allow firms to compete effectively in foreign markets. Moreover, international harmonisation of IPR regimes can reduce the transaction costs associated with international trade.
- However, there are theoretical cases against strengthening IPRs in developing countries. From a theoretical point of view, strengthening IPRs can increase the market power of foreign firms in developing countries, giving them incentives to increase the price of their products and decrease their exports to developing countries. Moreover, strengthening IPRs can reduce trade to the benefit of licensing.
- There is empirical evidence suggesting that IPRs can positively affect trade, at least with countries with high technical absorptive capabilities. However, stronger IPRs have differential effects across industries.
- Findings in the empirical literature show that international harmonisation of IPR regimes may encourage exports from emerging industrialised countries. However, this harmonisation does not seem to have increased exports from other developing countries.

The review in this chapter of the empirical evidence suggests further specific research directions. In particular, there is a need to understand better the effects of strengthening IPRs on trade in high-tech, medium-tech and low-tech industries. It is likely that different types of IPRs (e.g. patents, copyright) will affect industries differently.

CHAPTER 4 Intellectual property and innovation

4.1 Introduction

Harnessing R&D and innovation has been a priority for policymakers in developed countries, particularly as technological progress is considered to be key driver for economic growth in the long run (Solow, 1957; Romer, 1990; Grossman and Helpman, 1991; Aghion and Howitt, 1997). Empirical evidence has supported the view that technological progress drives economic growth (Jones, 2002; OECD, 2003; OECD, 2004; Aghion and Howitt, 2009).

In an open economy, technological progress can be driven either by technology creation, or technology diffusion and absorption. It is reasonable to assume that the respective contribution of creation and diffusion to technological progress depends on countries' level of technological development (Aghion and Howitt, 1997; Acemoglu et al., 2006). In less advanced economies, diffusion and absorption can drive economic growth, because countries at the forefront of technology act as a driver for growth by expanding the set of attainable knowledge, pulling others through a 'catch-up' effect. However, the strength of the catch-up effect at the technology frontier decreases with the level of technological development, to the benefit of technology creation. Indeed, the creation of more advanced technology becomes progressively more important as a country moves closer to the technology frontier, because catching up translates into increasingly smaller technological improvements (Vandenbussche et al., 2006).

The purpose of this chapter is to examine how the reinforcement of IPRs in developing countries affects technological progress in developing countries.

4.2 Intellectual property rights and innovation: the theory

Over the past two decades, there has been a growing academic literature investigating the relationship between IPRs and innovation. This relationship can be examined through the impact of IPRs on domestic innovation (i.e. technology creation) and IPRs' impact on technology transfer (i.e. technology absorption and diffusion).

The following sections review the theoretical arguments for and against stronger IPRs in developing countries, to influence technology transfer from developed countries and domestic innovation.

4.2.1 The case for stronger intellectual property rights

Intellectual property rights can provide incentives for firms to invest in R&D

Firms do not have the right incentives to invest in R&D and innovation if the benefits of such investment accrue to their competitors. This is the traditional argument about private under-investment in R&D due to market failure (Maskus, 2004; Foray, 2009).

The production of new products and processes generates new knowledge. New knowledge carries considerable economic value, but it has features that make it problematic for the market system to handle properly (Arrow, 1962). Specifically, knowledge is seen as a public good, and public goods have two basic attributes. First, they are non-rival in consumption, meaning that a person's use of a public good does not affect the amount of it that is available for others. Second, they are 'non-excludable', meaning that it is not possible to prevent individuals from enjoying the public good once it is available. Without IPRs, a free market economy can fail to induce an optimal investment in R&D and innovation, since investors would not be able to recoup the full benefit from their investment.

IPRs in general address this problem by attacking the 'non-appropriability' of knowledge that lies at the heart of this market failure. Specifically, by endowing innovators with property rights on their discoveries, patents can be a legal means of affecting the 'excludability' attributes of an otherwise public good. Stronger IPRs can give greater incentives to firms to invest in R&D.

Stronger intellectual property rights can create ownership advantages

Stronger IPRs give strong ownership advantages to firms in developed countries, which can encourage them to transfer their technology to developing countries through market channels: trade, FDI and licensing.

Stronger intellectual property rights can reduce asymmetric information in technology transfer

IPRs can significantly reduce asymmetric information problems in contracting for international technology transfer (Arora, 1995).The owner of a technology may have complete knowledge about its specifications, its effectiveness when deployed under different circumstances, associated know-how and the like, while the buyer has far less information about it. The buyer then could be unwilling to offer a price that would cover all of these claimed benefits before they are sure that such information is correct. However, the seller could be unwilling to reveal the information without a contract in place at an acceptable price: to do so could alter the negotiating terms in his disfavour at best, and immediately create a competitor based on the revealed knowledge at worst. Accordingly, many otherwise mutually beneficial technology transactions may break down. Stronger IPRs can allow the reduction of asymmetric information in contracting for technology transfer.

4.2.2 The case against stronger intellectual property rights

Intellectual property rights are not the only means to appropriate returns on R&D

IPRs are not the only means for firms to reap the benefits from their investment in R&D and innovation.

Several surveys carried out in developed countries have shown that other factors are much more effective than patents in enabling firms to profit from inventive efforts: trade secrecy, first-mover advantages and associated brand loyalty, the complexity of the learning curve and establishment of effective production, sales and marketing functions (Mansfield, 1986; Levin et al., 1987; Arundel and Kabla, 1998; Arundel, 2001).

Stronger intellectual property rights can increase market power

Stronger IPRs are likely to raise the costs of technology transfer, since they increase inventors' market power. Inventors can be expected to sell technologies at a price higher than marginal cost, which is socially less than optimal for the recipient country, at least in a static sense.

Strengthening intellectual property rights can be insufficient to reduce the asymmetric information problem

The argument developed by Arora (1995) is based on the transactional difficulties created by the fact that codified information and tacit knowledge are complementary and must be transferred together. However, this argument overlooks a problem regarding the recipient country's legal and technical capacities – it needs highly-skilled people who are able to deal with complex contract negotiations (Foray, 2009).

Intellectual property rights systems can encourage diffusion of free technical information

It is useful to recall that patent systems do not necessarily hinder the diffusion of technical information. Rather, patent systems can even stimulate the diffusion of technical information, since the inventor must publicly divulge the technical details of the new technological knowledge in exchange for patent rights. Technical description is an essential act. It is intended to provide sufficient 'instructions' for a specialist in that particular field, so as to be able to reproduce the invention and improve it. Strong IPRs may oblige investors to disclose their inventions fully.

In this sense, the patent system can generate a huge repository of technical information in any technological area which can be freely used by anyone looking for information about a given technology (Foray, 2009). As noted by Foray (2009), this occurred in Ethiopia, where certain technologies were needed to develop hearing aids powered by solar energy. A search was conducted to identify relevant patents related to hearing aids issued in developed countries. Detailed analysis of the information contained in these patents showed that the disclosed inventions were not protected in any African countries; therefore, such information was used to create the new technologies.

Weak intellectual property rights can encourage international technology transfer through non-market channels

International technology transfer often occurs through non-market channels: involuntary dissemination via copying and reverse engineering. During the period of weak IPRs in developing countries, copying was certainly a major channel for international technology transfer, in particular in the newly-industrialised countries. Historical cases show that several developed countries have used weak IPRs to boost the development of their industries (Foray, 2009). One can argue that it is plausible that IPRs may impede such

technology transfer while strengthening 'market-based' channels, i.e. technology transfer through trade, foreign direct investment and licensing

4.3 Intellectual property and innovation: the empirical evidence

The empirical literature on the impact of IPRs and innovation in a North–South context has increased significantly throughout the 1990s and 2000s. The empirical evidence can be divided into two main bodies of work: examining the effects of IPRs on international technology; and investigating how IPRs can impact on domestic innovation in developing countries.

4.3.1 Evidence on international technology transfer

Intellectual property rights tend to impact positively on licensing

The bulk of the empirical literature on the impact of IPRs on international technology transfer has focused on the market-based forms of technology transfer: trade, FDI and licensing. Previous chapters have discussed the empirical evidence on trade and FDI. The following paragraphs present the results of the empirical literature on licensing; however, these studies are scarce.

Yang and Maskus (2001) regressed the real volume of licence fees for industrial processes paid by unaffiliated foreign firms to US firms in 23 developed and developing countries in the 1980s and 1990s on the Ginarte-Park index.[7] They discovered that stronger patent rights attract larger arm's-length volumes of licensed technology, and that a 1 per cent rise in the index would increase licensing volumes by 2.3 per cent on average.

Smith (2001) relates US export, sales of foreign affiliates and licensing fees to the Ginarte-Park patent index in several developed and developing countries. In particular, Smith finds significant evidence that stronger IPRs increase licensing payments on average, at least for countries with strong imitative abilities.

Using different indices of the strength of IPRs, Park and Lippoldt (2005) provide empirical support that the strengthening of IPRs has had a net positive effect on the international licensing of technologies between unaffiliated parties during the 1990s. The empirical evidence is based on the licensing activities of US multinationals as well as on international licensing alliances between firms in developing or emerging and developed nations.

Branstetter et al. (2006) analysed affiliate data from 1982 to 1989 on US multinationals operating in 18 countries that reformed their IPRs during this period. Controlling for host country characteristics, they showed that such reforms substantially increased the royalty payments collected by US firms from their affiliates for the use or sale of intangible assets. Increases in royalty payments from the affiliates of parent companies that themselves extensively registered patents prior to reforms were in excess of 30 per cent.

[7] Australia, Brazil, Canada, Germany, Hong Kong, Indonesia, Israel, Italy, Japan, Korea, Malaysia, Mexico, New Zealand, Norway, Philippines, Singapore, South Africa, Spain, Sweden, Switzerland, the Netherlands, UK and Venezuela.

Using the firm-data from Japanese multinationals, Ito and Wakasugi (2007) found that stronger enforcement of IPRs accelerates the intra-firm technology transfer measured by royalty payments from the affiliate to its parent firms.

Intellectual property rights affect the channels of technology transfer

When examining the effects of IPRs on technology transfer, it is important to consider the modes of delivery of technology transfer through the different market channels: trade, FDI and licensing.

The decisions among the different channels of technology transfer depend on the strength of IPRs and ownership advantage (Smith, 2001). These decisions concern whether or not to transfer production, and thus knowledge, outside the source country and/or the source firm. Firms engaging in exports hold their knowledge inside both the source country and firm. Firms that establish affiliates abroad transfer knowledge outside the source country, but hold knowledge assets inside the source firm. Firms that license their knowledge assets to unaffiliated foreign firms transfer knowledge outside both the source country and firm.

Smith (2001) finds that strong IPRs have a larger effect on US knowledge transferred outside the country and firm, relative to knowledge located inside the country and internalised in the firm. In order words, strong IPRs give incentives to firms in developed countries to license their technologies to other firms in developing countries, since the former will be able to control better the knowledge transferred. Conversely, under weak IPRs, multinationals may be encouraged to transfer the knowledge only to their foreign affiliates in order to keep control of it.

These findings are corroborated further by subsequent empirical studies. Nicholson (2007) used a large cross-country, cross-sector panel dataset for 1995 using counts of the number of US firms engaging in FDI or licensing.[8] Nicholson found that firms in industries with high capital costs are more likely to maintain control over production knowledge in countries with less intellectual property protection by engaging in FDI. Moreover, when IPRs are strong, firms in industries with high investment in R&D are more likely to enter a market by licensing to an unaffiliated host firm (Nicholson, 2007).

4.3.2 Evidence on domestic innovation

Although there are many empirical studies on the relationship between IPRs and domestic innovation (i.e. technology creation) in developed countries, the empirical literature on developing countries is much more limited.

Stronger intellectual property rights seem to encourage innovation in emerging industrialised economies

Using panel data for 64 developing countries over the period 1975–2000, Chen and Puttitanun (2005) showed the positive impact of IPRs on innovations in developing countries.

Dutta and Sharma (2008) examined whether IPRs in India have increased innovation by firms. Using panel data on Indian firms from 1989 to 2005, they found strong evidence

[8] The sample comprises a large set of developed and developing countries.

that Indian firms in more innovation-intensive industries increased their R&D expenditure after TRIPS. The estimated within-firm increase in annual R&D spending after TRIPS was on average 20 percentage points higher in an industry with a one standard-deviation higher value of innovation intensity.

Weak intellectual property rights seems nevertheless to favour economic development in other less developed countries

One should not conclude from the preceding results that strengthening IPRs in developing countries necessarily encourages domestic innovation. The empirical literature has revealed the existence of non-linear function (i.e. a U-shaped curve) between IPRs and economic development, which initially falls as income rises, then increases after that (Maskus, 2000; Primo Braga et al., 2000). Moreover, Lall (2003) stresses that that countries at different levels of industrial and technological development face very different economic costs and benefits from stronger IPRs.

Falvey et al. (2004) investigate the impact of IPRs on economic growth suing panel data for 80 countries. They show that while the impact of IPRs on growth depends upon the level of development, the former are positively and significantly related to growth for low- and high-income countries, but not for middle-income countries. This suggests that while IPRs encourage innovation in high-income countries and technology flows to low-income countries, middle-income countries may have offset losses from reduced scope for imitation.

Chen and Puttitanum's (2005) results also confirm the presence of a U-shaped relationship between IPRs and economic development.

4.4 Conclusions and future research directions

This chapter has examined the link between IPRs and innovation in developed countries and concludes the following.

- Some theoretical arguments suggest that stronger IPRs are needed in developing countries to encourage domestic innovation due to market failure and to facilitate international technology transfer from developed countries due to information asymmetries in contracting.
- However, there are theoretical arguments against strong IPRs. The latter are not the only means for firms to recoup the benefits of their investment in R&D. First-mover advantages, the complexity of the learning curve and establishment of effective production, sales and marketing functions can help firms to appropriate the benefits of their information. By increasing market power, strong IPRs can increase the costs of international technology transfer. Moreover, well-structured IPRs can encourage the dissemination of free technical information in the economy. Finally, weak IPRs can encourage international technology transfer through non-market channels, i.e. imitation and reverse engineering.

- The empirical evidence suggests that stronger IPRs in developing countries may foster international technology transfer, at least to countries with strong technological absorptive capabilities.
- The findings from the empirical literature show that stronger IPRs may hamper innovation through technology diffusion and absorption in developing countries.

The review of the empirical evidence on international technology transfer through licensing reveals some future specific research areas. Little is known about the effects of IPRs on international technology transfer through non-market channels, mainly reverse engineering and imitation. More precisely, it would be interesting to investigate to what extent the free technical information divulged in the exchange of patent rights is used as a source for new inventions in developing countries. Furthermore, little is known on the relationships between IPRs and economic development: is this U-shaped relationship the result of the international context, or can it be used as a normative model? Are stronger IPRs a condition or consequence of development?

CHAPTER 5 Intellectual property and public health

5.1 Introduction

Pharmaceuticals have brought immense health benefits to developing countries, but one-third of the world's population does not have access to existing essential drugs[9] (WHO, 2002b); this estimate has remained unchanged since the mid-1980s. The proportion reaches 50 per cent in the poorest parts of Africa and Asia (WHO, 2002b). Moreover, pharmaceutical R&D on health problems specific to poor countries is woefully inadequate. The Commission on Health Research for Development (1990) showed that less than 10 per cent of global health research is directed towards diseases that afflict 90 per cent of the world's population – the so called '10/90 gap'.

It is clear, then, that IPRs in pharmaceuticals have two principal areas of impact which affect public health. First, there is the issue of access, where discussion focuses on the links between IPRs, exclusion of competitors and the availability and pricing of new medicines. Second, there is the issue of incentivising innovation, where discussion focuses on the role of IPRs in motivating R&D and marketing of new drugs, and the effect of IPRs on R&D expenditure and its allocation across diseases, countries and organisations.

Policies are required to protect the incentives for R&D in addition to reducing gross inequities of access. However, reforming IP regimes to improve access or innovation in developing countries involves making difficult assumptions, which have generated sustained debates in the context of the TRIPS Agreement. First, weakening IPRs to allow competition (either domestic or international) in order to improve access through lower prices assumes that other (less crucial, but significant) barriers to healthcare access are being addressed. Second, strengthening IP with the aim to encourage pharmaceutical innovation assumes that there is a market over which a monopoly can be granted. For some diseases, almost all sufferers are too poor to make even a monopoly a sufficiently attractive incentive to invest in R&D. This chapter examines some empirical evidence behind these assumptions and examines how IPRs may improve access or innovation for developing countries,

[9] The concept of essential drugs, as unanimously endorsed by the World Health Assembly, consists of "those that satisfy the health care needs of the majority of the population and should therefore be available at all times in adequate amounts and in appropriate dosage forms".

5.2 The importance of patents for pharmaceutical innovation

For more than 50 years, large empirical studies have found consistently that patents are extremely important for the pharmaceutical sector (for example Scherer, 1959; Cohen et al., 2002). As noted in Chapter 3 of this report, the evidence shows the sector is unusual in valuing patents so highly (Schankerman, 1998). It estimated that pharmaceutical R&D outlays would be reduced by 64 per cent in the absence of patent protection; while for other industries, the corresponding reduction was only 8 per cent (Grabowski, 2002).

The reason why patents are so critical to pharmaceutical firms in appropriating the benefits from innovation lies principally in the characteristics of the pharmaceutical R&D process. New drugs cost in the region of US$1 billion to discover, develop and gain regulatory approval (DiMasi et al., 2003).

The reason why R&D is so costly in the pharmaceutical industry is that most drug candidates fail to reach the market.[10] Normally, less than 1 per cent of the compounds examined in pre-clinical stages are cleared for testing on humans. Only 22 per cent of the compounds entering clinical trials endure the development process and achieve US Food and Drug Administration (FDA) approval (DiMasi, 1995). Moreover, the complete R&D process from synthesis to FDA approval involves undertaking successive trials of increasing size and complexity. Generally, the pre-clinical and clinical testing phases take more than a decade to complete (Kaitin and DiMasi, 2000).

Furthermore, manufacturing plants are expensive, costing between US$50 million and US$200 million, and unique manufacturing requirements usually mean that they are suitable for only one product (Pisano, 1996; Douglas, 2004). Outlays for production plants need to be committed early on, four or five years before licensing, if there is to be no gap between product licensing and market launch. Choosing to commit such large funds represents an uncertain decision with large financial risk, which patents can mitigate.

These expensive R&D costs are compensated for by patent-protected profits: profitability in the pharmaceutical industry and investment in R&D was found to be strongly correlated (Scherer, 2001; Giaccotto et al., 2005; Vernon, 2005).[11]

Perhaps most significantly, in the absence of patent protection, imitators can free-ride on the innovator's regulatory approval and duplicate the compound for a small fraction of the originator's costs. Imitation costs in the pharmaceutical industry are exceptionally low, relative to the innovator's costs for discovering and developing a new product.[12] Generic compounds need only demonstrate that they are bio-equivalent to the pioneering brand in order to receive market registration. This process only takes a few years and costs US$1 million to US$2 million (Reiffen and Ward, 2005). Furthermore, the prospect of success is

[10] Failure can be due to the compound's toxicity or carcinogenicity, manufacturing difficulties, inadequate efficacy, inconvenient dosage characteristics, economic and competitive factors and various other problems.

[11] Frank (2001) adds a more dynamic dimension to Scherer's observation that R&D outlays are affected significantly by changes in profitability, by emphasising that the link is to do more specifically with R&D investment today and expected, but uncertain, future profits.

[12] While R&D may cost in the region of US$1 billion, imitation costs are around US$1million. There are few other comparable industries where there is such a large disparity between the costs of innovation and imitation.

very likely, as reflected by the fact that many generic firms typically receive FDA approval and enter the market within a short time of the patent expiration of the pioneer brand. The case of Praziquantel – which was discovered, developed and licensed by Bayer, then immediately copied, improved and sold at a lower price by a Korean pharmaceutical company – is illustrative of this (Reich and Govindaraj, 1998).

5.3 Intellectual property rights and access to innovations

5.3.1 Patents are taken out only in selected countries

In most developing countries, patent protection for pharmaceuticals is available but not used. Nevertheless, those countries remain affected, because they tend to rely on exports from countries where there is more patent protection.

Firms may adopt the view that it is not worth the expense of obtaining and maintaining protection in countries that express small market demand and pose a limited threat of imitation. In a study of 53 African countries and 15 antiretroviral drugs, patenting prevalence was found to be only 21.6 per cent of the possible total (Attaran and Gillespie-White, 2001). On their own, such findings may suggest that patenting does not constrain access.

However, the picture changes when one considers that these countries import from others that may have significant market demand of their own, and do have the technological capability to imitate. Patenting in those countries is much more prevalent, such that 13 out of the 15 antiretroviral drugs are patent-protected in South Africa (WHO, 2002a). The ability of countries such as South Africa to imitate and export to countries that cannot do so for themselves will be curtailed if strong patent rights are tightly enforced there.

Thus, even if TRIPS is enforced selectively in only a few key countries, such as South Africa and other imitation (generic) exporters, the immediate outlook is bleak for countries that appear to rely on importing generic drugs as their principal means for addressing public health challenges. They will be forced to seek other channels (discussed below) to reduce the price of accessing medicines.

5.3.2 Accessing healthcare innovations by lowering prices

Patents increase price, generics reduce price

The price of antiretrovirals across 34 countries was found to be higher where there were product patents (Borrell, 2007). Introducing generic manufacturers to the market is one way to reduce the cost of accessing medicines. It follows that creating IP conditions that are favourable for generic competition will reduce price, and the empirical evidence seems to support this.

In the USA, where generic competition is strong and there is little price regulation, studies have found a sharp price decrease and a rapid loss of market share following patent expiry on a drug (Griliches and Cockburn, 1995; Reiffen and Ward, 2005). However, it should be noted that the USA has some features of its regulatory and competitive environment that are specific. For example, the Hatch-Waxman Act of 1984 allows the tail-end of patent terms to be infringed for the purposes of testing and regulatory clearance, allowing

generic products to mount the market as soon as patents expire (Grabowski and Vernon, 1992, 1996). In other countries with different specificities, where the market size may be smaller or governments exercise greater purchasing power, the generic entry effects are less pronounced (Pammolli et al., 2002).

Compulsory licensing reduces price to varying extents

Another source for lowering prices is to use compulsory licensing provisions in TRIPS: this authorises a third party to make, use or sell a patented invention without the patent owner's consent.[13] Governments have used this mechanism, or simply the threat of using it, to try and lower prices. While a reduction is likely, the extent of reduction is difficult to gauge. Price declines can be as steep as 90 per cent in a compulsory licensing regime, but if the issuance of compulsory licences does not result in generic competition, then the price decrease is not as substantial (Watal, 2000).

Scherer and Watal argue that "the compulsory licensing opportunities opened up by TRIPS should be seized selectively and imaginatively" (2002: 939). However, pursuing this option aggressively is subject to significant power relations. For example, the US Section 301 Watch List in the Trade Act of 1974 allows it to employ measures against any country that it considers to be denying US companies or persons adequate and effective protection of their IP rights (Parliamentary Office of Science and Technology, 2001). Abbott's (2005) legal analysis of the WTO trade rules finds that global institutions need to undertake regular checks and balances to the TRIPS framework, while ensuring that the USA does not exert its power to alter WTO rules in bilateral arrangements (i.e. TRIPS-plus). It is feasible that the conditions for engaging in compulsory licensing may be made more difficult for developing countries, for example, by tightening definitions of what constitutes a national emergency (Correa, 2006).

However, when compulsory licensing is engaged, royalties to pharmaceutical companies tend to be too low to recoup R&D investments. Theoretical and empirical analyses show that the 'adequate remuneration' that is supposed to be afforded to the patentee under TRIPS has been much lower than would be established under the 'foregone profits' standard of US patent law (Scherer and Watal, 2002). To avoid total free-riding on the R&D efforts of pharmaceutical companies, Scherer and Watal (2002) conclude that differential pricing strategies should be pursued aggressively, in order to ensure access for those who cannot afford to pay adequate remuneration.

Differential pricing is limited and depends on parallel imports and political support

Some authors (Scherer and Watal, 2002; Danzon and Towse, 2003; Danzon, 2007) find that the global pricing strategy that best combines equity with coverage of R&D costs is one where prices are much lower in nations with a low ability to pay, than in wealthy countries. However, such differential pricing faces two challenges.

[13] For example, local pharmaceutical companies may obtain compulsory licenses to produce generic versions of patented medicines, or to import generic versions of medicines from foreign manufacturers.

The first issue is in parallel importing,[14] where differential pricing is thought to be undermined by low-priced drugs and devices being exported to countries where they are higher priced. Although arbitrage between differentiated markets is overstated (Outterson, 2005), there is some evidence on the effects of arbitrage. Arbitrage lowers prices, but it does not drive down prices to levels of the lowest priced market. This is principally because intermediaries and arbitrageurs are the major beneficiaries, rather than the final importing country (Ganslandt and Maskus, 2004; Kyle, 2007).

The second, perhaps more intractable, issue is one of political resistance by populations in wealthy countries who may make the observation that the same product is available for substantially lower prices in other countries. The inhibition of parallel trade may turn on the nature of media coverage and the efficacy of various advocacy and non-governmental organisations. Scherer and Watal (2002) suggest that it may be more expedient politically to adjust tax law in way that makes more extreme differentiation in prices, or maybe even outright drug donation by pharmaceutical companies. Their quantitative analysis shows that when the marginal cost of production is low, donations actually can increase post-tax profits under US tax laws.

Even if these challenges could be overcome, would companies differentiate prices enough to make medicines accessible to poor people? The empirical evidence suggests not – or at the very least, that other considerations have a significant and possibly overriding effect on differential pricing (Scherer and Watal, 2002). Wong (2002) found that prices are not affected by countries' per capita income, but rather by their income inequality, suggesting that companies are targeting well-off sub-populations in developing countries.

So, price discounting occurs for public markets, but not for private markets. To the extent that public provision of healthcare meets poor people's needs, this outcome is consistent with notions of equitable access. However, poor people often are forced to purchase their medicines in private markets. In short, relying on unregulated markets to provide differentiated prices will not be sufficient for poor people, who need prices that are lower even than marginal production costs.

Access is not determined by price alone

Price – specifically the impact that IPRs have on it – is one factor among several that affect poor people's access to healthcare. Weaknesses in country-level physical, medical, financial and political infrastructures mean that many existing products needed by people in developing countries are not being purchased by patients, healthcare facilities, governments or non-governmental organisations.

Thus, for example, there is the prospect that many patients with AIDS in Africa would not benefit automatically from antiretrovirals, even at dramatically lower, affordable prices. Antiretrovirals require diagnosis, monitoring and long-term maintenance of demanding treatment regimens (so as to minimise drug resistance) that are difficult to sustain without

[14] Parallel import is the import and resale of a patented product which has been put legitimately on the market of the exporting country in another country without the consent of the patent holder. This means that drugs sold at a lower price in one country can be imported into another country where same drug is sold at a higher price.

adequate infrastructure and support. In many developing countries, access is a particularly complex problem, requiring political will and commitment of new resources.

5.4 Intellectual property rights and innovation for health

5.4.1 Limits in using intellectual property rights to address developing country problems

Some infectious disease create markets in developing countries that are not commercially viable at present[15]

While developing countries benefit from products based on other countries' R&D efforts, few products are tailored to the specific needs of the developing world. Indeed, very few products are now developed for diseases that primarily affect poor countries, so-called tropical or 'neglected' diseases.

Most of the current treatments and drugs for these diseases emerged from colonial requirements (Janssens et al., 1992). As western interests drifted away from these regions, tropical diseases have become increasingly neglected. Between 1972 and 1997, 1,450 drugs were licensed worldwide. Only 13 (fewer than 1 per cent) of those were developed specifically for tropical diseases: five of which were designed for veterinary purposes, two were designed for the US military, two were simply modifications of existing drugs (same active ingredient but new formulation and/or novel use), and one was derived from Chinese medicine (Trouiller et al., 2002).

For some diseases, at least 99 per cent of cases are located in low and middle-income countries (Lanjouw and Cockburn, 2001). In 1998 alone, these diseases were estimated to have caused the loss of almost 200 million Disability Adjusted Life Years (DALYs) and more than 5 million lives, a large share of them children (Lanjouw and Cockburn, 2001). The A-strain of the HIV virus is particularly widespread in poor countries but not in the developed world. Infectious and parasitic diseases account for one-third of the disease burden in low-income countries – nearly one-half in Africa – but only 3 per cent in high-income countries (WHO, 2002a). For these diseases, there is simply no free ride.

Even for diseases that affect developed countries as well as developing countries (such as cancer), the characteristics of poor countries make the products designed for developed markets unsuitable. For example, developing countries have weak infrastructure and need vaccines that can withstand breaks in refrigerated distribution chains and survive a long shelf-life. They also need products that do not require intense supervision by medical personnel. While Europe has 39 trained physicians per 10,000 people and the USA has 27, sub-Saharan Africa has only one (World Bank, 2008). The choice between vaccines and drug therapies is such an example. An HIV/AIDS vaccine would be far easier to deliver in a poor country than a combination of drug therapy cocktails, but efforts to develop a vaccine have been minimal in comparison to investment in treatment (Yaqub, 2009b).

[15] This section concentrates mainly on infectious disease-related public health issues.

For the pharmaceutical manufacturer, the key implication of these differences between developed and developing country disease environments is a reduction in available market size. This is important because, as Acemoglu and Linn (2006) find, market size can be directly related to innovation: "a 1 per cent increase in the potential market size for a drug category leads to approximately a 4 per cent growth in the entry of new non-generic drugs and new molecular entities" (2006: 1084).

The Europeans, Japanese and North Americans spend more than US$317 billion a year on prescription medicines for everything from high blood pressure to a dull mood – a powerful incentive for pharmaceutical companies to keep them supplied with current remedies and concoct new ones (Moynihan, 2004). In contrast, the market for pharmaceuticals in the poorest countries is tiny. The state of Connecticut in the USA spends more on health than the 38 low-income countries of sub-Saharan Africa combined (World Bank, 2008). In 1998, US health spending constituted US$4,000 per person, whereas sub-Saharan African nations' spending constituted only US$8 per person, with some countries reaching as little as US$2 per person (World Bank, 2008).

Accumulated technical knowledge is weak

The lack of understanding of some diseases, coupled with the complexity of the science and technology involved, makes the prospect of finding new medicines uncertain and risky. This lack of basic understanding limits the investment that it is prudent for industry to make. As noted forcefully below by Rosenberg (1974), approaches that seek to procure innovations by adjusting market incentives, such as awarding IPRs, must be implemented with an awareness of the state of accumulated scientific and technical knowledge (Yaqub, 2009a). As Rosenberg states:

> The demand for higher levels of food consumption, greater life expectancy, the elimination of infectious disease and the reduction of pain and discomfort, have presumably existed indefinitely in the past, but they have been abundantly satisfied only in comparatively recent times. It seems reasonable to suppose that the explanation is to be found in terms of supply side considerations. It is unlikely that any amount of money devoted to inventive activity in 1800 could have produced modern, wide-spectrum antibiotics, any more than vast sums of money at that time could have produced a satellite capable of orbiting the moon. The supply of certain classes of inventions is, at some times, completely inelastic – zero output at all levels of prices … On the other hand, the purely demand-oriented approach virtually assumes the problem away. The interesting economic situations surely lie in that vast intermediate region of possibilities where supply elasticities are greater than zero but less than infinity! (1974: 106)

To explain investment decisions, one needs to examine the technical problems faced by companies. If these problems are perceived by the companies, whether correctly or incorrectly, to be intractable, the size of the reward becomes irrelevant. Similarly, if the perceived time to commercial revenue is far away, any rewards that may accrue are discounted substantially, thus relegating market characteristics and policies when considering investment.

For the health problems facing developing countries, a chronic lack of scientific and technical understanding suggests a severe state of under-investment in R&D that is only just beginning to be addressed. For example, only 1 per cent of biomedical research papers make reference to tropical diseases (Lanjouw and Cockburn, 2001).

Empirical impact of intellectual property rights on shifting R&D priorities

In the face of such persuasive theoretical arguments, where market demand is small and accumulated knowledge is weak, evidence on the ability of IP measures to alter the direction of innovation is difficult to find.

One major study finds that the effectiveness of IPRs in shifting R&D priorities has been limited. Lanjouw and Cockburn (2001) have looked at patent data, bibliometric data and data from National Institutes of Health grants for empirical evidence regarding whether TRIPS has increased R&D for tropical diseases. Their research showed that there was no evidence for an effect, except perhaps a moderate improvement in the case of malaria. Even this particular effect is confounded by other factors such as increased public concern and media exposure, and technical developments which have allowed scientists to be able to grow the malaria parasite *in vitro*. A follow-up study conducted a decade after TRIPS confirmed that IP remains a relatively muted policy tool, showing that in 2003, R&D priorities had not changed much from 1998 baseline levels (Lanjouw and MacLeod, 2005).

5.4.2 Creating conditions for more effective intellectual property policy

Funding for R&D into neglected diseases

Funding for neglected diseases has increased in recent years, from US$2 billion in 2004 (Morel et al., 2005) to US$2.5 billion in 2007 (Moran et al., 2009). Attributing this increase solely to stronger IP protection is difficult, because other (possibly more significant) factors are likely to have played a role. If IP had been a leading driver, one might expect funding to have increased at both the research and product development levels. However, this is not the case – most neglected disease R&D activity has been focused on early-stage research problems (Kyle and McGahan, 2008). Accordingly, one study found a strong increase in citations to publications on neglected diseases alongside a small increase in patenting (Morel et al., 2005).

Other factors have played a role in redressing the neglect in funding. The 10/90 gap identified in 1990 led to considerable media exposure and political momentum, particularly regarding a few high-profile diseases. This instigated renewed activity, but this was highly concentrated on research for a few diseases.[16] By 2004, there were 63 neglected disease projects and, while IP protection may have improved, it was thought that this rise was due primarily to increased research funding by the philanthropic sector (Moran, 2005). In 2007, only 9 per cent of neglected disease R&D funding was provided by the private sector.

Neglected disease funding has increased, but these numbers suggest that these increases have been driven primarily by public and philanthropic efforts focused on a few diseases,

[16] In 2007, just over US$2.5 billion was invested in neglected disease R&D (Moran et al. 2009). The 'Big Three' (HIV/AIDS, tuberculosis and malaria) commanded 80 per cent of the funding, leaving many other important conditions such as pneumonia and diarrhoea still neglected (Yamey, 2002b; Molyneux et al. 2005). Moreover, 99.6 per cent of the funding was concentrated on product R&D, leaving diagnostics and delivery technologies severely neglected.

rather than by a strengthened IP environment which has increased funding for diseases evenly across various disease burdens.

Private sectors in developing countries are not responding to domestic markets

However, it would be wrong to conclude that strengthening IP protection does not have an effect on pharmaceutical industries in developing countries. For example, the Indian pharmaceutical industry has been the focus of considerable renewed discussion since India has strengthened IP protection (Chataway et al., 2007b). The problem is that the effect of stronger IP has not necessarily benefited poor people.

One might expect scientists working in India to have a comparative advantage in developing drugs targeting developing country markets, and thus, that new R&D activity would be most apparent there. However, the statistical survey results show a decline in R&D expenditure directed towards products suited specifically to developing country markets, from 16 per cent in 1998 to 10 per cent in 2003 (Lanjouw and MacLeod, 2005). This is despite a surge in total R&D expenditure and stock market value (Lanjouw and MacLeod, 2005; Arora et al., 2008). A better indication of the sector's intentions can be found in its patenting behaviour. Pharmaceutical patenting by India-based inventors has grown rapidly as a share of all patenting in the USA – to more than 2 per cent – with a similar trend in Europe (Lanjouw and MacLeod, 2005). Their principal market interests lie in developed countries.

The notion that nascent pharmaceutical industries respond no differently to changes in IP protection than established pharmaceutical industries is supported by case study evidence. TRIPS is not detrimental if seen from the perspective of a growing Indian pharmaceutical industry, but it does seem to be detrimental to consumer welfare in terms of availability and access (Chaudhuri et al., 2006).

The Indian pharmaceutical industry provides us with the message that strengthening IP protection increases domestic R&D expenditure significantly and patenting in developed economies (Dutta and Sharma, 2008; Liu and LaCroix, 2008). However, this finding needs to be qualified. It is likely that educational and broader economic development have played an important part. When these factors are controlled for, in a study across 26 countries over two decades, strengthening IP protection in the pharmaceutical sector does not seem to increase significantly domestic R&D expenditure, patenting and innovation (Qian, 2007). Indeed, there is a point in development at which IP regulation actually reduces innovative activities and simply serves to increase rents to established companies (Qiu and Yu, 2007). These results raise the prospect that low and middle-income countries have gained little in terms of domestic innovation, which could offset the new and higher flows of royalty payments to foreign firms.

One alternative to this scenario is to strengthen public sector capacities (Yamey, 2002a; Blume, 2005; Blume and Zanders, 2006). However, capacity building in the public sector is unlikely to develop the full range of competences needed to develop drugs persistently across a range of health needs. So, private sector engagement must be retained alongside these capacity-building efforts. Moreover, these efforts have been most effective when they are collaborative across developed and developing countries, or private and public sectors (Velho, 2004).

Intellectual property rights facilitate increased trade in knowledge, but may stifle innovation

IPRs play an important role in facilitating transactions in a market for knowledge which has come to play a much-discussed role in pharmaceutical innovation. While this sector continues to be dominated by large integrated firms that conduct much of their innovative activity in-house, recent decades have seen significant vertical restructuring of the industry, and these firms increasingly rely on externally sourced R&D (Roijakkers and Hagedoorn, 2006). Much of this industrial reorganisation has been due to underlying technological discontinuities (Orsenigo et al., 2001), but a significant factor has been the role of small firms which have been able to trade patented knowledge. In addition, other factors have included the ease with which small firms have been able to gather start-up capital and acquire ideas from universities which themselves are patented.

This is particularly important for developing countries, because small firms may be more open to risk-taking, less prone to organisational inertia, and better able to address neglected disease research problems, as evidenced by responses to the US Orphan Drug Act of 1983 (Kettler, 2000; Kettler and Marjanovic, 2004). The ability to patent their ideas provides a tangible point of attention which can be advertised, and perhaps traded.

In drug discovery, this active entrepreneurial sector, that bridges universities and large firms, has become a very important supplier of drug candidates and tools for performing R&D (Powell et al., 1996; Owen-Smith and Powell, 2004). One consequence of these changes is that pharmaceutical innovation now relies heavily on a complex network of contractual agreements linking a variety of actors at various stages of the drug development process. Between 1963 and 1999, more than one-third of new drugs approved originated in industrial alliances (Danzon et al., 2005). Empirical evidence on strategic technology alliances also shows an explosion of collaborative activity in the biomedical sector since the early 1990s, with many of these alliances spanning national boundaries.

While IPRs may support markets for knowledge, often a counter-argument is made that proliferation of patents may stifle biomedical innovation by raising transaction costs (Heller and Eisenberg, 1998). Some studies have shown patents to affect negatively researchers' access to knowledge, as measured by citations (Murray and Stern, 2007). In another counter-argument, some scholars have noted that historically, R&D departments have remained close to production and marketing departments, and that this is fundamental reflection of innovation process (Pavitt, 1999; Nelson, 2005). Separating these functions across the markets is likely to have contributed to the downturn in pharmaceutical innovation and exacerbated the myth of the biotechnology revolution (Hopkins et al., 2007).

So, IPRs facilitate and govern transactions in the market for technology (Arora et al., 2001). Technology licensing, collaborative R&D and contract research are very difficult to sustain on a commercial basis without well-defined and enforceable rights over research results. Therefore, it is widely believed that strengthening IPRs will not only promote domestic R&D activity, but also stimulate trade in technology. However, introducing markets between research and production is unprecedented and may harm innovation, and issuing patents of excessive scope may be choking innovation by raising transaction costs.

New institutional arrangements have emerged; the role of intellectual property rights is unknown

In an increasingly disaggregated and dispersed pharmaceutical industry structure, public–private partnerships have become prevalent, particularly for the research problems affecting developing countries. As noted in the previous sections, this partly reconciles market failure by addressing neglected diseases, with the reality that many R&D competences reside in the private sector. However, the role that IPRs may have played in their emergence is unclear.

Public–private partnerships may not be effective because they suffer bad management, political in-fighting and turf wars, as evidenced by the Children's Vaccine Initiative (Muraskin, 1998). However, recent detailed analyses that go beyond anecdotal cases find no evidence that they manage their portfolios less efficiently than commercial firms (Moran, 2005; Yaqub, 2009a). Indeed, they are likely to be more effective (Velho, 2004).

There are a variety of reasons for the success of public–private partnerships. For example, they are being created where public institutions drive research and the private sector assumes responsibility for production and delivery. Alternatively, private sector companies may undertake research funded by the public sector or charitable donors. In another rationale, partnerships between research institutions in the north and south are attempting to draw together innovative science with local experience of how that science can be best applied. All of these arrangements are constructed in some way on the basis that the public and private sectors are unable on their own to resolve the deep-rooted and tragic inequalities of innovation discussed in this section (Buse and Waxman, 2001; Towse and Kettler, 2002; Widdus, 2003).

Some recent studies have focused on the emergence of one specific public–private partnership: the International AIDS Vaccine Initiative (IAVI). These studies found that IAVI may not have developed a vaccine yet, but it has boosted developing country science and technology capacity significantly (Chataway and Smith, 2006). Moreover, IAVI may be acting as an important systems integrator or knowledge broker that draws together diffuse and dispersed knowledge, to create a R&D network that it coordinates centrally (Chataway et al., 2007a). Within these two important functions that IAVI serves, IPRs may be playing a crucial underlying role in providing a tangible focus for trade and a significant advertising role.

It seems that the emergence of public–private partnerships could represent a new paradigm for addressing innovation needs for public health in developing countries, at least as they relate to infectious, neglected diseases. However, in this discussion, the role of IPRs is a substantial gap in the literature. Public–private partnerships could be a way for private sectors to access public and philanthropic funding, or they could be a way of reconnecting and reorienting supply and demand. IPRs could be a contractual nexus for either of these possibilities.

5.5 Conclusions and further research directions

This chapter has examined the effects of IPRs on public health from two perspectives: the role of IPRs in access and their role in innovation.

Five main conclusions can be drawn on the role of IPRs in access.

- Patents are taken out only in selected countries where there is threat of imitation or large market. However, countries where patents are not taken out remain affected because they rely on exports from countries where there is stronger IP protection.
- Generic competition tends to reduce price dramatically. This implies that strengthening IP protection in developing countries will reduce accessibility by harming generic competition, without necessarily improving incentives for innovation on developing country problems.
- Compulsory licensing reduces price dramatically, but only if generic competition is introduced. The issuance of a compulsory licence by a government does not necessarily result in immediate supply by a third-party company. The looming threat that a third party may begin to supply soon can reduce price, but the price reduction is not as steep if generic competition is introduced to the market immediately after the licence is issued.
- Differential pricing depends on constraining parallel imports and gathering political support, but even with these measures, differential pricing is limited.
- Access is not determined by price alone: broader infrastructure weaknesses can play a role. While it remains difficult to establish the relative importance of the two concerns, it is worth noting that often, people in developing countries are more exposed to the market when seeking healthcare (which makes price more important) than people in developed countries who are insulated by extensive insurance and public health institutions.

Five main conclusions can be drawn on the role of IPRs in innovation.

- IP for innovations targeted at health issues of particular relevance to developing countries is of value to commercial product and technology developers only if a viable market can be created. The degree of need (and market size) is high, but creating viable markets entails a concerted international effort, such as the one displayed in setting up an advanced purchase commitment[17] for pneumococcal vaccines.
- Funding has improved, IP has been strengthened and the neglected disease landscape has changed considerably since 1990 in an effort to engage the pharmaceutical industry.
- However, pharmaceutical industries, including those in countries such as India, are responding imperfectly to developing country needs. Instead, they often focus on developed country markets.
- IPRs facilitate trade in knowledge but may stifle innovation by reducing researchers' access to knowledge and increasing the costs of collaboration.

[17] For more on advanced market commitments, see Kremer and Glennerster (2004).

- Public–private partnerships have emerged as a prevalent new institutional arrangement for addressing neglected diseases, but it is not clear what significant roles, if any, IPRs have in their formation.

In future, IP may have a bigger role to play in dealing with the health problems common to both developed and developing countries. There is evidence that many of their problems are converging.[18] The causes of this convergence remain unclear, but there are likely to be important implications for IP systems in both developed and developing countries.

This chapter also noted a significant lack of understanding in the role of IP in public–private partnerships. Since these types of arrangements have emerged as the dominant paradigm for addressing neglected diseases, further research on this issue is needed urgently.

A number of IP-related policy measures (such as government patent buy-outs, bifurcated patent systems, orphan drug legislature that extends patents and transferable IPRs) have been suggested either on entirely theoretical grounds or indirect empirical evidence. These require careful policy analysis in order to gauge their feasibility and implications with more confidence.

[18] Of the disease burden in high-income countries, 83 per cent is made up of non-communicable conditions such as cancer and cardiovascular disease (WHO, 2006). However, these diseases affect low and middle-income countries too, where cancer and cardiovascular disease are the second and third largest causes of death. In fact, nearly 50 per cent of deaths worldwide were due to cancer, cardiovascular disease, diabetes and chronic lung disease (Outterson, 2005).

CHAPTER 6 Intellectual property, genetic resources and traditional knowledge

6.1 Introduction

Genetic resources from plants, animals and micro-organisms are widespread in developing countries, amounting to 90 per cent of the world's genetic resources (Desai, 2007). These genetic resources have been utilised by communities and individuals in developing countries through generations and as such their use is embodied in what is referred to often as traditional knowledge. However, the use of such knowledge and resources is not limited to local contexts and many innovations relate to and draw on them (WIPO, 2009). For example, 45 per cent of all herbal-based patents were hosted in China alone in 1996 (Gupta, 1997), and 80 per cent of modern plant-based medicines have the same function as their original use by Aboriginal peoples (Farnsworth and Kaas, 1981).

The use of traditional knowledge and genetic resources, both inside and outside of their local context, raises the prospect that they may play an important role in driving development. The issue for policymakers is how this prospect might be realised best, particularly when the use of traditional knowledge and genetic resources is becoming increasingly subject to governance by various, and sometimes contradictory, IP systems (Lakshmanan, 2008).

TRIPS recognises the issue by allowing for *sui generis* protection of genetic resources, specifically plants, animals and biological processes (Commission on Intellectual Property Rights, 2002). *Sui generis* protection is a system of protection tailored to accommodate the special characteristics of traditional knowledge (Commission on Intellectual Property Rights, 2002). Since TRIPS, there has been pressure for increased protection of knowledge linked to genetic resources from plants, animals and micro-organisms. Bilateral agreements encourage countries to join the International Union for the Protection of New Varieties (UPOV) Convention. The UPOV Convention, formed in 1961, acknowledges breeders of new plant varieties through uniform and clearly defined principles for exclusive property rights, based on criteria that the variety is distinctive, uniform, stable and novel (Commission on Intellectual Property Rights, 2002).

Separate from TRIPS and the UPOV Convention, two international legal agreements have been formed that emphasise the knowledge and genetic resource rights of more marginalised stakeholders. In 1992, the Convention on Biological Diversity was created as

a legally binding convention that explicitly outlined principles of equitable access and benefit-sharing to govern the use and preservation of traditional knowledge. Similarly, the UN Food and Agriculture Organization (FAO) introduced farmers' rights in 1989 to ensure equality between farmers and plant breeders.[19]

By reviewing the existing literature, this chapter show that access and benefit-sharing are major themes beginning to emerge in the assorted mixture of empirical evidence, as well as in the disjointed theoretical debates regarding IP, traditional knowledge and genetic resources. These two themes, concerned with protecting the existing diversity of genetic resources and ensuring that a broad range of stakeholders access and benefit from traditional knowledge, can be distilled into a narrative about diversity. This overarching concern with the diversity of people accessing and benefiting from traditional knowledge helps to clarify issues in the literature for policymakers who have to make choices.

Modifying the IP arrangements, as discussed in this chapter, can be an opportunity for greater democratic agency and social equity in conjunction with traditional knowledge and genetic resources. Adapting IP arrangements so as to promote diversity of engagement in knowledge preservation and innovation can promote alternative pathways to development, building upon local contexts. In this sense, protecting traditional knowledge and genetic resources may empower marginalised stakeholders to drive development from the bottom-up, along multiple pathways.

6.2 Intellectual property, traditional knowledge and genetic resources: the theory

6.2.1 An emerging field of research

Unlike discussions about trade, FDI, innovation and public health, academic debate about the relationship between traditional knowledge, genetic resources and IP law begins by questioning the very relevance and appropriateness of IPRs rather than investigating the effects of such legislation. Discussions about the role of IPRs in traditional knowledge and genetic resources are relatively recent, emerging in the context of newly-formed legal agreements about traditional knowledge and genetic resources. There appears to be contested efforts to set the parameters and terms of debate in a largely emerging field. As such, for IP at least, there is a level of uncertainty in the theories about traditional knowledge and genetic resources that sets it apart from those about FDI, trade, innovation and public health.

A key difficulty begins with a lack of common understanding about what is meant by traditional knowledge. Traditional knowledge can serve different functions, ranging from communication, utilitarian needs, sanctions and codes of conduct to rites of passage, religious and spiritual practices. Often, traditional knowledge takes the form of literary, artistic or scientific works, dance, medical treatments, or agricultural technologies and

[19] Farmers' rights have been integrated into various countries' regulatory frameworks, ranging from India's national legislation to being included in the African Union's African Model Law for the Protection of the Rights of Local Communities, Farmers and Breeders and for the Regulation of Access to Biological Resources.

techniques, and can be held by communities or individuals (Gupta, 2004). Although the functions and forms of traditional knowledge may be diverse, there is a consistent notion that its nature can be explored by focusing on its transmission and any tangible trails that this may leave. Regardless of its function or form, traditional knowledge is discussed as a knowledge that develops overtime, cumulatively through generations, and is tied to established lifestyles, often occurring through customary everyday practices (Berlin, 1992; Brush, 1992; Berlin and Berlin, 1996; Ellen et al., 2000; Commission on Intellectual Property Rights, 2002).

6.2.2 Assumptions about the nature of traditional knowledge

Assumptions in the IP system and about the nature of traditional knowledge may not be congruent. The extremely incremental and often preserved nature of traditional knowledge contrasts with models of persistent knowledge accumulation in innovation theory that are assumed in current IP protection regimes (Nelson, 2005; Yaqub, 2009a). The protection offered through IP law is directed at individual entities (Simon, 2005), for discrete advances in knowledge and typically prominent inventions with clearly-defined inventors and owners of knowledge (Schüklenk and Kleinsmidt, 2006). A well-known justification for awarding patents is to motivate the allocation of (often vast) resources necessary for inventive activity (Mazzoleni and Nelson, 1998).

In contrast, traditional knowledge is either preserved or developed incrementally over long timeframes without the need for such motivations. Moreover, its dynamics are much more communal, which results in it being embodied across communities rather than within individual entities. So, while the evolution of traditional knowledge may be different from knowledge inputs for innovation processes, both are governed by an IP system that essentially is built around one set of assumptions about knowledge growth and attribution to individual entities.

In addition to conceptual difficulties regarding the growth of knowledge, there are legal and human rights issues that affect traditional knowledge and IPRs. IP protection can be a means to protect the holders of traditional knowledge, ensuring that those responsible for its inception and development maintain ownership and rights over that knowledge (Dutfield, 2001). However, many legal debates preclude discussion of the benefits of IP protection in the area of traditional knowledge, as they concern the fundamental legality of protection and the very right to ownership of knowledge, regardless of whether they benefit or not. Instead of discussing comparative benefits, debates surround the legality of ownership of traditional knowledge and genetic resources, and the right of prior informed consent before providing IPRs to a creative entity (Gupta, 1997; Coombe, 2003).

6.2.3 Human rights discourse

Human rights discourse is distinct from legal arguments in that it tends to seek possibilities for access and benefits to be facilitated through IP law in the area of traditional knowledge and genetic resources. For example, accessibility is emphasised by arguing that genetic resources and plant materials have an important public rights nature, where the universal right to access technologies for producing innovative goods as well as the innovative goods themselves must be maintained (Trommetter, 2005) This perception continues to inform the International Treaty on Plant Genetic Resources for Food and Agriculture.

Increasingly with IP law, particularly that in plant variety protection (PVP), genetic resources are considered often as private goods to be owned by and protected for individual entities.[20] As this shift towards privatising upstream elements in the innovation process occurs, questions arise about the ability to access to techniques and genetic resources which have been used over generations through traditional knowledge for subsistence in food and agriculture. By privatising the ownership of genetic resources, the practices and technologies that are fundamental to well-being and basic livelihood could become inaccessible to poor communities, particularly those in developing countries.

On benefit-sharing, some suggest that IPRs can be a means to facilitate benefit-sharing by recognising those who have contributed to innovation. However, similar to legal critics, many argue that IP protection is by its nature insufficient and inappropriate for protecting traditional knowledge and ensuring the realisation of benefits, because traditional knowledge can be conceived to have values that are beyond economic and profitability values (Posey and Dutfield, 1996). Traditional knowledge can be seen as inherently valuable because of its place in local communities' lifestyles, while IP can be seen as a mechanism that operates exclusively through the market where economic and profitability value is assumed (Commission on Intellectual Property Rights, 2002). As international law is fragmented into different areas, it cannot accommodate for the various cultural, social, economic and human rights aspects of traditional knowledge in communities in developing countries (Graber and Burri-Nenova, 2008).

The varied assumptions and positions about traditional knowledge and genetic resources make it difficult to find a unitary starting point for empirical evidence on traditional knowledge and IPRs. The lack of theoretical guidance precludes any kind of systematic review or meta-analysis.

6.3 Intellectual property, genetic resources and traditional knowledge: the empirical evidence

The empirical literature has not attempted to undertake any formal testing of hypotheses drawn from the theoretical literature. Instead, much of it has been influenced, perhaps instigated, by public allegations of misappropriation of traditional knowledge and genetic resources by firms and individuals in developed countries using the current IPR framework. Conspicuous events involving IP law and traditional knowledge, as well as theoretical debates, have informed the questions asked in empirical studies (Oguamanam, 2008).

Empirical evidence has tended to take the form of case studies that emphasise contextual factors and caution against broad generalisations of findings. However, we find an unexpected bounty of empirical case studies that are based directly on developing country contexts, and that the evidence routinely addresses the question of diversity or uniformity in development.

[20] There are exceptions to this trend. For example, see the UK Biobank, an archive facility for high-tech blood and urine stores that brings together specialist knowledge and systems: http://www.ukbiobank.ac.uk/.

Clearly, the theoretical literature on traditional knowledge, genetic resources and IP law is ambiguous and emergent, and the parameters of debate continue to be in their formative stages. Correspondingly, there is a similar level of uncertainty and lack of clarity in empirical studies. Empirical studies seek to test the validity of theoretical hypotheses. As such, in the empirical work on traditional knowledge and genetic resources, it is possible to see the lines of empirical questioning following legal and rights-based discourses about access, benefit-sharing and relevance of IP law to traditional knowledge and genetic resources. As will be deconstructed in this section, the empirical literature can be seen to follow issues of access, benefit-sharing and alternative, appropriate means for protecting traditional knowledge and genetic resources. However, this review will emphasise also the emergent and introductory nature of this body of empirical work, in which the streams of analysis continues to be weakly formed, at times overlapping and divergent.

6.3.1 Evidence from the perspective of developed countries

In developed countries, empirical studies show that profits and market power are concentrating among a few industries and firms. Wright and Pardey (2006) found that soybeans, cotton, maize and canola in developed countries are the main crops to benefit from IP protected innovations in genetic modification, generated mainly in North America.

Much of the literature from developed countries concerns the use of geographical indications (GIs). Already included in TRIPS, GIs protect products specific to a geographical area. There are three levels of protection for GIs in TRIPS: one for wines only, one for wine and spirits, and one for all products (O'Connor, 2004).[21] As defined in Article 22.1 of TRIPS, GIs identify goods

> "originating in the territory of a Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin" (Broude, 2005).

GIs facilitate the use of reputation in overcoming information asymmetries in markets. Unlike IPRs, GIs do not protect the knowledge embodied in products (Dutfield, 2000; Rangnekar, 2004); instead, protection is offered for the association of a given quality with a geographical location.

As outlined by Pacciani et al. (2001), GIs can provide space for niche markets, creating collective monopolies and facilitating market access. Through this space for market access, GIs can enable communities or individuals to capture a market premium for a product (Thiedig and Sylvander, 2000). In turn, the size of this premium is dependent on market size, competition, consumer perceptions and elasticity of demand (Correa, 2002). This premium is not necessarily assured for developing countries enforcing GIs. Rather, less well-known products with smaller markets may not have a price premium and countries without the relative power to appropriate rents against external actors will not necessarily benefit from GIs either (Loureiro and McCluskey, 2000; Pacciani et al., 2001). Thus, one consistent theme which can be drawn from the literature appears to be that economic and

[21] For an overview of the legal, economic and political issues surrounding GIs in TRIPS, see O'Connor (2004).

political contexts shape the benefits emerging from communities and countries that promote and enforce GIs.

Thus, it is not surprising that the USA and European Union (EU) have been divided about the value and use of GIs. The USA prefers to use trade marks to protect local knowledge, while EU countries commonly invoke GIs in the food sector (Josling, 2006). European countries vary in their experiences of GIs in protecting the share of market power held by local communities. Studies find that the effectiveness of GIs in protecting local communities' position in markets and production of local products depends on market conditions, and local capabilities to market and distribute products (Rangnekar, 2004).

Callois (2004) determined that quality labels do not necessarily ensure the transfer of profits and rural development; rather, if benefits occur, they are unlikely to benefit the whole rural region. Wilson et al. (2000) compared the price premiums for two varieties of protected potatoes, finding that premiums are higher for both protected products, but are significantly greater for the product that is protected through a highly coordinated and organised supply chain.

In contrast, Belletti (2000) found that unequal capabilities can prevent premiums from being captured by local producers. In the case of olive oil from Tuscany, he found that production was capitalised upon by areas outside of Tuscany, and that premiums were reallocated to favour bottling companies rather than producers (Belletti, 2000). Thus, the case studies from Europe show that local capabilities in developing market products, product, communication, marketing and distribution strategies determine the effectiveness of GIs for producers (Tregear, 2002).

6.3.2 Evidence from the perspective of developing countries

Uniform IP laws cannot ensure diversity of access and benefit-sharing

As evident from developed countries, the effectiveness of measures to protect diversity of knowledge depends on favourable market conditions and on communities' capabilities to appropriate a level of market power. This conclusion that protection of diversity in innovation and production depends on local capabilities presents specific concerns for developing countries.

Some studies find that there are strong price premiums for high-quality biological products originating from developing countries, such as coffee (Grote, 2007; Tregear et al., 2007). However, developing countries are threatened by declining shares of profits from economic activities. In the coffee industry, primarily located in developing countries, export earnings more than doubled between the early 1990s and early 2000s, while earnings to producers fell from a value of US$30 billion to fewer than US$6 billion (Rangnekar, 2004).

More specifically relevant to IPRs, the misappropriation of traditional knowledge from developing countries has occurred within the current international IP infrastructure, whether involving music, such as the soundtracks for Disney films, or Loren Miller claiming IP protection for the *ayahuasca* drink in the Amazon (Torremans et al., 2007).

Reinforcing the findings from developed countries, studies of historical experiences in developing countries also suggest that unequal influence is linked to a low capability to

engage in market production and exchange. Developing countries host the majority of genetic resources but often lack the technological capacity and capital to develop these resources sustainably. Trommetter (2005) suggests, through reference to historical case studies in pharmaceuticals and agriculture, that developing countries' capacity to negotiate, their bargaining power and perceptions of their commitment to enforce agreements affect the equitable benefit-sharing of genetic resources among those in developed and developing countries.

Richerzhagen and Holm-Mueller's (2005) case study of Costa Rica sums up the evidence well by illustrating that, with the right legal infrastructure and enforcement, IP can facilitate benefit-sharing, both with local communities and at the national level.

Tailored IP laws may support diversity of access and benefit-sharing

Cases where a clear lack of capability in developing countries to influence innovation processes correspond with a growing literature investigating measures to provide for diversity of participation in knowledge protection regimes in developing countries. This section reviews the empirical literature in each of these areas in turn, emphasising the evidence for the effectiveness of these different measures possible through IP law to protect the diversity of knowledge related to genetic resources in developing countries.

***Sui generis* intellectual property**

TRIPS allows for *sui generis* IP regimes in relation to genetic resources and traditional knowledge. Empirical studies have found that *sui generis* IP systems can facilitate increased influence on the part of local communities in developing countries in innovation.

To investigate the possibilities for *sui generis* protection to protect diversity, the empirical studies examine attempts to integrate traditional knowledge and IPRs through regional and national legislation. Earlier studies describe how different developing countries have tailored national laws to facilitate continued access to traditional knowledge (Oguamanam, 2008). These studies refer to experiences in a range of developing countries, spanning Latin America (Brazil, Peru), South and South-East Asia (China, India, Japan and Philippines) and Africa (Organization of African States). However, while describing the legal frameworks for *sui generis* protection, these studies do not provide evidence about their effectiveness in actually protecting diversity in access and benefit-sharing (Kongolo, 2001; Nyika, 2007; Sunder, 2007).

A few empirical studies have begun to explore the ability for *sui generis* systems to protect diversity in developing countries. Looking across developing countries, Dutfield (2000) reviewed biodiversity registers, community IPRs and local databases, concluding that the existing international IP regime is relevant to ensuring equity in access and benefit-sharing. Similarly, through interviews with companies in different economic sectors, ten Kate and Laird (2000) found that IP laws can allow for widespread involvement in innovation systems in developing countries, if policies involve relevant stakeholders in both the public and private sectors (ten Kate and Wells, 2001; Laird and ten Kate, 2002).

Case studies in Africa provide some evidence of the impact of *sui generis* systems in low-income developing countries. Kongolo (2001) analysed pharmaceutical patent protection in four African countries (Democratic Republic of Congo, Morocco, Nigeria and South Africa) (Kongolo, 2001). He found that a balance of interests was necessary to ensure equal

benefits from innovation, and determined that this could be achieved through a combination of IP law, certain provisions for parallel imports and compulsory licensing, and a *sui generis* system (Kongolo, 2001). Ng'etich (2005) was more cautious, determining that diversity in access and benefit-sharing in Kenya could be achieved through *sui generis* IP regimes, but that this depended on the outcome of debates on what constitutes prior informed consent, and on how local communities and governments negotiate ownership of knowledge (Ng'etich, 2005). Thus, while there are various degrees to which studies suggest that diversity can be facilitated through *sui generis* systems, the trend in the literature is to conclude that IP law can facilitate diversity in access and benefit-sharing. However, this depends on actors' ability to negotiate *sui generis* protection that responds to specific concerns at the country, sector and community levels.

Geographical indications

GIs are a second measure discussed in the empirical literature about how IPRs to be used to protect diversity in access and benefit-sharing in developing countries. With GIs, this is achieved by making provision for a price premium for the goods produced in a specific locality. Producers in developing countries have begun to use certification marks to develop brands and protection for their products, such as Jamaican Blue Mountain coffee or Juan Valdez and Café de Colombia. In addition, as evident in the Light Years project and in a recent World Bank report (Barconcelli et al., 2004), rural communities in developing countries have developed quality brands through interactions between local know-how and particular environmental conditions.

GIs are distinct from trade marks in several ways. Trade marks differentiate one product from another, are offered to individual producers and are allocated in response to human innovations. Distinct GIs provide protection to all producers within a locality and are allocated in response to a recognised, distinct characteristic pertaining to a good produced within a particular locality. The USA and EU take very different stances on issues of GIs and trade marks. The divide over GIs and trade marks politically tends to be between 'old world' and 'new world' countries, rather than developed and developing countries (Raustiala and Munzer, 2007). Amid discussions of developed countries, few studies attempt to measure the impact of GI on rural development in the form of income, market access and employment. Downes et al. (1999) suggest that IPRs and traditional knowledge are inherently conflictual in their effects on cultural rights and customary practice (Bérard and Marchenay, 1996; Downes et al., 1999). GIs can help to reconcile this difference by protecting localised knowledge and allowing knowledge to remain in the public domain within a specific community (Moran, 1993; Bérard and Marchenay, 1996).

The actual effectiveness and impact of GIs on economic and social development in developing countries remains largely unanalysed (Barconcelli et al., 2004). Developing countries may have even lower levels of influence in trade than developed countries. As such, communities with weak influence and low capabilities in market exchanges are less likely to benefit from GIs. In addition, although the extent is not yet measured empirically, the high costs involved in acquiring and enforcing GIs may be beyond the scope of the available resources in developing countries (Commission on Intellectual Property Rights, 2002). Currently, there is a lack of evidence as to the actual impact of GIs in communities in developing countries. As such, there is a need for empirical studies investigating the real

costs and benefits experienced in different developing countries, and how local capabilities and market conditions affect the profitability of GIs for local producers in developing countries.

Plant variety protection

In the agricultural industry, influence in innovation can be facilitated through PVP. Theoretical arguments are ambiguous about the effect on diversity in plant varieties in developing countries as a result of PVP. PVP can increase inequality in developing countries between the breeders who are protected by PVP, and farmers and agricultural workers who do not receive any protection for their knowledge (Srinivasan, 2005). Conversely, PVP can provide incentives for R&D in agriculture into technologies specifically relevant to developing countries. For example, as Indian rice is a larger market than US maize, there is substantial scope for profits for entities investing in innovations for agriculture in developing countries (Commission on Intellectual Property Rights, 2002).

Van Wijk and Jaffe (1995) found little evidence in Latin American countries (Argentina, Chile, Colombia, Mexico and Uruguay) that PVP leads to increased innovation and an increased range of available plant materials. However, they do suggest that PVP is likely to increase inequality between commercial farmers and the seed industry, and poorer farmers. IPRs are granted more often to foreign than domestic breeders in developing countries (Primo Braga and Fink, 1998b). Moreover, concentration in the agricultural sector through mergers and acquisitions by multinational companies in developing countries (Commission on Intellectual Property Rights, 2002) suggests a concentration of influence in agricultural production.

In contrast, while suggesting that the UPOV model could concentrate influence among large-scale commercial breeders and biotechnology companies, Robinson (2007) found that there is the potential for *sui generis* PVP regulatory frameworks to promote diversity in access and benefit-sharing. Recently, India and Thailand have developed *sui generis* PVP regimes. Across South-East Asia, Indonesia, Malaysia and Philippines have implemented degrees of *sui generis* regimes to varying degrees, often pressured to standardise IP law by UPOV and developed countries (Kanniah, 2005). Again, these are recent developments, and implementation is yet to be analysed. Evaluation of these regimes could provide insight into the conditions and capabilities affecting PVP's ability to foster diversity in access and benefit-sharing in the knowledge associated with plant genetic resources (Robinson, 2007; see also Brahmi et al., 2004).

Farmers' rights

Farmers' rights have been promoted as a means to limit breeders' rights (Fowler, 1994; Brush, 2003). The International Treaty on Plant Genetic Resources includes provisions to recognise farmers' rights by providing a compensation mechanism for farmers "who conserve and sustainably utilise plant genetic resources for food and agriculture" (Maskus et al., 2004). Farmers' rights can include the right to participate in benefits from utilising genetic resources in agriculture or the right to participate in decision-making about conserving and sustainably using such resources.

Modern agriculture in developing countries seems to be moving towards increasing integration and dependence on complex genetic resources from multiple sources and

breeds removed from traditional agricultural practices (Smale et al., 2002; Brush, 2003). The evidence on the impact of farmers' rights in innovation amid these processes is ambiguous. Currently, farmers' rights are often vague and lack the status of legal rights, becoming domestic rather than international in nature. In analysing the IPR environment in South-East Asian countries, Salazar et al. (2006) determine that while currently IPRs do not protect farmers' knowledge, IPR regimes could be part of an infrastructure bringing farmers into systems of knowledge protection. However, this depends on addressing challenges of access, recognition of collective innovation, freely available materials and benefit-sharing (Salazar et al., 2006). Among the few case studies on farmers' rights in developing countries, Brush (1998) determines that recognising maize farmers in Mexico through contracts is unlikely to provide for equality between farmers and seed companies; rather, efficient and effective benefit-sharing can occur through licensing agreements and institutions aimed at human capital development (Brush, 1998). Thus, empirical studies do not reject a place for farmers' rights in facilitating diversity in access and benefit-sharing. They affirm that the potential for IPRs to foster diversity depends on local contexts and capabilities.

6.4 Conclusions and further research directions

After reviewing the literature on the impacts of IPRs on traditional knowledge and genetic resources, this chapter concludes the following.

- Evidence about the relationship between IPRs and traditional knowledge and genetic resources begins from varied theoretical assumptions and debates. This lack of guidance inhibits the implementation of systematic reviews or meta-analyses.
- Empirical evidence shows that IPRs can facilitate diversity in access to knowledge and benefit-sharing from innovation in developed countries; however, this depends on individual, organisational and institutional capabilities.
- Tailored IP laws are a necessary prerequisite for knowledge protection systems to engage a wider range of people in accessing and sharing the benefits of knowledge in developing countries. Although evidence about implementation is scarce, this could be facilitated by using the provisions in TRIPS for *sui generis* protection and GIs.
- In isolation, PVP could impede diversity in access and benefit-sharing, but these measures could be combined with provisions for farmers' rights so as to promote diversity in knowledge systems in agriculture. However, at present, the empirical evidence about the impact of PVP and farmers' rights in developing countries is thin.

The review of the literature on genetic resources, traditional knowledge and genetic resources also reveals a need for further research to evaluate the relative impact of different IP protection measures on diversity in access and benefit-sharing. Specifically, there is little evidence about the impact of existing national *sui generis* systems and specific measures in the agricultural sector.

CHAPTER 7 Conclusion

This report reviewed the evidence on the effects of IPRs in developing countries in the context of the WTO TRIPS Agreement and the development of TRIPS-plus standards. TRIPS encouraged the international harmonisation of IPR regimes by providing a minimum standard of protection for IP, and a dispute resolution system for entities to challenge breaches of these standards. Since the establishment of TRIPS, there has been an increase in the number of new deals formed through bilateral and regional free trade agreements to strengthen these minimum standards of protection, the so-called TRIPS-plus standards.

This report has examined the impact of strengthening IPRs in developing countries in five main areas – FDI, trade, innovation, public health, and genetic resources and traditional knowledge – through a review of the most recent scholarly and grey literature.

The empirical findings from the report show that stronger IPRs seem to influence the decisions of individual firms in developed countries by encouraging them to export, invest and transfer their technologies through licensing in developing countries, in particular those with strong technical absorptive activities. It also found that stronger IPRs can hamper access to medicines in developing countries and do not necessarily encourage pharmaceutical innovation that responds to developing country needs. The report stressed that uniform IP laws cannot ensure diversity of access and benefit-sharing from genetic resources and traditional knowledge.

Finally, the report revealed important knowledge gaps in the empirical literature on the effects of strengthening IPRs in developing countries. Therefore, its findings should be interpreted with caution. For this reason, the report suggested several future research directions which should aim to provide further insights for policymakers on the effects of stronger IPRs in developing countries.

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Appendix: International patent protection – 1960–2005

Table 1 gives an overview of the summary of the scores by country of the patent rights index developed by Park (2008). The index integrates the effects of recent national and global legal developments, most notably the TRIPS Agreement, legislation dealing with emerging technologies such as software and biotechnology, and the revisions in national patent laws required to conform to international and regional agreements (such as the North American Free Trade Agreement (NAFTA), European Patent Convention 1973, African Regional Industrial Property Organization (ARIPO) and Cartagena Agreement, among others.

Table 1: Index of patent rights, 1960–2005

Country	Average, 1960–1990	1995	2000	2005
Algeria	2.74	2.74	3.07	3.07
Angola	0.00	0.88	1.08	1.20
Argentina	1.60	2.73	3.98	3.98
Australia	2.35	4.17	4.17	4.17
Austria	2.96	4.21	4.33	4.33
Bangladesh	1.34	1.87	1.87	1.87
Belgium	3.39	4.54	4.67	4.67
Benin	1.64	1.78	2.10	2.93
Bolivia	1.38	2.37	3.43	3.43
Botswana	1.59	2.08	3.32	3.52
Brazil	1.22	1.48	3.59	3.59
Bulgaria	1.83	3.23	4.42	4.54
Burkina Faso	1.62	1.98	2.10	2.93
Burma (Myanmar)	0.00	0.20	0.20	0.20

Burundi	1.98	2.15	2.15	2.15
Cameroon	1.74	2.10	2.23	3.06
Canada	3.00	4.34	4.67	4.67
Central African Republic	1.74	1.98	2.10	2.93
Chad	1.61	1.78	2.10	2.93
Chile	2.04	3.91	4.28	4.28
China	1.33	2.12	3.09	4.08
Colombia	1.05	2.74	3.59	3.72
Congo	1.74	1.90	2.23	3.06
Costa Rica	1.07	1.56	2.89	2.89
Cyprus	2.52	2.78	3.48	3.48
Czech Republic		2.96	3.21	4.33
Denmark	2.88	4.54	4.67	4.67
Dominican Republic	2.12	2.32	2.45	2.82
Ecuador	1.16	2.04	3.73	3.73
Egypt	1.41	1.73	1.86	2.77
El Salvador	1.71	3.23	3.36	3.48
Ethiopia	0.00	0.00	2.00	2.13
Fiji	2.20	2.20	2.40	2.40
Finland	2.64	4.42	4.54	4.67
France	3.29	4.54	4.67	4.67
Gabon	1.74	2.10	2.23	3.06
Germany	3.24	4.17	4.50	4.50
Ghana	1.47	2.83	3.15	3.35
Greece	2.40	3.47	3.97	4.30
Grenada	1.67	1.76	2.48	3.02
Guatemala	0.77	1.08	1.28	3.15
Guyana	0.82	1.13	1.33	1.78
Haiti	2.58	2.58	2.90	2.90

Honduras	1.25	1.90	2.86	2.98
Hong Kong	2.44	2.90	3.81	3.81
Hungary	2.20	4.04	4.04	4.50
Iceland	1.67	2.68	3.38	3.51
India	1.03	1.23	2.27	3.76
Indonesia	0.00	1.56	2.47	2.77
Iran	1.91	1.91	1.91	1.91
Iraq	1.95	2.12	2.12	1.78
Ireland	2.15	4.14	4.67	4.67
Israel	2.76	3.14	4.13	4.13
Italy	3.16	4.33	4.67	4.67
Ivory Coast	1.64	1.90	2.36	3.06
Jamaica	2.66	2.86	3.06	3.36
Japan	2.93	4.42	4.67	4.67
Jordan	0.66	1.08	3.03	3.43
Kenya	1.55	2.43	2.88	3.22
Korea (South)	2.55	3.89	4.13	4.33
Liberia	1.78	2.11	2.11	2.11
Lithuania		2.69	3.48	4.00
Luxembourg	2.16	3.89	4.14	4.14
Madagascar	1.05	1.85	2.31	2.31
Malawi	1.35	2.03	2.15	2.15
Malaysia	1.70	2.70	3.03	3.48
Mali	1.78	1.98	2.10	2.93
Malta	1.34	1.60	3.18	3.48
Mauritania	1.70	1.98	2.43	3.27
Mauritius	1.62	1.93	1.93	2.57
Mexico	1.19	3.14	3.68	3.88
Morocco	1.58	1.78	3.06	3.52

Mozambique	0.00	0.00	1.06	2.52
Nepal	1.79	1.79	1.79	2.19
Netherlands	3.43	4.54	4.67	4.67
New Zealand	2.67	4.01	4.01	4.01
Nicaragua	0.92	1.12	2.16	2.97
Niger	1.64	1.78	2.10	2.93
Nigeria	2.50	2.86	2.86	3.18
Norway	2.75	3.88	4.00	4.17
Pakistan	1.09	1.38	2.20	2.40
Panama	1.34	1.46	3.64	3.64
Papua New Guinea	0.00	0.00	1.40	1.60
Paraguay	1.13	1.53	2.39	2.89
Peru	0.59	2.73	3.32	3.32
Philippines	2.19	2.56	3.98	4.18
Poland	1.38	3.46	3.92	4.21
Portugal	1.48	3.35	4.01	4.38
Romania	1.50	3.52	3.72	4.17
Russian Federation		3.48	3.68	3.68
Rwanda	1.94	1.95	2.28	2.28
Saudi Arabia	1.83	1.83	1.83	2.98
Senegal	1.70	1.98	2.10	2.93
Sierra Leone	2.38	2.45	2.98	2.98
Singapore	1.64	3.88	4.01	4.21
Slovak Republic		2.96	2.76	4.21
Somalia	2.00	2.00	2.13	2.13
South Africa	2.94	3.39	4.25	4.25
Spain	2.74	4.21	4.33	4.33
Sri Lanka	2.27	2.98	3.11	3.11
Sudan	2.61	2.61	2.61	2.61

Swaziland	1.36	1.98	2.43	2.43
Sweden	2.86	4.42	4.54	4.54
Switzerland	3.04	4.21	4.33	4.33
Syria	1.68	1.87	1.99	2.19
Taiwan	1.26	3.17	3.29	3.74
Tanzania	1.84	2.32	2.64	2.64
Thailand	0.95	2.41	2.53	2.66
Togo	1.60	1.98	2.10	2.93
Trinidad and Tobago	1.78	2.33	3.63	3.75
Tunisia	1.45	1.65	2.32	3.25
Turkey	1.16	2.65	4.01	4.01
Uganda	1.77	2.85	2.98	2.98
Ukraine		3.68	3.68	3.68
United Kingdom	3.20	4.54	4.54	4.54
United States	4.14	4.88	4.88	4.88
Uruguay	1.54	2.07	3.27	3.39
Venezuela	0.92	2.82	3.32	3.32
Vietnam	1.38	2.90	2.90	3.03
Zaire (Democratic Republic of Congo)	1.49	1.58	1.78	2.23
Zambia	1.54	1.62	1.74	1.94
Zimbabwe	1.61	2.28	2.60	2.60

Source: Park (2008)

The patent rights index is a compositor index considering coverage of the protection, membership of international treaties, duration of protection, enforcement mechanisms and the existence of restriction on patent rights.

Table 2: Index of patent rights and its components

(1) Coverage	Available	Not available
Ability to patent pharmaceuticals	1/8	0
Ability to patent chemicals	1/8	0
Ability to patent food	1/8	0
Ability to patent surgical products	1/8	0
Ability to patent micro-organisms	1/8	0
Ability to patent utility models	1/8	0
Ability to patent software	1/8	0
Ability to patent plant and animal varieties	1/8	0
(2) Membership of international treaties	**Signatory**	**Not signatory**
Paris Convention and revisions	1/5	0
Patent Cooperation Treaty	1/5	0
Protection of new varieties (UPOV)	1/5	0
Budapest Treaty (micro-organism deposits)	1/5	0
Trade-related Intellectual Property Rights (TRIPS)	1/5	0
(3) Duration of protection	**Full**	**Partial**
	1	$0 < f < 1$
(4) Enforcement mechanisms	**Available**	**Not available**
Preliminary (pre-trial) injunctions	1/3	0
Contributory infringement	1/3	0
Burden-of-proof reversal	1/3	0
(5) Restrictions on patent rights	**Does not exist**	**Exists**
Working requirements	1/3	0
Compulsory licensing	1/3	0
Revocation of patents	1/3	0

Note: where f is the duration of protection as a fraction of 20 years from the date of application or 17 years from the date of grant (for grant-based patent systems). Overall score for patent rights index: sum of points under (1)–(5).

Source: Park (2008)