THE IMPACT OF INTELLECTUAL PROPERTY RIGHTS PROTECTION ON TECHNOLOGICAL PROGRESS

Visit Sripibool

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ABSTRACT

Title of Dissertation	The Impact of Intellectual Property Rights Protection on Technological Progress
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Intellectual Property Rights (IPR) protection has been a continuing concern by most member countries of WTO. The central issue is whether to adopt a strong or weak IPR protection. Developed countries tend to use various types of pressure to induce developing countries to enforce IP law strictly. On the other hand, the Trade-Related Aspects of Intellectual Property Rights (TRIPS) appears to require a minimum standard for IPR protection by its desire for IPR to contribute to the promotion of technological innovation. However, most developing and least developed countries are reluctant to follow the requirement of TRIPS because of their perception that IPR protection has scarcely brought them benefits or that they suffer from it. These concerns serve as the rationale for the general purpose of this study, which is to investigate the impact of IPR protection on technological progress and the role of TRIPS in the economic development and social welfare of developing countries.

The objectives of this study are: first, to investigate the impact of IPR protection on technological progress in WTO member countries; second, to investigate the role of TRIPS for the member states as claimed in the objectives of TRIPS; and to investigate the impact of IPR protection on social welfare.

The study uses panel data from 224 countries during 2006-2008 with fixed effect and random effect models. The level of technological progress is measured by the number of patent applications. This study uses the IPR index representing the degree of IPR protection in each country which is categorized by the specific characteristics of the countries. Secondary data for the research was obtained from relevant international agencies and organizations. Technological progress regression is tested for two steps. The first is for all countries of the observations, the second for the countries of innovator and user of technology. The social welfare regression is tested for the impact on the health care of infants that focuses on the system of strong and weak IPR protection.

The empirical results show that R&D expenditure plays the key role in technological progress, IPR protection does not impact on technological progress, and strong IPR protection increases infant mortality rate.

The results suggest that flexibility in the implementation of the TRIPS agreement would be appropriate for developing countries. Weak IPR protection would be the option for developing and least developed countries aiming at health welfare improvement. A strong IPR protection may have an adverse impact on social welfare.

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ABBREVIATIONS

Abbreviations	Equivalence
GATT	General Agreement on Tariff and Trade
GSP	Generalised System of Preferences
IIPA	International Intellectual Property Alliance
IPR	Intellectual Property Right
IP laws	Intellectual Property Laws
PFC	priority foreign country
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights
USTR	Office of the United States Trade Representative
WIPO	World Intellectual Property Organization
WHO	World Health Organization
WTO	World Trade Organization

CHAPTER 1

INTRODUCTION

1.1 The Significance of IPR Protection under the TRIPS Agreement

The World Trade Organization (WTO) has been recognized as an important international organization designed to supervise and facilitate trade liberalization. The organization officially commenced on 1 January 1995, under the Marrakesh Agreement, succeeding the 1947 General Agreement on Tariffs and Trade (GATT). Since its establishment, WTO has been beset by numerous trade disputes and has had to address trade-related issues, many of which remain unsettled. To begin with, trade disputes between developed and developing countries occur in many areas. Numerous trade barriers have been put up by developed countries making it difficult for developing countries to export their products. The non-tariff trade barriers especially have been seen to increase the gap of economic development between developed and developing countries.

WTO deals with regulation of trade between member countries; it provides a framework for negotiating and formalising trade agreements and supervises a dispute resolution process aimed at enforcing participants' adherence to WTO agreements, which are entered into by member governments. Most of the WTO issues began from previous trade negotiations, especially from the Uruguay Round (1986-1994). The organization is currently administering a trade negotiation called the Doha Development Agenda (or Doha Round), which was launched in 2001 to enhance equitable participation of poorer countries. As of May 2009, the WTO had 153 members, representing more than 95% of total world trade. Members have rights and obligations to comply with all agreements and trade regulations that aim to promote fair trade.

One of the most important agreements of WTO is an agreement relating to intellectual property rights (IPR), known as Trade-Related Aspects of Intellectual Property Rights (TRIPS). TRIPS sets minimum standards in the international rules governing IPR such as patent, copyright, trademark and trade secret. Participating countries agree to certain common standards in the way they enact and implement their domestic IPR laws, and set the mechanism to enforce such laws effectively. These standards include, among others, a patent law that gives a minimum period of protection of 20 years. However, this protection has been criticized by economists in terms of the economic impact of IPR protection. Nonetheless, there are pros and cons of a strong IPR protection.

Basically, IPR protection was conceived as a purely technical tool to contribute to technological development. This theoretical framework has been challenged from different directions. One of the more serious criticisms is that IPR protection benefits mostly large private economic actors and richer countries and hardly the developing countries. The appropriate degree of IPR protection has been the object of debates for a long time. The need to provide incentives for research into new technological innovations and the desire to reward inventors has always been difficult to balance because of the differences in the types of research and development and domestic conditions among countries.

Furthermore, the mandatory nature of TRIPS leaves no flexibility to developing countries in complying with its provisions according to their capacities. In fact, one of the many challenges that developing countries face is the need to reconcile the introduction of the minimum standards of IPR protection required by TRIPS with their specific needs and capacities. For most developing countries, the debate concerning the contribution of IPR protection to economic and social development has become intense. This is due to a number of converging factors. Firstly, TRIPS commits members to significantly raise their standards of IPR protection to advance economic and technology development. Secondly, TRIPS makes few concessions for small, economically weak countries. The weak implementation of the TRIPS provisions has led to major controversies such as the one on access to drugs by countries severely affected by HIV/AIDS. Thirdly, in the context of increasing protection of knowledge through IPR system, which has characterized developed countries over the past couple of decades, there are renewed debates over the appropriate level of IPR protection for social and economic development. One of the issues in this context is the so-called tragedy of the anti-commons: over-protection can be harmful to creativity or innovativeness when the basic tools of research are not ready, thereby significantly raising the cost of doing research. Moreover, in a North-South context, concerns over the appropriate degree of IPR protection includes all issues of long-standing debates in developing countries (Cullet and Kameri-Mbote, 2005: 3-4).

Article 7 states the objective of TRIPS, thus:

The protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations.

The above objective has been a source of controversy among developing countries because, in theory a country that protects and enforces IPR should be able to benefit from technological progress and enhancement of social and economic welfare. A question that has been raised related to this objective is why technology development in many developing countries continues to lag behind developed countries. The other issue is that most developing countries have been the recipient of complaints by the developed countries alleging them to have weak IPR protection. For example, TRIPS requires a single international patent law in order to harmonize patent laws throughout the members countries. This one-size-fits-all policy extends the stricter patenting laws, previously used in industrialised countries, to developing countries regardless of their radically different social and economic conditions.

The different views regarding the ambiguous benefits from IPR protection and its enforcement has led to concerns on the effectiveness and equitability of the provisions of TRIPS. The transition period provided by TRIPS allows most developing country members of the WTO to delay until the beginning of 2000 their implementation of TRIPS. Some countries were granted a longer transition period. Some like India, which did not grant patents on pharmaceutical products, were given until 2005, and the least developed countries were initially given until 2006. Generally, both developed and developing countries use TRIPS as a tool for trade negotiation. That is, developed countries require developing countries to enact and enforce IPR laws strongly and effectively. In the meantime, in order to meet the requirement of developed countries for trade benefits, most developing countries including Thailand have tried to set up a level of IPR protection that is higher than the requirement of TRIPS. Thailand for instance set up the first IPR court in the world, which is not required by TRIPS, Article 1. On the other hand some countries, such as China, India, Vietnam and other developing countries, have not set up IPR protection for their own domestic benefit.

As to the objective of TRIPS to promote innovation and economic development, the selected countries in the Table 1.1 shows the number of patents granted, which does not seem to be in line with this objective.

Table 1.1 The Challenge to the Objectives of TRIPS

Countries	Number of IP Cases	Degree of IPR Protection	Number of Patent Applications	GDP
U.S	12078	5.6	425966	42.92
Uruguay	12038	3.9	551	5.80
Thailand	7106	3.8	6248	3.25
China	6399	3.4	245161	0.51
Japan	1192	5.7	408674	34.32
Canada	416	5.6	42038	39.00
U.K	230	5.9	26003	39.21
Australia	141	5.4	25745	37.41
Georgia	49	2.8	535	1.75

Source: WIPO, United Nations: Statistics Division, 2006
Note: GDP: 1,000 US Dollars at current prices per capita

Table 1.1 illustrates the challenge to the objective of TRIPS. The statistics can be interpreted that the higher number of IP cases indicates a strong IPR enforcement; a high degree means stronger protection both in terms of law and administrative procedures. A low degree means weak protection. Table 1.1 however does not give consistent support to the proposition that a stronger IPR protection contributes to economic growth and technological progress. For example, the countries with strong IPR enforcement such as Thailand and China, which have high number of IP cases, have a small number of patent applications.

Many developing countries have been under pressure to enact or implement tougher or more restrictive conditions in their IP laws than are required by TRIPS. These are known as TRIPS Plus provisions. Countries are by no means obliged by international law to do this but many, such as Brazil, China and the Central American states have had no choice but to adopt these, as part of their trade agreements with the United States or the European Union. These have had a disastrous impact on access to medicines for health care of most developing countries. Many countries have been accused of weak IPR protection, such as India, China, Russia, Algeria, Argentina, Canada, Chile, Indonesia, Israel, Pakistan, Thailand, Venezuela, Brazil, Malaysia and Nicaragua. Most are developing countries and accused by the U.S. and other industrialized countries, International Intellectual Property Alliance (IIPA), and the United States Trade Representative (USTR) (IIPA, USTR report, 2008-2009). The allegation is mostly weak enforcement of IPR protection. WTO now comprises more than 153 countries but only a few, Thailand included, strictly follow the TRIPS provisions. There are problems of dual policies within the member states: one country may follow the requirement of TRIPS to promote technological progress, another may do so for international trade.

The objectives of WTO and the main idea of TRIPS are closely related. WTO provides a forum to negotiate for trade liberalization. It does not push every member to liberalize trade, but allows progressive liberalization according to the readiness and the level of economic development of the country. However, the members have to implement all agreements, international conventions, laws and regulations required by WTO. One of these is the protection of IPR under TRIPS.

TRIPS aims to reduce distortions and impediments to international trade, taking into account the need to promote effective and adequate protection of IPR and ensuring that measures and procedures to enforce IPR do not become barriers to trade.

IPR protection before TRIPS was accorded under the Paris Convention of 1883 on patents and other industrial property, and the Berne Convention of 1886 for literary and artistic works. A shortcoming of these Conventions is the lack of provision to enforce IPR and punish infringement. The enforcement provisions were subsequently introduced in TRIPS as administered by WTO (Scotchmer, 2004: 419). After TRIPS came into force, the issues of IPR protection and enforcement focused on the appropriate degree of IPR protection in member countries.

1.1.1 Problems of IPR Protection on Trade and Social Welfare in Developing Countries

For decades, the measures of IPR protection have been a continuing contention between developed and developing countries. One of the prominent issues relates to the appropriate degree of IPR protection that a member state can choose for its benefit in accordance with the objectives of TRIPS. In this regard, the member countries of WTO that have to implement TRIPS have adopted different policies to interpret the provisions. Some have opted for weak IPR protection for their own domestic economic welfare and technology development whereas others have chosen a strong IPR protection for other reasons.

These unharmonized policies of IPR protection have given rise to trade disputes. For example, in April 2008, the USTR put Thailand on the Priority Watch List According to Section Special 301 of the Omnibus Trade and Competitiveness Act of 1988. Its reasons were that Thailand did not protect the IPR of US firms and because the Thai Government exercised the Patent Act B.E. 2534 for compulsory licensing on medicines for AIDS and heart diseases. The USTR also needed to review the Generalized System of Preferences (GSP) on customs tariff for Thailand as granted by the United States of America (US). These were raised by the US government to force Thailand to revoke the compulsory licensing on medicines as allowed by the Patent law, enforce the IPR laws effectively, and accelerate the process of amending the patent and copyright laws for a longer protection period.

The trade conflict between Thailand and the US, and the unilateral measures imposed on Thailand were not the first such events. The US government had used unilateral measures against Thailand since the end of the 1980s. As a consequence of these measures, Thailand enacted and amended many domestic IP laws, leading to the establishment of the special IPR Court, so called ‘IP&IT court’, which was the first IPR court in the world. The Thai government has been under pressure to suppress IPR infringement strongly and continuously until now. Nonetheless, even though

Thailand has complied with all the requirements asked by the US government in order to neutralize trade opposition from the US, a number of trade sanctions are occasionally imposed by it.

The action of the US government does not follow the dispute resolution process of WTO which requires a trade dispute to be negotiated by multilateral parties not by a unilateral party, as the US government does. TRIPS allows the country members to enact domestic IP law to protect or enhance social welfare as stated in Article 31 of TRIPS 'compulsory licensing agreement' for example on medicines. However, the US government has asked Thailand to revoke the measure on medicines that mitigate the effect of HIV/AIDS virus and medicines that dissolve blood clot. The trade sanctions raised by the US government do not pertain to the substance of TRIPS and therefore have the characteristic of being arbitrary. Furthermore, the requirement of strong IPR protection measures asked by the US government does not follow TRIPS. TRIPS does not always require a strong IPR protection, rather it calls for an appropriate method and level of protection within a country's own legal system and practice (Article 1). Nonetheless, the US government has claimed that Thailand's IP laws enforcement does not meet the requirement of TRIPS.

The efforts of WTO through TRIPS to set the IPR legal standard to be transparent to ensure equality among member states has not been successful, in particular for developing countries. In practice, developed countries always use the negotiation channel to force developing countries to comply with their requests without concern for the provisions in TRIPS. For example from 1996 to 1997, in the disputes between US and Pakistan and US and India, the US government asked these countries to protect the patent on medicine products and agricultural chemicals. Pakistan agreed to a backward protection for the patent on two products since 1 January 1995 which is the date WTO came into force. Pakistan could have delayed implementing TRIPS for five years according to the provision on transition period allowed by TRIPS. In the trade dispute between the US and India, India argued that it should get the benefit of the transition period provided by TRIPS in Article 65 but India lost the case; the dispute settlement committee decided in favor of the US government. India finally complied with the claims of US government by enacting the Patent law and enforcing penalty for patent infringement. The trade dispute between the US and Argentina in 1999 and 2002, arose when the US government accused Argentina of not protecting pharmaceutical test data according to the agreement of WTO through TRIPS. Argentina complied with the requirement of the US government. Most trade disputes arise from allegations of weak IPR protection in accused countries. The claimants, such as the US government, USTR, IIPA, and several industrial countries (IIPA, USTR, 2008-2009), demand a strong IPR protection in order to protect their own trade benefits globally. If the accused countries do not follow the demands their exports are subjected to sanctions. For example, the US government put the accused countries in the list of priority foreign country (PFC), which were then threatened with the removal or reduction of their Generalized System of Preferences (GSP).

In fact, GSP was initiated under GATT in order to promote the economic development and trade of developing countries. GSP is the system for lowering or waiving tariffs or import taxes in developed countries for goods from developing countries. In the view of developed countries, to get a GSP a developing country must protect IPR adequately and effectively (Kwanpoj, 2008: 30).

Many developing countries are accused by developed countries, in particular the United States, of ignorance in enforcing IPR effectively, which means that these developing countries violate TRIPS. In 2008, USTR put Russia, Argentina, Chile, India, Israel, Pakistan, Thailand, and Venezuela on the priority watch list. Being on the list means having their GSP revoked or reduced by the US if they do not follow the recommendations of the US government to accelerate the process of IPR protection. Many other countries were in the watch list in 2008[1]. The watch list countries could be upgraded to priority watch list if they did not enforce IPR effectively according to the requirement of the US government (USTR Report, 2008). Recently, the U.S. released the degree of Watch Lists (see Table 1.2 for a sample of the countries in the List).

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[1] These include Algeria, Belarus, Bolivia, Brazil, Canada, Czech Republic, Ecuador, Egypt, Greece, Hungary, Indonesia, Italy, Jamaica, Kuwait, Lebanon, Malaysia, Mexico, Norway, The Philippines, Poland, Romania, Saudi Arabia, Spain, Taiwan, Tajikistan, Turkey, Turkmenistan, Ukraine, Uzbekistan, and Vietnam.

Table 1.2 The 2009 "Special 301" USTR Decisions for 2008 Estimated Trade Losses Due to Copyright Piracy (in Millions of U.S. Dollars)

Countries	Business Software		Records & Music		Totals
	Losses	Levels	Losses	Levels	Loss
	2008	2008	2008	2008	2008
PRIORITY WATCH LIST					
Algeria	NA	NA	NA	NA	NA
Argentina	265.0	75%	75.1	60%	340.1
Canada	742.0	32%	NA	NA	742.0
Chile	109.0	66%	21.0	66%	130.0
India	1060.0	66%	36.2	55%	1096.2
Indonesia	302.0	86%	20.0	95%	322.0
Israel (OCR)	NA	NA	NA	NA	NA
Pakistan	77.0	85%	NA	NA	77.0
People's Republic of China	2940.0	79%	564.0	90%	3504.0
Russian Federation (GSP)	2773.0	70%	NA	NA	2773.0
Thailand	295.0	76%	17.8	65%	312.8
Venezuela	NA	NA	NA	NA	NA
WATCH LISH					
Belarus	NA	NA	NA	NA	NA
Bolivia	NA	NA	NA	NA	NA
Brazil	1068.0	60%	117.1	48%	1185.1
Brunei	NA	NA	2.4	100%	2.4
Colombia	85.0	60%	NA	NA	85.0
Costa Rica	15.0	60%	14.8	60%	29.8
Czech Repulic	NA	NA	NA	NA	NA
Dominican Republic	NA	NA	NA	NA	NA
Ecuador	NA	NA	NA	NA	NA
Egypt	81.0	59%	NA	NA	81.0
Finland	NA	NA	NA	NA	NA
Italy	1242.0	49%	350.0	25%	1592.0
Jamaica	NA	NA	NA	NA	NA

Table 1.2 (Continued)

Countries	Business Software		Records & Music		Totals
	Losses	Levels	Losses	Levels	Loss
	2008	2008	2008	2008	2008
Kuwait	43.0	63%	NA	NA	43.0
Lebanon (GSP)	28.0	74%	3.0	70%	31.0
Malaysia	180.0	60%	26.2	60%	206.2
Mexico	497.0	60%	419.7	80%	916.7
Norway	NA	NA	NA	NA	NA
Peru	52.0	74%	57.2	98%	109.2
Philippines (OCR)	105.0	70%	117.0	83%	222.0
Poland (OCR)	438.0	55%	100.0	27%	538.0
Romania	115.0	70%	NA	40%	125.0
Saudi Arabia (OCR)	126.0	54%	13.4	NA	126.0
Spain	624.0	42%	NA	20%	637.4
Tajikistan	NA	NA	NA	NA	NA
Turkey	239.0	65%	NA	NA	239.0
Turkmenistan	NA	NA	NA	NA	NA
Ukraine	308.0	85%	NA	NA	308.0
Uzbekistan (GSP)	NA	NA	NA	NA	NA
Vietnam	123.0	83%	NA	95%	123.0
SPECIAL 306 MONITORING					
Paraguay	7.0	81%	NA	NA	7.0
OCR only					
Fiji (OCR)	NA	NA	NA	NA	NA
TOTALS	**14158.0**		**1964.9**		**16122.9**

Source: International Intellectual Property Alliance (IIPA), 2009: 1

Note: GSP means that the U.S. government is reviewing this country's IPR practices under the Generalized System of Preferences trade program. OCR means that an out of cycle review would be conducted by USTR in 2009.

The crucial issues are the lack of a clear definition of weak and strong protection, the economic development and social welfare impact that might occur in the countries with strong protection, and the appropriate degree of IPR protection in the developing countries. These problems come from the interpretation of IPR protection and the obligations of TRIPS as WTO's members (Scotchmer, 2004: 419). As such, it is very important to examine the role of TRIPS for developing countries.

Most developed countries scarcely recognize TRIPS, using it instead as a tool to enforce IPR in their own interest. They have not been concerned with the provisions on economic and social welfare of developing countries. Developed countries exert trade pressures on developing countries to set up the system of strong IPR protection regardless of the social and economic circumstances in those developing countries. To avoid trade punishment from developed countries, developing country members have to follow TRIPS, regardless of the effect of such move on their health welfare and economic development. There is a dilemma for policy makers to justify between the benefits from the objective of TRIPS and domestic social welfare (Gould and Gruben, 1996: 325). For example, if the developing countries do not use compulsory licensing on the patent of medicines for some diseases, which is allowed by TRIPS, the health care system in those countries could deteriorate because of the prohibitive cost of medicines. But compulsory licensing for patent protection is opposed by developed countries such as the United States (Office of the United States Trade Representative, 2009: 9-38).

Other examples illustrate the problems of IP law enforcement in developing countries. On 7 May 2009, the mass media in Thailand reported the news on the IPR enforcement in Patpong area, the big night market in the heart of Bangkok; the police operations that carried out the enforcement caused damages and injuries; the officers were not in uniform and did not show their identification; they carried firearms, were at times violent, and seized all items of goods for sale without verifying the legitimacy or authenticity of the products. After the police operation, groups of merchants protested at the Ministry of Commerce against the violence and complained that the government's IPR protection was excessive and inappropriate (Bangkokbiznews, 2009: 1). Allegations of excessive and inappropriate IPR protection have also been noted in China, Malaysia, India, and Indonesia. However, the view of World Intellectual Property Organization (WIPO) is that IPR protection in these countries is weak (Keplinger, 2008: 2-30). Thus, a critical question is whether or not IPR protection is always consistent with innovation and higher growth (Gould and Gruben, 1996: 324). The importance of the question relates to the developing countries not having a clear guideline on the appropriate minimum standard required by TRIPS and not feeling the benefit of TRIPS. These has led to uncertain policy on IPR protection and regulations; this uncertainty tends to jeopardize the economic growth and social welfare objectives of developing and even the least developed countries. A major issue is that the drawbacks of TRIPS can limit economic development and innovation in developing countries.

1.2 Research Questions

The previous studies have tried to examine the impact of IPR protection on economic growth, FDI, R&D and technological diffusion. But there is scarce evidence on the impact of IPR protection on technological progress. Thus, this study takes into account the impact of IPR protection on technological progress that challenges the objectives of TRIPS. It also investigates the effect of the degree (weak and strong) of IPR protection on technology progress in the countries that are the source of technological innovation and the user countries. This dissertation measures the impact of IPR protection on social welfare, which has not been directly investigated by previous studies.

The research questions focus on the following issues. Does strong IPR protection contribute to the promotion of technological progress? Is TRIPS useful for every country? How does IPR protection impact on social welfare in terms of infants' health welfare?

1.3 Purpose of Study

This study seeks to provide an understanding of the role of TRIPS in the promotion of technological innovation and the impact of IPR protection on technological progress and social welfare.

The purposes of the study are to investigate the (i) impact of IPR protection on technological progress in WTO member countries, (ii) the role of TRIPS in the member states as stated in its objectives, and (iii) the impact of IPR protection on social welfare.

The study is expected to provide the empirical evidence of the impact of IPR protection for the Thai policy makers to set up an appropriate IPR protection mechanism that encourages technological progress and economic growth.

1.4 Scope of Study

The study uses the number of patents as key indicator for innovation. Previous studies measure technological progress through total factor productivity or TFP (Bauer, 1988: 15). But TFP comes from many factors (Kripornsak, 1999: 4). Particularly relating to IPR are two factors to stimulate TFP in the countries, namely, innovation for technological progress and R&D. R&D is necessary to innovation and needs capable researchers. This means that the source of human capital and innovation is a sufficiently skilled workforce to be able to absorb and efficiently use the new and more advanced technologies (Serrano, Lopez-Bazo, Garcia-Sanchis, 2002: 18-19). Thus, one incentive for inventors or researchers is exclusive right or monopoly power in the market within a certain period, which is provided by IPR protection through the patent laws and other intellectual property (IP) laws.

To measure technological progress through TFP is ideal and given broader meaning because TFP comprises many indirect factors and does not directly depend on advanced innovation. Some of the factors of TFP such as infrastructure may not show a direct relation to technological progress (Khan, 2006: 389). Accordingly, this study tries to measure the level of technological progress through the number of patent applications, as has been suggested by previous studies (Mansfield, 1986: 177-

178, Besen and Raskind, 1991: 7-9). TRIPS provides the broad objective of IPR protection including the patent to technological progress, but there has been no studies on the impact of a strong IPR protection on technological progress and economic growth and social welfare, as Article 7 states.

One way to assess the level of technological progress is the Technology Achievement Index (TAI), which was developed by Desai, Fukuda-Parr, Johansson, Sagasti, (2002: 28-34). It comes from real technology sectors. Table 1.3 gives some indications that a country having less IPR cases can have a higher TAI. A high TAI means a high level of technological progress. Table 1.3 shows a picture that seems to contradict the expectations from a strong IPR protection, which will be investigated in the following chapters.

Table 1.3 The Ratios of IPR Enforcement Compared to TAI in Selected Countries

	Ratios of IPR Enforcement	**TAI**
Finland	0.2%	0.744
U.S.A.	40.5%	0.733
Japan	2.0%	0.698
S.Korea	21.5%	0.666
U.K.	0.8%	0.606
Canada	1.5%	0.589
Australia	0.5%	0.587
Thailand	23.8%	0.337
Taiwan	9.3%	N/A
Total	**100%**	

Source: Desai, Fukuda-Parr, Johanson, and Sagasti, 2002: 103

Finland is shown in the table as having the highest TAI but a low Ratio of IPR enforcement. On the contrary, Thailand has a high Ratio of IPR enforcement but has a lower TAI than many other countries. And even though the high Ratio of IPR enforcement indicates a strong IPR protection, the TAI of Thailand is very low. Thus, a strong IPR protection seems not to give any support for technological progress. This suggests that IPR protection and technological progress may not relate to innovation development as claimed by TRIPS.

1.5 Organization of the Study

The study is organized into five chapters. Chapter 1 is the introduction. Chapter 2 reviews literature on the historical background of IPR, legal framework worldwide, roles of TRIPS, social welfare implications, and the evidences of the pros and cons of IPR protection. The chapter also outlines the problem in the current context. Chapter 3 presents the frame of study, research methodology and sources of data. Chapter 4 describes the empirical results and discusses the regression results. Chapter 5 is the conclusion and recommendation.

CHAPTER 2

LITERATURE REVIEW

2.1 The Origin of IPR

Science grew explosively from the beginning of the Renaissance through the Industrial Revolution. The growing realization that innovation could lead to prosperity persuaded European governments to make unprecedented efforts to promote it. In the process, they developed the first systems of IPR and reinvigorated existing institutions with prizes, patronage and other rewards.

Medieval monarchs had long rewarded supporters by giving them patents -- legal monopolies over the right to provide particular goods and services. By the fifteenth century, rulers were offering patents to foreigners who agreed to import new technologies. By the sixteenth century, French local authorities were using a similar system to encourage domestic inventors. Eventually, patents became a reward for innovation.

In the beginning, patents were given at the discretion of the ruling authorities. Since they were not routinized under the authorities of a disinterested administrative body, they were subject to abuse. People complained that rulers created patent monopolies too lightly or too arbitrarily, or for corrupt reasons. The patent system was formalized largely as a remedy. The first formal patent statute was in Venice in 1474, and in 1623, the English Parliament passed the Statute of Monopolies. The statute defined the specific appropriate circumstances in which patents could be used to reward inventors, and was mainly aimed at limiting monopolies, rather than facilitating invention. The beginning of patent protection in England was marked, in 1657, by the pendulum clock being protected, followed by protection of the torsion pendulum clock (1675), the steam powered pump (1698), the first modern steam engine (1767), and punch card-controlled looms (1802). Greece granted a monopoly power for an inventor of new dish for a period of one year for its social and religious purpose. The aim of patent protection at that time was to safeguard the craft knowledge which had gained widespread reputation outside the region. Thus, it can be regarded as communal property rather than a monopoly held by an individual, as is the case at present. (Devaiah, 1992: 881-906).

Copyright examples can also be found in the Stationers' Company in London but these were granted to bookbinders, booksellers and printers, not to authors. They persuaded the British Government to enact the first British Copyright Act in 1710. The system gave the guild the power to limit competition much as copyright does today. Because the guild needed a government license to print books, the system also served as a form of censorship (Khong, 2006: 35-69).

The development of IPR protection in England was faster than in any other neighboring country at that time. Incentives for inventors including prizes became an important device for stimulating both basic science and technological innovation, but sometimes a challenge was posted without a prize, since winning it added to reputation and could attract a patron. For example, Newton solved the era's most important challenge in 1697 by calculating the path that a ball should take for the fastest descent to a point not directly beneath it. The solution opened the way to multivariate calculus. In a later period, prizes led James Maxwell (1879) to devise a mathematical theory of Saturn's rings and Heinrich Hertz (1894) to detect radio waves. Prizes were also offered for technological contributions, as opposed to basic science (Khan, 2007: 5-8).

Furthermore, an important example was the Danish king's support of Tycho Brahe in 1601, who made the astronomical observations that underlie the conclusion that the earth revolves around the sun. This laid the foundation for Newton's physics. In England, George III gave the astronomer William Herschel in 1822 a reward of UK$200 a year after he discovered Uranus. Herschel used the money to build the biggest telescope in Europe.

The second half of the nineteenth century and the early twentieth century were a golden age of technology development. The era brought the electric light, motion picture, phonograph, radio, telephone, airplane and automobile. Inventors were admired as never before or since. The lure of patents played a central role in this transformation.

However, the system of patent protection was imperfect in those times. One unavoidable difficulty was that, while patent rewards inventors, the inventors had to find the research fund by themselves. Many of the era's most prominent inventors got around this problem by working in basements or garages until they were established. Thomas Edison (1931), Gottlieb Daimler (1900), John Dunlop (1921), Alexander Graham Bell (1922), George Eastman (1932), and Guglielmo Marconi (1937) obtained their first patents while working in modest home laboratories in their spare time. But this model was not sustainable. Most of the twentieth century's hallmark inventions required large design teams and laboratories. This technological imperative put innovation beyond the reach of basement tinkerers.

Nowadays, the rise of big science in this century requires huge expenditures. One immediate consequence is that funding decisions could no longer be made between individuals. For example, in the field of astronomy, or space craft, state-of-the-art telescopes are too expensive for any individual. (Maurer, 2005: 1-18). The system of funding R&D and the way to get returns from the investment are more complicated.

2.1.1 Background and Development of IP Laws

2.1.1.1 Background

In the early days of industrialization, the governments of the advanced countries concentrated on controlling the migration of skilled workers. In 1719, France attempted to recruit hundreds of skilled workers from Britain while Britain introduced a ban on the migration of skilled workers for jobs abroad. According to British law at that time, anyone who migrated to abroad to work without the permission of the government was subject to punishment through fine or imprisonment. Workers allowed to migrate who did not return home in six months after being warned to do so by an accredited British official would in effect lose their right to own property in Britain, and have their citizenship taken away. Mentioned in the law were specific industries such as wool, steel, iron, brass or any other metal, and watch-making, but in practice the law covered all industries. The ban on emigration of skilled labor and suborning lasted until 1825. Subsequently, as increasing amounts of technologies got embodied in machines and machine exports came under control. Britain introduced a new Act in 1750 banning export of "tools and utensils" in the wool and silk industries, while strengthening the penalty for its violation. The ban in Britain law was widened and strengthened in subsequent legislations. In 1774, another Act was introduced to control machine exports in cotton and linen industries. In 1781, the 1774 Act was revised and the wording "tools and utensils" changed to "any machine, engine, tool, press, paper, utensil or implement whatsoever", indicating the increasing mechanization of the industries. In 1785, the Tools Act was introduced to ban exports of many different types of machinery. This ban lasted until 1842.

In the old days, technology transfer was not easy. For example, it took decades for the Continental European countries to assimilate British technologies, even in the days when technologies were relatively simple so that importing some skilled workers and perhaps a key machine could enable a technological follower to replicate what the leader was doing. It is because there were strict regulations and laws to prohibit doing so.

By the late nineteenth century, the patent and other IPR became a key issue in technology transfer. The bans on skilled worker migration and machinery exports by Britain were abolished by the mid-nineteenth century thanks to their increasing ineffectiveness. By the middle of the nineteenth century, the key technologies became so complex that importing skilled workers and machinery was no longer enough to achieve command over a technology. In many areas, an active transfer by the owner of technological knowledge through licensing of patents emerged as a key mode of technology transfer.

Most now-developed countries established their patent laws between 1790 and 1850, and established other elements of their IPR regimes, such as copyright laws (first introduced in Britain in 1709) and trademark laws (first introduced in Britain in 1862), in the second half of the nineteenth century. All of these IPR regimes were highly 'deficient' by current standards. Patent systems in many countries lacked disclosure requirements, incurred very high costs in filing and processing patent applications, and afforded inadequate protection to the patentees. Few allowed patents on chemical and pharmaceutical substances.

In the early days, the IP laws such as the patent laws accorded very inadequate protection for foreign citizens. Many of the laws were very lax on checking the originality of the invention. More importantly, in most countries, including Britain (before the 1852 Reform), the Netherlands, Austria, and France, patenting of imported inventions by their nationals was often explicitly allowed. In the US, before the 1836 overhaul of the patent law, patents were granted without proof of originality. This not only led to the patenting of imported technologies, but encouraged racketeers to engage in 'rent-seeking' by patenting devices already in use ('phony patents') and by demanding money from their users under threat of suit for infringement.

The experiences of Switzerland and the Netherlands in relation to their patent laws deserve even greater attention. The Netherlands, which originally introduced a patent law in 1817, abolished it in 1869, partly due to the rather deficient nature of the law but also having been influenced by the widespread patents as being no different from other monopolistic practices. Switzerland did not provide any protection of intellectual property until 1888, when a patent law protecting only mechanical inventions was introduced. Only in 1907, prompted partly by the threat of trade sanctions from Germany in retaliation to the Swiss use of its chemical and pharmaceutical inventions, did a patent law worth its name come into being. However, even this had many exclusions, especially the refusal to grant patents to chemical substances (as opposed to chemical processes). It was only in 1954 that the Swiss patent law became comparable with those of other advanced countries, although chemical substances remained unpatentable until 1978.

The 1878 the Paris Congress set up a commission to produce a draft convention that was discussed in the first 'official' meeting on an international IPR regime (with representatives from 19 governments) in Paris in 1880. This draft convention was eventually ratified by 11 countries in Paris in 1883 in the form of the Paris Convention of the International Union for the Protection of Industrial Property (the original signatories were Belgium, Portugal, France, Guatemala, Italy, the Netherlands, San Salvador, Serbia, Spain and Switzerland). It covered not just patents but also trademark laws (which enabled patentless Switzerland and Netherlands to sign up to the Convention despite not having a patent law). In 1886, the Berne Convention on copyrights was signed. The Paris Convention was subsequently revised a number of times (notably in 1911, 1925, 1934, 1958, and 1967) in the direction of strengthening patentee rights. Together with the Berne convention, the Paris Convention had formed the basis of the international IPR regime until the TRIPS agreement.

At that time, Switzerland and the Netherlands had no patent law. It is also interesting to note that the US, a strong advocate of patentee rights even then, did not acknowledge copyrights of foreigners until 1891. And as late as the late nineteenth century, when Germany was about to technologically overtake Britain, there was a great concern in Britain with German violation of its trademark.

Although Britain did not have a trademark law until 1862, before that time British manufacturers engaged in litigation to protect trademarks. In 1862, it introduced a trademark law which banned 'commercial thievery' such as the forging of trademarks and the labeling of false quantities. In the 1887 revision of the Act., mindful of German (and other foreign) infringement of the British trademark law, the British parliament specifically added the place or the country of manufacture as a part of the necessary "trade description". This revised Act banned not only patently false descriptions, but also misleading descriptions such as the then widespread German practice of selling counterfeit goods with fake logos.

Historical evidence shows that, in the early days of industrial development in the now-advanced countries, IPR was not well protected. Compared with the developed countries of the old days, the contemporary developing countries seem to be behaving much better in many ways. If that is the case, it seems unfair to ask the modern day developing countries to behave to a standard that was not even remotely observed when the now-advanced countries were at a similar, or even more advanced, stage of development. (Chang, 2001: 287-294).

2.1.1.2 Development of International IP Laws

There have been many endeavors to protect IPR. Most of developed countries have tried to organize the system and to design international laws for all countries. The result of all those endeavors is a large number y of conventions, as listed in Appendix A.

1) IPR Protection and Development in Asia

Recently, the rapid growth at 5.5 per cent in per capita GDP sustained over the 1960-90 period, and the even more impressive growth in exports in the East Asian economies, such as Japan; South Korea, Taiwan, Hong Kong and in Singapore, Malaysia, Thailand, Indonesia, and China, have attracted much analytical studies. While some analysts have attempted to dismiss the East Asian achievement as the result of factor accumulation along the production function, voluminous empirical evidence is now available to corroborate that a substantial proportion of East Asian growth was contributed by growth of total factor productivity (TFP) that has averaged between 2 to 4 percent per year over 1960-89 thus contributing over a third of the growth of output in these countries. Furthermore, evidence is now available to confirm that the assimilation of foreign technology was a critical component of the Asian Miracle. There seems to be consensus that the East Asian success owes a lotto their ability to imitate, absorb, assimilate, replicate or to carry out ‘duplicative imitation’ of foreign inventions. The existing evidence on the role of IPR protection in promoting growth is very trivial. Although the literature is ambiguous in acknowledging its role, the weak IPR protection typically adopted by these countries in the period of duplicative imitation or reverse engineering has played and important role in facilitating the firm level technological learning as has become clear from the case studies of Japan, Korea, Taiwan, India, and Thailand. The cases are summarized below:

(1) Japan

Japan greatly benefited from intellectual property generated in other developed countries in the early stages of its development. In Japan, IPR protection such as patent has been designed with the objective of contributing to the industrial development and not as an end by itself and contains several features that have helped the absorption of spillovers of foreign inventive activity by domestic enterprises. For instance, food, beverage, pharmaceutical products and chemical compounds were excluded from patent protection until 1975 to facilitate the process innovations. Japan's IPR system provides for utility models to encourage minor adaptations or improvements on the imported machinery or equipment by domestic inventors, and protection of industrial designs that only needed to demonstrate novelty and not inventiveness. The utility models and industrial designs have allowed Japanese firms to receive protection on technologies that were 'only slightly modified from the original invention'. The IPR system also employs the first-to-file principle rather than the first-to-invent principle incorporated in the US law, pre-grant disclosure and compulsory license. These features have been designed to favour adaptations by domestic enterprises. Almost all of the utility models and industrial designs have been granted to nationals. Quantitative studies confirm that the weaker patent system employed by Japan has facilitated absorption, transfer and diffusion of technology and contributed to the TFP growth during the period 1960-93 (Kumar, 2003: 22).

(2) South Korea

South Korea adopted the patent legislation only in 1961. However, the scope of patenting did not cover products and processes to manufacture food products, chemical substances and pharmaceuticals. The US pressure pushed Korea to strengthen its IPR regime in 1986, and extend product patent protection to new chemical and pharmaceutical products, adopt a comprehensive copyright law, and extend the patent term from 12 to 15 years. Korea has also followed an IPR protection that facilitated adaptation and imitative duplication of foreign technologies by domestic enterprises through utility models and industrial designs. That the soft IPR regime adopted initially was a part of conscious policy of the government to facilitate imitation by domestic enterprises has been documented well in the literature on Korean technological capability (Kumar, 2003: 23-25).

(3) Taiwan

Taiwan has also employed a weak IPR policy to facilitate local absorption of foreign knowledge through reverse engineering on the lines of Japan and South Korea. In fact Taiwan's government seemed to openly encourage counterfeiting as a strategy to develop local industries until 1980s. Taiwan allowed patents on food, beverages, micro-organisms, and new uses for products, only in 1994 under heavy US pressure. Like Japan and Korea, Taiwan also provides for utility models and design patents (Kumar, 2003: 25-26).

(4) India

India had inherited the Patents and Designs Act 1911 from the colonial times that provided for protection of all inventions and a patent term of 16 years. However, a few domestic chemical and pharmaceutical enterprises that tried to develop their own technology in the 1960s were prevented to work on their technologies by foreign patent owners using broad and vague provisions of the Patent Act. Under pressure from domestic industry, the government adopted a new Patents Act in 1970 that reduced the scope of patentability in food, chemicals and pharmaceuticals to only processes and not products. The term of process patents was reduced to 7 years in food, drugs and chemicals and 14 years for other products. The compulsory licenses could be issued after three years. It is now widely recognized that the 1970 Act had facilitated the development of local technological capability in the chemical and pharmaceutical industries by enabling the process development activity of domestic firms, as confirmed by a number of quantitative studies. The gradual build-up of technological capability of Indian enterprises is visible from a rising trend of residents in patent ownership in India, and in the ability of India to raise her share in the US patents. India ranked seventh amongst all developing countries in terms of US patents obtained (ahead of Brazil, China and Mexico) and fourth in the chemicals sector and in biotechnology. In particular, the rapid evolution of Indian pharmaceutical industry since the mid-1970s highlights the fact that weak IPR regimes could be instrumental in building local capabilities even in a poor country such as India. In 1970 much of the country's pharmaceutical consumption was met by imports and the bulk of domestic production of formulations was dominated by MNE subsidiaries. By 1991, domestic firms accounted for 70 per cent of the bulk drugs production and 80 per cent of formulations produced in the country. With their cost effective process innovations, Indian companies have emerged as competitive suppliers in the world of a large number of generic drugs. A steady growth of India's export of drugs and pharmaceuticals has transformed the industry from one that is highly import dependent to one that generates increasing export surplus for the country. The share of pharmaceuticals in national exports has increased from 0.55 per cent in 1970-71 to over 4 per cent by the 1999/00. India's share in world exports of pharmaceuticals has risen by 2.5 times over the 1970 to 1998 period making her the second largest exporter of pharmaceuticals after China among developing countries. Inter-firm comparisons show that domestic enterprises are more dynamic in terms of growth of investment and output, export-orientation, R&D activity, technology purchases and labor productivity compared to MNE subsidiaries. The development of process innovation capability of Indian enterprises has enabled them to introduce newer medicines within a short time lag of their introduction in the world market. The drug prices in India at a fraction of those prevailing in the developed countries are among the cheapest in the world making them affordable to the poor. The technological capabilities of Indian companies and institutions have attracted leading MNEs to start R&D joint ventures, commission contract research and set up R&D centers (Kumar, 2003: 27-30).

(5) Thailand

Thailand is in the midst of making the transition from an agricultural society to a newly industrialized country, and using increasing amounts of new technology, which stimulates economic growth. The value of such advanced technology has become widely accepted in Thailand and plays an integral part in the industrialization process. This increased technology transfer to Thailand raises important issues relating to IPR and the constant protection of such rights. Infringements and imitations of IP are inevitable in a developing country like Thailand, and may be viewed as a good thing by local business, but not by the foreign IPR owners.

In the last decade, Thailand's economic growth has been impressive. To sustain or further expand such growth, the country needs increasing amounts of high technology and know-how. The expansion and growth of business transactions and technological cooperation in the private and public sectors seem inevitable and further underline the country's need for high technology and know-how.

In the meantime, infringement and counterfeiting of IPR in Thailand are the biggest problems facing IPR owners. Advanced countries have alleged that IPR protection in Thailand is very weak or neglected. However, the Thai government has argued that Thailand strongly protects IPR over the minimum standard and follows the requirement of TRIPS completely.

2) Development of IP Law in Thailand

In view of the recent economic growth and the escalating problems of infringement and counterfeiting in Thailand, IPR owners necessarily have to seek protection through both active use and legal protection. An owner must provide evidence of her active use of IPR in order to prove her right over infringers, or she may have to defend against an action of cancellation for non-use.

Legal protection of IPR in Thailand is based on the provisions of various laws such as the Trademark Act B.E. 2534 (A.D. 1991), the Trademark Act (No. 2) B.E. 2543 (A.D. 2000), the Patent Act B.E. 2522 (A.D. 1979), the Patent Act (No. 2) B.E. 2535 (A.D. 1992), the Patent Act (No. 3) B.E. 2542 (A.D. 1999), the Copyright Act B.E. 2521 (A.D. 1978), the Copyright Act B.E. 2537 (A.D.1994), as well as other laws such as the Civil and Commercial Code, Penal Code, and Consumer Protection Act. Trademarks and patents are legally protected by a registration system, while copyright protection is automatic without registration. However, the Department of Intellectual Property provides a copyright registration system. The summary of IP laws in Thailand is as follows:

(1) Marks

Thailand has a standard system of mark registration. Trademark protection is currently implemented under the Trademark Act B.E. 2534 (A.D. 1991) as amended by Trademark Act (No. 2) B.E. 2543 (A.D. 2000), which became effective on June 30, 2000. Thailand adopted the International Classification of Goods and Services for the Purposes of the Registration of Marks. The Act classifies goods and services into 45 groups and provides for legal protection and registration of Trademarks, Service Marks, Certification Marks, Collective Marks and Trademark/Service Mark License/Registered User.

According to the Thai Trademark Act (No. 2) B.E. 2543 (A.D.

2000), a mark includes a photograph, drawing, invented picture, brand, name, word, text, letter, numeral, signature, group of colors, shape, or three-dimensional object, or any combination of these items.

A trademark can be registered if it meets the following conditions: It is distinctive, it is not forbidden under the Act, and it is not identical or similar to trademarks registered by others.

(2) Copyrights

Copyright is protected and governed by the Copyright Act B.E. 2537 (A.D. 1994), Ministerial Regulations B.E. 2540 (A.D. 1997), and Notification of the Ministry of Commerce as a List of Member Countries to the Convention Governing Protection of Copyrights or the Convention Governing Protection of Performers' Rights. Generally, protection is for the whole life of the copyright creator plus a further 50 years.

A copyright is inherent in every original work if: At the time of creating a yet unpublished work or else when it first became published, the author was either a Thai citizen or person resident at all times or most of the time in Thailand, or a national or resident of a member country of the Berne Convention or TRIPS.

(3) Patents

Thailand is not a party to any international convention concerning patent protection, but nationals of countries which grant reciprocal rights to Thai nationals or are members of the WTO have the right to claim priority rights within 12 months from the first foreign filing date. However, Thailand ratified its membership of the Patent Cooperation Treaty (PCT) on 24 September 2009 that provides a unified procedure for single filing patent applications to be protected in all member states.

Patents are protected under the Thai Patent Act B.E. 2522 (A.D. 1979), Patent Act No.2 B.E. 2535 (A.D. 1992), and Patent Act No. 3 B.E. 2542 (A.D. 1999), covering both inventions and product designs. The Acts provide protection for patents, design patents and petty patents.

(4) Other related IP laws

Thailand has also enacted many other IP laws such as Trade Secrets Act, Geographical Indication Protection Act, Plant Varieties Protection Act, Protection of Layout-Designs of Integrated Circuits Act, Thai Traditional Medicine and Local Knowledge Protection and Promotion Act, The Production of CDs Product Act etc.

(5) Conventions

Thailand is a member of the International Convention for the Protection of Literary and Artistic Works (Berne Convention) concluded at Berne in September 1886, revised at Berlin on November 13, 1908, and completed by the Additional Protocol signed at Berne on March 20, 1914. Thailand did not accept the revisions of the Berne Convention as amended by the Rome Act of 1928, by the Brussels Act of 1948, or by the Stockholm Act of 1967. However, Thailand did accept Sections 22 to 38 of the Berne Convention revised in Paris in 1971.

Thailand has adhered to the Berne Convention since 1931 and TRIPS since January 1, 1995. Copyrighted work of a creator from a member country of both the Berne Convention and TRIPS shall enjoy protection under the Copyright Act of 1994. The Act also protects foreign performers' rights of member countries of TRIPS.

Thailand is not a signatory to the Rome Convention of 1961 or the Universal Copyright Convention. Therefore, only persons with unpublished works who are nationals, subjects, or residents of a country party to the Berne Convention, and those whose works were first published in such a member country may claim copyright protection in Thailand, provided certain conditions are met.

In early November 2007, Thai government has successfully secured the National Legislative Assembly's approval for joining the Paris Convention.

2.2 Debates on IPR Protection

2.2.1 Economic Justification of IPR Protection

IPR is the temporary grant of monopoly right intended to give economic incentives for the innovative activity. IPR exists in the form of patents, copyrights, and trademarks. IPR, particularly patents, have been considered as a tool that fosters economic development by promoting innovation and inventiveness (Cullet and Kameri-Mbote, 2005: 4).

IPR is categorized into two groups: Industrial property, which includes inventions (patents), trademarks, industrial designs, and geographic indications of source; and Copyright, which includes literary and artistic works such as novels, poems and plays, films, musical works, artistic works such as drawings, paintings, photographs and sculptures, and architectural designs. Rights related to copyright include those of performing artists in their performances, producers of phonograms in their recordings, and those of broadcasters in their radio and television programs.

Idea, product, invention, and innovation are protected by laws more than 100 years since the Paris Convention for the protection of industrial property enacted on March 20, 1883. At that time, the convention was initiated to protect the diligence of inventors to take advantage from their persevering, but 100 years ago the contribution of IPR protection to economic growth was not obvious until the model of economic growth was introduced.

The economic rationale for IPR protection is to encourage the development of new products, and thus generate consumer surplus. The net profit that accrues to inventors is also a social benefit, since it is a transfer from consumers. However, profit is recognized as a necessary evil, since the flip side of profit is deadweight loss. There is no economic rationale for protecting inventors per se.

There has been a recent expansion of IPR protection under the TRIPS that has extended IPR protection beyond what is optimal. Some commentators have suggested that this is because trade negotiators are captured by industry. Capture is undoubtedly an important phenomenon, but IPR protection can become overprotective even if trade policy negotiators are equally concerned with all domestic interests including those of both consumers and producers. This is because IPR protection is a tool by which cross-border externalities can be recaptured by the innovating country. Of course, the domestic interests of countries innovators must be balanced against the interest of domestic consumers for evidence that national differences give rise to different IPR protection policies, and evidence on how IPR protection policies affect trading relationships and FDI (Scotchmer, 2004: 435-436). Furthermore, the objective of IPR protection is to create incentives that maximize the difference between the value of intellectual property that is created and used and social cost of its creation (Besen and Raskind, 1991: 5-25).

There has been considerable controversy on the role of IPR protection in determining inward FDI flows and their effect on technology licensing and trade. Exports, FDI and arm's length technology licensing are considered as alternative modes of servicing a foreign market by firms. Stronger protection increases the value or revenue productivity of a firm's intellectual property such as technology, brand and trade names. Strong protection should help exporters by making imitation and counterfeiting more difficult. The strong IPR protection may induce greater dollar volumes of licensing, but it is impossible to claim that strong IPR protection encourages more licensing contracts and additional transfer of technological information (Yang and Maskus, 2001: 23). However the effect of IPR strength on FDI and licensing is not that straight forward. By reducing the transaction cost of transfer of knowledge by multinational enterprises (MNE) to foreign countries, stronger protection may encourage arm's length licensing of the knowledge and reduce the need for undertaking FDI, while the countries in which weak IPR protection tend to attract lower FDI volumes (Yang and Maskus, 2001: 3). On the other hand, it has been argued that poor IPR protection tends to adversely affect the investment climate and hence the likelihood of MNE investments. The sparse empirical verification of these contentions has generally shown an insignificant influence of the extent of IPR on inward FDI. Frischtak (1989:16-20) found that there is no significant role of IPR protection in influencing the pattern of FDI and technology transfers. Kumar (2003: 13-21) examined the role of an index of the strength of patent protection as measured by Ginarte and Park in 1997 in explaining the sales and value addition of affiliates of

US and Japanese affiliates in 74 countries in seven broad branches of industry and at three points of time in the framework of an extended model of location of foreign production. The strength of patent protection regime although with a positive sign never had a statistically significant coefficient for affiliate sales or value added in the case of new U.S. multinational enterprise (MNEs). However, the strength of patent regime does not appear to be a significant factor in determining the patterns of US or Japanese FDI. Some further analysis of the same data set at the level of seven broad sectors, currently in progress and reported in Kumar (2003: 19) suggests that strength of patent protection does not influence the patterns of US affiliate sales in any of the seven branches of manufacturing except the miscellaneous industry where it had a significant but negative coefficient. However, the effect is larger on arm's length licensing than on FDI. These conclusions are consistent with those of Yang and Maskus (2001: 15-22) who find that patent rights promote arm's length trade and have a less significant effect on internalized technology transfers through FDI. In 1995, Kumar studied the R&D intensity of affiliates of US MNEs in 54 countries in 1977, 1982, and 1989, and found that strength of patent protection had a significant positive influence on R&D intensity of affiliates located in developed countries and has a negative coefficient in a developing country sub-sample, which however is not statistically significant. Thus strong patent protection does not appear to be a prerequisite even for R&D investments by MNEs in developing countries. The R&D investments of MNEs are highly dependent upon the country's ability to provide necessary technological resources and local technological capability. These conditions have to be created before R&D investments from MNEs can take place. The IPR protection may not affect the flow of investment in R&D significantly but may affect the nature or direction of R&D activity conducted (Kumar,1996: 8). Therefore, availability of abundant trained low-cost human resource and scale of ongoing R&D in their own fields appear to be more important considerations for establishing R&D in developing countries than the strength of IPR regime.

The importance of IPR protection to economic rationale was originally examined in the Solow growth model, which treats it as exogenous. The model focuses on four variables: output (Y), capital (K), labor (L), and "knowledge" or the "effectiveness of labor" *(A)*. From the production function $Y(t) = F(K(t), A(t)L(t))$, t denotes time. The implication of this model is that output changes over time only if the inputs to production change. The amount of output is obtained from given quantities of capital *(K)* and labor *(L)*. However, this growth model adds A to L referred to as effective labor and technological progress (Romer, 2001:9). This in turn implies that technological progress is embodied in labor input. Even the main assumption of the Solow growth model depends on capital, labor and knowledge, but knowledge or technological progress will still show through labor called the rate of labor-augmenting technological progress (Mankiw, 2003: 208). However, the Solow model does not explain the determinants of technological progress (Mankiw, 2003: 215). In the Solow model, saving leads to growth temporality, but diminishing returns to capital eventually force the economy to approach a steady state. In the long run, growth finally is only determined by exogenous technological progress. This explanation raises the attention of policy makers to focus on IPR protection as a tool to promote technological progress (Agreement on Trade-Related Aspects of Intellectual Property Rights. 1994: 319-351).

Later, the Endogenous Growth Model introduced by Paul Romer in 1990, deeply interpreted K as a type of capital. This model, $Y = AK$, assumes that one extra unit of capital produces A extra units of output (Mankiw, 2003: 223). But Romer (2001: 99-101) introduced the research and development model on the production of new technologies. The model used the dynamics of knowledge accumulation without capital; the production function for output becomes $Y(t) = A(t)(1-a_L)L(t)$, A denotes 'effectiveness of labor' or technology. The fraction a_L of labor force is used in the R&D sector and fraction $1-a_L$ in the goods-producing sector. This equation implies that output per worker is proportional to A, and thus that the growth rate of output per worker equals the growth rate of A (Romer, 2001: 101). It means that the long-run growth rate of output per worker is determined by technological accumulation of labor force. However, the production of new ideas depends on the quantities of capital and labor engaged in research and development on the level of technology. The endogenous growth model explains the role of IPR protection on economic growth in various dimensions.

It is difficult to measure accurately the level of technology progress because there are no specific numbers to indicate the technological achievement in every country. However, most studies have attempted to estimate technological progress by using various determinants such as total factor productivity (Khan, 2006: 392-395), number of patents (Bessen and Maskin, 1999: 34), and Technological Achievement Index (Desai et al., 2002: 95-102). These approaches comprise various variables. However, this study will not go into further detail on the process of calculation on the level of technological progress. Its scope will focus on the role of IPR protection impacts on technological progress and social welfare impact from IPR protection, and the role of TRIPS.

As specified in TRIPS, in order to promote technological innovation, the countries have to protect and enforce IPR. So far, the contribution of IPR protection to technological progress and economic growth is ambiguous. Most developing countries have tried to enact and enforce IP laws as required by TRIPS and requested by developed countries. Some of developing countries have not done so because they find no positive impact from strong IPR protection on their economic welfare. This argument comes from two different empirical results of strong IPR protection. One is that strong IPR protection will lead to economic growth from FDI and lead to technological progress (Ngassam, 2006: 33-39). The rest argue that imperfect IPR protection will maximize growth in the long run because growth is driven by two types of innovation in existing sectors: leapfrogging in monopolistic sectors, and innovation after imitation in competitive sectors (Horii and Iwaisako, 2005: 31).

2.2.2 Two-Country Model of IPR Protection: Open Economy Considerations

The real world is made up of two different perspectives of IPR protection. If neither country protects IPR, there is no incentive for private agents to undertake the required R&D to develop the new product. Thus, a country may protect IPR in the way which provides the benefits from such protection. Figure 2.1 provides an explanation for differentiating countries into two types.

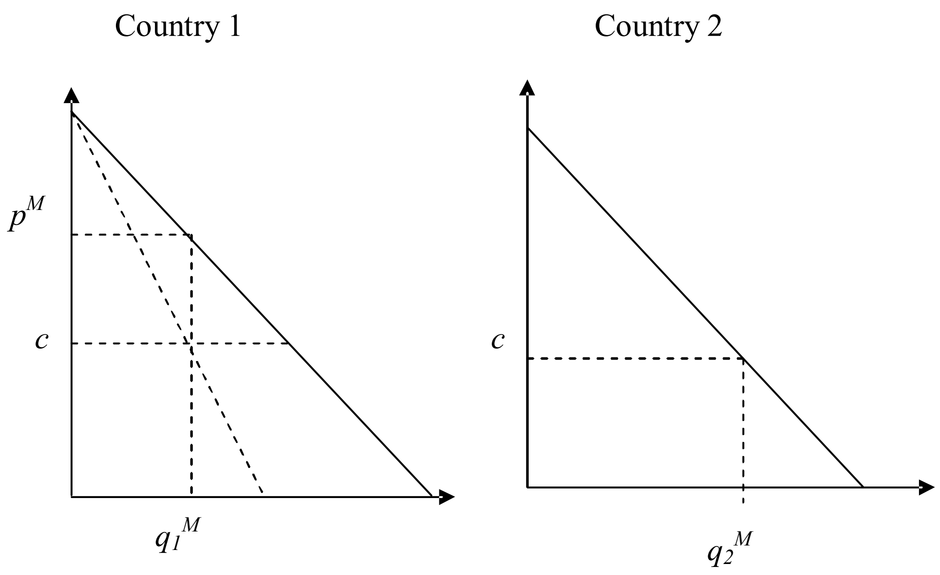

Figure 2.1 IPR Protection, Two-Country Model

If the profit is the motive to protect IPR for two countries, the impact of protection can occur in the following: for example, the profits of innovators in two countries are π_1, π_2, respectively. If both countries protect IPR equally, then the solution is $\pi_1 + \pi_2 = \pi_0$. If only one country, say Country 1, provides patent protection, then the per-period profit for the innovator is $\pi_1 < \pi_0$. Two possibilities can happen in this context, if π_1 is large enough, the innovation will be undertaken anyway. Consequently, Country 1 has the same price and quantities as with the integrated economy case, whereas Country 2 has access to the innovation at the competitive price $p^c = c$ with efficient quantity provision q^c. From this point, there would seem to be no dynamic gains from strong IPR protection. But Country 2 may increase its consumption of the new product invented in Country 1, and therefore, Country 2 increases welfare. But such potential welfare gains are uneven because all new products will move to Country 2 where there is weak or no IPR protection (because products and knowledge can be transferred to another country in open economy). However, if π_1 is not enough to justify investment in R&D, no innovation takes place. In such a case both countries lose from absence of IPR protection in one of the countries. However, IPR protection cannot be tailored to one product, and discussing welfare implication in just one market is misleading.

There is no obvious evidence for strong IPR protection provided by TRIPS. Suppose that Figure 2.1 illustrates the *status quo ante*, with Country 1 already offering IPR protection and Country 2 without the protection, and consider the *ex post* situation where the innovation has taken place. The effect of strengthening IPR in Country 2, to the standard of country 1, is to reduce consumption and welfare in Country 2, and to provide a profit windfall of π_2 to the innovator. And, if the innovator is in Country 1, that means new monetary transfer that Country 2 must make to Country 1. Understandably, countries with lower IPR protection can see immediate negative effects of strengthening IPR protection.

For many years, economists have recognized the important role IPR plays to facilitate trade. Today the arguments for and against IPR protection are still under vigorous debate, particularly in GATT. Discussions on the TRIPS was included in the Uruguay Round because many governments contend that weak or nonexistent IPR protection distorts natural trading patterns and reduces the ability of firms to transfer technology abroad. Moreover, nonexistent patent protection may lower the world's R&D by reducing incentives, and thereby diminishing worldwide growth (Taylor, 1994: 361)

2.3 Empirical Studies on the Role of IPR Protection

Economists have tried to estimate the role of IPR protection in various ways. One of the prominent studies on the issue of strong IPR protection is of Maruyama (2006:1-6). The study investigates how a stronger IPR protection in a developing country affects the expansion of absorptive capacity. This study claimed that after the TRIPS came into force in 1995, many developing countries reformed their IPR policy to provide more extensive protection of IPR. The study addresses the problem by using patent data on patent citation-lags: the time lag between the cited patent and citing patent. The data is collected from United States Patent and Trademark Office (USPTO). Maruyama (2006) hypothesizes that the value of R&D output represents the effect of IPR. It focuses on the absorptive capacity because the purpose of R&D in developing countries is to enable it to use advanced foreign technologies as soon as possible. Thus, it is not appropriate to use the value of the R&D output. The study uses the definition of the absorptive capacity from Cohen and Levinthal (1990:128-1989) as "…the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends".

Maruyama (2006) showed how many years Chinese companies took to develop the new invention after a patent was published by another entity. As with other economists, Maruyama (2006) believes that stronger IPR protection induces international technology transfer and has a positive effect on developing absorptive capacity. Thus, the following hypotheses are developed.

1) The stronger patent protection shortens the patent citation lag (the ability to absorb technology).

On the other hand, it would raise the imitation cost and hinder the development of the absorptive capacity. Thus, another hypothesis is

2) The stronger patent protection prolongs the patent citation lag.

Those two hypotheses are examined with regressions of the following form.

$$(CT\ LAG)_t = \beta_0 + \beta_1(IPR\ DMY) + \beta_2(Tch\ IMP)_t + \beta_3(FDI)_t + \beta_4(Htch\ IMP)_t + \beta_5(RD)_t + \beta_6(Trend) + \beta_7(CHM\ DMY) + \beta_8(FGN\ DMY) + \varepsilon_t$$

where *CT LAG* is the citation lag of the n^{th} patent published in year *t*. *IPR DMY* is a dummy variable which equals 1 of t > 2001 and zero otherwise. *TcH IMP* is the volume of Chinese technology import, *Htch IMP* is the volume of high-tech product import in China in year *t.* This variable is used to consider the reversed engineering, *FDI* is the volume of FDI to China in year *t*, and *RD* is the expenditure on R&D in China in year *t*. *Trend* is a trend variable which takes the same value with *t*. This is included to control the effect of natural growth. *CHM DMY* and *EGN DMY* are dummy variables which show the technological characteristics of each patent. *CHM DMY* equals 1 if the patent belongs to chemical field, and *EGN DMY* equals 1 of the technology belongs to engineering field. To categorize these patents, Maruyama (2006) used Derwent Innovation Index (DII). DII classified all of the patents into three categories: chemical, engineering and electronics. *FGN DMY* is a dummy variable which equals 1 if the patent is a foreign one, and zero if it is a Chinese one.

The estimated result of β_1 is positive and statistically significant, which is in accord with hypothesis 2. The study showed that the strengthening IPR protection in developing countries has a negative effect on the countries' absorptive capacity . However, there are long-standing arguments about the degree of protection. These as described in the next section.

2.3.1 Strong IPR Protection to Technological Progress

IPR protection has played a key role in technological development for more than 100 years. The IP laws in the earlier periods days did not proclaim their important role in fostering economic growth, Nonetheless they contributed greatly to many areas of technological development by providing security to the endeavor of the inventors or creators. Through the years the view emerged that strong IPR protection facilitates the emergence of new technologies by balancing the benefits that products and technologies provide society with the need to provide both incentives for continued innovation and an environment in which that innovation is rewarded. The historical record in the industrialized countries of the OECD demonstrates that IPR protection has been one of the most powerful instruments for economic development, export growth, and the creation and diffusion of new technologies (Business and Industry Advisory Committee to the OECD, 2003: 1-19).

In 1942, Schumpeter found that technological progress played the key role for economic development (Witt, 2002:13). Then Romer (1990:78-80) gave evidence that growth rate depends on knowledge and technological component, while Gould and Gruben (1996: 323-350) showed that IPR protection is a significant element of economic growth by stimulating innovation. These results concur with Park and Ginarte (1997: 56-60). More recently, Maskus (2002:1-24) supported the proposition that inadequate IPR could stifle innovation and technical change even in developing countries but added that strong IPR protection alone is not sufficient to establish effective conditions for further technology development and growth. Another recent study held that IPR protection affects economic growth indirectly by stimulating the accumulation of factor inputs like R&D and physical capital (Falvey, Foster, and Memedovic, 2006: 15). These studies believed in technological progress as the key factor for economic development and growth, but did not delve deeply into the issue of weak or strong IPR protection.

The economists who believe in strong IPR protection claim that technological progress is the engine of growth and IPR protection is necessary for every country. Many studies support this belief. For example, Maskus and Penubarti (1995: 227-248) used an augmented version of the Helpman-Krugman model of monopolistic competition to estimate the effects of patent protection on international trade flows. Their results indicate that higher levels of protection have a positive impact on bilateral manufacturing imports into both small and large developing economies. This study showed that trade flows from developed countries in terms of exporting high technology goods from firms located abroad may increase. This study focused on the view of foreign firms. They found that weak IPR protection may deter them to export their patented goods into a foreign market if potential "pirates" can diminish the profitability of the firm in that market because of a weak IPRs regime. Maskus and Penebarti's work supports having a strong IPR protection in order to enhance the environment for international trade. However, it did not show empirical evidence of the relationship between strong IPR protection and international trade. Following the study of Maskus and Penubarti, Fink and Braga (1999: 12) found that the strengthening of a country's IPR protection such as a patent regime would tend to increase imports. If the foreign market has weak IPR protection, a firm may choose to reduce its sales. However, the work of Fink and Braga (1999) confirmed a positive link between IPR protection and trade flows for developing countries, not for developed countries. It implies, however, that IPR protection in developed countries does not affect their trade flows. This raises the question of what is the real impact of IPR protection. Yang and Maskus (2004: 27) concluded that strengthened IPR is likely to have been the primary cause of innovation. However, their work focused only on IPR protection as a tool of innovation for firms. The study did not consider other factors for innovation. Neither did it explain the relationship between innovation and patent protection. Moreover, in an era of trading, there is no positive link between

IPR protection and trade flows in developed countries; the strong correlation between the strength of IPR protection and the level of economic development can be measured by per capita. The effects of IPR protection on bilateral trade flows are theoretically ambiguous (Ngassam, 2006: 36-39). Another result has limited evidence that IPR reform can spur domestic innovation; the study found that U.S firms respond to changes in IPR regimes abroad by significantly increasing technology transfer to reforming countries. (Branstetter, Fisman and Foley, 2005: 25). Kwan and Lai (2003: 21-22) used U.S data to calibrate the model and found that under-protection of IPR is much more likely than over-protection. Moreover, in the case of over-protection the welfare losses are trivial, whereas in the case of under-protection the welfare losses can be substantial.

2.3.2 Weak IPR Protection to Technological Progress

Some studies show that stronger IPR protection reduces the probability of imitation as well as the number of competitive sectors, in which it is easier to innovate than in monopolistic sectors. Other studies also show that stronger IPR protection increases the number of monopolistic sectors in which state-of-the-art quality goods have not yet been imitated.

Strong IPR protection does not necessarily facilitate growth. (Horii and Iwaisako, 2005: 31). Moreover, the impact of IP laws reform in developing countries may not stimulate technological progress. Branstetter, Fisman and Foley (2005: 25) found no causal relationship between domestic innovation and IP law. The negative impact of strong IPR protection is not only expressed in patent protection but also in other types of IPR such as trademark and copyright. Furthermore, the impact of IPR protection on growth, innovation and technology diffusion in developing countries is likely to depend on a number of factors. In the poorest countries, a stronger IPR protection is not likely to lead to substantial benefits in terms of innovation or technology diffusion. The administrative cost of developing a patent system and the enforcement of TRIPS, along with the potential abuses of market power in small closed markets, suggest that such countries could lose out from TRIPS. A strong IPR protection in the poorest countries could inhibit or lengthen the imitative stage of development that seems to be necessary in order to develop innovative capacity in many industries (Falvey, Foster, Memedovic, 2006: 45-47). Like Kwo (2007) came up with the empirical result that full protection policy that banned counterfeiting entirely turned out to be the most inferior welfare policy. These interesting findings permit any country to reply explicitly to the inquiry of this exposition that some counterfeiting can be welfare enhancing. Thee authors who support weak IPR protection found that strong IPR protection can encourage monopoly in goods markets, thus making deadweight loss to society,. They also found that it impedes long-term growth. These studies provide the argument that weak IPR would be an appropriate mechanism to encourage technology diffusion. That is, once the good quality of technology or the state-of-the-art can be imitated, knowledge and know-how will be dramatically diffused. This means that society can derive greater benefit than if knowledge or technology is restricted. Kwo (2007: 11-12) subsequently proposed that novelties are partially nonexcludable, leading to market failures and welfare losses due to quality underproduction. Strong IPR protection creates inefficiency because of higher prices that cause welfare losses due to quality underutilization becoming more severe. It means that once a novelty is launched into the market, it is almost impossible for the innovator to exclude counterfeiters from copying the product. This leads to a market failure and thus a "second best solution", through IPR laws, becomes a satisfactory remedy. Consequently, it was shown that IPR laws enhance the *ex ante* incentives for new discoveries thereby mitigating the problem of quality underproduction. But it also simultaneously creates quantity underutilization through higher prices. As a second best solution, it is not surprising that the welfare levels obtained were inferior. The solution therefore is to find a trade-off between the two conflicting objectives of underproduction and underutilization. A counterfeiting optimum policy was therefore established to strike this balance. The welfare levels of these three potential policies, namely, non protection policy, full protection policy and counterfeiting optimum policy are idealistic but not the best solution since applying any of the will bring forth welfare losses. A criterion for minimizing the social welfare losses in a static framework that was adopted to decide which policy is optimal. The study concludes that for low imitation rates, the non protection policy is preferable. For higher imitation rates, the optimal monitoring policy is favorable. Both policies accommodate a quantity of counterfeiting. Conversely, the full protection policy that banned counterfeiting entirely turnrd out to be the most inferior welfare policy. The study further concludes that some counterfeiting can be welfare enhancing. However, Kwo (2007) just tried to find the solution of social welfare policies for IPR protection. The study does not explain the impact of technological progress from the second best solution, in other words, it does not explain the relationship between IPR protection and technological progress.

Horii and Iwaisako (2005: 5-31) studied the growth effects of IPR protection in a quality-ladder model of endogenous growth. The results show that stronger IPR protection reduces the probability of imitation and raises the reward for innovation. However, it reduces the number of competitive sectors. The study shows that imperfect IPR protection is more useful than perfect protection. They put forward the hypothesis that stronger IPR protection unambiguously provides greater incentives to innovate. But the weak relationship observed between IPR protection and the rate of economic growth suggests that IPR protection may have negative effects on economic growth. A well-known drawback of strong IPR protection is that innovators enjoy longer periods of monopoly, which tends to increase the number of monopolistic sectors within the economy. To demonstrate this drawback, earlier studies found that consumer welfare is not necessarily improved when IPR protection is strengthened. This is because consumers then face higher prices thereby reducing welfare. Horii and Iwaisako describe a mechanism in which stronger IPR protection negatively affects the long-term rate of economic growth by examining two properties of R&D. The first property is the differences in the environment for R&D provided by monopolistic and competitive sectors. In a monopolistic sector, where right holder holds exclusive right to produce a state-of the-art good, the right holder has little incentive to further improve the product because it can secure monopoly profits without such efforts. Thus, in monopolistic sectors, innovative efforts are made only by outside firms, which succeed only when they create a good of higher quality than the former right owner. Such leapfrogging innovations are more difficult to achieve than innovations in competitive sectors because the outside firms have no experience in producing state-of-the-art quality goods. Thus, it is more difficult for outside firms to invent new high quality goods in monopolistic sectors than it is in competitive sectors.

The second property of R&D projects is that they take time and their outcomes (successes or failures) are revealed only after the projects are completed. This means that individual innovators must initiate R&D projects without knowing whether other innovators' projects will eventually succeed or fail. Thus, there is a non-negligible probability that more than two innovators may independently succeed in innovating the same intermediate good of the same quality. Given the nonrivalry of the knowledge obtained by innovation, this duplication of innovations is not only wasteful and useless from the viewpoint of economic growth, but also reduces the profits and incentives of innovators.

Horri and Iwaisako (2005) re-examined the relation between IPR protection and economic growth. They assume that innovations are imitated over time and that strengthening IPR protection reduces the probability of imitation. On the balanced growth path, stronger IPR protection increases the number of monopolistic sectors in which the state-of-the-art quality goods have not yet been imitated. Conversely, it reduces the number of competitive sectors in which the state-of-the-art quality goods have already been imitated and any firm can produce them.

The results of Horri and Iwaisako's study show that strong IPR protection does not necessarily facilitate economic growth. The long run economic growth rate is maximized by an imperfect rather than perfect protection of IPR. These results challenge the objectives of TRIPS stated in Article 7.

2.3.3 The Role of IPR Protection in Promoting Innovation

A large number of studies have found that a strengthening of IPR protection contributes little to domestic innovation. Lall (2003:3) found that weak IPR protection played a vital role in the technological development of Korea and Taiwan. Those countries are the best recent examples of the use of copying and reverse engineering to build competitive and innovative technology-intensive industrial sectors. Weak IPR protection such as patents can help local firms in the early stages to build technological capabilities by permitting imitation and reverse engineering. The study classifies the countries into four groups based on national technological activities that were derived from two variables: research and development financed by productive enterprises and the number of patents taken out in the United States. The study yields an index for technological intensity, technological leadership, moderate technological activity, low technological activity, and negligibly significant technological activity calculated from R&D per capita and patents per 1000 people.

Many studies analyze the impact of IPR protection on technological progress in terms of the rate of innovation. Some of studies use the patent protection as a determinant of technology development. They measure the level of technology transfers based on the legal reform on IPR protection. The finding suggests that one of the primary mechanisms by which economies may benefit from IPR reform is through larger technology flows from multinationals. However, a change of IPR policy would have less impact when patent protection was already strong. The policy change would have more of an effect when protection was weak and would be less effective when countries were far behind the technological frontier (Lerner, 2002: 24-29).

For firms, Branstetter, Fisman and Foley (2005: 4-14) hypothesize that strong IPR protection induces foreign firms to produce and sell technologically advanced goods in the host countries, and the strong IPR protection should increase the value of technology flows from parents to afflliliates following regime changes. The estimated model is given by:

$$Transfer_{ilt} = \alpha_0 + \alpha_{il} + \alpha_t + \beta_0 y_{jt} + \beta_1 P_{it} + \beta_2 H_{jt} + \beta_3 A_{ilt} + \beta_4 R_{jt} + \beta_5 R_{jt} * Pat_{il} + \varepsilon_{ilt}$$

where l indexes the individual affiliate, i the affiliate's parent firm, j the uaffiliate's host country, and t the year. The dependent variable measures the volume of intrafirm royalty payments for intangible assets. The key variable of interest is R_{jt}, the post reform dummy variable is equal to one in the year of and years following patent reform in country j. The specification includes time-invariant fixed effects for the affiliate (α_{ij}), year fixed effects for the entire sample (α_t), and country-specific time trends. As a consequence, identification of the effect of reforms comes from differences in the timing of reforms. P_{it} is a vector of time-varying characteristics of the patent firm, including measures of size and R&D investment. These variables control for the natural tendency for technology transfers from a parent to change as these state variables change over time. H_{jt} is a set of time-varying characteristics of the host country, including the log of GDP per capita and indicator of whether the host country imposes restrictions on inward FDI. A_{it} is a vector of time-varying characteristics of individual affiliates, including the log of affiliate sales. Pat_{il} is the dummy variable of patent applications as the parent of the median affiliate in the reform country over the same period are assigned a high patent, Pat_{il} equal to one. For other affiliates that have parents that can be matched to patent database of the country, Pat_{il} is equal to zero.

Branstetter, Fisman and Foley (2005) further examine the relationship between affiliate R&D and technology transfers from the parent to measure the change in R&D spending of affiliate in reforming countries. This test is the following:

$$R\&D_{ilt} = \alpha_0 + \alpha_{il} + \alpha_t + \beta_0 y_{jt} + \beta_1 P_{it} + \beta_2 H_{jt} + \beta_3 A_{ilt} + \beta_4 R_{jt} + \beta_5 R_{jt} * Pat_{il} + \varepsilon_{ilt}$$

The dependent variable measures the level of R&D spending conducted by affiliate *l* of parent *i* in year *t*.

Changes in technology transfer are not constrained to take place between parents and their affiliates. Firms also license intangible assets to arm's length parties. They predict that the type of licensing may also increase after reform. To test this relationship, variations of the basic specification are used to analyze:

$$License_{ilt} = \alpha_0 + \alpha_{il} + \alpha_t + \beta_0 y_{jt} + \beta_1 H_{jt} + \beta_2 R_{jt} + \varepsilon_{ilt}$$

Here, the dependent variable measures royalty payments received by parent firm *i* from unaffiliated parties in country *j* in year *t*. However, they have no detailed data recorded on the characteristics of licensee or licensor firms. As a result, firm/country fixed effects ($\alpha_{ij)}$ take the place of affiliate fixed effects, and it is not possible to control for characteristics of firms that pay or receive licensing fees. Other right hand side variables include a vector of host country characteristics (H_{jt}), and host-country specific time trends (y_{jt}).

Branstetter, Fisman and Foley (2005) also hypothesize that when IPR protection reform occurs and the patent laws are strengthened, the multinational firms may have the incentive to file patents for all of the technologies currently employed in the jurisdiction of the reforming countries. This would imply a temporary increase in foreign patent filing that would eventually fall off as firms completed protection of the portfolio of technologies currently used in the country in question. However, multinational firms may be induced by the patent regime change to transfer new technologies into the jurisdiction. This predicts not only a one-time shift in the level of patent filings but also increased growth in foreign patenting over time in the reformed jurisdictions after reforms. To test this predictions take the form;

$$Patent_{jt} = \alpha_0 + \alpha_j + \alpha_t + \beta_0 y_{jt} + \beta_1 H_{jt} + \beta_2 R_{jt} + \beta_3 R_{jt} * y_{it} + \varepsilon_{jt}$$

Here the dependent variable measures the number of patents filed by domestic or foreign applicants in country *j* in year *t*. They estimate separately for domestic and foreign patenting in the countries that underwent IPR reform. Patent applications in year *t* are a function of country (α_j) and year (α_t) fixed effects as well as host country characteristics (H_{jt}).

In this work, they categorize the reforms into four groups; 1) changing the administration of the patent law and related statutes, 2) changing both the law itself and the administration of the law, 3) reforming the expansion of patentable subject matter, 4) enacting new IPR laws and promulgating new administrative procedures. The results provide strong evidence that U.S. multinational firms respond to changes in IPR regimes abroad by increasing technology transfers to reforming countries. As the legal reforms to strengthen patent protection abroad are carried out, intrafirm royalty payments made by affiliates to parents increase, and the increases are concentrated among affiliates of parents that intensively patent innovations in the U.S. prior to reform. There is additional evidence that the increase in the volume of technology transferred comes from patent data drawn from countries that undertake reforms. While the level of domestic patent applications is unaffected by reforms, foreign patent applications increase, in terms of both level and growth rates. The study also finds that the absence of strong IPR protection may limit the deployment by multinational firms of more advanced technologies to the weak IPR protection countries. The existence of a stronger IPR protection will induce multinational firms to deploy technologies because they have a legal remedy against imitation.

However, the study of Branstetter, Fisman and Foley (2005) did not demonstrate that strong protection enhances welfare in the reforming countries; it did not produce evidence of the effect of IPR on domestic innovation. The hypothesis of the study i.e. that IPR reforms increase technology transfers between countries, was tested by analyzing how measures of U.S. affiliate activity and levels of foreign patenting change after reform. This gave no conclusive support to the hypothesis. For one thing, the study focused on only 12 countries (Argentina, Brazil, China, Indonesia, Japan, South Korea, Mexico, The Philippines, Spain, Taiwan, Thailand, and Turkey), which may may be too small a sample to sufficiently measure the impact of strong IPR protection according to the main purpose of TRIPS agreement; there are many other countries that have reformed their IPR regimes after TRIPS came into enforce.

The role of IPR protection on international trade, innovation, and economic growth is also examined by Schneider (2005: 22-23). The study used a unique panel data-set of 47 developed and developing countries from 1970 to 1990. The results suggest that 1) high-technology imports are relevant in explaining domestic innovation both in developed and developing countries, 2) foreign technology has a stronger impact on per capita GDP growth than domestic technology, 3) IPR protection affects innovation rate, but the impact is more significant for developed countries, 4) the results regarding FDI are inconclusive.

Schneider (2005) uses a panel data set consisting of four separate 5-year periods, 1970-1974, 1975-1979, 1980-1984, 1985-1989, for a cross-section of developed and developing countries. The panel regressions are estimated using country fixed effects. Due to the short length of the panel (four periods), some within-country effects were not captured. Therefore, he estimates OLS regressions. All variables are used in natural logs and expressed in real terms.

For innovation regression, Schneider (2005) follows various studies such as Griliches (1991: 9-24). The stock of human capital and the level of R&D expenditures should also be positively correlated with the rate of innovation. In addition, factors that affect the profitability of innovation, such as the size of the market should contribute positively. However, the expected sign of the IPR variable is ambiguous. But Maskus, Saggi and Pattitanum (2003: 23) found that strong IPR protection would be useful for the advanced countries with rapid innovation rates, which presumably are higher-technology industries. In lower-technology industries it is more likely that stronger patent protection would induce firms to shift toward greater use of FDI and lesser use of licensing.

In order to examine the determinants of innovation, the regression of Schneider (2005) is :

$$I_{it} = \beta_0 + \beta_1 HK_{it} + \beta_2 HDC_{it} + \beta_3 R\&D_{it} + \beta_4 GDP_{it} + \beta_5 IPR_{it} + \beta_6 FDI_{it} + \beta_7 INF_{it} + \mu_{it} ,$$

$$\mu_{it} = \alpha_i + \varepsilon_{it} \qquad (1)$$

Where I_{it} is the innovation rate in country i, HK_i is the level of human capital stock, and HDC_i in the real import level of high-technology goods from developed countries. $R\&D_i$ is the level of R&D expenditures in country i. GDP_i is the real gross domestic product scaled by population, IPR_i is the Ginarte and Park (1997) patent protection index for country i, and FDI_i measures inflows of foreign direct investment into country i, INF_i is a fixed effects regressions, α_I represents an individual effect which is unknown.

Schneider (2005) further examines international trade and IPR protection on economic growth. This hypothesis is that GDP growth depends positively not only on the stock of physical capital, but also on the quality of that capital. The GDP growth regression considers domestic innovation, as well as foreign innovation. Growth of per capita high-technology imports from developed countries is used as a proxy for the effect of foreign technology on domestic growth. The study also includes FDI and IPR in the growth regression in order to examine if those variables have a direct effect on growth.

$$\gamma y_{it} = \beta_0 + \beta_1 \gamma k_{it} + \beta_2 I_{it} + \beta_3 \gamma HDC_{it} + \beta_4 FDI_{it} + \mu_{it} \qquad (2)$$

In the GDP growth regression as shown in the equation (2), Schneider (2005) considered the growth of real per capita GDP(γy_i,) as a function of the growth in the per capita physical capital stock (γk_i), the innovation rate (I_i), the growth of real per capita import levels of high-technology goods (γHDC_i), and foreign direct investment inflows (FDI_i). The author also considers an alternative specification in which the level of IPR protection (IPR_i) is included in place of the innovation rate as presented in the equation (3):

$$\gamma y_{it} = \beta_0 + \beta_1 \gamma k_{it} + \beta_2 IPR_{it} + \beta_3 \gamma HDC_{it} + \beta_4 FDI_{it} + \mu_{it}\,,$$
$$\mu_{it} = \alpha_i + \varepsilon_{it} \qquad (3)$$

Schneider (2005) showed that the size of the market has a positive impact on innovation. The author proposed per capita GDP as a proxy for a country's individual stock of knowledge. Therefore, the higher the country's knowledge stock, the higher the innovation rate. High-technology imports from developed countries (HDC) also have a positive effect on domestic innovation. Human capital stock (HKstock) and R&D expenditures (R&Dexp) have a positive and statistically significant effect on domestic innovation. The infrastructure measure, electricity production (Elect), is positive and significant in all regressions in which it is included. Domestic innovation also seems to respond to the level of IPR protection. But FDI inflows are not significant in the OLS regression. It means that FDI does not contribute to domestic innovation. Finally, the result suggests that IPR protection has a stronger impact on domestic innovation for developed countries.

The result of the growth regression showed that the growth in per capita physical stock (K Stock) has the greatest effect on real per capita GDP growth. The second strongest impact comes from the growth of per capita high-technology imports from developed countries (HDC), which can be interpreted as a proxy for foreign innovation. Domestic innovation appears significant in the fixed effects regression for developed countries only. These results suggest that foreign innovation is more important than domestic innovation in determining per capita GDP growth.

IPR protection appears significant to GDP growth in the fixed effect regression with all countries. But for innovation, the result regarding IPR protection is interesting i.e. a strong IPR protection has a stronger impact on domestic innovation for developed countries and may even negatively impact innovation in developing countries.

One of the IPR protection problems in many countries is the weak IP law enforcement. For example, a number of poor nations, such as Ghana and Nigeria, have strong IP laws on paper because they were British colonies and modeled their IP law regimes on the United Kingdom Patent Act. However, enforcement difficulties significantly reduce the effectiveness of patents in those countries. In this regard, Maskus, (2000a: 103) examined the relationship between the level (weak to strong) of patent protection (as patent index) and income level from the 1984 data. A simple regression of the index on current income resulted in this relationship:

$$PATENT = -0.51 + 0.49\log(INCOME),\ R^2 = 0.37$$

Both coefficients were highly significant statistically. Thus, as real income rises, there is a corresponding increase in patent strength across countries. The calculation suggests that as income rises by $ 1,000 (a 29 percent increase evaluated at the sample mean), the patent index would increase by 0.14 units (a 4.5 percent increase). Income alone can explain 37 percent of the variation in corrected international patent rights. However, the patent protection declines as income rises from a low level and then accelerates sharply toward the highest income levels. Thus, there seems to be a quadratic relationship between IPR protection and GNP per capita, estimation of which resulted in this equation:

$$PATENT = 10.5 - 2.63\log(INCOME) + 0.21[\log(INCOME)]^2,\ R^2 = 0.50.$$

Adding the squared term lets income explain 50 percent of the variation in IPR protection across countries. This specification strongly suggests that countries tend to weaken their patent laws as incomes begin to rise and then strengthen them after a certain point (Maskus, 2000a: 105).

As to the role of TRIPS in developing countries, Gorasia (2002) studied the potential impact of TRIPS on FDI and technology transfer according to Article 7 of the Agreement. The study showed that where patents are granted worldwide, there is little incentive for multinational firms to increase FDI, in other words, FDI will not increase as a result of TRIPS.

The TRIPS agreement is meant to promote the dissemination of technology. However, Gorasia (2002) argued that the provision of Article 27 of TRIPS agreement, "to exclude from patentability inventions which is necessary to protect public order or morality, including to protect human, animal or plant life or health or to avoid serious prejudice to the environment, diagnostic, therapeutic and surgical methods for the treatment of humans or animals", may inhibit the dissemination of technology to developing countries. The role of patents has been found to be very insignificant in transfer of technology transactions. Gorasia (2002: 23) concludes that Article 27 of TRIPS is having a detrimental impact on developing countries.

The above-cited literature focused on the impact of IPR protection, in particular of patent, to economic growth, technology transfer and FDI. But they provide no result about IPR protection on technology development in the countries where IPR protection are enforced.

Gee, Azmi, Ghani and Alavi (2007: 3-18) used co-integration test and long-run equation analyses to examine the impact of IPR protection on Malaysian economic development. The study aims to explore the long – run effects of three different variables (i.e., intellectual property creation, economic growth, and foreign direct investments) on IPR protection. They developed three different models for the investigation, as follows:

The first model, which is adopted to investigate the long-run relationship between the IPR protection and IP creation, is written as:

$$\ln(P) = \alpha + \gamma_1 \ln R\&D + \gamma_2 \ln GDP + \gamma_3 \ln(IP) + \gamma_4 \ln(K) + \varepsilon \qquad (1)$$

where ln(P) is natural logarithm of total number of patents application filed, lnR&D is natural logarithm of research and development, lnGDP is natural logarithm of GDP per capita, ln(IP) is natural logarithm of the intellectual property index, lnK is natural logarithm of private capital.

The second model used to explore the long-run relationship between IPR protection and economic growth is written as:

$$\ln GDP = \beta_1 \ln K + \beta_2 \ln L + \beta_3 \ln(IP) + \varepsilon \qquad (2)$$

where lnGDP is natural logarithm of GDP per capita, lnL is natural logarithm of labour farce, ln(IP) is natural logarithm of the intellectual property index, lnK is natural logarithm of private capital

The third model, which aimed at examining the long-run relationship between IPR protection and FDI, is written as:

$$LnFDI = \alpha + \delta_1 \ln L + \delta_2 \ln GDP + \delta_3 \ln(IP) + \varepsilon \qquad (3)$$

where lnFDI is natural logarithm of foreign direct investments, lnGDP is natural logarithm of GDP per capita, lnL is natural logarithm of labour force, lnIP is natural logarithm of intellectual property index.

The results in Model 1 confirm that there is a long-run relationship between number of patents filed and GDP per capita, IPR protection level and R&D. It is found that R&D, IP index and private investments have positive long run relationship with the number of patents filed in the country. However, the long-run relationship between patent filing and the GDP per capita appears negative.

The results in Model 2 show that in the case of Malaysia, an upper-middle income country, improvement in the standard of IPR protection in the country has positively influenced the GDP growth in the long run.

The results in model 3 show that there is a long-run relationship between GDP and IP index and FDI. However, the correlation between labour force and FDI inflows appears to be negative. This could be explained by graduation of the economy to less labor intensive industrial activities. As with the others, the study of Gee, Azmi, Ghani, and Alavi (2007) had not explained the impact of IPR protection to technological progress and the issue of social welfare.

Later, Kim, Lee, and Park (2006: 13-21) studied the direct and indirect effects of IPR protection on economic growth, and assessed the extent to which the impact will differ by level of economic development. The study used a panel data of countries from 1975-2003 and divided into five-year spans. Five-year averaging is used to smooth out business cycles. Time dummies are included to control for common long run growth and innovation rates. The sample countries are classified in two groups: high income and middle-to-low income countries. They found that IPR protection (using an index of patent protection) do not directly affect the rate of economic growth in any income group, but indirectly by stimulating R&D investments.

Kim, Lee, and Park (2006) augment conventional growth models to incorporate the IPR variable. To fix ideas, if the production function is Y = f(K, R, H, AL), where Y is output, K is physical capital, R is research and development capital, H human capital, L labor, and A technical efficiency, and also assume that A is a function of IPR, A(IPR). They construct an equation (1) that is the model to estimate whether IPR has a direct relationship with economic growth:

$$\ln(y_{it}) - \ln(y_{it-1}) = \alpha + \beta\ln(y_{it-1}) + \gamma\ln(pop.growth_{it}) + \delta\ln(invest_{it}) + \lambda\ln(R\&D\ intensity_{it}) + \varphi\ln(second.enroll_{it}) + \phi\ \ln(IPR\ index_{it}) + \eta D*\ln(IPR\ index_{it}) + \mu_i + \nu_{it} \quad (1)$$

where y_{it} is GDP per capita in country i in year t, y_{it-1} is GDP per capita in country i expressed in year t-1, *pop.growth* is growth rate of population of country i, *invest* is investment measured by the ratio of gross capital formation to GDP, *R&D intensity* is ratio of R&D expenditures to GDP, *second.enroll* is Human capital measured by the secondary school enrollment rate, *IPR index* is the index of patent rights, μ_i is the fixed effect, v_{it} is assumed to be zero, and the correlation between μ_i and v_{it} to be zero.

Next, they constructed the R&D equation, where R&D is a function of technology opportunity and technology cost variables. The authors allow for dynamics in R&D by lagging dependent variable to account for costs of adjustment of R&D and intertemporal knowledge spillovers. The model specification is as follows:

$$(R\&D\ intensity_{it}) = \alpha + \gamma(IPR\ index_{it}) + \eta D*(IPR\ index_{it}) + \delta(Phdpop_{it}) + \lambda(DSR_{it-1}) + \sigma(extratio_{it}) + \eta_i + \nu_{it} \quad (2)$$

where *R&D intensity* is ratio of R&D expenditures to GDP, *IPR index* is an index of Patent Rights, *Phdpop* is number of persons who hold doctoral degrees in science and engineering from U.S. universities (per million people), *DSR* is ratio of domestic saving of GDP, *extratio* is ratio of Exports to GDP, D = 1 if mid or low-income countries, otherwise D=0, μ_i is the fixed effect, v_{it} is assumed to be mean zero, and the correlation between μ_i and v_{it} is zero.

Innovation is represented by the ratio of R&D expenditure to GDP. A dynamic specification, lagging dependent variable, is adopted on two grounds. The first is the adjustment and installation costs associated with R&D expenditures which make such expenditures persistent over time. Another is intertemporal knowledge spillovers that make current R&D expenditure on the past R&D.

In both equations (1) and (2), they analyze the role of economic development through the interaction between the IPR variable and dummy variable (D=1 if a middle or low income country, and 0 otherwise). Taking the partial derivative of the dependent variable in equation (2) with respect to the IPR variable yields the effect of patent protection on R&D by economic development. For example,

$\partial(\text{R\&D intensity}_{it}) / \partial(\text{IPR index}_{it}) = \gamma + \eta'$ is the impact of patent protection on R&D for middle-to-low income countries and γ that for high-income countries.

From the study of Kim, Lee, and Park (2006: 29), they found that patent protection does not have a statistically positive direct effect on the growth rate. The patent protection impacts economic growth indirectly by influencing R&D intensity. This suggests that merely strengthening IP institutions and laws does not by itself raise the growth rate of output per capita. Rather, the potential role for stronger IP institutions and laws is in affecting the environment in which productive activities take place.

The contribution of Kim, Lee, and Park (2006) is to stress the importance of instituting the right type of incentive mechanism for innovation. However, current academic and policy debates have focused on the effect of strong IPR protection on raising developing country standards to developed country levels, and restricting imitation, piracy, and infringement in developing countries. A further question that arises from the conclusion of this work is, "What are the suitable forms of IPR protection for developing countries, and at what level of economic development does patent protection change from being an insignificant influence on innovation and economic growth to a significant influence?"

2.3.4 Summary of Arguments of IPR Protection

A summary of the arguments for and against weak and strong IPR protection provided by the studies that have been reviewed is presented in Table 2.1 and Table 2.2. The first table presents the views of developed countries.

Table 2.1 Views of Developed Countries Concerning IPR Protection

Strong IPR protection	Weak IPR protection
Create incentive for R&D	Free rider problem & Reduced incentives to innovate
Increase FDI/Trade Flow	More price competition
Stimulate technology diffusion and technological progress	Reduce FDI and Trade flow
Cause less price competition	

From the perspective of developing countries, however, a strong IPR protection is unfair. They contend that developed countries have advanced knowledge and larger sizes of markets and would thus benefit from a strong IPR regime. On the other hand, a strong IPR protection in developing countries may deteriorate economic welfare and hamper other social and economic development efforts. The developing country viewpoints are summarized in Table 2.2

Table 2.2 Views of Developing Countries Concerning IPR Protection

Strong IPR protection	Weak IPR protection
Monopolies in IPR causing negative impact and dead weight loss	Stimulate technology diffusion and raise knowledge accumulation
Reduces innovation by limiting imitation to develop the production of new goods	Promote competitive markets
Impede new comers entering into the markets	Provide R&D environment for developing countries
Opportunity cost of developing countries decreases and the costs from paying royalties increases that may significantly outweigh the benefits from insignificantly additional knowledge.	Increase access to affordable knowledge goods Reduce cost of IPR litigation

The different views toward strong and weak IPR protection summarized above are influenced by the different economic conditions in each country and historical background of protection. An examination of IPR protection in an institutional context may add to the understanding of these viewpoints.

2.3.5 The Role of IPR through International Organization

IPR protection is expected to encourage innovation by rewarding the inventor. Strong IPR protection may also inhibit diffusion of knowledge and even technology development in the countries that are technology followers. However, there remain a number of important gaps concerning the role of IPR in international technology transfer, particularly in developing countries and countries with economies in transition (Arora, 2009:55).

TRIPS sets up international standards for IPR protection, but that standard may not favor the developing countries for the following reasons:

1) The most direct 'international' impact of TRIPS on the developing countries is that these countries need to increase their royalty payments, which can be a problem especially in a situation of foreign exchange shortage.
2) IPR protection required by TRIPS is likely to lead to more widespread monopoly pricing and other restrictive behaviors of some pharmaceutical and agro-chemical firms. Given that the developing countries usually have weak anti-trust law and weak law enforcement capacity, it is unlikely that they can successfully restrain the monopolistic behaviors of the big players.
3) The high human resource cost of running a sophisticated IPR regime in developing countries. Implementing TRIPS would add to these costs. This is not only because the required technical and legal standards for the domestic IPR regimes will be made higher, but also because the disputes in the WTO will require legal expertise and other specialized skills that are not easily available in developing countries.
4) The costs of competition for R&D between developed and developing countries. Developing countries are likely to find it difficult to develop their own technological capabilities.

Against these beliefs, the on-going attempt to harmonize and strengthen the IPR protection worldwide, as part of the TRIPS Agreement, is widely seen to be adversely affecting the technological activity in developing countries if the developing countries have less capacity to absorb technology transferred (Yang and Maskus, 2008: 20).

In this regard, Dutta and Siddharth (2008: 7-29) studied the impact of TRIPS on the development of innovation in developing countries, with India as the case. They found that an annual R&D spending after TRIPS was on average 20 percentage points higher in industries with a one standard deviation higher value of innovation intensity. They also found that patenting by India in the U.S. increased after TRIPS, and to a greater extent in more innovation intensive industries.

Dutta and Siddharth (2008) also examined the effect of TRIPS by comparing changes in innovative activity across industries expected to be affected differentially by a strengthening of IPR. The regression denotes Y_j as a measure of the importance of R&D to industry *j*. If patent reforms cause more innovative activity in domestic firms, then they expect the impact of these reforms to be increasing in Y_j. It is tested by estimating a linear regression of the differences-in-differences type specification:

$$\chi_{ijt} = \alpha Y_j + \beta Post_t + \gamma Post_t * Y_j + \varepsilon_{ijt}$$

Where χ_{ijt} is a firm-level outcome of interest and $Post_t$ is a dummy indicating that the observation is from a year following the IPR change. The coefficient of interest is γ, which measures how the change in outcome varies according to the industry-level IPR importance measure Y_j. For instance, if χ_{ijt} measured firm R&D expenditure, then a positive estimate of γ would mean that the increase in firm R&D following TRIPS was greater in industries with higher Y_j. Under the identifying assumption that other factors affecting innovation were uncorrelated with $Post_t * Y_j$, this would indicate a causal influence of patent reforms on R&D.

Dutta and Siddharth (2008) interpreted the results to mean that the anticipated onset of stronger IPR protection was responsible for generating greater incentives to invest in innovative activities by domestic firms, which then facilitated the transfer of technology between firms. They concluded that the immediate short-term effects of the TRIPS in India showed promising trends about the ability of stronger IPR protection to create incentives for greater R&D and transfer of technology.

2.3.5.1 Two Sides of IPR Protection - the North and the South

In terms of international law, a pact requiring substantial stiffening of the developing countries (the South) IPR protection was signed in 1994. It required all developed countries (the North) to adopt minimum IPR standards by January 1, 1996. The corresponding deadlines were January 1, 2000, for all developing and transition economies, and January 1, 2006, for the least-developed countries.

In practice, TRIPS agreement mainly required raising IPR protection in the South, which boosts the innovation rate without increasing the price burden on the North's domestic consumers. This benefits the North at the expense of the South's exports of traditional goods. The possibility of reaching the aim of international IPR agreements can bridge the gap between North and South. However, the excessive IPR protection may cause some economic drawbacks, one of which is reducing access to affordable knowledge goods (Lai, 2008: 2).

In principle, the TRIPS-compliant IPR system is good for less-developed countries. A sound IPR system would place these countries on a more sustainable development path. However, fully implementing TRIPS in the South can greatly increase the cost of accessing technology, with grave implications on the South's growth and living standards. This possibility can be explained from the number of patent applications in the selected member countries of TRIPS, as shown in Table 2.3.

Table 2.3 The Development of Patent Applications to Technological Progress

	Number of total patent applications				Number of high-tech patent applications			
	Total		% share		Total		% share	
	1995	2003	1995	2003	1995	2003	1995	2003
World - total	83817	163011	100.0	100.0	14826	37644	100.0	100.0
EU-27	35335	62250	42.2	38.2	4405	10840	29..7	28.8
US	28293	48786	33.8	29.9	6453	13845	43.5	36.8
Japan	13301	27987	15.9	17.2	3055	6834	20.6	18.2
South Korea	551	5400	0.7	3.3	135	1924	0.9	5.1
Switzerland	1872	3113	2.2	1.9	115	331	0.8	0.9
Canada	1217	2736	1.5	1.7	263	793	1.8	2.1
Australia	905	1958	1.1	1.2	134	396	0.9	1.1
China	120	1898	0.1	1.2	12	703	0.1	1.9
Israel	502	1587	0.6	1.0	92	490	0.6	1.3
India	41	1003	0.05	0.6	2	164	0.02	0.4
Russian Federation	309	641	0.4	0.4	38	108	0.3	0.3
Taiwan	107	572	0.1	0.4	15	119	0.1	0.3
Norway	358	533	0.4	0.3	24	90	0.2	0.2
Singapore	61	416	0.1	0.3	17	196	0.1	0.5
South Africa	125	415	0.1	0.3	10	54	0.1	0.1
New Zealand	158	376	0.2	0.2	8	59	0.1	0.2
Brazil	87	348	0.1	0.2	6	36	0.04	0.1
Mexico	40	145	0.05	0.1	:	:	:	:

Source: European Commission, 2007:54

Table 2.3 shows that the increasing rate in the patent applications has occured in the same countries that have advanced technology such as US, Japan, South Korea, Switzerland, and Canada since TRIPS came into enforce in 1995. Until 2003, the share of patent applications does not change. It implies that TRIPS agreement does not impact on technological progress in every county.

In fact, TRIPS provides international standard of IPR protection to the North (U.S., Japan, Switzerland) and the South (such as, China, India, Taiwan, Singapore, South Africa, Brazil, Mexico). The convention encourages all members to promote innovation which is a key to global growth and raising living standards. However, most technology is originated in the North. Economists such as Lai (2008: 1) found that technologies will diffuse quickly only if consumers in the South can afford them. Technology-and knowledge-intensive products are increasingly subject to patent rights and other IPR laws that maintain high prices. From this point, the North, being the technology-originating countries, wants the South to strengthen its IP rights, but the South resists, citing unfairness. Herein lies one reason for the policy conflicts between developed and developing member countries of TRIPS.

There are two factors to separate the North-South views on IPR protection:

1) The North specializes in innovation or knowledge-intensive industries, such as pharmaceuticals, computers, precision machine tools and business software. The South relies more on producing traditional goods, such as textiles and toys (Lai, 2008: 5).
2) Markets for the North's innovation-intensive goods have become increasingly globalized through trade liberalization, declining transport costs and new communications technologies. But the South cannot get these benefits.

The variation of IPR protection across countries emerges from fundamental differences. Firms in the North, which benefit from stronger IP laws, contend that they lose profits in the South where IPR protection is weak. Not surprisingly, the North advocates international harmonization of IPR protection standards. That is, the South, in the view of the North, should adopt the North's standards. In accord with this point of view, Figure 2.2 shows that most of the patents granted belong to the

North. The implied question is that if the South has strong IPR protection, the North will be protected by the South. And what does the South get?

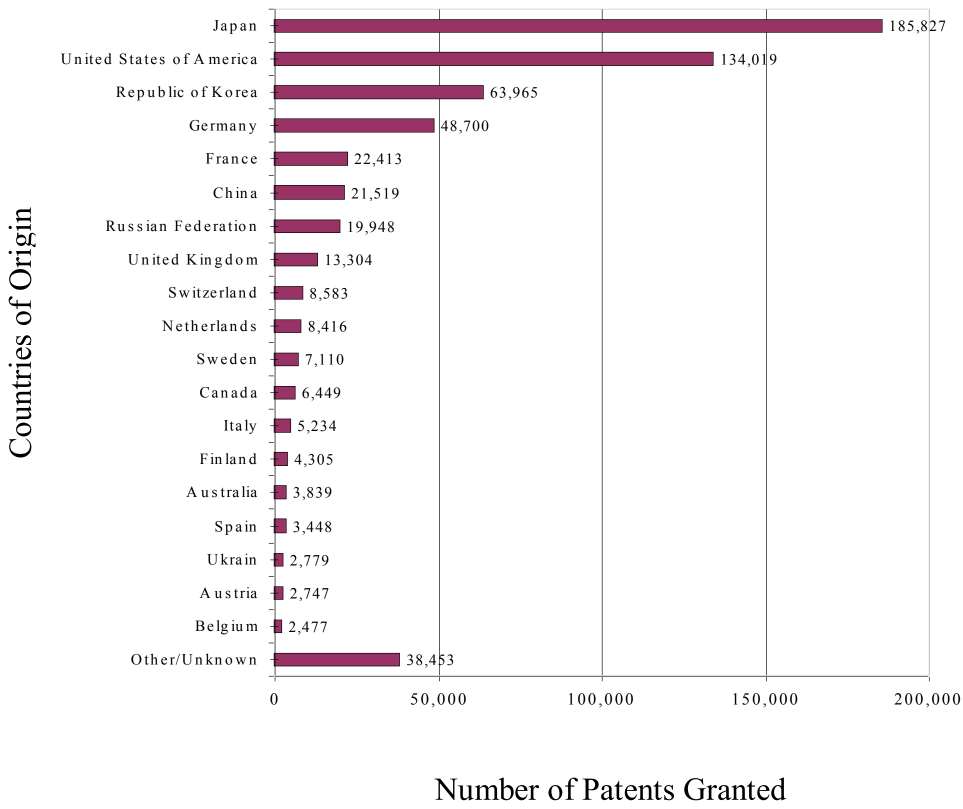

Figure 2.2 Patents Granted by the Countries of Origin of the Application in 2005
Source: WIPO Patent Report, 2007: 41

On patent filing, the capacity of developed countries for patent filing has not changed much between 2000 and 2006, as shown in Figure 2.3.

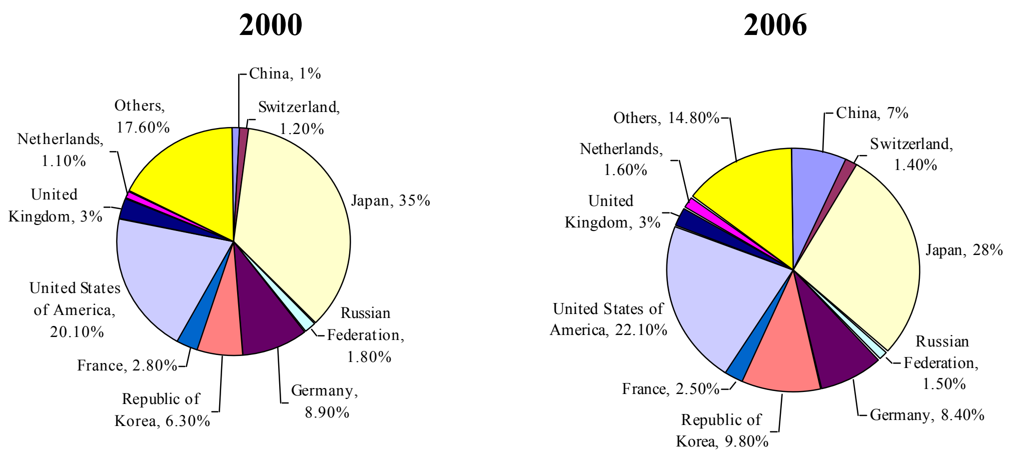

Figure 2.3 Share of Countries in Total Patent Filings
Source: World Patent Report, 2008:16

The South, accordingly, is reluctant to harmonize, arguing that its stage of economic development does not justify strong IPR protection. Moreover, the South contends that the strong IPR will provide the economic power to the North. Nevertheless, the North compels or induces the South to set up a strong system of IPR protection through international trade, FDI, tariffs, and other means.

The stated goal of TRIPS has stimulated much interest in, and research on, the economics of IPR protection. Researchers and policymakers have been curious to see the extent to which stronger IPR protection can influence R&D and innovation, international trade and technology transfer, productivity growth, and national and global welfare (Park, 2008: 1). If this assumption is true, the role of TRIPS is very important to every country. However, the degree of IPR protection before and after TRIPS came into force (1 January 1995) shows insignificant changes, as seen in Table 2.4

Table 2.4 Index of Patent Rights 1960-2005 before and after TRIPS

	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	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	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	0.00	2.96	3.21	4.33
Denmark	2.88	4.54	4.67	4.67
Dominican	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

Table 2.4 (Continued)

	Average 1960-1990	1995	2000	2005
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	0.00	2.69	3.48	4.00
Luxembourg	2.16	3.89	4.14	4.14
Madagascar	1.05	1.85	2.31	2.31

Table 2.4 (Continued)

	Average 1960-1990	1995	2000	2005
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 N.	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
Russian	0.00	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	0.00	2.96	2.76	4.21
Somalia	2.00	2.00	2.13	2.13

Table 2.4 (Continued)

	Average 1960-1990	1995	2000	2005
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	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	0.00	3.68	3.68	3.68
UK	3.20	4.54	4.54	4.54
USA	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	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
Mean	1.80	2.58	3.05	3.34
S.D.	0.80	1.09	1.00	0.89
Coef.	0.45	0.42	0.33	0.27
Skewness	0.09	0.14	-0.07	-0.43

Source: Park, 2008: 2-3.

The bottom of Table 2.4 shows that the mean value of the index of patent protection has increased over time, while the coefficient of variation (i.e. standard deviation to mean) has fallen. This reflects a narrowing gap in the strength of patent systems worldwide. Moreover, the distribution of patent strength around the world has switched from being positively skewed before the late 1990s to being negatively skewed thereafter. This means that most of the countries have a patent index score that is above the mean. These trends reflect the adoption of stronger patent laws across countries particularly after TRIPS came into force, as well as the introduction of patent laws in countries which did not previously have patent systems, such as Indonesia in 1991, Angola in 1992, Ethiopia in 1996, Mozambique in 1999, and Papua New Guinea in 2000. The main reason that the average increase in the patent rights index is smallest in the top ranking countries is that the high income countries such as US, Germany, France, and Japan, already had relatively strong patent systems in 1990. Hence, countries in the top rank have had fewer patent law provisions to incorporate in order to conform to international agreements. The reason that the average increase in the patent rights is next smallest in the bottom rank is that this group consists of least developed countries which had low levels of patent protection in 1990. While required to make the most substantive adjustments in their patent systems, they have been granted, under the WTO agreement, an extension until July 2013 to become compliant with TRIPS. Another factor affecting the bottom ranked group is cost. The direct and administrative cost of drafting new patent legislations, developing skilled personnel, and building the necessary IPR institutions is likely to be burdensome to least developed economies. These costs affect the capacity of low income countries to adopt stronger patent laws, and help explain why their patent index scores do not increase at the same pace as that of middle income countries (Park, 2008: 3). Given that most developing countries are currently net importers of technology, TRIPS would seemingly benefit principally developed countries at the expense of users in developing countries, and, importantly, not benefit local science and innovation. Some argue that the poor populations in developing nations, with few resources and little capital, need access to illegitimate, infringing or unpatented products, which are cheaper to import or engineer locally than more expensive patented items and that strong IPR protection will impede this access (Greenbaum, 2009: 1605). Thus, there are few benefits from IPR in terms of stimulating local innovation in developing countries. On the contrary, while there is technological activity in many countries, it consists of learning to use imported technologies efficiently rather than to innovate on the technological knowledge. In this regard, weak IPR protection can help local firms in the early stages to build technological capabilities by permitting imitation and reverse engineering, as with the firms in South Korea, and Taiwan (Lall, 2003: 1-5).

The imbalance in the TRIPS agreement would widen the technology gap and lead to the growing dependence of developing members on developed ones, which can aggravate access problems. The flaws in TRIPS lie in its extending absolute protection on pharmaceutical products, seemingly impinging on the basic human right to survive. The overprotection of patent introduced from TRIPS reflects the fact that developed countries begin to impose their will to reinforce patent protection globally for their own benefits by turning a blind eye to the public health crisis aggravated by the implementations of such patent policy (Peng, 2009: 49)

After TRIPS came to force, all member countries have tried to reform their domestic IPR laws. In this regard, there are many studies on the role of IPR protection in those reforms. For example, Branstetter, Fisman and Foley (2005: 2) believed that legal reforms that strengthen IPR increase the transfer of technology by multinationals to reforming countries.

2.3.6 The Impact of TRIPS and Technological Progress in Developing Countries

Under the provisions of TRIPS, WTO agreement divides IPR into three major groups: (1) copyright and related rights whose main purpose is to promote and reward creativity, (2) industrial property which typically includes patents and trade secrets intended to give incentive and protect innovation, design, and the creation of technology, and (3) trademarks and geographical indications intended to promote fair competition, and to protect the consumer (Greenbaum, 2009: 1605). It is expected that the impacts of TRIPS on developing countries will vary according to their levels of economic development. The needs of stronger IPR protection seem to gain from the rich countries and encourage innovation (Lall, 2003: 9-11). However, the expected benefits of TRIPS remain questionable.

There are reasons to believe that the enforcement of IPR has a positive impact to growth prospects. But strong protection depends on economic and social circumstances. Countries with a high ratio of R&D in gross domestic product (GDP) or a high proportion of scientists and engineers in the labor force have stronger IPR protection than others. Those with the fewer innovators and creators choose weak IPR protection until they acquire better domestic innovative and absorptive capabilities. If this assumption is true, developing countries have nothing to do with TRIPS and no need to set up a strong IPR protection. Moreover, under the assumption of short term high costs for setting up and maintaining astrong IPR protection, the developing countries would be paying higher prices for technology and products from developed countries in the initial periods. They will reap the benefits in the long term, but this has little to do with laws and regulations in developing countries.

2.3.7 Determinants of Technological Progress

One measure of the level of technology progress is total factor productivity (Kripornsak, 1999: 2-4). The technology achievement of a country can be measured by the number of patents, the number of internet hosts per capita, receipts of royalties and license fees from abroad per capita, technology exports, telephones per capita, and years of schooling in population aged 15 and older (Desai et al., 2002: 99-101). The determinants of technological progress are still an issue of debate. However, level of human capital stock, the real import level of high-technology goods from developed countries, R&D expenditures in country, GDP, degree of IPR protection, and FDI are very interesting determinants to technological progress (Schneider, 2005: 533)

Some aspects of technological progress are low price and ease of telecommunication as facilitatedby the internet, which can spur innovation (Welfens and Audretsch, 2002: 32). However, the previous studies showed that technological progress may be stimulated by supply-side factors. These factors of innovative process can be seen in the the increasing role of scientific inputs in the innovative process, and the increase in R&D activities. In particular, the three factors of innovation are (1) the accumulation of knowledge, (2) the intervention of institutions, and (3) the number of selective and focusing institution for non-economic interests which play the key role in technology development (Dosi, 1982: 151-160). IPR protection is considered an incentive for spurring innovation (Kanwar and Evenson, 2001: 17-22)

The studies cited above show the linkage between IPR protection and innovation. However, the effectiveness of IPR protection in particular for patent varies from industry to industry, and it is most effective only in the chemical and pharmaceutical industries. Despite the fact that the patent system is defended partly on the grounds that it increases the rate of innovation, its effects in this regard is very small in most industries. A study of Mansfield (1986: 180) showed that in industries like pharmaceutical and chemicals where patents seem to be important over 80 percent of the patentable inventions are patented. Even in industries like motor vehicles, where patents are frequently said to be relatively unimportant, about 60 percent of the patentable invention seem to be patented. However, in most of the engineering industries, in particular electrical & electronic goods, and instruments etc, patent protection was not found to be essential for the introduction of inventions. This finding was confirmed by most of the subsequent studies. For instance, a survey conducted by Levin, Klevorick, Nelson and Winter (1987:783-817) showed that product patents were found to be highly effective as a means of appropriating returns only in five of 130 narrowly defined lines of businesses thatincluded drugs, organic chemicals and pesticides. However, other means of appropriation are more important than the patent system (Levin et al., 1987: 816). Schankerman (1991: 25-31) in an analysis of French patent renewal data for the period 1969-72, concludes that patent protection is a significant, but not the major, source of private returns to inventive activity and that its importance varies sharply across technology fields. The main reason for the limited effectiveness of patents is the ability of competitors to legally ‘invent around’ patents. Gallini (1992: 52) finds that longer patent life pushes the rivals to invent around the patent inventions. Hence, optimal patent life is sufficiently short to discourage imitation.

Cohen and Levinthal (1989: 593), in their comprehensive model explaining R&D intensity, considered technological opportunity as well as appropriability as determinants. They also assessed the net impact of the spillovers of R&D. Technological opportunity is a function of technological and research output in that area as well as the output of other R&D units, which the patent owners wish to protect by reducing the spillover effects. The analysis showed that the positive absorption incentive associated with spillovers seemed to increase relative to the negative appropriability incentive in the case of many industries. A more detailed analysis to examine whether the spillovers on balance actually encouraged R&D in some industries found that in the case of chemicals, electrical, and electronics, R&D intensities increased with spillovers. Therefore, the available evidence does not indicate that further tightening of IPR protection would increase expenditures on R&D.

On the contrary, strong patent laws could hurt subsequent R&D effort by restricting spillovers. In the medium and long term the firm would be subject to the threat of competition and the advent of better or improved products from rivals. Hence, the need for the firm to safeguard its market position through continuous innovative activities. This process prevents the original creator of a new technology from being complacent and prompts the monopolist to be constantly creative. A legal protection as provided by the patent system for a longer term of twenty years, therefore erodes the threat of potential competition and hence, the need for continuous improvement (Kumar and Siddharthan, 1997: 75-77).

The above review of literature suggests that the role of IPR protection as a determinant of innovative activity is weak. In fact stronger IPR protection may actually affect the innovative activity adversely by chocking the absorption of knowledge spillovers that are important determinants of innovative activity. Mazzoleni and Nelson (1998: 273-284), from a survey of theoretical and empirical studies also conclude that there is reason for concern that the present movement towards stronger patent protection may hinder rather than stimulate technological and economic progress.

It is necessary to view the overall scenario of all factors that are assumed to affect the environment for technology development in any country. These factors are the variables that influence innovation, and are presented in Figure 2.4

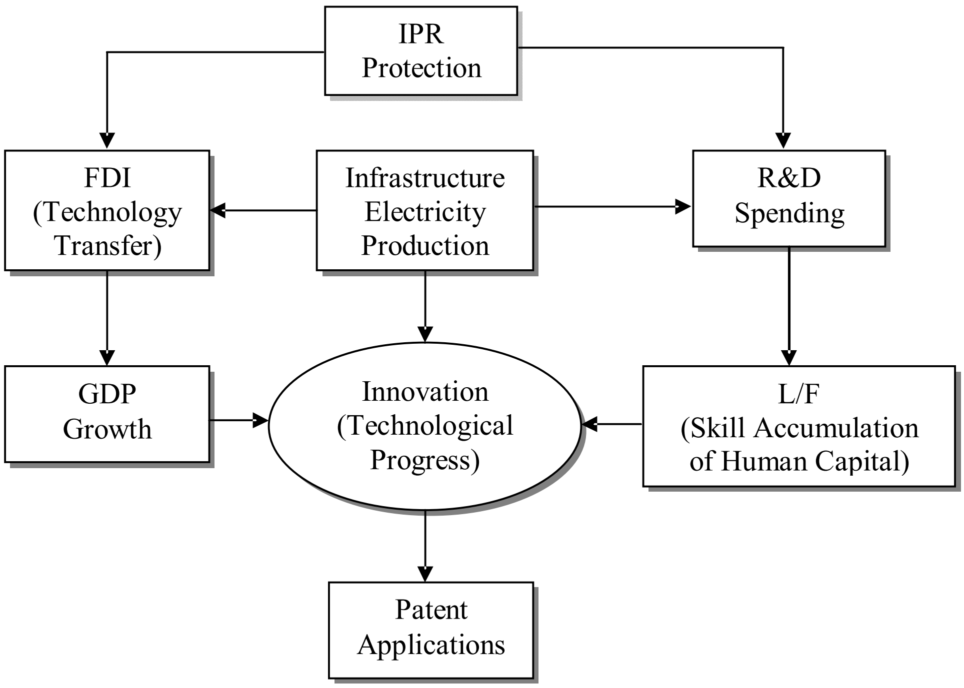

Figure 2.4 Factors Related to Technological Progress

Figure 2.4 shows that innovation or technological progress comes from many sources. Some suggest that technology change depends on R&D, institutions, and political stability (Dosi, 1982: 155). IPR protection is one of the aspects of institution which is closely related to R&D conditions and sometimes having an impact on political policies. Such protection can be seen in the patent system which stimulates the conditions of innovation but which effects are very small (Mansfield, 1986: 180); strong IPR protection may lead to technology transfer and increase the benefits to developed countries, but not developing countries (Nicholson, 2002: 22), while some study found that IPR is an incentive for spurring innovation with a strong positive association with R&D investment (Kanwar and Evenson, 2001: 22). Furthermore, endogenous innovation, according to the theory of growth, relies on capital accumulation and human capital (Grossman and Helpman, 1994: 35-36). Cohen and

Levinthal (1989: 593) found that R&D creates a capacity to assimilate and exploit new knowledge for technological opportunity whereas the World Bank says that trade and FDI are the key determinants of technological progress (Global Economic Prospects, World Bank, 2008: 106-116) because these are the source of technology transfer and technological diffusion. Moreover, the results for the pooled sample suggest that market size, high-technology imports from developed countries, the stock of human capital, the level of R&D expenditure, infrastructure, and the level of IPR protection are all important factors in explaining the rate of innovation (Schneider, 2005: 543)

Since IPR protection assures that innovators reap the fruits of their endeavor, it would be useful in a country where there are many innovators, which is usually a developed country, because IPR protection is a significant determinant of economic growth (Gould and Gruben, 1996: 345-346). While TRIPS emphasizes that IPR can promote innovation, empirical evidence on the role of IPR protection in promoting innovation and growth in general remains scarce and inconclusive (Lall, 2003: VI). However, as a safeguard, IPR protection would be necessary for individual or firms to invest in R&D for technological progress because, at least, their innovations will be protected for economic benefits.

Labor force can also be a determinant of technological progress because every innovation is produced by a given quantity and quality of labor. Labor is also referred to as 'human capital' (Romer, 2001:133-137, Mankiw, 2003: 214-216) which is a collective representation of experience, knowledge, skills and health of workers (Bresnahan, Brynjolfsson and Hitt, 1999: 10). An increase in the supply of skilled labor accelerates skill-biased technological change (Kiley, 1997: 14-15)

Electricity production implicitly represents the rate of growth and rate to technological progress (Bertoldi and Atanasiu, 2009: 7-9,81). Economic growth and electricity consumption go side by side (Siddiqi, 2010: 2) because technological progress will consume more energy such as electricity. Energy is both a product and input of technological activity. Technological change of a time-saving nature can especially have a large influence on energy use as many time-saving devices (e.g. faster modes of transport) require an increase in energy consumption (Binswanger, 2001:121) Even though electricity is an old technology that is still not diffused to large parts of the world it is crucial to almost all forms of technology development. Therefore, it is of great importance when measuring technology diffusion. However, the problem in measurement is that no data is available on the national level on how many people have access to electricity. The closest proxy available is consumption (Desai et al., 2002: 121) or it can be a proxy of infrastructure (Schneider, 2005: 537).

Patent applications represent the rate of innovation because ideas and knowledge are unobservable. In order to measure the development of innovation in any country, it is necessary to consider the patent intensity in the fields of technology that need to be investigated (Bottazzi and Peri, 2003: 2) One way to measure technological progress is the number of patent applications (Schneider, 2005: 536) in order to illuminate the process of innovation and technical change (Griliches, 1990: 1701-1702).

IPR protection, R&D spending, and economic growth are also the sources of technological progress. The protection may affect economic growth in important ways. Explanations of economic growth are increasingly focusing on the power of expected profits to motivate innovation (Gould and Gruben, 1996: 323-324). That without IPR protection means the lack of an incentive structure can be a significant mitigating factor for technological change, and erode the incentive for R&D (Kanwar and Evenson, 2001: 22). Economic growth is endogenously determined by the development of human capital stock of households, sector-specific human capital and R&D stocks of firms, and the total factor productivity. R&D activity in the economy is thus modeled as a sector-specific R&D activity and represents the key driver of economic growth, which yields new product innovations and adds to the knowledge base of industry and the marketplace as a whole (Verbic, Majcen and Čok, 2009: 18-19).

All these factors are relevant to the framework of technological progress and their respective roles have been the subject of academic debates, as reviewed in Chapter 2. Therefore, the empirical analysis will be examined in order to understand the nature, magnitude and dirction of the impacts of these factors on technological progress.

2.4 Social Welfare Implication from IPR Protection

Ultimately, it is very important to understand whether IPR protection enhances social welfare, not only by invention and the dissemination of useful technical information, but also by providing incentives for investment in the commercialization of new technologies that promote economic growth, create jobs and advance other social goals, such as good public health.

There is contentious debate as to whether developing nations will gain from implementing and enforcing an IPR system similar in strength to those that exist in developed nations. Although there is no simple answer, common sense would advise that there is no one-size-fits-all solution: every country should tailor its IPR to its unique situation, goals, and long-term needs. Designing IPR protection that are either too strong or too weak will harm the country‘s well-being (Greenbaum, 2009: 1609).

There is no empirical evidence on the welfare effects from IPR protection. However, Levin et al. (1987 : 816) before the period of TRIPS, point that improving the protection is not necessarily socially beneficial. Empirical work has so far indicated a positive cross-sectional relationship between strong appropriability, as measured by variables constructed from the survey, and innovative performance. But the social cost-benefit calculation is not straightforward. Stronger protection will not yield more innovation in all contexts and, where it does, innovation may come at excessive cost. The problems from the degree of protection make it difficult for policy makers to choose between the benefits and loss from setting up regulations like IPR laws and their mechanisms of enforcement. To stimulate innovation, governments try to ensure that inventors can profit from inventing. But protecting innovators too stringently may limit the dissemination of new ideas (Gould and Gruben, 1996: 325)

For the least developed and developing countries such as the countries in Africa, IPR protection can impact on agricultural development, environmental management, health and poverty alleviation generally. The question that arises here is the extent of the contribution of IPR protection to economic and technological development at the national level. There is no consensus on the economic or social utility of granting IPR.

In fact, there are few studies demonstrating the beneficial impact of the grant of patents on economic and social development (Cullet and Kameri-Mbote, 2005: 8-9)

To concentrate on the impact of IPR protection on social welfare, the patent system works very well in industrialised countries where the burden of health care on both governments and individuals is relatively light and ensures the continuing development of new drugs. But in poor countries, where the burden of health care is very heavy, the patent system has failed to provide an adequate response to many prevalent diseases and has restricted access to cheaper drugs (Mabika and London, 2007: 2) The Doha Declaration affirms that TRIPS does not and should not prevent members from taking measures to protect public health. The human rights advocacy community has been concerned about the detrimental impacts of drug patent and other intellectual property restrictions on access to affordable medicines and treatments (Mabika and London, 2007: 12)

There are many fundamental problems in the access to health services in developing countries which are unrelated to the patents (Rozanski, 2007: 6). However, for health welfare, modern medical technologies allow tremendous improvements in health even for low income groups. For example, in sub-Saharan Africa, life expectancy has increased by 10 percent, from 45 to 49 years, and infant mortality has fallen by 30 percent, from 133 per thousand births to 93.. Unfortunately, since then, life expectancy in sub-Saharan Africa has fallen again due to the AIDS pandemic. Even though the life expectancy of people is generally getting longer, many people in developing countries who could benefit from pharmaceuticals do not receive them. The failure of antiretroviral therapy to reach more than a tiny fraction of people with AIDS in developing countries has attracted wide-spread publicity, but even medicines that are far cheaper and easier to deliver are not reaching many of the people who need them. More than a quarter of children worldwide and over half of children in some countries do not receive the vaccines that are part of World Health Organization (WHO) Expanded Program on Immunization, although these cost only pennies per dose and require no diagnosis. Three million lives are lost annually as a result. Only a small fraction of children in poor countries receive the newer hepatitis B and Haemophilus influenzea b (HIP) vaccines, which cost a dollar or two per dose. One in four people worldwide suffers from intestinal worms, although treatments only need to be taken once or twice per year, have virtually no side effects, and cost less than a dollar per year. These examples suggest that while IPR protection prevents some from obtaining needed pharmaceuticals, eliminating these rights would not help the majority of those without access to drugs (Kremer, 2002: 67-68). In fact, the cause of all death among children under 5 years of age in poor countries like sub-Saharan Africa is associated with diarrhea that can be prevented or alleviated if there is access to reasonably priced medicine. This is an access issue.

Related to the above problems of health welfare, it is interesting to examine the health care of infants impacted from IPR protection. Infant health however depends on many factors such as economic effects including income inequality and employment particularly of women. Social effects comprise of many factors such as maternal education (Verdiell, 2003: 9-10)

The justification for the inclusion of the independent variables in this model is that patent protection is one of the main drivers of the high price of medicines. Cost of medication impacts on the health care of people especially in poor countries. However, health care impact may comprise of many factors such as clean water, sanitation, and socioeconomics Kembo and Ginneken (2009: 368-370) studied the determinants of childhood and infant morbidity and mortality. They used socioeconomic variables such as maternal education and sanitation (source of drinking water and toilet facility). A mother's education is important because it facilitates her integration into a society. Education heightens her ability to make use of government and private health care resources and her ability to take care of the children and improve the capacity of the household to earn livelihood. With sanitation, household contamination is still a big problem. Pipe water is provided to a minority of households. Sanitation measures are still inadequate in many poor countries. Improvement in hygiene and sanitation decreases mortality through the mechanism of less exposure of children to contamination making them less susceptible to life-threatening diseases.

Magnani et al (1996: 569-576) conducted a study of hygiene and sanitation on the individual/household level and community level. For the individual level, source of drinking water is one of variables. The findings suggest that initiatives to mobilize additional resources for the expansion and improvement of basic primary are care services.

For GDP per capita variable, Baird, Friedman, and Schady (2009: 1-17) showed that there is a large and negative association between GDP per capita and infant mortality. On average, a one percent decrease in GDP per capita is associated with an increase in mortality of infants. The short-term fluctuations in aggregate income can have important consequences on the likelihood that a child survives the first year of her life.

Some studies show that IPR protection promotes welfare and that the social return of innovations may be higher than the private return. But these estimates have been made only for a few products (Nogues, 1993: 25). The impact on the innovators may occur at the level of social welfare through the market structure from competitive to monopoly. For example, in the medicine markets, when IP laws are introduced, the social costs may also change, as shown in Figure 2.5

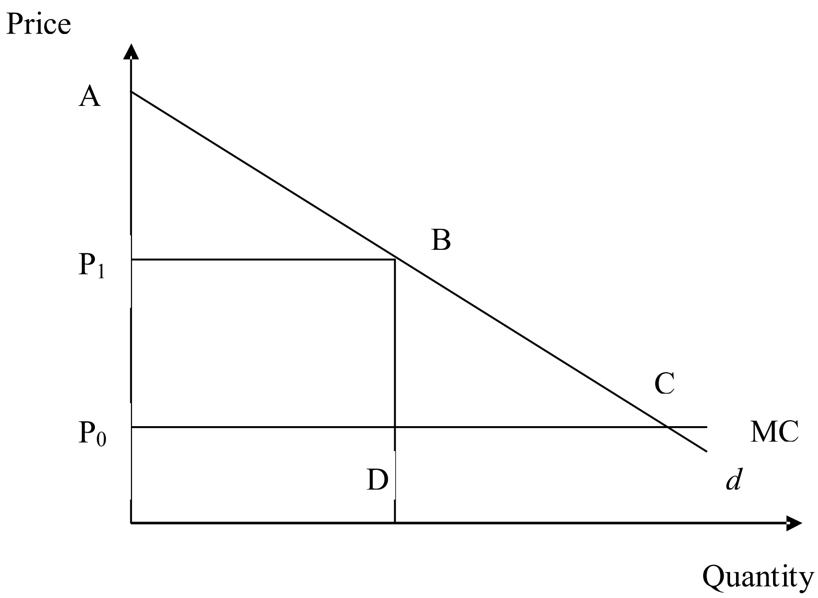

Figure 2.5 Welfare Problems

Source: Nogues, 1993: 29

The existence of IPR protection such as patents makes a great difference in this regard. The fact that patent owners are the first to exploit a market for a considerable period of time helps to create consumer loyalty in favor of the brand name drug; this loyalty is often reinforced by the medical profession. In this situation it has been found that upon patent expiration, brand name companies are able to retain a portion of the market and price their drugs higher than that of their generic competitors. On the other hand, in the absence of patents, several brands have been allowed to exist and compete.

It is assumed that the market is for a drug that fights a disease, say Z, that marginal costs (MC) are constant. Somewhat more controversial is the interpretation of the demand curve, in picturing a single demand curve to all drugs that fight a disease of type Z, there is a couple of assumptions: that different brands of drugs are perfectly substitutable and that the demand curve reflects their social value. The first assumption depends very much on the knowledge of the consumer regarding quality and degree of bioequivalency of drugs from different brands. If the consumer believes that a drug from a particular company is superior to that of its competitors, then this company will be able to exploit product differentiation.

What is the social cost of introducing patent protection? As presented in Figure 2.5, in the competitive case, price equals marginal cost, $P_0 = MC$, and the consumer surplus of patients suffering from a disease *Z* is AP_0C. In this situation, the introduction of patents will transform a competitive market into a monopoly. Prices will increase from P_0 to P_1, and patients suffering from a disease *Z* will lose P_0P_1BC. Society loses less because part of the loss to consumers is transferred as monopoly profits to the patent owner. It is likely that part of these monopoly profits will be used to finance R&D which is in fact the basic justification for patents. If, as is likely the case, R&D is carried out in the laboratories which the patent owner operates in industrial countries, then the loss to society is higher than the misallocation triangle *BDC*; the extent to this extra loss depends on the amount of the monopoly profits transferred abroad. The net social loss to society of the introduction of patent protection can be estimated by adding the consumption misallocation triangles *BDC* in the market of all patented drugs to the amount of monopoly profits which are transferred abroad for R&D purposes.

Figure 2.4 illustrates the methodology. This figure depicts the aggregate demand schedule for patent drug *(d)* as a function of a price index *(P)* of these drugs. It can be assumed that both the marginal cost and demand schedules are linear. Under these assumptions and in the presence of monopoly, it can be shown that

area AP_1B = area BDC, (1)

area P_0P_1BD = area ($AP_1B + BDC$) = 2 × area BDC. (2)

These equalities allow a simulation of the welfare loss from different assumptions regarding the extent to which the industry's income in period 1(I_1) with patent protection exceeds the income in period 0 (I_0) without patent protection. Thus, it is reasonable to assume that the monopoly income I_1 will be greater than that observed in the period without patent protection (Nogues, 1993: 32). Furthermore, in the perspective of innovation output, IPR protection may not necessarily provideyield social benefit. The protection will not yield more innovation in all contexts and, where it does, innovation may come at excessive cost (Levin et al., 1987: 816). The problem of social welfare from IPR protection also occurs in the access to health care services. One study found no evidence that TRIPS has stimulated innovation in developing market, and the IPR protection has had a negative effect on access to vaccines (Milstien and Kaddar, 2006: 360-364). The study of Milstien and Kaddar is a qualitative study, however, with no empirical result. In this regard, Peng (2009: 32-39) concludes that the requirements of a high global standard (i.e. strong) may be unfair for the developing countries.

2.4.1 Analysis of IPR Policy on Social Welfare

It is now necessary to investigate the IPR policies that the government in any country as WTO member can implement.

Inevitably, IPR policies have direct effects on the social welfare. The social welfare can be defined as W= CS + π + G, where CS is consumer surplus, π is the producer surplus, and G is the government's fiscal surplus. The government's surplus is given as

$$G = \phi\, pmD_c - M,$$

where ϕ is the cost of the counterfeiters that is the risk of being caught which is always greater than 0 ($\phi > 0$), pm is the expected fine collection per unit of the counterfeit product, D_c is the demand of the counterfeited products, and M is the degree of IPR protection. The first term on the right-hand-side of the equation is the government revenue collected as fine from counterfeiters minus the cost of IPR enforcement (Kwo, 2007: 6). Therefore, the level of G is intensely involved with the counterfeiting monitoring rate ϕ.

In the case of weak or no IPR protection, the inventor launches new product amidst a non IPR protection regime, this implies that $\phi = 0$, meaning that $M = 0$, and consequently the government will obtain $G = 0$. This new technology is then available to the public for free. Counterfeiters can than reproduce the product and sell it into the market with the low prices, and the profit of the genuine producer decreases. Such a counterfeiting laissez-faire policy will have the following effects on the society. Inventors will be unable to reap the fruits of their labors. This will cause *ex ante* inefficiency since no firm will have any incentives to invest again. Such a high degree of counterfeiting entails that the quality of the product provided in the society will be inferior to the social optimal level. This will instigate the problem of social welfare losses due to quality underproduction. This suggests that an absolute non-protection policy or unrestricted counterfeiting accommodating regime cannot be welfare enhancing. The problem at this point is what happens to the social welfare if the government imposes a strong policy that bans all counterfeits from the market.

On the other hand, the government decides to impose a very strong enforcement of IPR protection, such that no counterfeit exist in the market. Such a full-protection policy will have the following contradicting consequences on the social welfare. At the outset of strong IPR protection, it is assumed that only one legitimate producer will exist in the market. In this case, the producer will therefore act as a monopoly and set its price above its marginal cost (higher than the social optimum price). This will enable to earn supernormal profits. Such reward system will definitely provide the incentives to invent which will be missing in a non protection policy. Furthermore, the genuine producers will guarantee superior quality products which will mitigate the social welfare loss cause by quality underproduction. However, this positive effect in a full protection policy is overshadowed by other detrimental effects on the social welfare.

As mentioned above, the cost of the counterfeiters is the probability of being caught. Hence, it is positively related to the monitoring rate ϕ . This implies that increases in the monitoring rate ϕ (strong IPR protection) leads to an equivalent increase in the price of counterfeit goods as well as decreases in its demand, *ceteris paribus*. Intuitively, by imposing a strong IPR policy, where the price of the counterfeited products will skyrocket, leading to a fall in the demand for counterfeited goods to zero, $D_c = 0$. This will ensure the effectiveness of the policy since there is no incentive any longer to fake the original product. One can therefore infer from the equation, since $D_c = 0$, the government revenue will be zero, leaving the society with a negative government surplus of $G = -M$, (i.e. the cost of imposing a stricter IPR protection). The consumers are now left to face just the sole monopolist, who will obviously set his price above the social optimum price.

The undesirable high price of the monopoly will consequently deprive some potential consumers from acquiring the product. This will create an inefficiency problem through a reduction in consumer surplus and a deadweight loss in the society welfare due to quantity underutilization. Furthermore, strong IPR enforcement will also lead to inefficiency of quality underproduction, it creates the problem of quality underproduction more serious. Hence, a policy of no counterfeiting, strong protection, cannot be welfare enhancing (Kwo, 2007: 9)

Along with social welfare and optimal monopoly power from IPR protection is a fascinating issue: the incentive for human inventiveness and creativity, which are intangible assets. IPR are quite relevant in that context, allowing the producers of new and/or original work to assert legal ownership on the outcome of their efforts. The notion of IPR comes from western civilization, and IPR protection in general has evolved into the mainstay of western legal tradition. For European countries and the United States, a systematic legal framework was first achieved in the nineteenth century. Because IPR are rooted in the law, they have traditionally been the prerogative of national jurisdictions, although international cooperation in this area through multilateral treaties and conventions has a long history. The internationalization of IPR gets a tremendous recognition by TRIPS, which is incorporated as one of the core agreements constituting WTO and came into effect on 1 January 1995 (Moschini, 2004: 1). TRIPS is remarkable because it bundles together the main provisions of the major IPR agreement, and strengthens the requirements of existing agreements in some crucial areas. Also because it includes the final package as a required element for participation in WTO.

TRIPS has been controversial since it came into force. Is provisions extend the scope of IPR protection. In particular, TRIPS also addresses obligations related to the enforcements of those rights. Member governments (WTO members) must provide procedures and remedies under their domestic law to ensure that IPR is effectively enforced. The procedures must be fair and equitable, should not discriminate against foreigners and must not be unnecessarily complicated, costly or subject to unreasonable time delays. Compliance with these requirements is generally difficult for many developing country members of WTO.

The difficulty from TRIPS for developing countries is to require the member states to set a minimum standard of IPR laws and enforcement procedures. The required standard is interpreted differently in these countries. This is the main source of controversy surrounding a strong IPR protection.

If the objectives of TRIPS are practical, why are countries reluctant to set up a strong protection? How does TRIPS stimulate technological progress and economic growth? To answer these questions, it is necessary to investigate the role of technological progress on economic growth, which starts at the classic production function:

$$Y = AF(K,L),$$

where A is a measure of the current level of technological progress called total factor productivity. Output now increases not only because of increases in capital and labor but also because of increases in total factor productivity. If total factor productivity increases by 1 percent and if the inputs are unchanged, then output increases by 1 percent.

Allowing for changing technology adds another term to the equation accounting for economic growth:

$$\Delta Y/Y = \alpha(\Delta K/K) \quad + \ (1 - \alpha)(\Delta L/L) \quad + \ \Delta(A/A)$$

Growth in Output	=	Contribution of Capital	+	Contribution of Labor	+	Growth in Total Factor Productivity

This is the key equation of growth accounting. It identifies and allows anyone to measure the three sources of growth, namely, changes in the amount of capital, changes in the amount of labor, and changes in total factor productivity.

Because total factor productivity is not observable directly, it is measured indirectly. It means that if data on the growth in output, capital, and labor are available, the data on capital's share of output can be estimated. From these data and the growth-accounting equation, the growth in total factor productivity can be computed to make sure that everything adds up:

$$\Delta(A/A) \quad = \quad \Delta(Y/Y) - \alpha(\Delta K/K) - (1 - \alpha)(\Delta L/L)$$

$\Delta(A/A)$ is sometimes called the Solow residual. In this regard, changes in output cannot be explained by changes in inputs because of changing total factor productivity. Total factor productivity can change for many reasons. Changes most often arise because of increased knowledge about production methods, technological progress, education and experience of workers, government regulation and so on.

One of the most important factors that affect total factor productivity is technological progress. However, technological progress comes from many sources such as knowledge accumulation, research and development (R&D), human capital (years of schooling and training) (Romer,1990: S99). Furthermore, technological evolution is driven by a combination of technical, economic, social, political and organizational process (Tushman and Rosenkopf,1992: 338-343), FDI and Trade (Global Economic Prospects, World Bank, 2008: 108). In accordance with the objectives of TRIPS Article 7, the protection and enforcement on IPR can drive technological progress in member states, and the IP regulations and institutions for law enforcement can play a key role in promoting technological development.

It is important to illustrate the economic rationale for IPR protection in order to investigate the economy where there is a continuum of potential inventors, each with a unique possible innovation that is indexed by the parameter $\theta \in [0,\overline{\theta}]$. To represent the fact that each potential innovation has a different social value, it is assumed that the willingness to pay in R&D is the same for all innovations, but that each innovation entails a different R&D cost. Specifically, the per-period marginal willingness to pay for each innovation is assumed linear and written as : $p = \alpha - \beta q$. Once developed, each innovation can be produced at a constant unit cost, c, and yields a flow of benefits. If $c = 0$, such that the potential per-period benefit from each innovation (which would be attained if the innovation were efficiently supplied) is $\alpha^2/(2\beta)$, and thus the potential value to society of the innovation is $\alpha^2/(2\beta r)$, where r is the discount rate. Let the possible innovation be ordered according to their cost, and for simplicity write the fixed cost $F(\theta)$ of developing countries the θ innovation as $F(\theta) = \theta^2$. Thus all innovations for which $\theta \leq \theta^*$, where $\theta^* = \sqrt{\alpha^2/(2\beta r)}$, should be undertaken. But if innovation can be copied without cost, no one has an incentive to innovate in a competitive setting.

To explain the role of IPR protection on technological progress, one should investigate the main source of innovation, which is R&D. If policy makers depend on the expanding–variety type R&D as the engine of technology progress and growth, they can track the characteristics of goods; that is, there is only one final good, which can be used for consumption, for production of intermediate goods, and for R&D, which is needed to invent new varieties of intermediate goods. The production function for the final good is characterized by an expanding variety of producer intermediates of the form:

$$Y = L^{1-\alpha} \int_0^A x(i)^{(\alpha i)} di \,, \quad 0 < \alpha > 1 \qquad (1)$$

where Y is the quantity of final good; L is labor input; $\chi(\iota)$ is the variety of producer intermediates with index ι : and A, the number of varieties, increases over time as a result of innovations. The final good market is perfectly competitive.

The intermediate good market is monopolistically competitive. Sellers are innovators of intermediate goods and buyers are final good producers. There is no uncertainty innovation. Motivated by the prospect of monopoly profit, an innovator invests in β units of a final good and obtains a blueprint of a new variety. It then earns the opportunity to produce the new intermediate good at unit marginal cost (i.e., the cost of one unit of final good) and sell the differentiated intermediate good at a profit-maximizing markup of $1/\alpha$.

To examine the role of IPR protection, the imitation process can be assumed to the form

$$A_c = \mu(A - A_c),\ \mu > 0 \qquad (2)$$

The variable A_c is the number of goods that have been imitated: whereas $A - A_c$ in the number of goods that have not been imitated and thus available for imitation. The parameter μ captures the degree of IPR protection, with higher value meaning weaker protection. It is the hazard rate at which the market power of an intermediate good producer disappears at the next date, given that its market power has not been eroded so far. This rate is defined as the rate of imitation. The rate of imitation is dependent on many factors. One way to capture explicitly all these factors is to decompose μ into two terms: $\mu \equiv \iota\delta$, where ι is the natural rate of imitation (the rate of imitation when there is no IPR protection at all), and $0 < \delta < 1$ is an index of the strength of IPR protection provided by the government, with higher δ representing weaker protection. Full IPR protection implies that $\delta = 0$, and no IPR protection implies that $\delta = 1$. The parameter ι is dependent on the level of technology, use of any measures by the innovator to prevent or delay imitation, the stock of human capital, entrepreneurship, entry barriers, anti-trust policies, etc. The parameter δ is dependent on IPR protection such as patent length and breadth, laws on trademark, copyrights and trade secrets, and enforcement of IPR. Although μ is influenced by an array of factors, it is assumed that government imposes IPR policy in the degree of δ, while ι is assumed to be constant. Regarding to μ as a parameter that can be controlled by the government through its IPR policy. Hereinafter, this explanation shall refer to a tightening of IPR protection as a decrease in μ (caused by a decrease in δ)

Once a product is imitated, it is assumed that competition will drive the price down to marginal cost. Thus, it can be classified into two groups of intermediate goods: goods with index $\iota \in (0, A_c)$ are the imitated ones that are competitively priced, and the rest, with index $\iota \in (A_c, A)$, that are still under monopoly. The demand functions for the two groups are

$$\chi(\iota) = \begin{cases} \alpha^{1/(1-\alpha)} \equiv \chi_c, & \iota \in (0, A_c) \\ L\,\alpha^{2/(1-\alpha)} \equiv \chi_m, & \iota \in (0, A_c) \end{cases} \qquad (3)$$

Clearly, $\chi_m < \chi_c$, which reflects the usual monopoly distortion in resource allocation. To simplify the analysis, it can also be assumed that imitation is costless. It follows that resource constraint for the economy can be written as

$$Y = C + \beta\dot{A} + A_c\chi_c + (A - A_c)\,\chi_m \qquad (4)$$

where C is aggregate consumption.

Taking into account μ and the instantaneous profit at each future date, a potential innovator decides whether or not to enter into the innovation business. Under the assumption of free entry into the innovation business, the present discounted value (PDV) of net profits of an innovator is equal to zero in equilibrium. That is, the rate of return to innovation, r_m, must be equal to the real interest rate adjusted for imitation risk:

$$r_m = r + \mu \qquad (5)$$

The value of a firm equals the cost of innovation if there are no barriers to entry in the innovation business. Therefore, the PDV of the net profits of a firm is zero. If there are entry barriers in the innovation business, the PDV of net profits of an innovator is positive. The higher the barrier, the larger the PDV of net profits (Kwan and Lai, 2003: 853-878)

In this regard, one may find that IPR protection is a regulation that provides incentive for innovation. At the same time, it also intervenes in the market to promote and/or set up obstacles to technological progress. That is, the tradeoff between the loss and gain of innovators and consumers leads to the possibility of an optimal IPR protection, optimal in the sense of maximizing the social welfare on technological progress for the member countries, as said in the objective of TRIPS.

2.4.2 Does IPR Protection Contribute to Social Welfare?

Another social effect from IPR protection will be analyzed for greater understanding. If every country complies with the objectives of TRIPS because IPR protection creates incentive for all innovators, what is the welfare effect from such protection?

One of many characteristics of IPR protection is the length of time for monopoly power to inventors and creators. The analysis of this framework would focus on the impact of IPR protection on the production innovation. For example, the length of IPR protection such as patent $T > 0$ is available to innovators, such that the innovators can behave as a monopoly for T periods. Monopoly pricing yields a per-period of $\alpha^2/(4\beta)$ for each innovation undertaken, such that the present value to the innovator (assuming that the same discount rate r applies) is

$$\pi_0 = \int_0^T \frac{\alpha^2}{4\beta} e^{-rt}\, dt = \frac{\alpha^2}{4\beta r}(1\text{-}e\text{-}^{rT}).$$

With this IPR system, all innovations for which $\pi_0 \geq F(\theta)$ are undertaken, that is, all innovations for which $\theta \leq \hat{\theta}$, where $\hat{\theta} = \sqrt{\alpha^2(1-e^{-rT})/(4\beta r)}$. It means that the IPR system , such as patent, can improve social welfare, but being relative to a competitive innovation system, and the flow of innovations is still less than socially desirable (i.e., $0 < \hat{\theta} < \theta^*$).

For the IPR protection, with patent, the total surplus from each innovation that is undertaken is

$$S = \int_0^\infty \frac{3\alpha^2}{8\beta} e^{-rt}\, dt + \int_T^\infty \frac{\alpha^2}{8\beta} e^{-rt}\, dt = \frac{\alpha^2}{8\beta r}(3 + e^{-rt}) \text{ (Moschini, 2004:12).}$$

It means that each innovation may provide a surplus value within the period of protection. However, after period T the innovation is competitively available at zero cost. To derive an explicit solution for the optimal IPR protection such as the patents, assume that θ is uniformly distributed with unit density. The total R&D cost $R(\hat{\theta})$ of undertaking all innovation projects for which $\theta \leq \hat{\theta}$ is

$$R(\hat{\theta}) = \int_0^{\theta} F(\theta)d\theta = \frac{1}{3}\left(\frac{\alpha^2}{4\beta r}\right)^{3/2} (1-e^{-rt})^{3/2}.$$

Accordingly, the net social welfare SW = $\pi_0 T + \hat{\theta}$ S - $R(\hat{\theta})$. That is, the profits of firms within the period of patent protection plus the surplus from each innovation minus the cost of R&D.

In fact, the optimal IPR protection is finite. Although setting $T = \infty$ would increase the flow of innovation, this is not optimal because each innovation is underprovided by the monopolist. With $T = \infty$, fewer innovations are developed, but each one is efficiently supplied after T period. The market for a typical innovation is illustrated in Figure 2.6 (for the case $c > 0$), where q^M represents the monopolistically supplied innovation for the duration of patent protection, and q^c represents the efficient level of the provisions to innovation.

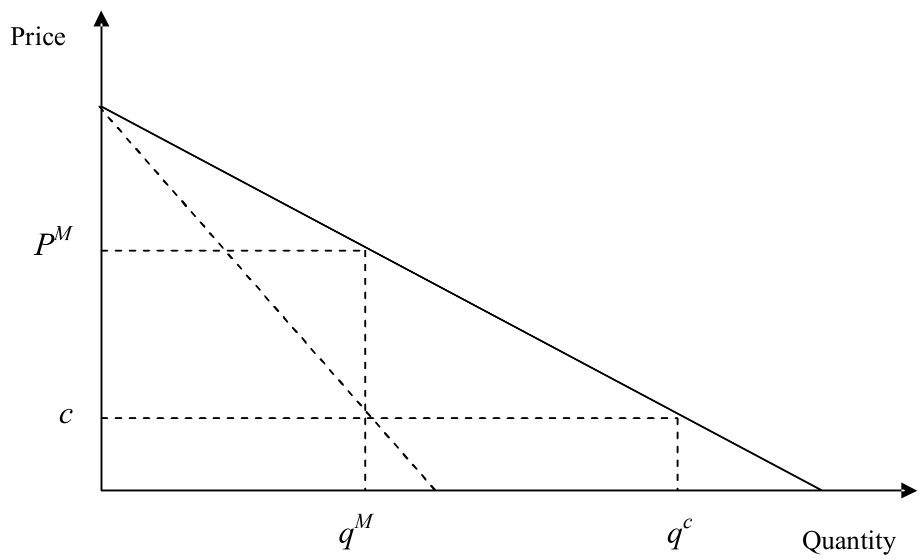

Figure 2.6 Patent Protection and Incentive to Innovate: Integrate Economy
Source: Moschini, 2004: 13

Now suppose that the economy grows, such that the aggregate demand for each innovation expands. This change can be parameterized by increasing α or by decreasing β. High demand for innovation may be appropriate when a given economy becomes wealthier. Such growth entails that more innovations are desired by the economy (θ^* increases). But the optimal patent protection T^* is independent of α and/or β. Thus, small and large economies may have equal scope for patent protection. This result is somewhat special and due to the particular structure of economy. For example, for any given innovation, a growth in demand allows larger monopoly profit and would suggest that a shorter period of patent protection is needed to justify incurring the required fixed R&D cost. But a wealthier economy desires more innovations. Accordingly the incentive for private R&D under IPR protection derives from the profits that a monopolist can realize, which is directly affected by an expansion of the economy. Thus, weakening of IPR protection may be necessary.

2.4.3 TRIPS and Weak IPR Protection

One favorable argument for TRIPS is the degree of protection and enforcement. That is, weak IPR protection may be desirable for developing countries and TRIPS may not be suitable for every country. It is because the optimal trade-off between dynamic gains and static losses calls for limiting the monopoly power granted to the innovator. From a welfare perspective, strong IPR protection should proceed only as far as necessary to provide enough innovation incentive. This argument is made by Deardorff (1992: 48-50) who assumed that invention can take place only in the country where R&D investment can achieve a reduction in the unit cost, but this process innovation can be imitated by the firm at no cost in the country without or weak IPR protection. However, in order to imitate, the imitating firm must have the same capability as the innovating firm. From this perspective, IPR protection may not be necessary for a developing country where there is low capability of technological absorption.

Those backgrounds and debates about IPR protection in this chapter show the origin of IPR, IP laws development, the impact of IPR protection on trade, technological diffusion, and social welfare. The impact of IPR protection on technological progress is still debatable. The model and methodology to investigate the impact of IPR protection on technological progress are presented in the next chapter.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Frame of Study

This study focuses on the impact of IPR protection on technological progress. To be examined are the factors that may contribute to technological progress, in particular the degree of IPR protection and other factors including expenditure on R&D, the labor force, GDP per capita, FDI, and Electricity production (as proxy to Infrastructure). A proxy to technological progress is the number of patent applications (Schneider, 2005:536; Dushnitsky and Lenox, 2005:620). As such, this will be used to represent the level of technological progress in a country. The total number of patent applications is thus the dependent variable. The independent variables are R&D expenditure, IPR protection index, total labor force, GPD per capita, FDI, and electricity production.

The study also investigates the role of TRIPS agreement in the member countries of WTO. In order to understand the impact of TRIPS on the development and welfare of developing countries, the study will examine the impact of IPR protection on technological progress in the innovator countries and user countries of technology. The study further investigates the impact of IPR protection on health care of infants by examining the rate of infant mortality in a condition of strong and weak IPR protection.

The study is organized into three parts in line with its objectives. The first part examines the impact of IPR protection on technological progress in a general perspective. This part describes and analyzes the specific impacts of the independent variables on technological progress. The second part compares the impact of IPR protection on technological progress in the innovator countries and user countries of technology. The third part examines the impact of strong and weak protection on the rate of death tolls of infants.

The research questions and purposes of the study address the concern on whether a strong IPR protection contributes to the promotion of technological progress, TRIPS is useful for every country, and how IPR protection affects health welfare of infants. The details of the research methods employed are presented in three parts.

3.2 Model Specification of IPR Protection on Technological Progress

The empirical specifications of the impact of IPR protection on technological regression is based on the theoretical models developed by Schneider (2005: 533-534), Yang and Maskus (2001: 65-66). It is assumed that the rate of technological progress can be measured by the number of patent applications, which reflects the innovative activities in the countries.

Thus, the baseline model employed in this study is the following

$$INV_{it} = X_{it}^{/}\beta + \alpha_{i} + \varepsilon_{it}$$

where INV_{it} is the natural log of the total number of patent applications in the countries, $X_{it}^{/}$ is a vector of explanatory variables, all variables in log, except IPR protection index, that vary over countries and over time, α_{i} is unobserved country fixed effects. The country specific effects might reflect factors such as persistent differences in political environments and/or government subsidy for innovation in a given country and national culture which may not be captured by the set of regressors included in the specification and ε_{it} is the usual random disturbance terms, assumed to be i.i.d. with mean zero and constant variance.

The empirical model for technological progress regression uses both fixed and random effects. Fixed effects model is very important because data are collected from different sources that might affect the dependent variable that need to be controlled. Unfortunately, it can never be certain that all the relevant control variables are present, so that if this study estimates plain OLS model there is concern about unobservable factors that are correlated with the variables included in the regression. Omitted variable bias would result. It is normally assumed that these unobservable factors are time-variant so that fixed effect regression will thus eliminate the omitted variable bias.

The random effects model is also necessary because it is assumed that the unobserved effect a_i is uncorrelated with each explanatory variable under the assumption as: Cov $(X_{it},a_i) = 0$ for each time period *t* and variable 1...*N*. The random effect model is sometimes described as a regression with a random constant term. In other words, it is assumed that the intercept is a random outcome variable that is a function of a mean value plus a random error. A composite error term is formed as follows: $V_{it} = a_i + u_{it}$ (Studenmund and Cassidy, 1992 : 11-13). Thus, random effect model is expected to be reliable. In the theoretical framework, if the individual effects are the result of a large number of non-observable stochastic variables, then the random effects interpretation is demanded. And if the sample does not contain a large percent of the population, the random effects model would be the model of choice (Sherron and Allen, 2000: 1-2)

Moreover, the reason to use fixed effects and random effects models is that there are probable correlations between the number of patents and other independent variables. There are country-specific aspects of IPR protection because of differences in domestic conditions, which may not be captured by the included independent variables. Ignoring these country-specific effects in the regression would create omitted variables bias and inconsistent estimators. The samplings data are also collected from many sources with different characteristics of countries, which might be biased due to unobservable heterogeneity related to macroeconomic factors, country attributes, or country characteristics. Thus, fixed effect methodology is included to control for macroeconomic trends that may affect overall patent numbers. And to recheck the results, random effects will be employed that is assumed that the regressor and the country-specific effects are uncorrelated (Dushnitsky and Lenox, 2005: 623-625). This simultaneity problem always occurs in the empirical literature on productivity measurement (Djankov and Hoekman, 1999: 15-16). Thus, both fixed effects and random effects are used in this study in order to reveal whether fixed effect or random effect is most appropriate. The Hausman specification test to choose between fixed or random effect frameworks suggests that random effects is most appropriate. However, the results of estimation will present both fixed effects and random effects models, such as the work of Yang and Maskus (2001: 65-70) and the study of Schneider (2005: 532).

The reason for using the panel data is that panel data are most useful when it is suspected that the outcome variable depends on explanatory variables which are not observable but correlated with the observed explanatory variables. If such omitted variables are constant over time, panel data estimators allow a consistent estimation of the effects of the observed explanatory variables (Schmidheiny, 2009: 1).

3.3 Technological Progress Regression

In order to investigate the impact of IPR protection on technological progress, the technological progress regression is:

$$Patent_{it} = \beta_0 + \beta_1 R\&D_{it} + \beta_2 LF_{it} + \beta IPR_{it} + \beta_4 GDPpc_{it} + \beta_5\ FDI_{it} + \beta_6 Elec_{it} + u_{it} \qquad (1)$$

$$u_{it} = \alpha_i + \varepsilon_{it}$$

where $Patent_{it}$ is the total patent applications as a proxy of technological progress; Schneider (2005:536) and (Dushnitsky and Lenox,2005:620) used patent applications as a proxy of innovation because of the time gap between the application process and the issuing of a patent, the use of data on patent applications instead of granted patents provides a more timely account of innovative activity. Moreover, Crepon and Duguet (1996:16) suggest that innovation output is measured through the number of patent applications (Desai et al., 2002: 101), an increase in the number of patents represents the rate of innovation (Mansfield, 1986: 180) and as mentioned in TRIPS agreement Article 7.

$R\&D_{it}$ is the level of real R&D spending, and related to LF_{it} that is the total labor force which represents the number of human capital in each country because the stock of human capital and the level of R&D expenditures should be positively correlated with the rate of innovation (Schneider, 2005: 533). Data on R&D expenditures is reported in U.S. dollars.

IPR_{it} is IPR protection index. The index ranks the degree of IPR protection on an adjusted scale of 1 to 7 based on the estimation of International Property Rights Index (2007: 45, 2008: 22-23, 2009: 20-21) which is calculated from the methodology of Ginarte and Park (1997: 284-288). This index is based on five categories of IP laws, such as patent laws, namely, the extent of coverage, membership in international IPR agreement, provisions for loss of protection, enforcement mechanisms, and the duration of protection (International Property Rights Index, 2007: 41). The index does not vary too much with time. It means that since 1960 to 2005 the degree of protection in each country does not present an obvious increase (Park, 2008: 2-3). This index is reliable, recognized and used for many studies such as Schneider (2005: 533), Briggs (2007: 16-18), Kanwar and Evenson (2001: 11), Chatterjee et al. (2008: 14-15), and Andres (2003: 3). The degree of IPR protection is estimated in this study based on the hypothesis that strong IPR protection may give negative impact on technological progress; there is no previous study focused on this aspect. The coefficient on the variable *IPR* is expected to be negative. The data of IPR protection index (weak & strong) of every member country of TRIPS, both developed and developing, show the degree of standard protection. Most countries have the protection of both the laws in books and enforcement. Only a few countries have strong protection. There are infinitesimal differences in the degrees of protection.

$GDPpc_{it}$ is the real GDP per capita; Stern, Porter and Furman (2000: 20-21) demonstrate that a production function for international patents depends on GDP per capita, which is a proxy for each country's knowledge stock (Schneider, 2005: 533). The coefficient on the variable *GDPpc* is expected to be positive.

FDI_{it} is the level of inflows of foreign direct investment since Grossman and Helpman (1995: 62-65) suggest that FDI can potentially help disseminate technology to the host country. Thus, the coefficient on the variable *FDI* is expected to be positive. The data is reported in U.S. dollars.

$Elec_{it}$ is electricity production as a proxy of infrastructure suggested by Schneider (2005: 537). The electricity production may represent the level of technological progress because most of technological innovation consumes electricity. Thus, the coefficient on the variable *Elec* is expected to be positive.

α_i is a country specific effect which is unknown.

i is a county, *t* is times

To test the multicollinearity among variables to examine whether the model is reliable, the variance inflation factor (VIF) is tested because VIF measures the impact of collinearity among the variables in a regression model. the results show that VIF are less than 10 (l_redex = 2.67, l_totlf = 5.99, ipr = 2.42, l_gdppc= 6.72, l_fdi=266, l_elecpr = 6.65) which means that multicollinearity is not a problem (Ayyangar, 2007: 5). The test for multicollinearity is shown in Appendix B.

Heteroscedasticity of the variables is present when the variances are unequal or inconstant (the opposite is homoscedasticity, that is, all variables are reliable) Heteroscedasticity makes the estimation unreliable. To this problem, the random effect model has been already tested by Breush and Pagan Lagrangian multiplier (Griffiths, Hill, Judge, 1992: 495). Test: Var(u) = 0, the result is chi2(1) = 0.42. Prob > chi2 = 0.5183. The p-value is greater tan 0.05 so H_0 is accepted which means heteroscedasticity is not present. This technique follows Studenmund and Cassidy (1985: 382-385). The test for heteroscedasticity is presented in Appendix C.

3.4 Health Welfare Regression

IPR protection may negatively impact also on social welfare. However, data on welfare from IPR protection for the countries are not available, and the impact of IPR protection on social welfare is still not clear (Nogues, 1993: 50-51). A previous survey shows that strong IPR protection is not necessarily socially beneficial (Levin et al., 1987: 816) Thus, in order to investigate the welfare impact from IPR protection, it is interesting to estimate the social welfare on the issue of public health, which is a debatable issue (Faunce et al., 2005: 10, Cullet, 2003: 160) because TRIPS claims to support public health as expressed in the Doha Declaration in 2001 (Trade Directorate & Trade Committee, 2003: 10). Under the restriction of database from the World Health Organization (WHO), this part of the analysis uses cross sectional data to investigate this question.

To investigate the social welfare impact, this study estimates the health welfare of population from the number of infant mortality. This is based on the assumption that the rate of infant mortality may depend on the ability to access medicines under the restriction of IPR protection such as a patent. Infant mortality was chosen as the proxy of health welfare because IPR protection has an impact on the price of pharmaceutical products under a patent protection. That is, the developing and least developed countries have little or no resource to purchase a pharmaceutical product for any price above marginal cost (Hasper, 2005: 30). One of crucial problems of IPR protection is the ability to access medicines of children in the poor countries. For example, the World Health Organization, reporting on the health situation in the South-East Asia Region between 2001 to 2007, revealed that the top ten countries with a large number of unvaccinated infants in the year 2006 included the very poor countries (World Health Organization Regional Office for South-East Asia, 2008: 76-80). Furthermore, the situation of AIDS in Brazil and South Africa presents the problems of patent protection on the ability to access high-priced medicines. The percentage of infected is up to 30% (Serra, 2004: 9-14).

The reason to estimate the infant mortality to indicate the level of social welfare is because the health care of the population in any country can be estimated by the number of infant death (Kremer, 2002: 67-68). The independent variables are factors of schoolings, factors of public health that is measured by the percentage of population with access to clean drinking water and sanitation, economic status measured through GDP per capita, and index of IPR protection which categorizes the groups of countries into two groups, namely, strong and weak IPR protection. The data on IPR protection index is collected from the last year of the countries.

To investigate death tolls, years of schooling, infrastructure such as the access to cleaned water and sanitation in rural areas is measurable (Alves and Belluzzo, 2005: 25-27, Villegas, Compadre, Otero, 2005: 445-451). Furthermore, income distribution or GDP per capita can impact on the rate of infant death (Waldmann, 1992: 1300) and percentages of labor activities (Tanveer and Elhorst,2008:18, Kishor and Parasuraman, 1998: 34-36). Thus, to examine the impact of IPR protection on the death tolls of infants, the health welfare regression is:

$$infmort = \beta_0 + \beta_1 ipr(strong\ \&\ weak) + \beta_2 gdppc + \beta_3 schyear + \beta_4 sant\_rural + \beta_5 drkwater\_rural + \beta_6 econact + u_{it} \quad (2)$$

where *infmort* is death toll of infants, *ipr* is IPR protection index in the countries compared to both strong and weak protection. *gdppc* is GDP per capita. *schyear* is average years in schools of population in the country, *drkwater_rural* is percentage of households in rural area that have access to clean drinking water, *sant_rural* is percentage of households that use sanitary facilities in rural area, and *econact* is percentage of labor force participation.

3.5 Data and Sources

All data are secondary, and collected from various sources. The maximum sample size is 224 countries for the years 2006-2008 when data are available (the list of countries appears as Appendix B). The empirical studies that investigated the link between IPR protection and Trade, R&D, technological diffusion, and economic growth faced the same problem of limitation of data on IPR protection index (Briggs, 2007: 38, Maruyama, 2006: 3-4, Schankerman, 1991: 5-6 , Branstetter et al., 2005: 9-11). Thus, the major constraining factor for sample countries is the lack of some data for some countries; this was but not significant impact because it can be resolved by statistics techniques. All variables are estimated in natural log, except IPR protection index, which was expressed as real number of degree of protection adjusted from 1 = weak to 7 = strong because the variable is a discrete number that cannot take log, rather than a continuous number of other variables.

The proxy for technological progress (innovation) is defined as the number of patent applications. The patents are the innovative output (Stern et al., 2000: 23). Data on patent applications over the 2006-2008 broken down by nationality of applications (foreign & domestic) are available from the World Intellectual Property Rights Organization (WIPO: WIPO Statistics Database). Descriptive statistics of patent applications filed for some countries are provided in Appendix C.

Data on R&D expenditures comes from the United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics. The data is reported in U.S dollars.

Labor force data comes from the International Labor Organization, using World Bank population estimates.

Data for IPR protection index reflect the degree of IPR protection in each country. The IPR protection index of the years 2006, 2007, and 2008 are extracted from the International Property Rights Index and the Global Competitiveness Report of the World Economic Forum.

A problem with the IPR index is that it is based primarily on the laws in force against infringement but not on their enforcement or implementation. Thus, the index may overestimate or underestimate the degree of IPR protection in a country where strong IPR laws are on the books but do not work in practice because of weak enforcement or other administrative obstacles. To control the variation of the degree of IPR index across countries, the index is accordingly imported from International Property Rights Index because it incorporates broader categories of IPR protection, and, it is most comprehensive and accurate in the present. The index also exhibits greater variability across countries and is likely to support more precise estimation (Yang and Maskus, 2001: 67)

The degree of protection is, at best, a rough measure of the theoretical concept of IPR protection. Undoubtedly, measurement error is possible because constructing any general measure of IPR protection requires judgment. A common way to cope with this problem is to consider the proxy to measurement error and use the instrumental variables technique of estimation. Thus, the variables used are already tested to be correlated with the independent variable they are instrumenting for, and have to uncorrelated with the primary regression's error term (Gould and Gruben, 1996: 336).

This study also needs to measure the impact from IPR protection on technological progress in countries with different attributions. For example, the innovator countries and user countries have different technological capability. That is, each country, intuitively, depends on the different attributions. Accordingly, to differentiate the innovator and the user countries, the study uses the number of patent applications divided by GDP per capita to differentiate the countries that innovators from those that are users of technology. To generate the ratio of innovator and user countries; generate ratio = totpatent/gdppc. When the ratio is greater than mean (0.61) for any country, it is assumed that the country is a technology innovator. If the ratio is less than 0.61, it is assumed that the country is a technology user. The result of the calculation is summarized in Table 3.1

Table 3.1 The Calculation of Mean Values to Classify the Innovator and User Countries of Technology

Variable	Obs	Mean	Std. Dev.	Min	Max
Ratio	393	.6061916	3.109756	0	35.28403

The data on GDP per capita comes from the World Bank, International Comparision Program database and UNESCO.

Data on FDI inflows comes from the United Nations Conference on Trade and Development (UNCTAD), and International Monetary Fund, Balance of Payments Statistics Yearbook and data files. This variable is reported as net inflows of investment. The data is reported in current price in millions U.S. dollars.

Data on electricity production (Elec) measured as kilowatts per hour (kw/h) comes from the World Bank Development Indicators and International Energy Agency, Energy Statistics and Balances of Non-OECD Countries, Energy Statistics of OECD countries, and Energy Balances of OECD countries. Electricity production is measured at the terminals of all alternator sets in a station. In addition to hydropower, coal, oil, gas, and nuclear power generation, it covers generation by geothermal, solar, wind, and tide and wave energy, as well as that from combustible renewable materials and waste. Production includes the output of electricity plants that are designed to produce electricity only as well as that of combined heat and power plants.

Table 3.2 describes the descriptive statistics of variables used in the empirical tests.

Table 3.2 Descriptive Statistics

Variables	# of observations	Mean	Std. Dev.	Min.	Max
Totpatent	224	196357.9	365330.5	0	1432571
Edexp	224	148.2075	224.6774	0	907.9
Rotlf	224	771.52	944.1085	13.25	3112.65
Ipri	224	5.522679	1.028637	3.89	7
Fdppc	224	7928.05	8485.434	273.09	29805.33
Fdi	224	139.5619	276.2823	-1.4	1730.51
Elecpr	224	3540.849	4492.425	14.43	19704.07

The expected signs are that the possibility of β(ipr) would be negative. In the meantime, the signs of *β(R&D), β(LF), β(GDPpc), β(FDI), and β(Elec*) are expected to be positive because they would directly impact on technological progress in some aspects, as shown in some of the reviewed studies.

Table 3.3 Top 15 Countries of Highest Patent Applications

No.	Countries	Number of Patent Applications	IPR Ranking
1	United States of America	425966	5.6
2	Japan	408674	5.7
3	Republic of Korea	166189	5
4	China	210501	3.9
5	Germany	60585	6
6	Canada	42038	5.6
7	Russian Federation	37691	2.9
8	Australia	26003	5.9
9	United Kingdom	25745	5.4
10	Brazil	24074	3.3
11	France	17249	6
12	Mexico	15505	3.2
13	Hong Kong (SAR), China	13790	5.4
14	Singapore	9163	6.3
15	Israel	7496	4.5

Table 3.3 illustrates the inconsistency of the degree of IPR protection and its impact on technological progress. The table shows that strong protection countries such as France, Singapore, Australia, and United Kingdom have patent applications fewer than some countries such as United States of America, Japan, Republic of Korea, which have a lower degree of protection. It means that technological progress in some countries with low degree of IPR protection tends to grow faster than the countries with high degree of protection. The details are presented in Appendix E.

The result of the test as to whether the variables vary together or opposite to the data are presented in the correlation matrix in Table 3.4

Table 3.4 Correlation Matrix to Test the Correlation of Variables

corr ltotpatent lrdexp ltotlf ipr lgdppc lFDI lelecpr time (obs=227)								
	ltotpa~t	lrdexp	ltotlf	ipr	lgdppc	lFDI	lelecpr	time
ltotpatent	1.0000							
lrdexp	0.5482	1.0000						
ltotlf	0.5252	-0.0635	1.0000					
ipr	0.4301	0.7828	-0.1743	1.0000				
lgdppc	0.4560	0.8176	-0.2782	0.7881	1.0000			
lFDI	0.6310	0.5033	0.4071	0.4277	0.5021	1.0000		
lelecpr	0.8383	0.3909	0.7773	0.2881	0.2915	0.7049	1.0000	
time	-0.0091	0.0333	-0.0027	-0.0223	0.0325	0.1013	0.0314	1.0000

A Correlation matrix describes correlation among the variables. The diagonal elements (correlations of variables with themselves) are always equal to 1.00. The correlation coefficient indicates the degree of linear relationship between two variables. The correlation coefficient always lies between -1 and +1. -1 indicates perfect negative linear relationship between two variables, +1 indicates perfect positive linear relationship and 0 indicates lack of any linear relationship.

For example, in Table 3.4, to investigate the correlation between R&D expenditure and total patent application, the value in the correlation matrix is 0.5482. This means that R&D expenditure and total patent application vary positively in the same way, but not in perfect relationship (because the perfect relationship is 1). The correlation value of IPR protection index and R&D expenditure is 0.7828, which means that IPR protection and R&D expenditure vary in positive direction and the linear relationship is greater than the relationship of R&D and the number of patent application. The value of IPR protection compared to total labor force is -0.1743. It means that the relationship of these two variables varies in opposite direction.

The correlation matrix in Table 3.4 measures the degree to which two variables either vary together or inversely. Since the standard deviation of standardized data is 1.00, the results show that the log of total labor force and log of R&D expenditure, IPR protection index and the log of total labor force, the log of GDP per capita and the log of total labor force, time with log of total patent application, the log of total labor force, and IPR protection index vary in opposite directions. The rest of the variables vary together in the same direction.

3.5.1 Data for the Health Welfare Regression

Data used for the social welfare regression is selected from some countries where data is available, not the pooled data of every country. The selected countries are those that have the latest updated IPR index i.e. for 2006, 2007 or 2008. As such, the expected results of this part may be initial results. However, IPR protection is expected to have a negative impact on infant mortality.

CHAPTER 4

EMPIRICAL RESULTS

This chapter presents and discusses the results of the study according to the objectives. First is, the impact of IPR protection on technological progress, followed by the impact of IPR protection on the innovator and user countries of technology, and finally, the impact of IPR protection on health welfare.

4.1 Factors that Determine Technological Progress

The results present both fixed effects and random effects that exhibit similar results. However, the interpretation will be expressed only in random effect because it is most appropriate, as explained in Chapter 3. The random effect estimation results are presented in the right column of Table 4.1

Table 4.1 The Results of Technological Progress Regression

ln(totpatent)	Fixed Effect	Random Effect
ln(rdexp)	.289**	.284**
	(2.33)	(2.29)
ln(totlf)	-.172	-.161
	(-1.46)	(-1.36)
IPR	-.020	-.005
	(-0.16)	(-0.04)
ln(gdppc)	.104	.111
	(0.46)	(0.49)
ln(fdi)	-.086	-.097
	(-1.21)	(-1.40)
ln(elecpr)	1.367***	1.363***
	(11.50)	(11.45)
_cons	-9.689	-9.727
	(-6.32)	(-6.31)
R^2	0.766	0.766
Observations	223	227

Note: Estimated coefficients are shown together with t-statistics in paretheses.

**denotes 5% level of significance

*** denotes 01% level of significance

The result shows that R&D expenditure (*rdexp*) has a positive significant impact on the number of patent applications. The estimated coefficient for R&D expenditure is 0.284. It means that as the level of R&D expenditure increases 1%, the number of patent applications will increase 0.284 %.

The estimated coefficient on total labor force *(totlf)* is -0.161., but insignificant.

Regarding IPR protection (*IPR*), as expected, the coefficient for IPR is -0.005. It is negative, but insignificant.

GDP per capita (*gdppc*) has a positive but insignificant impact on the number of patent applications. The estimated coefficient is 0.111.

FDI (*fdi*) has a negative but insignificant impact on technological progress. The estimated coefficient is -0.097.

Electricity production (*elecpr*), which is proxy to infrastructure, plays a key role in technological progress. The estimated coefficient is 1.363. It means that a 1%

increase in the electricity production will increase the number of patent applications by 1.363 %, which is significant.

The above results present a number of important implications on the pathways to technological progress. First, the level of technological progress depends on the level of R&D expenditure; increasing the level of R&D funding would positively impact on the development of technological progress. In fact, this variable always impacts on technological progress *per se*. The result is not surprising. Without any restriction, the more a country invests in research and development, the higher its output. This strongly suggests a very high priority to R&D investment to accelerate technological development.

Second, the results on the total labor force reminds that a large number of labor force does not necessarily contribute to technological progress. One implication of this variable is that countries with high numbers of workers may be in the initial stage of economic development. The level of technology in a high labor force country is not sophisticated. This result concurs with the study of Horii and Iwaisako (2005: 31), which finds that labor force effect is negative and insignificant as well.

IPR protection has no sign to indicate any impact, one way or the other, on technological progress. The finding shows that IPR protection is not relevant to technological progress. This neutral impact of IPR protection on technological progress is noted in many countries. For example, the strong IPR protection countries such as Singapore, France and Australia have fewer patent applications than the countries with lower IPR protection such as the U.S.A., Japan, Republic of Korea, and China, as presented in Table 3.3.

In answer to the research question, "Does a strong IPR protection contribute to the promotion of technological progress?" the result shows that IPR protection does not impact on technological progress.

In essence, IPR protection is a legal tool meant to promote economic prosperity. TRIPS, IP laws, and other international conventions have the same goals; to facilitate the procedures of resource allocation to be fair, to promote perfect competition in the markets, and to provide the mechanisms to safeguard social welfare. This is why laws and economics cannot be separated. The remark of Ronald Coase, in 1961, "Forget about the law, look at costs and benefits to see how economic life is conducted", (Stigler, 1992: 457) might be impractical because economic agents are essentially humans and human behavior cannot be controlled and predicted. Someone who cares only about costs and benefits, not about competitiveness and wealth of society, may govern the market for his or her own benefit. How can this problem, should it arise, be handled without laws and regulations?

Economics needs efficient laws to provide economic efficiency. But efficiency and justice do not always come together. Efficient laws would usually place the burden of the high cost of enforcement on individuals, firms, and governments. Very efficient laws tend to be excessively enforced which can lead to monopolies and abuse of power. The strictness of laws may conflict with one large and popular branch of economics, welfare economics, which is saturated with talk of fairness (Stigler, 1992: 458-462), and fairness may not prevail in an economy where economic laws like TRIPS or IPR protection are so strict as to stifle economic growth.

The result on the IPR protection answers the research question about the objective of TRIPS. Since the overall results of IPR protection show no impact on technological progress, it implicitly means that the objectives of IPR protection may not always be compatible with technological development. TRIPS may be appropriate for some countries but may not be useful for every country. This interpretation follows the study of Lall (2003: 32).

The results on IPR can imply that laws and regulations, but especially a mere PR protection, may not directly stimulate economic development by generating technological progress. Laws and regulations are important but may not be the key factors of economic growth. To promote technological progress, , according to the endogenous growth theory, the country should focus on other variables such as R&D rather than on laws and regulations. However, laws and regulations can be effectively used to remedy market distortions to allow the economic agents to compete fairly, and balance individual benefits and public well-being.

The result of GDP per capita shows that it is not relevant to technological progress.

FDI came up with an unexpected result; it means that an increase in FDI may not stimulate technology development, which implies that the countries with high FDI inflows may be more preoccupied with attracting foreign investment than promoting technology development.

Electricity production (=infrastructure) plays a key role in technological development; it has a significant impact on technological progress. This result implies that infrastructure is a key factor of technological progress.

These results provide some useful and practical suggestions for policy makers. For one, it may not be useful to spend a large amount of public money to set up the legal system to enforce IPR more strictly than necessary because the investment does not pay back in terms of technological development.

Optimally, countries may enforce IPR differently. Two countries may have identical laws and procedures of enforcement, but one may turn a blind eye to its local infringement while the other does not (Gould and Gruben, 1996: 331-332).

A positive aspect of the findings is that R&D spending would have a significantly positive impact on technological progress; the more the country invests in R&D, the higher the level of its technological progress. This has a straightforward policy implication: If the government wants to promote a conducive technology environment, they should promote R&D through a variety of ways, such as cooperating with the advanced technology firms, supporting the private sector to invest in R&D, facilitating the procedures for R&D, and other strategies.

4.2 The Impact of IPR Protection on the Innovator and User Countries of Technology

As to the impact of IPR protection on technological progress in the different attributions of countries, the empirical results show that both innovator and user countries of technology receive similar results, as shown in Table 4.2.

Table 4.2 The Empirical Results of the Impact of IPR Protection on the Innovator and User Countries of Technology

ln(totpatent)	Random Effect (Technological Innovators)	Random Effect (Technological Users)
ln(rdexp)	.570	.017
	(0.82)	(1.60)
ln(totlf)	-.086	.002
	(-0.72)	(0.23)
IPR	1336.59	-81.472
	(0.29)	(-0.66)
ln(gdppc)	1.440	.018
	(0.61)	(1.03)
ln(fdi)	.142	-.002**
	(1.65)	(-2.74)
ln(elecpr)	.078**	.010**
	(.020)	(3.82)
Time	-6990.258**	-50.024**
	(-2.96)	(-3.09)
_cons	-22862.92	88.274
	(-0.70)	(0.21)
R^2	0.691	0.524
Observations	39	296

Note: Estimated coefficients are shown together with the t-statistics in in parentheses

** denotes 5% level of significance.

The expected coefficient of R&D expenditure of innovator countries is 0.570, and 0.017 for the technological user countries. Both groups of countries receive positive but insignificant impact on technological progress from R&D expenditure.

The expected coefficient of total labor force of innovator countries is -0.086, and 0.002 for technological user countries. The result for both groups of countries is insignificant.

The expected coefficient of IPR protection index of innovator countries is 1336.59, for technological user countries it is -81.472, but were both insignificant.

The expected coefficient of GDP per capita of innovator countries is 1.440, for technological user countries it is 0.018; the impact is insignificant for both groups of countries.

The expected coefficient of FDI of innovator countries is 0.142, but insignificant. However for the technological user countries, the expected coefficient is -0.002. This means that a 1% increase in FDI in the user countries will have a corresponding 0.002% decrease in the number of patent applications.

The expected coefficient of electricity production of innovator countries is 0.078, and 0.01 for the technological user countries. The technology of both groups of countries receive a positive impact from the positive impact of electricity production on technological progress. An increase in electricity production by 1%will increase the number of patent application in innovator countries by 0.078%, which is significant In technology user countries, an increase in electricity production of 1% will increase the number of patent applications by 0.01%, which is also significant

The expected coefficient of time of innovator countries is -6990.258, and -50.024 for the technological user countries. It means that if the period of time for IPR protection in innovator countries is prolonged by 1 year, the patent filing will decrease by 6990.258 applications. In technological user contries, if the time of protection is prolonged by 1 year, the patent filing will decrease by 50.024 applications.

From the results, it can be seen that electricity production (=infrastructure) has a positive and significant impact on technological progress for both groups of countries. But the period of time gives a significantly negative impact on technological progress. The reason for the negative results is the time constraint for technological development; the time variable is a short run of 3 years. Technological development requires more than 3 years to produce an innovation. The Traditional Neoclassical Growth Model (Todaro and Smith, 2003: 130) provides the rationale for a longer period; the Model proposes that technological progress becomes the residual factor explaining long term growth.

IPR protection does not impact on technological progress , in the innovator countries because their legal mechanisms such as IPR protection may be a trivial incentive for the innovators to invent or do research for the innovation. A small number of innovators invent technology because of IPR protection. But, in the innovator countries, technological progress depends on other factors. The implication of the impact of IPR protection is similar to that of R&D expenditure, GDP per capita, and FDI; they give a positive but insignificant impact on technological progress. Most innovator countries are developed so that all the factors mentioned would be in a steady state, which means that the rate of return from technological progress would increase by the same magnitude for all those factors.

In the countries of technological user, R&D expenditure, labor force, and GDP per capita have positive but insignificant impact on technological progress, the same pattern as in technology innovators but for a different reason. In technological user countries, increases in R&D spending, labor force, and GDP per capita are not relevant to technological progress because they may have low capability for research and development in technologies and, low skills of labor for a short run technology development. For these reasons, an increase in GDP per capita would have no impact on technological progress.

FDI has a significantly negative impact on technological progress, implying that an increase in FDI in the user countries of technology may negatively impact on technological progress. The result is ambiguous. The reason could be that the countries lack the necessary infrastructure and skilled workers. If so, an FDI may not stimulate technological assimilation. Technology transfer through FDI would also be not possible. FDI in countries of technology users may in fact be a way to seek the low labor costs of foreign countries.

The overall result shows that for both innovator and user countries of technology, IPR protection is not relevant to their technological progress.

To further investigate the impact of IPR protection on technological progress, both strong and weak without the time effect, the study estimates the Random effects model to examine the countries with weak protection (IPR protection index <=3) and the countries with strong protection (IPR protection index >3) as shown in Table 4.3.

Table 4.3 The Impact of the Degree of IPR Protection on Technological Progress

ln(totpatent)	GLS Random Effect (Weak)[a]	GLS Random Effect (Strong)[a]
ln(rdexp)	-.073*	-.076
	(-1.77)	(-1.25)
ln(totlf)	.070	-.063
	(1.48)	(-0.56)
IPR	-404.868	2158.54
	(-1.62)	(0.67)
ln(gdppc)	.088	.287
	(1.10)	(1.39)
ln(fdi)	-.110**	.049
	(-2.61)	(0.74)
ln(elecpr)	. 019**	.070**
	(6.91)	(4.66)
Constant	419.337	-7959.158
	(0.56)	(-0.69)
R^2	0.857	0.680
Observations	37	86

Note: Estimated coefficients are shown together with t-statistics in parenthesis.
* denotes 10 % level of significance.
** denotes 5 % level of significance
[a]Weak means the degree of IPR protection index <=3, Strong > 3 based on the degree of IPR protection form the weakest = 1 to the strongest = 7.

The results in Table 4.3 show exhibit no sign of IPR protection impact on technological progress with both strong and weak degree of protection. But R&D expenditures and FDI in the countries of weak IPR regimes have significantly negative impact on technological progress i.e. if R&D expenditures and FDI increase, the number of patent applications would decrease. The results can be interpreted as follows: In the countries with weak IPR protection, R&D activities and FDI may not be directly related to technology activities. And because of the weak IPR regime, there is no incentive to conduct research in advanced technology in order to get a patent because of the risk of a free rider on the innovation. This has the effect of reducing the research and the number of patent applications. Nevertheless, electricity production causes significantly positive impact on technological progress; the number of patent applications would increase with an rise in electricity production.

For the countries with strong IPR regimes, increasing the electricity production can increase the number of patent applications significantly. It implies that infrastructure is a key factors to innovation. R&D expenditure and total labor force show negative impact, but not significant. That is, increasing R&D expenditures and labor forces does not relate to the number of patent applications, which means technological progress does not directly relate to R&D expenditures and the number of labor force. Other variables have positive but not significant results. The results for the countries with strong protection is worth reexamining in a further study because the method to categorize the group of strong protection countries may be too crude. For example, the study set >3 to 7 for strong protection. But within the range 3 - 6 (intermediate to high before the strongest degree of 7) it is difficult to differentiate the causes and effects of the protection because the countries within the degree of 4, 5, 6, and 7, may have different specific effects and different capacities to absorb technology.

However, in this attempt, the results show that IPR protection does not impact on technological progress.

4.3 The Factors that Affect the Death Tolls of Infants

Infant mortality tolls depend on many factors. In order to investigate effect of IPR protection on infant mortality rates, OLS estimations ware carried out to compare the degree of strong and weak protection.

Table 4.4 Health Welfare for Strong and Weak IPR Protection by OLS

Infmort	OLS (1) (Strong Protection	OLS (2) (Weak protection)
IPR	1.514**	3.385
	(2.06)	(1.40)
gdppc	-0.000	.000
	(-0.99)	(0.64)
schyear	-5.266**	-3.921**
	(-4.68)	(-4.06)
sant_rural	-.171	-.103
	(-1.64)	(-0.77)
drkwater_r~l	-.549**	-.628**
	(-3.02)	(-3.35)
econact	.174	0.074
	(1.07)	(0.39)
_cons	144.227	131.963
	(7.44)	(6.99)
R^2	0.794	0.800
Observations	89	89

Note: Estimated coefficients are shown together with t-statistics in parentheses.
** denotes 5% level of significance

First, the study examines the rate of infant mortality in the countries of strong protection. The results of OLS(1) show that the level of access to clean drinking water and the number of years of schooling (a variable of the level of education of population) shows negatively significant relation. In other words, the more number of years in school of the overall population, the lower the rate of infant mortality. A higher educational attainment would also increase people's ability to take care of infant health. Clean drinking water is a crucial factors to infant survival; a higher level of good quality drinking water decreases the tolls of infant death.

As to IPR protection, the result shows a significantly positive relation between degree of protection and infant mortality. A strong IPR protection may increase the number of infant death significantly. This result suggests the detrimental effect of strong IPR protection on health welfare; it would significantly increase the rate of infant mortality.

Secondly, OLS(2) for the weak protection countries gives this result: IPR protection shows a positive impact on infant death, but insignificant. It means that infant mortality toll does not relate to the weak degree of protection. However, the level of education and the level of access to clean drinking water still play a significant role on infant health, as shown by the results of OLS (1).

4.3.1 Welfare Implication for Health Care

As Table 4.4 shows, a strong IPR protection provides positive impact to health care. But a strong IPR protection may cause problems of access to medicines in developing and least developed countries. This contention has support from the empirical results, which show that the death toll of infants increases in the countries where IPR protection is strict. This result is in accord with earlier international concerns about the impact of TRIPS in developing countries. These concerns led to the Doha Declaration on the TRIPS and Public Health. The Declaration confirmed a number of flexibilities that member countries can use to implement the TRIPS, including the adoption of an international principle of exhaustion of rights (under which parallel imports may be accepted) and the granting of compulsory licenses (under which the government or a third party can do) subject to certain conditions of use of a patented invention without the consent of the patent power (Correa, 2006: 400)

The welfare loss in health care may be a consequence of the IPR system: medicines, like any other product, can be protected by IP laws. Such protection means that their production, importation and commercialization are subject to a given period of exclusive rights, which allows title-holders to charge prices above marginal costs. These prices may mean that a large and, especially poorer segment of the population of developing countries, is deprived of access to the medicines they need.

4.3.2 Welfare Analysis for the Objectives of TRIPS

The results of all regressions reflect the controversies surrounding the objectives of TRIPS in many aspects. First, technological progress and social welfare do not depend on the degree of IPR protection. Second, a strong IPR protection in every country does not enable global economic efficiency and equity; strong IPR protection may sometimes hurt developing countries. These implications can also be explained by Figure 4.1, shown below,

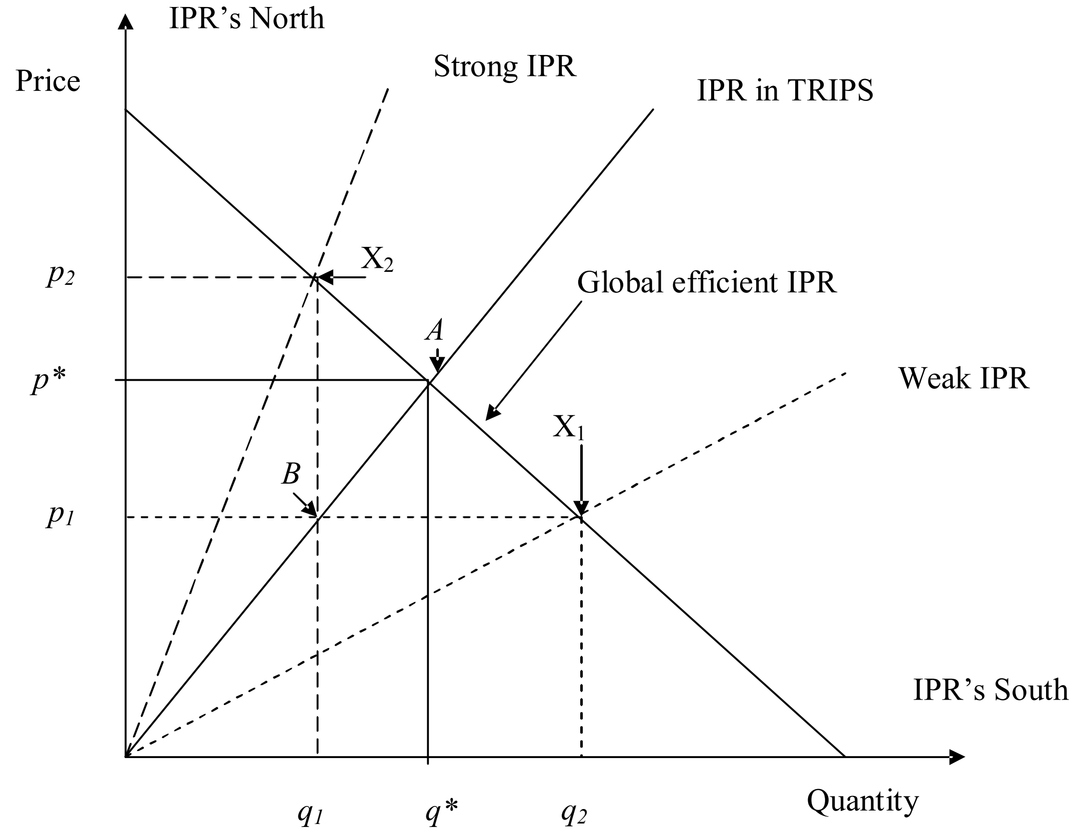

Figure 4.1 The Trade-off between Global Efficient IPR and Weak Protection

In the simple framework of monopoly of power, if every country follows TRIPS the global IPR protection is efficient and every country in the world earns equally and gets the same benefits, as TRIPS aims for. The intersection between completely global IPR protection and TRIPS' harmonization worldwide occurs at *A*. This situation provides welfare environment showing at p^* and q^* for every country. This assumes that technological progress and economic growth will thrive everywhere. In this regard, the objective of TRIPS is fulfilled.

But it is obvious that a strong IPR protection does not contribute to social welfare because the strong IPR protection increases monopoly powers and monopoly prices at p_2 and decreases quantities at q_1 because of the absence of competitive conditions in R&D and in technology diffusion, and the high costs of innovations. This results in social loss and the welfare effect decreases. This result follows the study of Kwan and Lai (2003: 853-873).

On the other hand, a weak IPR protection can help the local firms in early stages to build technological capabilities by permitting reverse engineering. This promotes technology assimilation throughout the country. Local firms and small firms can be in competitive and innovative-intensive industrial markets. The variety of creativities is produced in the low prices at p_1 with a large number of goods produced at q_2. In this circumstance the welfare increases for all, the countries are able to use this opportunity to invest in skills development and R&D for technological progress.

Therefore, it may be concluded that the effective IPR protection required by TRIPS is not appropriate for every country. In particular, most of developing countries may loss social welfare and the opportunity for technology development. This conclusion follows that of Todaro and Smith (2003: 97), that the important area of scientific and technological research, developing countries are in an extremely disadvantageous competitive position *vis a vis* the developed countries.

Consequently, as proposed by TRIPS, a strong IPR protection may provide competitive advantages for innovative firms, allowing them to appropriate larger returns from creative activity and generating incentives for additional invention. But this would not happen in every country. Should the developing countries decide to choose the policy of strong IPR protection, they have to weigh the benefits of strong IPR protection against the loss of social welfare.

This analysis follows the hypothesis of Chen and Puttitanun (2002: 17-21) that the developing countries, through domestic firms, can raise their productivities by imitating technologies of developed countries, and their abilities to do so depend on their degree of IPR protection. Developing countries consist of two local domestic firms, one with the ability to develop a patentable new technology that improves the product quality, the other with the capacity to imitate the new technology.

In a local sector with high capability to absorb technology, less imitation means more incentive for the domestic innovation firm to invest in a higher technological product, which leads to more efficient investment and to a higher social surplus.

In the meantime, increased protection of IPR makes imitation in both sectors more difficult, but it has different effects on the country's welfare. In importing sector which relates to the TRIPS for international arguments, less imitation means lower product quality of the domestic firms and thus less competition for and higher price of the products of the foreign firm. As a result, there is a reduction of consumer surplus and domestic social welfare.

In order to get the optimal IPR protection, developing countries may follow the concept of technological development of Todaro and Smith (2003: 97). That is, the process of scientific and technological advance in all stages is heavily concentrated in the rich nations. In this regard, policy makers may ponder Rostow's stages of economic growth, which postulates that the pre-condition for take-off into self-sustaining growth includes technological progress, which may not occur in the traditional society. Technological progress will happen in the countries where conditions are present for take-off or which are driving towards maturity. The same conditions are absent in the developing countries, which have a low capacity to absorb advanced technology of the rich nations.

The findings of this study suggest that the governments of developing countries should balance the trade-off between social welfare such as health care and the degree of IPR protection as required by TRIPS. Accordingly, to implement the TRIPS provisions, governments should enhance the technological capabilities of domestic agents.

To conclude this chapter, the empirical results suggest that IPR protection does not relate to technological progress, strong IPR protection decreases health welfare, and the TRIPS agreement may not be appropriate for every country.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The purposes of this study are to investigate the impact of IPR protection on technological progress in WTO member countries, to investigate the role of TRIPS for the member states as claimed in its objectives, and to investigate the impact of IPR protection on health welfare.

The study uses three-year panel data of 2006-2008 with fixed effects and random effect model.

The results show that IPR protection does not impact on technological progress, whereas R&D spending plays a key role on technological development. Accordingly, the contribution of IPR protection to technological progress and economic prosperity, as stated in the objectives of TRIPS, may be ambiguous.

R&D spending is an important determinant for developed and developing countries to technological progress.

IPR protection is not significant in determining technological progress in both countries of technological innovator and technological user, which suggests that IPR protection does not relate to technological progress.

The impact of IPR protection on health welfare is positive. That is, when the degree of IPR protection increases, infant mortality, which is the proxy of health welfare, rises.

To summarize the conclusions, IPR protection is not relevant to the promotion of technological progress. The objectives of TRIPS to promote technological innovation may not be practical. For the health welfare impact, IPR protection may have an adverse impact on health care.

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5.2 The Policy Recommendation

The study shows that IPR protection does not impact on technological progress. Nonetheless, the most important source of economic growth is technological progress (Todaro and Smith, 2003: 82), and to earn technological progress the countries have many options. One is to increase investments in R&D. For countries that are members of WTO and obliged to follow the TRIPS. a weak IPR protection would be the choice in the early stage of technology development, even as policy makers should be aware that TRIPS is not a key factor in the promotion of technological innovation.

An important question for many countries is whether or not a strong IPR protection is a good strategy for economic development. The specific challenge, which is fraught with pitfalls for developing countries, is to choose the policies to protect IPR under the pressures from international trade and international obligations like TRIPS. If the choice is strong protection, developing countries must first clearly identify their national interests and needs. Choosing a strong or weak system is difficult and attended by risks because the choice would depend on domestic factors in each country that government needs to concentrate, as shown in Appendix F. However, from the results, the policy makers in developing countries would not concentrate on the degree of IPR protection because there is no sign for technological progress i.e. the effect is neutral. The important determinants of technological progress are R&D spending, and the environment for technological assimilation through low cost technology transfer, which is normally facilitated by governments. However, the policy maker may not neglect policies on IPR protection for local firms and emerging enterprises that permit them to imitate new innovations from developed countries. As Lall (2003: 1) notes, weak IPR protection had played a vital role in the technological development of South Korea and Taiwan. They are the best recent examples of the use of copying and reverse engineering to build competitive, technology-intensive industrial sectors with considerable innovative ‘muscle’ (Salami and Goodarzi, 2010: 3).

TRIPS is likely to shift the burdens for technology development to developing countries. The process of acquisition of local technological capability by developing countries is likely to suffer from the requirement of TRIPS. The strengthening of IPR regime may further limit the access of technology by developing country enterprises. A number of these local enterprises will come under pressure to close down or form alliances with larger firms. For example, drug prices are likely to go up upon introduction of product patents, causing substantial welfare losses in developing countries. TRIPS will lead to a substantial increase in the flow of royalties and license fees from developing countries to developed countries. It is by no means clear that strong IPR protection will increase inventive activity even in the developed world especially for solving the problems and diseases faced by the least developed and developing countries.

On the question of what is an ‘optimal’ policy of IPR protection for developing countries, a balance should be sought that is suitable to the economic and social realities of the country. Some IPR policies are good for the North (the countries have advanced technology or developed countries), whereas quite a different approach is good for the South (developing countries). Consequently, the policies of IPR protection in the North and the South would be different.

Is TRIPS useful for technology development? This is perhaps the question that has attracted the most attention from most developing countries. The controversy in TRIPS is spurred by the wide differences across developed and developing countries. For example, patent is mainly an activity of developed countries, and it is insignificant in most developing countries (Moschini, 2004: 28-30). The impact of TRIPS on technological progress is very complex. The contribution of TRIPS on IPR protection depends on the stage of development: At earlier stages, weaker (not stronger) IPR protection is more likely to foster economic development. However, the results from this study leans toward the conclusion that TRIPS is not useful for technological progress.

As IPR protection is not shown to have an impact on technological progress, the issue related to the degree of strength or weakness of IPR protection is irrelevant to technological development in developing countries. This recommendation follows the argument of Maskus (2000a: 73) on the policy of protection: IPR protection in developing countries should be coupled with policies that promote liberalizing trade and investments, curbing corruption, promoting human capital and technical skills, as well as fostering social and economic freedom.

As member of global conventions (listed in Appendix A), the fundamental trade-off in setting IPR protection is inescapable. On the one hand, static efficiency requires wide access to users at marginal social cost, which may be quite low. On the other hand, dynamic efficiency requires incentives to invest in new information for which social value exceeds development costs. These are both legitimate public goals, yet there is clear conflict between them. Economists often note that IPR protection operates on the mixture of these two market distortions. Excessively weak IPR protection satisfies the static goal but suffers from the dynamic distortion of insufficient incentives to create IPR. The economy experiences a slower growth, more limited culture, and lower product quality. A common alternative expression of this trade-off is that IPR protection generates monopoly positions that reduce current consumer welfare in return for providing adequate payoffs to innovation, which then raises future consumer welfare.

This trade-off underlines the need for public intervention to fulfill the obligations to international conventions like TRIPS. In principle, society would want that the degree of IPR protection is appropriate for the situation of the country. Because IPR protection is incapable of being operated so precisely, it is the second-best remedy for the underlying market distortions. That such protection might be too weak or too strong depends on the choices the policy makers have to make in the context of the specific problems of the country.

There are some implications for policy makers. The developing countries that have the capacity to absorb or develop new technologies and switch from imitative to innovative R&D are more likely to be interested in promoting strong IPR protection (Ginarte and Park, 1997: 299). However, it is important to understand that strong IPR protection is costly to maintain and administer. It requires the resources to educate people and officers for monitoring and enforcement. The policy makers have to consider the technological capabilities in their own countries. To follow the TRIPS without concern for welfare loss may disadvantage a country in terms of technological development in the long run. If the governments only concentrate on international trade policy by enacting strong IPR laws and setting a strong system of enforcement (with or without pressure from developed countries), that country will remain a user and a buyer of technology in perpetuity.

Policy makers may promote technological progress by increasing R&D expenditures and facilitate the establishment of infrastructures for R&D.

The developing countries should adopt a weak IPR protection in the first state of development, and launch proper educational and training programs to develop the skills to access, analyse and use technology information. In this regard, policy makers may formulate specific plans for supporting new inventors such as providing easy access to capital and professional and technical advice, to facilitate public and private initiatives in R&D.

5.3 Further Study

This dissertation answers the impact of strong IPR protection on technological progress, and the role of TRIPS for developing countries. But the scarcity of data on IPR cases and IPR enforcement in countries did not permit exploring the determinants of the degree of IPR protection in each country. In this regard, it would be useful to study in-depth the factors that explain the decisions to choose a weak or a strong IPR protection and the key factors to promote a conducive R&D environment in the least developed and developing countries?

This study did not mainly focus on social welfare from IPR protection, however, it tried to investigate the impact of a strong IPR protection on health care. Due to the limited data on welfare, this study only included the countries that have data on IPR and selected Health Outcomes categorized by WHO (World Health Organization) in cross section data that focuses on life expectancy from the policy of IPR protection. The finding indicates that health care may deteriorate with a strong IPR protection. However, this part of the study is an initial investigation, and such an important social-economic concern as public welfare needs closer study.

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APPENDICES

Appendix A List of International Conventions

Year	International Convention	Date of		Copyright and Related Rights		Industrial Property				
		basic text	entry into force	Copy right	Related Rights	Patents	Trade marks	Industrial Designs	Appellations of Origin	Others
1883	Paris Convention for the Protection of Industrial Property (revised at Stockholm on July 14, 1967, and amended on September 28, 1979)	March 20, 1883	July 7, 1884			✓	✓	✓	✓	✓
1886	Berne Convention for the Protection of Literary and Artistic Works (revised at Paris on July 24, 1971, and amended on September 28, 1979)	Septem ber 9, 1886	Decem ber 5, 1887	✓						
1889	Convention on Literary and Artistic Property (First South American Congress on Private International Law, Montevideo)	January 11, 1889	yes	✓						
1889	Convention on Patents of Invention (First South American Congress on Private International Law, Montevideo)	January 10, 1889	yes			✓				
1891	Madrid Agreement for the Repression of False or Deceptive Indications of Source on Goods (Madrid Agreement (Indications of Source) (revised at Lisbon on October 31, 1958)	April 14, 1891	July 15, 1892						✓	
1891	Madrid Agreement Concerning the International Registration of Marks (Madrid Agreement (Marks))(revised at Stockholm on July 14, 1967)	April 14, 1891	1891				✓			
1902	Treaty on Patents of Inventions, Industrial Drawings and Models and Trade-Marks (signed at Mexico City, at the Second International American Conference)	January 27, 1902,	yes			✓	✓	✓		
1906	Convention on Patents of Invention, Drawings and Industrial Models, Trade Marks, on Literary and Artistic Property (signed at Rio de Janeiro, at the Third International American Conference)	August 23, 1906,	yes	✓		✓	✓	✓		
1910	Convention for the Protection of Inventions, Patents, Designs and Industrial Models	August 20, 1910	July 31, 1912			✓		✓		
1910	Convention on Literary and Artistic Copyright (Buenos Aires Convention), signed at Buenos Aires at the Fourth International Conference of American States and revised on February 11, 1928, at the Sixth International American Conference The use of the term "All rights reserved" was a result of this convention.	August 11, 1910	yes	✓						

Year	International Convention	Date of		Copyright and Related Rights		Industrial Property				
		basic text	entry into force	Copy right	Related Rights	Patents	Trade marks	Industrial Designs	Appellations of Origin	Others
1910	Convention on the Protection of Trade Marks, signed at Buenos Aires, August 20, 1910 at the fourth International Conference of American States	August 20, 1910	Re placed				✓			
1911	Agreement on Patents and Privileges of Invention, signed at the Bolivarian Congress, Caracas	July 18, 1911	July 18, 1911			✓				
1923	Convention for the Protection of Commercial, Industrial, and Agricultural Trade Marks and Commercial Names, signed at Santiago, at the Fifth International Conference of American States, replaced the Convention for the Protection of Trade Marks 1910	April 28, 1923	yes				✓			
1925	The Hague Agreement Concerning the International Deposit of Industrial Designs, of November 6, 1925, as revised at The Hague on November 28, 1960, and supplemented at Stockholm on July 14, 1967, and amended in 1979	Novem ber 6, 1925	the 1999, the 1960 and the 1934 Act are in force,					✓		
1929	General Inter-American Convention for Trade Mark and Commercial Protection, signed at Washington, , at the Pan American Trade Mark Conference	Febru ary 20, 1929	April 2, 1930				✓			
1946	Inter-American Convention on the Rights of the Author in Literary, Scientific, and Artistic Works, signed at Washington, D.C., at the Inter-American Conference of Experts on Copyright	June 22, 1946	April 14, 1947	✓						
1948	Agreement for Facilitating the International Circulation of Visual and Auditory Materials of an Educational, Scientific and Cultural Character (Beirut Agreement)	Dece mber 10, 1948	August 12, 1954	✓						
1950	Agreement on the Importation of Educational, Scientific and Cultural Materials (the Florence Agreement)	Novem ber 22, 1950	May 21, 1952	✓		✓		✓		
1952	Universal Copyright Convention, adopted at Geneva and revised at Paris on July 24, 1971	Septem ber 6, 1952	Septem ber 16, 1955	✓						
1953	European Convention Relating to the Formalities Required for Patent Applications, Paris,	Decem ber 11, 1953	June 1, 1955			✓				
1955	European Convention on the International Classification of Patents for Invention	Decem ber 19, 1954	August 1, 1955			✓				
1957	Nice Agreement Concerning the International Classification of Goods and Services for the Purposes of the Registration of Marks, (revised at Geneva on May 13, 1977, and amended on September 28, 1979)	June 15, 1957	April 8, 1961				✓			
1958	European Agreement Concerning Program Exchanges by Means of Television Films (Paris)	Decem ber 15, 1958	July 1, 1961	✓	✓					

Year	International Convention	Date of		Copyright and Related Rights		Industrial Property				
		basic text	entry into force	Copyri ght	Related Rights	Patents	Trade marks	Industrial Designs	Appellations of Origin	Others
1958	Lisbon Agreement for the Protection of Appellations of Origin and their International Registration (revised at Stockholm on July 14, 1967, and amended on September 28, 1979)	Octo ber 31, 1958	Septem ber 25, 1966						✓	
1960	Agreement for the Mutual Safeguarding of Secrecy of Inventions Relating to Defence and for Which Applications for Patents Have Been Made (Paris, 1960)	1960	Un knowm			✓				
1960	European Agreement on the Protection of Television Broadcasts (Strasbourg,) and additional Protocol (Strasbourg, January 22, 1965)	June 22, 1960	July 1, 1961		✓					
1961	Rome Convention for the Protection of Performers, Producers of Phonograms and Broadcasting Organizations	Octo ber 26, 1961	May 18, 1964		✓					
1962	Benelux Convention Concerning Trademarks	March 19, 1962	July 1, 1969				✓			
1962	Benelux Convention on Trade Marks	March 19, 1962	July 1, 1969				✓			
1962	Uniform Benelux Law on Marks	March 19, 1962	January 1, 1971				✓			
1963	Convention on the Unification of Certain Points of Substantive Laws on Patents for Invention (Strasbourg,)	Novem ber 27, 1963	August 1, 1980			✓				
1965	European Agreement for the Prevention of Broadcasts Transmitted from Stations Outside National Territories (Strasbourg,)	January 22, 1965	Octo ber19, 1967		✓					
1966	Benelux Designs Convention	Octo ber 25, 1966	January 1, 1974					✓		
1966	Benelux Convention on Designs or Models	Octo ber 25, 1966	January 1, 1974					✓		✓
1966	Benelux Uniform Law on Designs or Models	Octo ber 25, 1966	January 1, 1974					✓		✓
1968	Central American Agreement for the Protection of Industrial Property (Marks, Trade Names and Advertising Slogans or Signs) (San José,)	June 1, 1968	Octo ber 1, 1975				✓			
1968	Locarno Agreement Establishing an International Classification for Industrial Designs (signed at Locarno, and amended on September 28, 1979)	Octo ber 8, 1968	April 27, 1971					✓		
1969	Convention Relating to the Protection of Appellations of Origin, Abidjan,	January 10, 1969	yes						✓	
1970	Patent Cooperation Treaty (PCT), (done at Washington, amended on September 28, 1979, and modified on February 3, 1984)	June 19, 1970	January 24, 1978			✓				
1971	Convention for the Protection of Producers of Phonograms Against Unauthorized Duplication of Their Phonograms (Geneva Convention/Phonograms Convention)	Octo ber 29, 1971	April 18, 1973		✓					
1971	Strasbourg Agreement Concerning the International Patent Classification (amended on September 28, 1979)	March 24, 1971	Octo ber 7, 1975			✓				

Year	International Convention	Date of		Copyright and Related Rights		Industrial Property				
		basic text	entry into force	Copyri ght	Related Rights	Patents	Trade marks	Industrial Designs	Appellations of Origin	Others
1973	Convention on the Grant of European Patents (European Patent Convention) (amended by Decision of the Administrative Council of the European Patent Organization of December 21, 1978)	Octo ber 5, 1973	January 1, 1999			✓				
1973	Council of Mutual Economic Assistance (CMEA), Agreement on the Legal Protection of Inventions, Industrial Designs, Utility Models and Trademarks in the Framework of Economic, Scientific and Technical Cooperation (Moscow,)	April 12, 1973	yes			✓	✓	✓		✓
1973	Trademark Registration Treaty	June 12, 1973	August 7, 1980				✓			
1973	Vienna Agreement Establishing an International Classification of the Figurative Elements of Marks, (done at Vienna and amended on October 1, 1985)	June 12, 1973	August 9, 1985				✓			
1973	Vienna Agreement for the Protection of Type Faces and their International Deposit	June 12, 1973	not yet in force	✓						
1974	Convention Relating to the Distribution of Programme-Carrying Signals Transmitted by Satellite / Brussels Convention	May 21 , 1974	August 25, 1979		✓					
1975	Agreement on the Unification of Requirements With Regard to the Formulation and Filing of Patent Applications	July 5, 1975	Octo ber 2,1975 Dura tion 5 years			✓				
1975	Convention for the European Patent for the Common Market (Community Patent Convention) Replaced by Agreement Relating to Community Patents	Decem ber 15, 1975	Re placed			✓				
1975	Council of Mutual Economic Assistance (CMEA), Agreement on the Unification of Requirements for the Execution and Filing of Applications for Inventions (Leipzig)	July 5, 1975	yes			✓				
1976	Agreement on the Creation of an Industrial Property Organization for English-Speaking Africa, Lusaka,	Decem ber 7, 1976	Febru ary 15, 1978			✓	✓	✓	✓	✓
1976	Council of Mutual Economic Assistance (CMEA), Agreement on the Mutual Recognition of Inventors' Certificates and Other Titles of Protection for Inventions, Havana,	Decem ber 18, 1976	yes			✓				
1977	Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure (done at Budapest and amended on September 26, 1980)	April 28, 1977	August 19, 1980			✓				
1978	Geneva Treaty on the International Recording of Scientific Discoveries, adopted at Geneva	March 3, 1978	not yet in force			✓				
1979	Madrid Multilateral Convention for the Avoidance of Double Taxation of Copyright Royalties	Decem ber 13, 1979	not yet in force	✓						
1981	Nairobi Treaty on the Protection of the Olympic Symbol adopted at Nairobi	Septem ber 26, 1981	Septem ber 25, 1982				✓			

Year	International Convention	Date of		Copyright and Related Rights		Industrial Property				
		basic text	entry into force	Copy right	Related Rights	Patents	Trade marks	Industrial Designs	Appellations of Origin	Others
1989	Treaty on the International Registration of Audiovisual Works (Film Register Treaty)	April 20, 1989	Febru ary 27, 1991	✓						
1989	European Convention on Transfrontier Television	May 5, 1989	January 5, 1993		✓					
1989	Washington Treaty on Intellectual Property in Respect of Integrated Circuits	May 26, 1989	not yet in force							✓
1989	Protocol Relating to the Madrid Agreement Concerning the International Registration of Marks (Madrid Protocol, adopted at Madrid)	June 27, 1989	Decem ber 1, 1995				✓			
1989	Agreement Relating to Community Patents signed at Luxembourg	Decem ber 15, 1989	yes			✓				
1991	UPOV Convention for the Protection of New Varieties of Plants (revised at Geneva on October 23, 1978, and on March 19, 1991)	Decem ber 2, 1 961	April 28,200 5			✓				
1992	Convention on Biological Diversity	June 5, 1992	Decem ber 29, 1993			✓				
1992	European Convention on Cinematographic Co-Production	Octobe r 2,1992	April 1, 1994	✓						
1992	North American Free Trade Agreement	Decem ber 1992	January 1, 1994	✓	✓	✓	✓	✓	✓	✓
1993	Banjul Protocol on Marks Within the Framework of the African Regional Industrial Property Organization (ARIPO) (amended on November 28, 1997,May 26, 1998 and November 26, 1999)	Novem ber 19, 1993	January 1, 2000				✓			
1994	Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)	April 15, 1994	January 1, 1995	✓	✓	✓	✓	✓	✓	✓
1994	Eurasian Patent Convention, signed at Moscow on	Septem ber 9, 1994	August 12, 1995			✓				
1994	European Convention Relating to Questions on Copyright Law and Neighbouring Rights in the Framework of Transfrontier Broadcasting by Satellite	May 11, 1994	unkno wn	✓	✓					
1994	Trademark Law Treaty (TLT), done at Geneva	Octo ber 27, 1994	August 1, 1996				✓			
1995	ASEAN framework agreement on intellectual property cooperation. Declaration of Bangkok. ASEAN framework agreement on intellectual property cooperation and Framework agreement on services. Bangkok	Decem ber 15, 1995	-	✓	✓	✓	✓	✓	✓	✓
1996	WIPO Copyright Treaty, adopted at Geneva	Decem ber 20, 1996	March 6, 2002	✓						
1996	WIPO Performances and Phonograms Treaty, adopted at Geneva	Decem ber 20, 1996	May 20, 2002		✓					
1999	Agreement on Measures for the Prevention and Repression of the Use of False Trademarks and Geographical Indications	June 4, 1999	June 4, 1999				✓		✓	

Year	International Convention	Date of		Copyright and Related Rights		Industrial Property				
		basic text	entry into force	Copyright	Related Rights	Patents	Trade marks	Industrial Designs	Appellations of Origin	Others
2000	Cartagena Protocol on Biosafety	January 29, 2000	September 11, 2003			✓				
2000	Patent Law Treaty	June 1, 2000	April 28, 2005			✓				
2006	Singapore Treaty on the Law of Trademarks	March 27, 2006	not yet in force				✓			

Appendix A Classified the patent protection

Paris Convention for the Protection of Industrial Property	Convention on Patents of Invention
Treaty on Patents of Inventions, Industrial Drawings and Models and Trade-Marks	Convention for the Protection of Inventions, Patents, Designs and Industrial Models
Convention on Patents of Invention, Drawings and Industrial Models, Trade Marks, on Literary and Artistic Property	Agreement for the Mutual Safeguarding of Secrecy of Inventions Relating to Defence and for Which Applications for Patents Have Been Made
Agreement on Patents and Privileges of Invention	Benelux Convention on Designs or Models
European Convention Relating to the Formalities Required for Patent Applications	European Convention on the International Classification of Patents for Invention
Convention on the Unification of Certain Points of Substantive Laws on Patents for Invention	Strasbourg Agreement Concerning the International Patent Classification
Benelux Uniform Law on Designs or Models	Patent Cooperation Treaty
Convention on the Grant of European Patents	Convention for the European Patent for the Common Market
Agreement on the Legal Protection of Inventions, Industrial Designs, Utility Models and Trademarks in the Framework of Economic, Scientific and Technical Cooperation	Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure
Agreement on the Unification of Requirements With Regard to the Formulation and Filing of Patent Applications	Agreement on the Mutual Recognition of Inventors' Certificates and Other Titles of Protection for Inventions
Agreement on the Unification of Requirements for the Execution and Filing of Applications for Inventions	Agreement on the Creation of an Industrial Property Organization for English-Speaking Africa
Geneva Treaty on the International Recording of Scientific Discoveries	UPOV Convention for the Protection of New Varieties of Plants
Agreement Relating to Community Patents	Agreement on Trade-Related Aspects of Intellectual Property Rights
Convention on Biological Diversity	North American Free Trade Agreement
Eurasian Patent Convention	Declaration of Bangkok
Cartagena Protocol on Biosafety	Patent Law Treaty

Appendix A Classified the trademark protection

Paris Convention for the Protection of Industrial Property	Madrid Agreement Concerning the International Registration of Marks
Treaty on Patents of Inventions, Industrial Drawings and Models and Trade-Marks	General Inter-American Convention for Trade Mark and Commercial Protection
Convention on Patents of Invention, Drawings and Industrial Models, Trade Marks, on Literary and Artistic Property	Convention for the Protection of Commercial, Industrial, and Agricultural Trade Marks and Commercial Names
Convention on the Protection of Trade Marks	Benelux Convention Concerning Trademarks
Nice Agreement Concerning the International Classification of Goods and Services for the Purposes of the Registration of Marks	Central American Agreement for the Protection of Industrial Property (Marks, Trade Names and Advertising Slogans or Signs)
Benelux Convention on Trade Marks	Uniform Benelux Law on Marks
Agreement on the Legal Protection of Inventions, Industrial Designs, Utility Models and Trademarks in the Framework of Economic, Scientific and Technical Cooperation	Agreement on the Creation of an Industrial Property Organization for English-Speaking Africa
Trademark Registration Treaty	Trademark Law Treaty
Vienna Agreement Establishing an International Classification of the Figurative Elements of Marks	Protocol Relating to the Madrid Agreement Concerning the International Registration of Marks
Nairobi Treaty on the Protection of the Olympic Symbol	North American Free Trade Agreement
Banjul Protocol on Marks Within the Framework of the African Regional Industrial Property Organization	Agreement on Measures for the Prevention and Repression of the Use of False Trademarks and Geographical Indications
Agreement on Trade-Related Aspects of Intellectual Property Rights	Singapore Treaty on the Law of Trademarks
Declaration of Bangkok	

Appendix A Classified the copyright protection

Berne Convention for the Protection of Literary and Artistic Work	European Agreement on the Protection of Television Broadcasts
Convention on Literary and Artistic Property	Convention on Literary and Artistic Copyright
Convention on Patents of Invention, Drawings and Industrial Models, Trade Marks, on Literary and Artistic Property	Agreement for Facilitating the International Circulation of Visual and Auditory Materials of an Educational, Scientific and Cultural Character
Inter-American Convention on the Rights of the Author in Literary, Scientific, and Artistic Works	Agreement on the Importation of Educational, Scientific and Cultural Materials
Universal Copyright Convention	WIPO Copyright Treaty
European Convention Relating to Questions on Copyright Law and Neighbouring Rights in the Framework of Transfrontier Broadcasting by Satellite	Rome Convention for the Protection of Performers, Producers of Phonograms and Broadcasting Organizations
European Agreement for the Prevention of Broadcasts Transmitted from Stations Outside National Territories	Convention for the Protection of Producers of Phonograms Against Unauthorized Duplication of Their Phonograms
Vienna Agreement for the Protection of Type Faces and their International Deposit	Convention Relating to the Distribution of Programme-Carrying Signals Transmitted by Satellite
Madrid Multilateral Convention for the Avoidance of Double Taxation of Copyright Royalties	European Agreement Concerning Program Exchanges by Means of Television Films
Treaty on the International Registration of Audiovisual Works	European Convention on Transfrontier Television
North American Free Trade Agreement	Agreement on Trade-Related Aspects of Intellectual Property Rights
European Convention on Cinematographic Co-Production	WIPO Performances and Phonograms Treaty
Declaration of Bangkok	

Appendix B Collinearity Diagnostics

Variable	VIF	SQRT VIF	Tolerance	R- Squared
lrdexp	2.67	1.63	0.3742	0.6258
Ltotlf	5.99	2.45	0.1670	0.8330
Ipr	2.41	1.55	0.4158	0.5842
Lgdppc	6.72	2.59	0.1489	0.8511
lFDI	2.64	1.63	0.3785	0.6215
lelecpr	6.65	2.58	0.1504	0.8496

Mean VIF 4.51

	Eigenval	Cond Index
1	6.8485	1.0000
2	0.0824	9.1148
3	0.0343	14.1322
4	0.0180	19.4978
5	0.0092	27.3021
6	0.0064	32.6038
7	0.0011	79.4007

Condition Number 79.4007

Eigenvalues & Cond Index computed from scaled raw sscp

(w/ intercept)

Det(correlation matrix) 0.0100

All VIFs are less than 10 which means multicollinearity is not a problem.

Appendix C Heteroscedasticity Test

Breusch and Pagan Lagrangian multiplier test for random effects

ltotpatent[year,t] = Xb + u[year] + e[year,t]

Estimated results:

	Var	sd = sqrt(Var)
ltotpat~t	6.891454	2.625158
e	1.661492	1.288989
u	0	0

Test: Var(u) = 0

chi2(1) = 0.42

Prob > chi2 = 0.5183

the p-value is greater than 0.05 so we accept H0 which means heteroscasticity is not presented.

Appendix D Countries of Observations

A: Afghanistan Albania Algeria American Samoa Andorra Angola Anguilla Antigua and Barbuda Argentina Armenia Araba Australia Austria Azerbaijan

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B:Bahamas Bahrain Bangladesh Barbados Belarus Belgium Belgium-Luxembourg Belize Benin Bermuda Bhutan Bolivia Bosnia and Herzegovina Botswana Brazil British Indian Ocean Territory British Virgin Islands Brunei Darussalam Bulgaria Burkina Faso Burundi

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C:Cambodia Cameroon Canada Cape Verde Cayman Islands Central African Republic Chad Chile China China, Hong Kong SAR China, Macao SAR China, Taiwan Province of Christmas Island Cocos (Keeling) Islands Colombia Comoros Congo Cook Islands Costa Rica Cte d'Ivoire Croatia Cuba Cyprus Czech Republic

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D:Democratic People's Republic of Korea Democratic Republic of the Congo Denmark Djibouti Dominica Dominican Republic

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E:Ecuador Egypt El Salvador Equatorial Guinea Eritrea Estonia Ethiopia

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F:Faeroe Islands Falkland Islands (Malvinas) Fiji Finland France French Polynesia

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G:Gabon Gambia Georgia Germany Ghana Gibraltar Greece Greenland Grenada Guam Guatemala Guinea Guinea-Bissau Guyana

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H:Haiti Honduras Hungary

I:Iceland India Indonesia Iran (Islamic Republic of) Iraq Ireland Israel Italy

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J:Jamaica Japan Jordan

K: Kazakhstan Kenya Kiribati Kuwait Kyrgyzstan

L: Lao People's Democratic Republic Latvia Lebanon Lesotho Liberia Libyan Arab Jamahiriya Lithuania Luxembourg

M:Madagascar Malawi Malaysia Maldives Mali Malta Marshall Islands Mauritania Mauritius Mayotte Mexico Micronesia (Federated States of) Moldova Mongolia Montserrat Morocco Mozambique Myanmar

N: Namibia Nauru Nepal Netherlands Netherlands Antilles New Caledonia New Zealand Nicaragua Niger Nigeria Niue Norfolk Island Northern Mariana Islands Norway

O: Occupied Palestinian territory Oman

P: Pakistan Palau Panama Papua New Guinea Paraguay Peru Philippines Pitcairn Poland Portuga

Q: Qatar

R: Republic of Korea Romania Russian Federation Rwanda

S: Saint Helena Saint Kitts and Nevis Saint Lucia Saint Pierre and Miquelon Saint Vincent and the Grenadines Samoa Sao Tome and Principe Saudi Arabia Senegal Serbia and Montenegro Seychelles Sierra Leone Singapore Slovakia Slovenia Solomon Islands Somalia South Africa Spain Sri Lanka Sudan Suriname Swaziland Sweden Switzerland Syrian Arab Republic

T: Tajikistan Thailand The former Yugoslav Republic of Macedonia Timor-Leste Togo Tokelau Tonga Trinidad and Tobago Tunisia Turkey Turkmenistan Turks and Caicos Islands Tuvalu

U: Uganda Ukraine United Arab Emirates United Kingdom of Great Britain and Northern Ireland United Republic of Tanzania United States of America Uruguay Uzbekistán

V: Vanuatu Venezuela (Bolivarian Republic of) Viet Nam
W: Wallis and Futuna Islands Western Sahara
Y:Yemen
Z:Zambia Zimbabwe

Appendix E Degree of IPR Protection and Technological Progress compared to GDP Annual Growth Rate for the Selected Countries.

	Countries	Number Of Patent Filing	IPR Index	GDP 1000 US Dollars at Current Prices
1	Algeria	669	2.5	3.48
2	Angola	0	N/A	2.85
3	Argentina	0	2.7	5.55
4	Armenia	193	2.7	1.76
5	Australia	26003	5.9	37.41
6	Austria	2649	6.2	38.63
7	Azerbaijan	0	3.5	2.36
8	Bahamas	80	N/A	18.87
9	Bahrain	0	4.9	21.50
10	Bangladesh	310	2	0.44
11	Barbados	0	4.8	11.76
12	Belarus	1525	N/A	3.79
13	Belgium	651	5.5	37.65
14	Belize	37	N/A	4.32
15	Bolivia	0	1.9	1.11
16	Bosnia and Herzegovina	217	2.3	2.88
17	Brazil	24074	3.3	5.81
18	Brunei Darussalam	0	3.9	30.06
19	Bulgaria	291	2.9	4.16
20	Burundi	0	2.2	0.11
21	Canada	42038	5.6	39.00
22	Chile	3215	3.6	8.89
23	China	210501	3.9	2.07
24	Colombia	0	3.4	2.87
25	Congo	0	N/A	1.95
26	Costa Rica	0	3.5	5.08
27	Croatia	436	3.7	9.30
28	Cuba	257	N/A	4.43
29	Cyprus	34	4.7	23.77
30	Czech Republic	836	3.9	13.86
31	Czechoslovakia	0	N/A	N/A
32	Democratic People's Republic of Korea	0	3.4	0.51
33	Denmark	1691	6.2	51.34
34	Dominica	0	N/A	4.67
35	Dominican Republic	242	N/A	3.29
36	Ecuador	0	2.4	3.12
37	Egypt	0	3.6	1.48
38	El Salvador	0	2.8	2.73

Countries		Number Of Patent Filing	IPR Index	GDP 1000 US Dollars at Current Prices
39	Estonia	45	4.8	12.04
40	Ethiopia	0	3.3	0.16
41	Fiji	0	N/A	3.72
42	Finland	2018	6.2	39.85
43	France	17249	6	35.68
44	Georgia	535	2.8	1.75
45	Germany	60585	6	35.10
46	Ghana	0	3.3	0.53
47	Greece	0	4.1	27.79
48	Guatemala	528	2.7	2.35
49	Guyana	0	2.1	1.22
50	Haiti	0	N/A	0.49
51	Honduras	0	3.4	1.33
52	Hong Kong (SAR), China	13790	5.4	26.41
53	Hungary	924	4.1	11.13
54	Iceland	371	6	52.56
55	India	0	3.7	0.78
56	Indonesia	4606	2.9	1.59
57	Iran (Islamic Republic of)	0	N/A	3.45
58	Iraq	0	N/A	1.65
59	Ireland	935	5.6	51.67
60	Israel	7496	4.5	20.60
61	Italy	0	4.3	31.44
62	Jamaica	153	3.5	3.82
63	Japan	408674	5.7	34.32
64	Jordan	0	4.6	2.50
65	Kazakhstan	1557	3.4	5.04
66	Kenya	71	3.1	0.65
67	Kiribati	0	N/A	0.80
68	Kyrgyzstan	0	2.7	0.54
69	Lao People's Democratic Republic	0	N/A	0.60
70	Latvia	151	3.6	8.78
71	Lebanon	0	N/A	5.44
72	Lesotho	0	3.2	0.73
73	Liberia	0	N/A	0.19
74	Libyan Arab Jamahiriya	0	4	8.20
75	Lithuania	99	N/A	8.59
76	Luxembourg	52	5.6	88.31
77	Macau (SAR), China	131	N/A	29.93
78	Madagascar	44	3	0.29
79	Malawi	0	3.1	0.16
80	Malaysia	0	4.8	5.70
81	Malta	805	4.3	14.88
82	Mauritius	0	4.1	5.12
83	Mexico	15505	3.2	7.95
84	Moldova	312	3.5	0.88

	Countries	Number Of Patent Filing	IPR Index	GDP 1000 US Dollars at Current Prices
85	Mongolia	213	2.5	1.17
86	Morocco	910	3.3	2.09
87	Namibia	0	4.5	3.13
88	Nepal	0	2.6	0.29
89	Netherlands	2716	5.9	40.54
90	New Zealand	7365	5.8	25.60
91	Nicaragua	0	2.7	0.97
92	Nigeria	0	2.9	0.92
93	Norway	6076	5.8	71.52
94	Pakistan	1788	3.2	0.91
95	Panama	0	4	5.25
96	Paraguay	0	2.2	1.51
97	Peru	1271	2.5	3.32
98	Philippines	3265	3.1	1.36
99	Poland	2812	3.4	8.92
100	Portugal	220	4.9	18.13
101	Republic of Korea	166189	5	18.16
102	Romania	876	3.5	5.68
103	Russian Federation	37691	2.9	6.88
104	Rwanda	0	N/A	0.24
105	Saint Lucia	0	N/A	5.72
106	Saint Vincent and the Grenadines	0	N/A	4.01
107	Samoa	0	N/A	2.32
108	Saudi Arabia	538	4.5	14.77
109	Serbia and Montenegro (formerly Yugoslavia)	0	2.8	3.64
110	Seychelles	0	N/A	8.21
111	Sierra Leone	0	N/A	0.32
112	Singapore	9163	6.3	30.16
113	Slovakia	283	3.7	10.40
114	Slovenia	299	4.4	18.60
115	Solomon Islands	0	N/A	0.86
116	Somalia	0	N/A	0.28
117	South Africa	5781	5.3	5.23
118	Spain	3427	4.7	27.91
119	Sri Lanka	0	3.7	1.43
120	Sudan	0	N/A	0.93
121	Swaziland	0	N/A	2.42
122	Sweden	2859	6	42.17
123	Switzerland	2102	6.3	50.49
124	Syrian Arab Republic	257	3.8	1.61
125	T F Y R of Macedonia	0	N/A	3.10
126	Tajikistan	26	2.9	0.42
127	Thailand	6248	3.8	3.25
128	Trinidad and Tobago	551	3.2	13.66
129	Tunisia	0	4.4	3.00
130	Turkey	1232	3	5.31
131	Turkmenistan	0	N/A	1.33

Countries		Number Of Patent Filing	IPR Index	GDP 1000 US Dollars at Current Prices
132	Uganda	0	2.7	0.35
133	Ukraine	5890	2.7	2.29
134	United Kingdom	25745	5.4	39.21
135	United Republic of Tanzania	0	N/A	0.34
136	United States of America	425966	5.6	42.92
137	Uruguay	0	3.9	5.80
138	Uzbekistan	509	N/A	0.59
139	Venezuela	0	2	1.63
140	Viet Nam	0	3	0.67
141	Zambia	0	3.4	0.94
142	Zimbabwe	0	2.9	0.13

Appendixe F List of Categories for Strong or Weak IPR Protection

Fact-based Indexes	Strong Protection	Weak Protection
The number of IP laws in a country	Large	Small
Term of IPR protection	15- 20 years and longer	Less than 15 years
Practical penalty for Infringement	Yes	No
There are provisions for preliminary injunctions in laws.	Yes	No
Compulsory Licensing can be granted.	No	Yes
Cost of enforcement	Low	High
Time for enforcement	Short	Long
Satisfactory Outcomes of enforcement	Yes	No
Level of Piracy	Low	High
Effective Remedies	Yes	No
Strength of Exclusivity	Yes	No
Ban on Parallel Imports	Yes	No
Policing Actions	Effective	Not effective
Periods of Imprisonment	Long	Short
Enforcement Mechanisms	Yes	No
Adequacy of Court Systems	Yes	No
Administration Process	Fast Flow	Slow Flow
Appeal Process	Yes	No
Public Commitment	Yes	No
Member of International Conventions	Yes	No

BIOGRAPHY

NAME	Visit Sripibool
ACADEMIC BACKGROUND	Bachelor's Degree in Laws from Thammasat University, Bangkok, Thailand in 1988, Barrister-at-Law of the Thai Bar Association, Bangkok, and Master's degree in Laws from Indiana University, Bloomington, United States of America in 2000.
PRESENT POSITION	Chief Judge of Nakhon Sawan District Court, Nakhon Sawan Province, Thailand.
EXPERIENCES	Awarded a grant by Japan Patent Office in 2003 tor attend the IPR Experts program in Tokyo. Awarded a grant by the USPTO (U.S. patent office) in 2004 to attend the IPR program in Washington. Awarded a fellowship grant from Max Planck Institute to serve as expert in IPR for the training program on IPR held in London University, London, United Kingdom in 2007. Serving as a Judge for the Courts of Justice of Thailand since 1993 to the present. Variously served as the Provincial Judge in Chiengmai Province, Suphan Buri Province; Judge of the Central Intellectual Property and International Trade Court in Bangkok.