Patents, Technical Efficiency and Innovation in Philippine Manufacturing

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Declaration

Except where otherwise indicated, this thesis is my own work.

Glorivic Maite Salveron-Evangelista

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To my family

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Abstract

Under the new agreement signed by member nations of the World Trade Organisation, the protection of intellectual property rights now forms a vital part of world trade rules. The aim of this thesis is to identify the economic implications of these new rules in the Philippine economy. For a country like the Philippines, the implications of stronger rules on intellectual property rights warrant consideration not only because of the current international pressure from industrial countries to enforce these rights, but as a means of enhancing the technological capability of the country to generate appropriate technology for its development.

A theoretical model has been constructed to analyse the likely impact of increased patent protection on output and reverse engineering efforts of developing countries. Comparative static analysis shows that a regime of stronger patent protection could have two opposing effects in developing countries. While the new rules will increase the supply of foreign technology available to Philippine firms, they will also raise the cost of acquiring these technologies, thus, the end result depends on which effect dominates.

Any benefit from stronger patent protection in developing countries however, would depend on other policy settings in these countries particularly those policies that affect the ability of a country to absorb and exploit existing and new technologies. A review of the technological capability of the Philippines suggests that the current state of the country's technological development decreases the potential benefits that could be derived from a regime of stronger patent protection. While the country has a considerable number of educated and trained engineers, very few are engaged in research and development activities. Moreover inappropriate trade, industrial and

macroeconomic policies have distorted technological choice and undermined the allocation of resources in the country. The challenge then for the government is to use the five year transitional period prescribed in the TRIPs agreement to correct its past mistakes in order to ensure that the benefits from strengthening patent protection would outweigh its cost implications.

Are there possible gains associated with patenting in the Philippines? An econometric analysis shows that an increase in industry specific innovations (both foreign and domestic) has a positive impact on the technical efficiency of various manufacturing industries in the Philippines. In this regard, a patent policy that stimulates inventive activity would have some positive repercussions on the country's technological development. Moreover, the nature of inventive activity in Philippine industry suggests that the recognition and enforcement of utility or petty patents would be beneficial from the point of view of developing countries where innovation is generally adaptive.

The positive implications of patent protection in Philippine industry is also reinforced in the analysis of the determinants of domestic innovation from which the relationship between domestic and international patenting could be deduced. Empirical estimates suggest that foreign patenting on balance increases derivative inventions in the chemical and engineering industries; however, in the case of light industries, the result indicates that foreign patents tend to inhibit derivative innovations. This implies that a regime of stronger patent protection would be more beneficial to the development of non-traditional, technology-intensive industries in the Philippines.

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Glossary

ADB	=	Asian Development Bank
ANU	=	The Australian National University
ASEAN	=	Association of South East Asian Nations (In this study, only five countries are considered: Indonesia, Malaysia, Philippines, Singapore and Thailand.)
BOI	=	Board of Investment
BPTTT	=	Bureau of Patents, Trademarks and Technology Transfer
DEA	=	Data envelopment analysis
DOST	=	Department of Science and Technology
DTI	=	Department of Trade and Industry
EC	=	European Community
FDI	=	Foreign direct investment
GATT	=	General Agreement on Tariffs and Trade
GDP	=	Gross domestic product
GNP	=	Gross national product
ICOR	=	Incremental capital output ratio
IEDB	=	International Economic Data Bank
IPC	=	International Patent Classification
IPF	=	Investment possibility function
IPR	=	Intellectual property rights
ISIC	=	International Standard Industrial Classification
NICs	=	Newly Industrialising Countries (Hongkong, Republic of Korea, Singapore and Taiwan)
NSO	=	National Statistics Office
NSTA	=	National Science and Technology Authority

OECD	=	Organisation for Economic Cooperation and Development
PIDS	=	Philippine Institute for Development Studies
PSIC	=	Philippine Standard Industry Classification
R&D	=	Research and development
RCA	=	Revealed comparative advantage
SFPF	=	Stochastic frontier production function
SITC	=	Standard International Trade Classification
STMP	=	Science and Technology Master Plan
SUR	=	Seemingly unrelated regression
TFP	=	Total factor productivity
TRIPs	=	Trade Related Aspects of Intellectual Property including counterfeit goods
UN	=	United Nations
UNCTAD	=	United Nations Conference for Trade and Development
UNESCO	=	United Nations, Educational, Scientific and Cultural Organisation
UNIDO	=	United Nations Industrial Organisation
UR	=	Uruguay Round
US	=	United States (of America)
USIS	=	United States Information Service
USTR	=	United States Trade Representative
WB	=	World Bank
WIPO	=	World Intellectual Property Organisation
WTO	=	World Trade Organisation

Chapter 1

Introduction

The rapidly changing patterns of world production and trade coupled with the increasing role of technological innovation in enhancing productivity and growth in industry have recently enhanced the economic value of knowledge and new ideas in the world economy. There is increased political pressure for the protection of the so called advanced technologies which, in the current state of increasing globalisation of world production are readily copied, thus, diminishing the incentive to undertake research and development. Most industrial countries are in broad agreement that the international trading system provides inadequate protection to intellectual property rights (Beath 1990). This inadequate protection is particularly evident in markets of developing countries where patent and copyright infringements are a common practice which then effectively reduce the incentive to innovate.

As a result of the intense efforts of the industrial countries led by the United States, the legal protection of intellectual property rights through patents, copyrights, trademarks and trade secrets has become a part of world trade rules. The Final Act of the Uruguay Round (UR) contains an agreement on trade-related aspects of intellectual property rights (TRIPs) which will be administered by the World Trade Organisation (WTO). The agreement obliges member nations to provide a minimum standard of protection that grants patent rights for at least 20 years. Industrial countries are expected to comply within a year, while developing countries have been given an additional four year grace period, and least developing countries ten (GATT

1994; Baldwin 1995).[1] Despite the agreement, the economic implications of stronger patent protection in developing countries are still controversial. TRIPs represents a significant and unusual change in the GATT approach. It is unusual because it requires 'positive' integration by WTO members. This is in contrast to other GATT/WTO liberalisation which is regarded as 'negative' integration like the removal of tariff barriers. Thus, in the case of TRIPs 'harmonisation' is unique, and although it is enforceable under the WTO dispute settlement procedures, it will not be easy.

Some doubts are expressed whether developing countries should strengthen their intellectual property right protection. Critics of a unified system of intellectual property rights say that developing countries would face potential costs from a regime of stronger patent protection. Earnings from patent protection accrue to knowledge producers who are mostly found in industrial countries. The social cost of patent protection is similar to losses incurred by society in the presence of a monopolist. A contrary view suggests that developing countries will benefit from greater access to new technologies which a regime of stronger patent protection would bring. Developing countries seeking to foster new industries depend on access to patented technology to compete on the international market. Many of these technologies cannot be pilfered and in the case of high-technology products, foreign companies must be attracted to build local plants or share their expertise with local producers. In a regime of lax patent protection this would rarely occur. From these two opposing views, it may be deduced that a shift towards stronger patent protection could have both negative and positive repercussions in developing economies. The major challenge facing

[1] An additional five years is also given in areas where patent protection is not available (eg. pharmaceuticals and chemicals).

developing countries therefore, is to transform such a policy regime from a rent transfer mechanism into an effective instrument for their own technological needs (Primo Braga 1995).

1.1 Objectives of the Study

This thesis analyses the impact of strengthening intellectual property protection in developing countries, particularly the Philippines, by focusing on patents, the major form of protection. Patent protection warrants consideration not only because of current international pressure to enforce intellectual property rights in the WTO, but as a means of enhancing the technological capability to generate appropriate technology for economic development. Studies on the economic implications of patent protection in developing countries have been confined largely to theoretical analyses which rely on very restrictive assumptions. This study presents some empirical findings using econometric techniques to examine two related hypotheses: (i) does patenting make a positive contribution to Philippine manufacturing? and (ii) does patenting stimulate domestic innovation? Specifically, this thesis aims to address the following issues:

(i) What are the perceived benefits and costs associated with intellectual property right protection in developing countries?

(ii) What does economic theory suggest about the repercussions of intellectual property right protection in developing countries?

(iii) Given that there are benefits and costs associated with a regime of stronger patent protection, does the current technological capability of the Philippines lead to the conclusion that benefits would outweigh the costs involved?

(iv) One perceived gain from strengthening protection of intellectual property rights is that it will encourage inventive activity at the global level. Will an increase in industry specific innovation or knowhow be beneficial in Philippine manufacturing?

(v) Empirical studies suggest that inventive activity in developing countries like the Philippines generally involves adaptation to meet local needs (Deolalikar and Evenson 1989; 1990; Dahab 1986; Mikklesen 1885). Will stronger patent protection aid or hinder this type of innovative activity?

3.2 Organisation of the Study

This thesis is organised as follows:

Chapters 2 presents an overview of the nature of intellectual property rights and reviews the inclusion of intellectual property right protection in international trade negotiations.

Chapter 3 examines the divergence in the interests between industrial and developing countries when it comes to patent protection. It presents the economic implications of patent protection in developing countries like the Philippines. While costs are involved, what benefits might a country expect from strengthening intellectual property right protection?

Chapter 4 considers existing theoretical studies of patent protection in developing countries. Most of these studies suggest that on balance developing countries would lose from a regime of stronger patent protection. However, a model is proposed showing that patent protection may have two opposing effects in developing countries: a production effect which is positive and a rent effect which is negative. The final result depends on which effect dominates. In developing countries with substantial technological capability the production effect is likely to dominate.

Chapter 5 assesses the technological capability of the Philippines and draws some insights into the implications of stronger patent protection in that country.

Chapter 6 examines the relationship between industry specific technological innovation and technical efficiency in Philippine manufacturing.

Chapter 7 is a pooled regression analysis of the determinants of domestic innovation in Philippine manufacturing industry. The emphasis is on the relationship between domestic and international patenting in light, chemical and drug, and engineering industries in the Philippines.

Finally, chapter 8 summarises and offers general conclusions.

Chapter 2

The Protection of Intellectual Property Rights: An Overview

The protection of intellectual property rights has long been regarded as a territorial issue, despite a number of international agreements among different countries. Many industrial economies set up institutions and enforcement mechanisms necessary for its protection. Developing countries however, showed little interest for its protection until recently when the legal protection of intellectual property rights was made a vital part of world trade rules.

2.1 Nature of Intellectual Rights

Intellectual property rights are defined as control over information or equipment that has commercial value. If the right can be defined, then it could be bought and sold in a market. The creation of new ideas has repercussions on society's welfare as measured by: consumer surplus, producer surplus and the rents that accrue to the owner of the idea. However, the interests diverge when it comes to intellectual property. The inventor will prefer the highest price possible as a reward for the novel idea generated. The producer wants easy access to ideas to facilitate production at minimum costs. The consumer's interest is to purchase the best products at the lowest possible prices. This latter concern is achieved through competition and implies that from a consumer's point of view the interest lies in the greatest possible dissemination of ideas. The more firms with access to an idea, the lower the product price. But this is not in the interest of either the inventor or the producer (Beath 1990).

Research and development and intellectual property rights pose problems in resource allocation. Because ideas are intangible, the benefits can not be completely appropriated. This raises questions related to spillover and infringements as well as concern over private and social returns when externality effects are considered (Beath 1990). Moreover, economic efficiency requires that ideas should be made available at marginal cost to all users, but marginal cost is zero if the nature of knowledge is a public good.

Since the benefits from knowledge are hard to appropriate once produced and that other users can not be perfectly excluded, the private returns to investments in new ideas are lower than social returns (Beath 1990). This notion forms the main rationale for providing protection to intellectual property which represents society's attempt to balance the interest of knowledge producers and users. In doing so, the aim is to promote inventive effort and dissemination of information by transferring some portion of the consumer surplus to the inventor. In principle both parties gain from intellectual property protection.

This view has been accepted in most industrial countries. Developing countries, however, believe the bulk of the gains from strengthening intellectual property protection accrue to the industrial countries where most technology is developed. Despite the lack of consensus among industrial countries about the standard to set for intellectual property protection, it became a contentious issue between the industrial and the developing countries in the Uruguay Round negotiations.

2.2 Intellectual Property Rights and the GATT

The Uruguay Round agenda went beyond the scope of the GATT negotiations and the traditional concern with reducing tariffs. The new issues introduced onto the agenda at Punte del Este (September 1986) included trade in services and trade aspects of investment policies and intellectual property rights. The industrial countries particularly the United States, insisted that intellectual property rights should be included. Technologies, brand names, copyrights are being copied and counterfeit products manufactured mostly in developing countries. The US position on the issue of intellectual property rights was summarised in a message from Washington to the US Trade Representative (USTR),

> *...requiring the USTR to identify those foreign countries that deny adequate and effective protection of intellectual property or deny fair and equitable access for US persons relying on intellectual property protection and to determine which of those countries are priority foreign countries...*
>
> *If a country is identified as a priority foreign country, the USTR must within 30 days of identification, decide whether to initiate an investigation. If the investigation is initiated, the USTR has up to 6 to 9 months to decide whether the measures under investigation are actionable, and if so, decide what response is appropriate, including possible retaliation (United States Information Service 1992).*

Early in the 1970s a call was made for strengthening the protection intellectual property rights. Some commentators questioned whether the GATT was an appropriate forum for discussions on intellectual property rights. These issues were regarded as under the jurisdiction of the World Intellectual Property Organisation (WIPO), established in 1967 by a convention and brought into force in 1970 (Deardorff 1990). Many developing countries opposed the idea of bringing intellectual property rights within the GATT framework, because they feared that the industrial countries would have an advantage in the conduct of negotiations. Moreover, intellectual property rights are not necessarily related to trade or trade barriers; hence, the negotiating group in the Uruguay Round was given the task of just dealing with issues relating to trade and as a result, the trade related intellectual property rights including counterfeit goods or TRIPs group was created and included in the international trade policy issues.

By the mid 1980s, the limitations of intellectual property protection under the WIPO system became apparent. Although developed countries had their share of violations, it was more rampant in developing economies where legal protection is generally weaker (Lesser 1990a). In 1989 for example Finland, Norway and Spain were pressured by the United States to protect pharmaceutical products and processes or face retaliatory trade actions under Section 1988 of the Trade and Competitiveness Act. Later the EU also adopted similar policies against these three countries for failing to provide protection on pharmaceutical products (Lesser 1990a). The chemical and pharmaceutical industry is one area where patent protection is important. Innovation in this industry is costly and imitation is generally easy thus, strong patent protection is necessary to reward firms for their inventive effort (Frischtak 1990). Mansfield (1986) reports that based on a random sample of 100 firms from 12 industries in the United States, 65 per cent of the innovations by pharmaceuticals firms would not have been marketed without protection. This is because the investment needed to develop new chemical products are also substantial. Virts and Weston (1981) estimate the cost to be approximately US$54 million based on 1976 prices while the Pharmaceutical

Association estimated this cost to be in the range of US$50 million to US$125 million in 1990 (Nogués 1990b).

The US International Trade Commission estimated that in 1986, US companies worldwide registered losses between US$43 billion and US$61 billion dollars due to inadequate protection in developing countries. This forced the United States to put pressure on a number of developing countries in Asia to reform their intellectual property laws and to increase enforcement efforts by threatening to remove their Generalized System of Preference benefits.

Brazil and India were put in the priority watch list by the United States in the late 1980s for failing to provide protection on foodstuff and pharmaceuticals. In 1995, major multinational firms have taken the battle against copyright pirates in Asian countries that distribute products ranging from Mickey Mouse souvenirs to Microsoft computer programs. In 1994, Microsoft claims that software piracy in Asia cost the company around US$2.22 billion while Walt Disney estimates its loses from Asian counterfeiters to be US$1 billion (Philippine Daily Inquirer 1995).

In China, it is believed that the pirating of compact disks is costing US companies around US$1.35 billion a year (The Australian 1994). Sega Enterprises of Japan also reported substantial losses due to video game piracy done by an electronic company in China.

In South Korea, there has been a growing concern about its enforcement and protection of copyrights, trade secrets and integrated circuits. Piracy of computer programs is also a serious problem with many large firms allegedly engaged in internal unauthorized copying of computer programs (United States Information Services 1992). The International Intellectual Property Alliance (IIPA) estimates loses from copyright violations in South Korea to be around

US$356 million in 1994. Moreover, in the area of sound recordings and video manufacturing, many licenses have been issued to reproduce and distribute these products based on false documents (United States Information Services 1992).

The Philippines along with other Southeast Asian economies was placed in the priority watch list mainly because of the problems of enforcement and inadequate protection of trademarks and copyrights. The IIPA estimates that in 1994, trade losses due to piracy in the Philippines, Thailand and Indonesia amounted to US$ 441 million (Philippine Daily Inquirer 1995).[1] In addition to very little penalties to infringers, the United States believed that many Southeast Asian countries do not clearly protect U.S. sound recordings. Piracy of these products including motion pictures is extensive and estimated to be in excess of 60 per cent of the market (United States Information Services 1992). The Philippines was put in the priority watch list in 1989 and Thailand got added into the list two years later despite making some amendments to the Thai Patent Law. Thailand was put in the priority foreign country list for the inadequate enforcement of copyright and patent laws resulting to significant losses in U.S. motion picture, sound recording and computer software industries.

Intellectual property right protection is important in information–related technology industries because of the fierce competition in this field and the sector's strong reliance on research and development in order to survive.[2] In many developed countries, these industries not only rely on patents,

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[1] Losses due to piracy in the Philippines is estimated at US$119 million. For Thailand and Indonesia, the estimated losses are US$154 million and US$168 million respectively.

[2] As defined by Mody (1989) information-related technology industries include process and communication services as well as electronic hardware.

trademarks and trade secrets but also on software copyright protection and on the protection of semi-conductor chip design. The significance of each type of protection vary over time and across subsectors of the industry (Primo Braga 1990b).

For the audio, video and publishing industries on the other hand, protection is important because these creative efforts usually involve costs that are higher than the subsequent manufacturing costs of printing a book or stamping out a compact disc (The Australian 1994). In recent years, with the growing recognition that weak intellectual property protection has negative repercussions on local entertainment industries, various interest groups in developing countries have asked their government to strengthen copyright protection. India, one of the top nine film–exporting nations in the world and Brazil having the largest TV network in the developing world are realizing that they also have their own intellectual property to protect (Primo Braga 1990b and The Australian 1994).

All the above violations demonstrate that after many conventions and agreements covering patents, copyright and trademarks under the jurisdiction of the WIPO, the level of harmonization achieved remained limited. It also became clear that membership alone can not guarantee the strength of patent protection that exist at a country level. Indeed, although the world IPR system under WIPO has bigger coverage than GATT membership, there are some drawbacks: (i) the rules themselves are not broad enough and allows exceptions on some products like food, drugs and chemicals; (ii) the present system relies on the national treatment principle to provide protection but weak systems in other countries make the agreement inadequate; and (iii) the absence of enforcement provisions or any dispute settlement mechanisms (Baldwin 1995). The Uruguay Round agreement on TRIPs addressed the above issues and made substantial progress in overcoming them by requiring all GATT members to provide copyright, trademarks and patent protection for a specified number of years on the goods and services covered under the agreement. Enforcement procedures are also contained in the agreement, requiring countries to establish civil judicial procedures whereby individuals and firms can seek to enforce their intellectual property rights.

The primary objective of bringing intellectual property rights into the GATT framework was to harmonise its treatment in different countries. In the Uruguay Round negotiations, the United States pushed persistently for bringing national laws and enforcement mechanisms into conformity with US procedures on patents, copyrights and trademarks. Other industrial countries prefer 'convergence' rather than full harmonisation. The European Union (EU) was concerned with national rules that discriminate against foreign imports in favour of domestic activity (Beath 1990). But despite the lack of consensus among industrial countries on the manner of implementation of intellectual property right protection, the industrial countries have been successful in having intellectual property on the agenda of the Uruguay Round and upon its conclusion, an agreement on TRIPs has been drafted which would be administered by the World Trade Organisation (WTO), the successor to the GATT.

2.3 The TRIPs Agreement

The legal protection of intellectual property through patents, copyrights, trademarks and trade secrets entered into effect in January 1995 when the WTO holds its inaugural meeting. One of the WTO's three councils will supervise the Uruguay Round agreement on trade related aspects of intellectual property rights. The agreement is based on traditional GATT principles of non-discrimination and transparency. In addition, it provides for a minimum standard of protection of intellectual property rights, with WTO members free to determine the appropriate method of implementing the agreement within their legal systems and practices. The TRIPs agreement has seven parts: (i) general provisions and basic principles; (ii) standards concerning the availability, scope and use of intellectual property rights, (iii) enforcement of intellectual property rights, (iv) acquisition and maintenance of intellectual property rights and related *inter-parties* procedures, (v) the dispute prevention and settlement, (vi) the transitional arrangements, and (vii) institutional arrangement and final provisions.

General provision and basic principles are similar to those in other intellectual property conventions. Article 3 contains a national treatment provision under which the residents of other members must be given treatment that is no less favourable than that accorded to its own nationals with regard to intellectual property protection (GATT 1994). Article 4 introduces the most-favoured-nation provision (MFN). Under this provision and with a few defined exceptions, any advantage, favour or benefit, a member gives to the nationals of other member countries must be extended immediately and unconditionally to the nationals of all other members, even if the treatment is more favourable than that which is extended to its own nationals. Deviations from MFN are permitted if they represent international agreements on judicial assistance or law enforcement of a general nature, or rights not covered by the TRIPs agreement, or international agreements on aspects related to protection of intellectual property right that were have been put into force before the WTO agreement (Primo Braga 1995)

The principle of transparency is introduced in Article 63. Member countries have an obligation to publish their laws and regulations on intellectual property rights, as well as judicial decisions and administrative rulings on intellectual property rights. This practice would help governments and holders of intellectual property right to be acquainted with measures affecting their interests.

Intellectual property right standards on the TRIPs agreement establishes minimum standards on the availability, scope and use of intellectual property rights, including copyright, trademarks, geographical indications, industrial designs, patents, integrated circuit designs, trade secrets, as well as control of anti-competitive practices in contractual licenses.[3]

The Paris Convention (1883) obliges members to comply with the substantive provisions on patent protection. That agreement provides for a minimum 20 year patent term for most inventions, whether product or processes, in all fields of technology. This implies that many countries have to change their patents' laws to accommodate the new provisions.

Inventions may be excluded from patents if commercial exploitation is prohibited for reasons of public order and morality. Exemptions are also permitted for diagnostic, therapeutic and surgical methods for the treatment of humans or animals, plants, and essentially biological processes for the production of plants and animals. With regard to plant varieties, however, members are required to provide protection either by patents, or by a specific individual *sui generis* system (such as plant breeders' rights).

The TRIPs agreement also identifies the rights of the patentee which include the exclusive right of importation as provided. (Article 28). However, no stipulation has been provided on the conditions of exhaustion of intellectual property rights at the international level. This implies that after the first

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[3]See GATT (1994) and Primo Braga (1995) for a more detailed discussion of the other forms of protection other than patent protection.

distribution of a product covered by patent protection, a title holder will no longer have the right to prevent further distribution of the protected product in the domestic market. Furthermore, the agreement does not prevent the import of protected goods from third parties.

Detailed conditions regarding the use of a patent by governments without authorisation from patent owners are set out in Article 31. The article, imposes strict conditions on the use of compulsory licenses.

Process patents, arising from their protection are automatically extended to the product directly obtained from the process. This is designed to strengthen the protection granted to process patents. Enforcement of this provision (Article 34) stipulates that under certain circumstances the burden of proof is placed on alleged infringers to demonstrate that the process used to produce an identical product is different from the patented process.

Enforcement of intellectual property protection is required from member governments of the WTO who are required to provide procedures and remedies under their domestic laws that ensure that intellectual property rights are protected, regardless of the holder of the rights. For the industrial countries, particularly the United States, this was crucial because standards are only relevant if they are enforceable. Enforcement procedures should be fair and equitable, not complicated or costly, nor entail unreasonable time limits and unwarranted delays. They should not create barriers to legitimate trade and should be open to judicial review. There is no obligation to establish a judicial system for the protection of intellectual property rights that is distinct from the system of enforcement of general laws, nor to give priority to intellectual property rights.

The civil and administrative procedures and remedies outlined in the agreement give judicial authorities the right to order the disposal or destruction of goods that infringe the provisions of the TRIPs agreement. Customs authorities are also given the power to prevent suspected pirated and counterfeit goods from being imported and exported. Members are obliged to provide for criminal procedures and penalties to deter wilful infringers.

Acquisition and maintenance of agreement conditions are outlined in Article 62. It requires that procedures like registrations, should be consistent with the set provisions. The granting of patent protection must be expeditious so that the effective period of protection is not be diminished.

Dispute prevention and settlement will take place under the integrated Dispute Settlement Procedures established in the WTO agreement. For dispute prevention, the possibility of cross-sectoral retaliation from other member countries is expected to play a role in strengthening protection of intellectual property rights on a global basis (Primo Braga 1995). However, there is a five year moratorium in the use of the integrated dispute settlement procedures to handle indirect violations such as foreign exchange restrictions on royalty payments which would impair the benefits of patent holders.

Transitional arrangements allow industrial countries one year to bring legislation and practices into conformity with the TRIPs agreement. On the other hand, developing countries and economies in transition have five years transition period. In addition, these countries are entitled to an additional five year transitional period in technology areas that were not protected prior to the agreement. All member countries have only one year for transition to national treatment, MFN and multilateral agreements on acquisition and maintenance of protection. Least developed countries are given 11 years for transition to comply with the provisions of the agreement. They are entitled to request further extensions except for its national treatment and MFN obligations.

Institutional arrangements are set up to execute the provisions of the agreement. These arrangements include (i) the creation of the Council for TRIPs which would monitor the operation and implementation of the agreement, (ii) measures adopted to accommodate the protection of specific subject matter, (iii) conditions for review, (iv) amendments, (v) reservations, (vi) security exceptions and (vii) an exhortation to international cooperation (Primo Braga 1995).

2.4 Patent Protection in Developing Countries: Some Stylised Facts

Most nations conferring patent rights prior to the TRIPs agreement had agreed to accept broad guidelines that come from the Paris Convention of 1883. As of 1988, the Paris Convention had been adopted by 98 member countries, including many developing countries who are also members of the WTO (Appendix 2.1). Most of developing countries are former colonies of industrial countries which adopted the patent laws of their metropolitan powers. The Philippines, for example, adopted the Spanish patent law system when it was under Spain but when it came under United States' control, it adopted the US system.[4] (Sapalo 1992).

The Philippine's patent system based on the US system was established on June 20, 1947 by the Republic Acts 165 and 166. The Office became the

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[4]The Philippines has a long history of patent protection and records show that the country observed patent protection even before 1862 when the country was still a colony of Spain. The country adopted the Spanish patent law which grants the inventor an exclusive right to the exploitation of his invention. The patent term is usually set at five, ten or twenty years depending on the preference of the inventor. Patent grants for five or twenty years may be renewed; however, the entire term of patent protection should not exceed twenty years.

During the Spanish rule, no formal organisation or institution was set up to administer patent applications and grants in the country; all patent applications made by domestic residents had to be sent to Spain for examination and grant.

The Philippines was ceded to the United States by Treaty of Paris in 1898. By the provisions of Article 13 of the treaty, patents granted during the Spanish period continued to be enforced. But subsequently, all patent applications were filed with the United States Patent Office.

authority to grant letters of patents for inventions, industrial designs and utility models. The Patent Office was originally placed under the Department of Justice. Several months later, it was transferred to the Department of Commerce and Industry which became the Department of Trade and Industry (DTI).

The Philippines became a member of the Paris Convention in 1965. The international system of patent classification came into effect in the 1970s. During the transition, each patent was given both US and international patent classification.

Under the Philippine patent system, priority is given to the first person to invent. In most Western European nations however, patents are issued to the first person to file a claim to be the original inventor. The life of a patent in the Philippines is normally set at 17 years from the date of patent issue. To be granted a patent in the Philippines, an inventor has to meet three criteria: novelty, usefulness and non-obviousness.

Available statistics show that a substantial proportion of patents granted in developing countries go to foreign firms or non-nationals (see Table 2.1). In general, leading industrial countries like the United States, Japan and Germany dominate patents in the developing countries. Foreign patents are concentrated on the chemical and drug industries, as well as high technology intensive industries.

Despite the presence of a law protecting patents in most developing countries, the dominance of foreign nationals in patent grants has always worried the developing countries and has raised doubts about the merits of such a policy. In the 1970s, most developing countries made an effort to obtain better terms of technology transfer from the industrial countries. Some developing countries such as India even changed their system of intellectual property right protection, on the grounds that royalties and patent fees constituted 'unfair trade' because industrial countries had no moral or natural right to be awarded such protection in developing countries (Evenson 1992).

Enforcement of intellectual property laws is a problem in most developing countries. In the Philippines for example, limited enforcement is evident in the backlog of pending applications and cases of patent disputes for settlement in domestic courts. These delays reduce the effective life of a patent. Of the 362 cases pending in the Philippines in September 1992, only 3 cases were resolved in that month, while 15 new cases were filed.

Table 2.1 **Distribution of invention patents granted in selected countries, 1965, 1975 and 1990,** in per cent

	1965		**1975**		**1990**	
	Domestic	**Foreign**	**Domestic**	**Foreign**	**Domestic**	**Foreign**
Industrial Countries						
Germany, Fed. Rep. of	59.7	40.3	49.6	50.4	38.8	61.2
Japan	66.2	33.8	79.2	20.8	84.8	15.2
USA	80.1	19.9	64.7	35.3	52.4	47.6
NICs						
Hongkong	..	..	..	..	2.1	97.9
Singapore	..	..	..	..	0.0	100.0
South Korea	61.2	38.8	48.0	52.0	32.9	67.1
ASEAN						
Malaysia[a]	4.3	95.7	1.3	98.7	4.5	95.5
Philippines	4.0	96.0	10.4	89.6	3.0	97.0
Thailand[b]	..	..	25.0	75.0	5.0	95.0

[a]1980 figures for 1975.

[b]1982 figures for 1975.

Source: World Intellectual Property Organisation, ***World Industrial Property Statistics***, various issues, WIPO, Geneva.

2.5 TRIPs and the Protection of Intellectual Property Rights in Developing Countries

The agreement on trade-related aspects of intellectual property is annexed to the Marrakech agreement that established the World Trade Organisation. To comply with the agreement requires revisions to existing patent law legislations, systems and practices in industrial and developing countries. Developing countries with inadequate protection face major changes. A number of developing countries will have to revise their patent laws to raise protection up to 20 years and to cover both product and process patents. Moreover, many developing countries provided only limited protection on pharmaceutical and chemical products; to comply with the minimum standard set out in the agreement these countries must expand the coverage of protection on pharmaceutical and chemical products.

For the Philippines, compliance with the agreement entails significant changes in laws and practice notwithstanding the well established patent system. Changes will include revisions in the patent laws to accommodate protection of plant varieties, an extension of patent protection to 20 years and additional legal reform in to ensure stricter enforcement of patent laws.

Appendix 2.1. **Overview of Patent Protection Among WTO Member Countries**[a]

GATT Member Countries	**Duration of Patent Protection**[d]	**Membership in Major WIPO Conventions** P-Paris Convention, B-Berne Convention, U-International Convention for the Protection of New Varities of Plants (UPOV) GPB-Grants Plant Breeder's Rights but not a member of UPOV	**Available Patent Protection** 1-Petty Patents, 2-Pharmaceuticals, 2a- Processes in pharmaceutical production patented under some circumstances, 3-Food Products, 3a-Processes in food production patented under some circumstances, 4-Chemical Products, 5-Plant/Animal Varieties, 5a-Plant Varieties but not animal varieties, 6-Surgical Procedures, 7-Microorganisms and Products Thereof
Developing Countries and Transition Economies			
Angola	..	P	..
Antigua and Barbuda	..	..	..
Argentina	5,10,15 GD	P,B	3,4,5,6,7
Bahrain	..	..	..
Bangladesh[b]	16 GD,EP	P	2,3,4,5,6,7
Barbados	15 FD,EP	P,B	2,3,4,7
Belize	..	..	..
Benin[b]	..	P,B	..
Bolivia	15 GD	P,B	5,6,7
Botswana[b]	20 FD	..	2,3,4,5,6,7
Brazil	15 FD	P,B	1,2a,3a,5,6
Brunei	..	..	..
Burkina Faso[b]	..	P,B	..
Burundi[b]	..	P	..
Cameroon	10 GD	P,B	2,3,4,7
Central African Republic[b]	10 FD,EP	P,B	2,3,4,7
Chad[b]	20 FD	P,B	3,4,5,6,7
Chile	..	P,B,GU	2,3,4,5,6,7
Colombia	5 GD,EP	B	2a,3a,4,7
Congo	10 FD,EP	P,B	2,3,4,7
Costa Rica	..	B	..
Cote d'Ivoire	10 FD,EP	P,B	2,3,4,5,6,7
Cuba	10 FD	P	7
Cyprus	20 FD	P,B	2,3,4,7
Czech Republic	15 AD	P,B	5
Dominica	..	..	..
Dominican Republic	5,10,15 GD	P	2,3,4,5,6,7
Egypt	15 FD,EP	P,B	4,5,6,7
El Salvador	..	B	..
Fiji	..	B	..
Gabon	15 FD,EP	P,B	2,3,4,7
Gambia[b]	20 FD	P,B	2,3,4,5,6,7
Ghana	20 FD	P,B	3,4,7
Grenada	..	..	..
Guatemala	..	..	..
Guinea Bissau[b]	..	P,B	2,3,4,5,6,7
Guyana	..	..	..

GATT Member Countries	Duration of Patent Protection[d]	Membership in Major WIPO Conventions P-Paris Convention, B-Berne Convention, U-International Convention for the Protection of New Varities of Plants (UPOV) GPB-Grants Plant Breeder's Rights but not a member of UPOV	Available Patent Protection 1-Petty Patents, 2-Pharmaceuticals, 2a- Processes in pharmaceutical production patented under some circumstances, 3-Food Products, 3a-Processes in food production patented under some circumstances, 4-Chemical Products, 5-Plant/Animal Varieties, 5a-Plant Varieties but not animal varieties, 6-Surgical Procedures, 7-Microorganisms and Products Thereof
Haiti	5,10,20 GD	P	2,3,4,5,6,7
Honduras	..	P,B	..
Hongkong	..	..	..
Hungary	20 FD	P,B,U	4,5
India	14 PD	B	5,7
Indonesia	..	P	2,3,4,5,6,7
Israel	..	P,B	..
Jamaica	..	B	..
Kenya	20 FD	P,B	2,3,4,7
Korea Republic of	12 PD	P	1,2,5,6,7
Kuwait	..	..	..
Lesotho[b]	20 FD	P,B	2,3,4,5,6,7
Macau	..	..	..
Madagascar[b]	..	P,B	2,3,4,5,6,7
Malawi[b]	16 PD,EP	P,B	2a,3a,4,5,6,7
Malaysia	15 GD	P,B	2,3,4
Maldives[b]	..	..	..
Mali[b]	10 FD,EP	P,B	2,3,4,7
Malta	..	P,B	..
Mauritiana[b]	10 FD,EP	P,B	2,3,4,7
Mauritius	14 FD,EP	P,B	2,3,4,5,6,7
Mexico	14 GD	P,B	2a,3a,7
Morocco	20 FD	P,B	3,4,5,6,7
Mozambique[b]	..	..	..
Myanmar[b]	..	..	..
Namibia	..	B	..
Nicaragua	..	..	..
Niger[b]	10 FD,EP	P,B	2,3,4,7
Nigeria	20 FD	P	2,3,4,6,7
Pakistan	16 GD,EP	B	3,4,5,6,7
Paraguay	..	B	..
Peru	5 GD	B	4,7
Philippines	17 GD	P,B	1,2,3,4,5,6,7
Poland	15 FD	P,B	1,7
Qatar	..	..	..
Romania	..	P,B	..
Rwanda[b]	20 FD	P,B	2,3,4,5,6,7
Saint Kitts and Nevis	..	..	..
Saint Lucia	..	B	..

GATT Member Countries	Duration of Patent Protection[d]	**Membership in Major WIPO Conventions** P-Paris Convention, B-Berne Convention, U-International Convention for the Protection of New Varities of Plants (UPOV) GPB-Grants Plant Breeder's Rights but not a member of UPOV	**Available Patent Protection** 1-Petty Patents, 2-Pharmaceuticals, 2a- Processes in pharmaceutical production patented under some circumstances, 3-Food Products, 3a-Processes in food production patented under some circumstances, 4-Chemical Products, 5-Plant/Animal Varieties, 5a-Plant Varieties but not animal varieties, 6-Surgical Procedures, 7-Microorganisms and Products Thereof
St. Vincent & Grenadines	..	..	..
Senegal	10 FD,EP	P,B	2,3,4,7
Sierra Leone[b]	20 FD	..	2,3,4,5,6,7
Singapore	..	..	..
Slovak Republic	..	P,B	..
Sri Lanka	15 GD	P,B	2,3,4,7
Suriname	..	P,B	2,3,4,5,6,7
Swaziland	..	P	..
Tanzania	20 FD	P	2,3,4,7
Thailand	15 FD	B	4,6,7
Togo[b]	..	P,B	..
Trinidad and Tobago	14 GD	P,B	2,3,4,5,6,7
Tunisia	..	P,B	..
Turkey	5,10,15,20 FD	P,B	4,6,7
Uganda[b]	20 FD	P	2,3,4,7
United Arab Emirates	..	..	..
Uruguay	15 GD	P,B	1,3,5,6,7
Venezuela	5,10,15 GD	B	5,6,7
Yugoslavia	..	P,B	..
Zaire[b]	20 FD	P,B	2,3,4,5,6,7
Zambia[b]	16 PD	P,B	2,3,4,5,6,7
Zimbabwe	..	P,B	..
Industrial Countries			
Australia	16 PD,EP	P,B	2,3,4,5,6,7
Austria	18 PD	P,B	2,3,4,7
Belgium	20 FD	P,B,U	2,3,4,7
Canada	17 GD	P,B	3,4,7
Denmark	20 FD	P,B,U	2,3a,4,7
Finland	20 FD	P,B	4,7
France	20 FD	P,B,U	2,3,4,7
Germany	20 FD	P,B.U	1,2,3,4,7
Greece	15 FD	P,B	3,4,5,6,7
Iceland	15 GD	P,B	4,5,6,7
Ireland	16 PD,EP	P,B,U	2,3,4,5,6,7
Italy	20 FD	P,B,U	1,2,3,5a,7
Japan	15 PD	P,B,U	1,2,3,4,5,7
Liechtenstein	20 FD	P,B	2,3,4,7
Luxembourg	20 FD	P,B	2,3,4,6,7
Netherlands	20 FD	P,B,U	2,3,4,7

GATT Member Countries	Duration of Patent Protection[d]	Membership in Major WIPO Conventions P-Paris Convention, B-Berne Convention, U-International Convention for the Protection of New Varities of Plants (UPOV) GPB-Grants Plant Breeder's Rights but not a member of UPOV	Available Patent Protection 1-Petty Patents, 2-Pharmaceuticals, 2a- Processes in pharmaceutical production patented under some circumstances, 3-Food Products, 3a-Processes in food production patented under some circumstances, 4-Chemical Products, 5-Plant/Animal Varieties, 5a-Plant Varieties but not animal varieties, 6-Surgical Procedures, 7-Microorganisms and Products Thereof
New Zealand	16 PD	P,B,U	2,3,4,5,6,7
Norway	20 FD	P,B	4,7
Portugal	15 GD	P,B	1,6,7
South Africa	20 FD	P,B,U	2,3,4,7
Spain	20 FD	P,B,U	1,3,7
Sweden	20 FD	P,B,U	2,3,4,7
Switzerland	20 FD	P,B,U	2,3,4,7
United Kingdom	20 FD	P,B,U	2,3,4,7
USA	17 GD,EP	P,B,U	2,3,4,5,6,7

[a]Based on GATT membership as of April 15, 1994 and patent protection of 1988.
[b]Least developed countries according to the United Nations.
[c]According to GATT, developing countries include Lantin America, Europe (Romania, Turkey and Yugoslavia), Africa (excluding South Africa), the Middle East and Asia (including Oceania) less the OECD members therein. Transition economies include the Czech Republic, Hungary, Poland and the Slovak Republic.
[d]FD from filing date; PD from publication date; GD from grant date; EP extension possible-normally 5 years.

Source: Primo Braga, C.A., 1995. *Trade-Related Intellectual Property Issues: the Uruguay Round agreement and its economic implications*, presented at the Uruguay Round and the Developing Countries, A World Bank Conference, January 26-27, 1995.
Siebeck, W. E., 1990. *Strengthening Protection of Intellectual Propertyin Developing Countries: a survey of the literature*, The World Bank, Washington D.C.

Chapter 3

Intellectual Property Right Protection and Trade: The Conflict Between Industrial and Developing Countries

The divergence of interests between industrial and developing countries over the protection of intellectual property has been highlighted in the Uruguay Round negotiations. While the benefits of increased patent protection will almost certainly increase incomes of patent holders in industrial countries and increase net national income, these gains may result in costs for the developing countries.

3.1 Accounting for Intellectual Property in Trade: The Interest of Industrial Versus the Interest of the Developing Countries

Intellectual property can be accounted for in international commerce either directly or indirectly. The indirect approach involves the embodiment of patented information in goods and services passing in trade. The direct approach records intellectual property in international trade in two ways: first, innovating firms or individuals may opt to sell or to rent their patented information for royalties and licensing fees; and second, firms may choose to retain control over the use of their valuable ideas through direct foreign investment. In the latter case, returns to intellectual property are included in fees from affiliates, repatriated profits and capital income (Maskus 1990).

Trade in intellectual property and technology intensive goods

Despite a number of limitations and difficulties inherent in measuring international trade in intellectual property[1], it would be vital to show the basic indicators of this trade to see how the interest among the developing and industrial countries diverge from each other when it comes to issues related to intellectual property. The developing countries included in the analysis are ASEAN countries and newly industrialising countries. These countries include most of the fast growing economies of Asia which have been identified by industrial countries like the United States, Japan and the European Union as engaging in unfair trade because of inadequate protection. The Philippines will be highlighted throughout the analysis.

The share of intellectual property and technology-intensive goods in exports and imports of the identified countries are shown in table 3.1. Intellectual property-intensive goods[2] are selected based on the prominence of intellectual property disputes and the inclusion of goods that rely on the major forms of protection like patents, trademarks and copyrights (Maskus 1990). Technology intensive goods[3], on the other hand, represent goods have high ratios of research and development expenditures in value added. Trade in intellectual property as embodied in goods has been growing rapidly in recent

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[1]These measurement problems include: (1) disentangling the effect of the value of intellectual property on the traded prices of goods and services; (2) the fact that trade in inputs is often intra-firm in nature suggests that prices may have little relation to the economic value on the underlying intellectual property; and (3) direct market transaction measures like licensing fees may be an unreliable indicator of the economic value of intellectual property because possible changes in policy regimes can affect its exploitation (Maskus 1990).

[2]The list of intellectual property intensive goods was obtained from Maskus (1990) and includes: pharmaceuticals, perfumes and cosmetics, polymerization products, metal-working machine tools, automatic data processing machines, electronic micro-circuits, motor vehicle parts, travel goods and handbags, measuring and controlling instruments, watches, printed matter, toys and sporting goods, and recorded discs and tapes.

[3] The Krause system of classification was used to identify the products included in this group. Technology intensive goods is composed of: chemical elements and compounds, petroleum and coal, medicinal products, fertilizers, explosives and pyrotechnical products, plastic materials, other chemicals, machinery, electrical machinery and equipment, aircraft, photo and cinema supplies, and developed cinema films.

years (table 3.1). Also evident from table 3.1 is that the share of intellectual property and technology intensive goods in total exports has become increasingly significant for the ASEAN developing countries and the newly industrialising countries in Asia. The Philippines illustrates this clearly, particularly in electronic microcircuits, and measuring and controlling instruments. The export share of these two goods in total manufactured exports was negligible until late in the 1970s, when their share increased sharply, reaching 20 and 22 per cent respectively, by 1990.

Figure 3.1 shows the trend of revealed comparative advantage indices (RCA) of selected intellectual property goods across countries (regions) computed using 3.1

$$RCA = \frac{X_{iw}^{k} / X_{iw}^{T}}{X_{ww}^{k} / X_{ww}^{T}} \qquad (3.1)$$

where X refers to exports, superscripts k and T stand for the commodity and total exports respectively. The first subscript indicates the reporting country (region) while the second, indicates the trading partner which in this case is the world. The index is also known as the export specialisation ratio and is defined as the country's (region's) sectoral share of intellectual property and technology intensive goods divided by the world sectoral share of intellectual property and technology intensive goods.

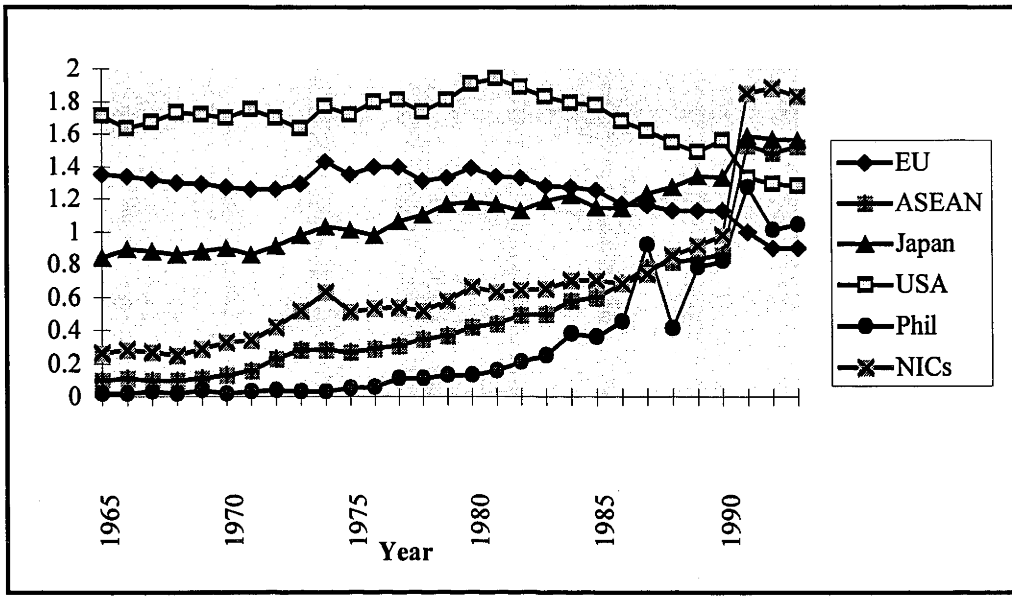
Table 3.1 **Share of intellectual property and technology intensive goods in selected countries and regions, 1965, 1975, 1985, 1990 and 1993,** in per cent

Country/Region	1965	1975	1985	1990	1993
USA					
Share of IP Intensive Goods, Exports	13.1	13.3	21.0	23.2	23.9
Share of Technology Intensive Goods, Exports	34.7	38.0	45.1	44.9	44.6
Share of IP Intensive Goods, Imports	4.8	8.2	13.6	18.5	21.8
Share of Technology Intensive Goods, Imports	10.4	13.8	20.6	25.1	27.9
European Union					
Share of IP Intensive Goods, Exports	10.6	12.0	14.1	16.8	16.9
Share of Technology Intensive Goods, Exports	27.3	29.9	31.7	32.3	33.7
Share of IP Intensive Goods, Imports	6.7	9.0	12.7	15.8	17.3
Share of Technology Intensive Goods, Imports	16.9	19.6	24.4	28.2	28.7
Japan					
Share of IP Intensive Goods, Exports	8.5	9.5	19.6	26.6	29.0
Share of Technology Intensive Goods, Exports	17.1	22.3	29.2	38.1	40.9
Share of IP Intensive Goods, Imports	4.4	4.2	6.3	10.5	12.7
Share of Technology Intensive Goods, Imports	11.7	8.6	13.3	17.2	19.0
Newly Industrialising Countries					
Share of IP Intensive Goods, Exports	7.2	16.2	20.0	29.1	34.0
Share of Technology Intensive Goods, Exports	5.3	11.3	17.6	29.0	36.3
Share of IP Intensive Goods, Imports	7.4	12.1	17.8	25.8	28.4
Share of Technology Intensive Goods, Imports	17.5	25.6	27.4	34.6	35.9
ASEAN					
Share of IP Intensive Goods, Exports	0.4	1.8	10.0	18.1	28.4
Share of Technology Intensive Goods, Exports	0.6	2.0	8.7	15.1	30.0
Share of IP Intensive Goods, Imports	8.1	7.8	17.8	25.4	28.2
Share of Technology Intensive Goods, Imports	22.6	34.2	35.4	43.0	44.0
Philippines					
Share of IP Intensive Goods, Exports	0.1	0.1	12.2	33.2	19.4
Share of Technology Intensive Goods, Exports	0.4	1.1	9.2	23.5	15.3
Share of IP Intensive Goods, Imports	7.2	7.8	10.9	32.6	14.0
Share of Technology Intensive Goods, Imports	27.2	32.2	22.8	45.2	31.8

Source: International Economic Data Bank, The Australian National University, based on United Nations Trade Statistics, 1995.

Figure 3.1

Selected countries and regions: revealed comparative advantage indices of intellectual property intensive goods, 1965-93



Source: International Economic Data Bank, The Australian National University, based on United Nations Trade Statistics, February 1995.

Industrial countries like the United States, Japan and EU have a strong comparative advantage in intellectual property-intensive goods. Middle income countries comprising ASEAN and the newly industrialising countries have recently been catching up in this trade. RCA figures for specific IP and technology intensive goods (Tables 3.2 and 3.3) suggest that the United States has a strong comparative advantage in automatic data processing machines, motor vehicle parts, printed matter and recorded disc and tapes, chemical compounds, manufactured fertilisers and aircraft, electronic microcircuits, and measuring and controlling equipments, explosive and pyrotechnical products, electro-medical and x-ray equipments. The interest of the United States then is for foreign nations to strengthen intellectual property protection in order to prevent residents of other countries from copying, as well as from importing infringed goods elsewhere.

The EU also shares the same interests as the United States; however, its concern is directed more towards the protection of pharmaceutical products, perfumes and cosmetics, and polymerisation products. Japan, on the other hand, overwhelmingly relies on its high technology-intensive exports of metal working machine tools, automatic data processing machines, measuring and controlling instruments and both electrical and non-electrical machineries.

The interests of middle income countries like the newly industrialising countries and the ASEAN are different from those of the industrial countries. The comparative advantage of the middle income countries relies on non-sophisticated and mostly labor intensive goods like travel goods and handbags, watches, toys and sporting goods and electronic micro-circuits (table 3.2). These countries are criticised for having a weak system of protection for intellectual property. However, most governments of developing countries believe that production of this type of goods may be enhanced more by technological diffusion or the dissemination of ideas from other countries which may be hampered by strengthening intellectual property protection. Nevertheless, it should be recognised that as these countries become more technologically sophisticated, their interest may change toward the provision of non-discriminatory intellectual property protection, particularly in the area of patent protection (Maskus 1990).

Table 3.2 **Revealed comparative advantage indices of selected countries and regions in selected intellectual property intensive goods, 1970, 1980, 1990 and 1993**

Country/Region	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
USA													
1970	1.0	0.7	1.0	1.0	2.1	2.5	2.2	0.2	1.9	0.0	1.4	0.7	1.9
1980	1.2	0.9	1.2	0.7	3.0	2.4	2.0	0.3	2.1	0.1	1.2	1.0	1.9
1990	1.0	0.8	1.0	0.5	1.7	1.7	1.6	0.1	1.6	0.1	1.5	0.7	2.0
1993	0.9	0.9	1.1	0.8	1.4	1.3	1.8	0.1	1.4	0.1	1.6	0.7	2.0
EU													
1970	1.4	1.8	1.6	1.5	1.1	1.2	1.2	1.3	1.2	0.3	1.5	1.0	1.4
1980	1.5	2.0	1.9	1.4	1.2	0.8	1.4	1.0	1.2	0.3	1.8	0.9	1.1
1990	1.4	1.8	1.4	1.2	0.8	0.5	1.2	0.8	0.9	0.2	1.5	0.6	1.0
1993	1.6	1.9	1.4	1.1	0.8	0.5	1.1	0.6	0.8	0.3	1.4	0.5	1.1
Japan													
1970	0.4	0.5	2.3	0.6	1.6	0.9	0.4	2.0	1.1	1.8	0.4	3.1	1.1
1980	0.3	0.2	1.0	2.0	1.7	2.4	0.9	0.3	1.8	3.4	0.4	1.6	3.6
1990	0.3	0.2	0.6	2.3	2.1	2.5	1.6	0.1	2.1	1.8	0.3	0.7	1.6
1993	0.3	0.2	0.7	2.4	1.8	2.4	1.7	0.0	2.0	1.6	0.3	0.6	1.2
NICs													
1970	0.3	0.7	0.2	0.1	0.1	3.2	0.2	6.8	1.5	1.6	0.7	7.7	0.2
1980	0.4	0.5	0.6	0.6	0.5	4.7	0.2	11.7	2.0	7.7	0.7	8.8	1.9
1990	0.2	0.4	1.0	0.7	3.0	3.1	0.2	3.5	1.8	3.3	0.7	3.5	1.5
1993	0.2	0.4	1.3	0.9	3.2	3.1	0.2	1.8	2.0	2.0	0.8	1.9	1.2
ASEAN													
1970	0.3	0.4	0.1	0.0	0.0	0.4	0.2	0.5	0.3	0.3	0.3	0.1	0.3
1980	0.4	0.2	0.2	0.1	0.1	4.5	0.1	0.4	1.6	0.5	0.2	0.4	0.7
1990	0.2	0.4	0.4	0.2	2.5	3.9	0.1	0.9	1.9	1.0	0.5	1.1	0.6
1993	0.2	0.5	0.5	0.3	2.9	3.1	0.1	0.8	1.8	0.8	0.4	0.9	0.6
Philippines													
1970	0.1	0.0	0.0	..	..	..	0.0	0.8	0.0	..	0.0	0.0	0.0
1980	0.1	0.0	0.2	..	0.0	1.1	0.3	1.1	0.4	0.9	0.0	1.2	0.0
1990	0.1	0.1	0.2	0.0	1.0	7.1	0.2	2.3	3.3	3.1	0.0	1.9	0.0
1993	0.1	0.1	0.2	0.0	0.6	2.8	0.3	1.4	1.4	0.0	0.1	1.3	0.1

Legend:

1-Pharmaceuticals
2-Perfumes and cosmetics
3-Polymerisation products
4-Metal-working machine Tools
5-Automatic data processing machines
6-Electronic micro-circuits
7-Motor vehicle parts
8-Travel goods and handbags
9-Measuring and controlling instrument
10-Watches
11-Printed matter
12-Toys and sporting goods
13-Recorded discs and tapes

Source: International Economic Data Bank, The Australian National University, based on United Nations Trade Statistics, 1995.

Table 3.3 **Revealed comparative advantage indices of selected countries and regions in technology intensive goods, 1970, 1980, 1990 and 1993**

Country/ Region	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
USA															
1970	1.6	2.0	1.0	1.0	0.9	1.1	1.5	1.7	1.2	0.6	1.2	1.8	4.5	1.8	1.6
1980	1.4	0.2	1.2	2.1	1.2	1.2	1.8	1.9	1.2	0.8	2.6	2.3	4.6	2.2	2.3
1990	1.3	1.4	1.0	1.9	1.5	1.1	1.4	1.4	1.2	1.3	2.1	1.6	4.3	1.4	1.1
1993	1.2	0.8	1.0	1.6	2.4	1.2	1.5	1.4	1.0	1.3	2.1	1.3	3.7	1.2	0.8
EU															
1970	1.2	0.6	1.4	1.0	1.3	1.6	1.5	1.3	1.4	1.3	1.4	1.2	0.6	1.5	1.0
1980	1.5	0.6	1.5	0.9	1.1	1.9	1.7	1.4	1.4	1.3	1.4	1.1	1.1	1.5	1.4
1990	1.2	0.9	1.4	0.7	1.2	1.4	1.5	1.1	1.0	1.0	1.1	0.8	1.0	1.2	1.0
1993	1.3	0.9	1.6	0.8	0.8	1.4	1.4	1.1	1.0	0.8	1.2	0.5	1.2	1.2	0.7
Japan															
1970	1.1	0.1	0.4	0.6	0.5	1.6	0.3	0.9	1.3	1.9	0.5	1.1	0.1	0.7	0.4
1980	0.9	0.1	0.3	0.5	0.1	1.0	0.6	1.4	1.9	2.4	1.0	1.8	0.1	2.1	0.3
1990	0.8	0.2	0.3	0.1	0.0	0.7	0.6	1.6	1.7	1.1	2.2	2.3	0.1	2.6	0.1
1993	0.8	0.1	0.3	0.1	0.0	0.7	0.6	1.6	1.7	0.9	1.7	2.4	0.1	2.4	0.1
NICs															
1970	0.1	1.0	0.3	0.6	0.2	0.2	0.1	0.2	0.3	0.3	0.0	2.0	0.1	0.1	1.3
1980	0.3	6.4	0.4	1.2	0.6	0.5	0.3	0.4	0.9	1.0	0.1	2.3	0.3	0.1	1.6
1990	0.4	1.5	0.2	0.3	0.3	0.9	0.4	1.1	1.4	1.0	0.1	2.2	0.2	0.4	3.3
1993	0.5	0.5	0.2	0.3	0.2	1.2	0.6	1.3	1.4	1.0	0.1	3.1	0.1	0.5	3.0
ASEAN															
1970	0.1	0.9	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.4	0.0	0.1	0.0
1980	0.1	6.2	0.4	0.4	0.2	0.1	0.2	0.2	0.8	0.2	0.0	1.9	0.3	0.0	0.4
1990	0.4	2.0	0.2	0.6	0.2	0.4	0.7	0.8	0.9	1.1	0.1	2.5	0.2	0.5	0.3
1993	0.4	0.3	0.2	0.6	0.2	0.4	0.7	1.1	1.1	1.1	0.1	3.1	0.1	0.5	0.4
Philippines															
1970	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980	0.3	0.0	0.1	0.0	0.7	0.1	0.3	0.0	0.0	0.1	0.0	0.5	0.0	0.0	0.1
1990	0.4	3.9	0.1	1.6	0.5	0.1	0.5	0.3	0.4	4.7	0.0	4.3	0.0	0.0	3.5
1993	0.2	0.0	0.1	2.9	1.0	0.2	0.3	0.2	0.3	5.0	0.0	2.8	0.0	0.0	5.4

Legend:

1-Chemical elements and compounds
2-Petroleum and coal
3-Medicinal products
4-Manufactured fertilisers
5-Explosives, pyrotechnical products
6-Plastic materials
7-Other chemicals
8-Non electrical machinery
9-Electric power machinery
10-Electric distributing machinery
11-Electro-medical and x-ray equipment
12-Other electrical machinery
13-Aircraft
14-Photo cinema
15-Developed cinema film

Source: International Economic Data Bank, The Australian National University, based on United Nations Trade Statistics, 1995.

The trade intensity indices for selected intellectual property and technology intensive goods are presented in tables 3.4 and 3.5 respectively. The intensity index is a useful measure to assess the relative importance of a particular bilateral trading relationship. The index is defined in equation 3.2 as the share of a country's exports going to another country, divided by the share of the other country's world imports net of the first country's imports. The index exceeds unity where trade specialisations are complementary or where trade resistances are lower than average.

$$I_{ij}^{k} = \frac{X_{ij}^{k}}{X_{iw}^{k}} \bigg/ \frac{M_{jw}^{k}}{M_{w}^{k} - M_{iw}^{k}} \qquad (3.2)$$

On balance, it could be deduced that there has been a decline in the intensity of trade in intellectual property and technology-intensive goods among the fast growing economies of Asia (tables 3.4 and 3.5). With the great expansion of trade since 1965, bilateral trading relationships of the ASEAN and the newly industrialising countries with other industrial countries like Japan and the United States has become significant. This is due in part to improvements in communication and transport which in recent years have diminished resistances to trade between these countries, and in part to changes in the mix of goods produced and consumed as these economies developed. The complementary relationship between the Philippines, ASEAN and the NICs is largely due to outsourcing activities. Multinational corporations in technology-intensive industries are prominent in this trade and their outsourcing activities yield trade between ASEAN and the home economies or the NICs and the other countries considered in the study. The Asia-Pacific regions for example are part of a significant global network of aerospace subcontractors. Countries like Japan South Korea, Taiwan, Singapore and

Indonesia provide major aerospace components and assemblies directly to airframe and engine manufacturers in North America and Europe (Lefebvre *et al* 1997). With manufacturing operations and assemblies located outside the industrial countries, product development is often done jointly with firms from developing countries. In the case of the electronics industry in the Philippines, although most local subsidiaries and joint ventures with foreign firms are exporting, it is often done as part of a complementing scheme with other ASEAN-based subsidiaries (Lapid 1996).

A number of broad conclusions can be drawn from examining the trade flows of intellectual property and technology intensive goods. First, trade in these types of goods has been growing rapidly in recent years for both industrial countries and the fast growing economies of Asia. In this regard, the interest of most industrial countries, particularly the United States, in bringing issues related to intellectual property in the GATT system seems to be understandable given the potential threat of cheating and infringement (Maskus 1990). The kind of intellectual property right system envisioned by the industrial countries for the developing countries is to have a system of protection that does not discriminate against foreign goods, thereby enabling foreign firms in these countries to obtain patents to protect products that industrial countries export directly to developing countries, and to protect products produced in developing countries by subsidiary firms of foreign multinational corporations.

Second, the interest of industrial countries in trade in intellectual property as embodied in goods, is for the protection of research and development or technology-intensive products. The interest and comparative advantage of the developing Asian economies is in relatively labour-intensive exports.

Table 3.4 **Trade intensity indices[a] of selected countries and regions in selected intellectual property intensive goods, 1965, 1975, 1985, 1990 and 1993**

From	Year	To USA	EU	Japan	NICs	ASEAN	Philippines
USA	1965	-	0.7	1.9	0.9	0.9	1.6
	1975	-	0.7	1.8	1.2	1.1	1.3
	1985	-	0.7	2.1	1.2	1.1	2.7
	1990	-	0.6	2.1	1.1	1.0	1.5
	1993	-	0.5	1.5	0.8	1.2	3.7
EU	1965	0.6	0.8	0.3	0.3	0.4	0.3
	1975	0.5	0.9	0.3	0.3	0.3	0.3
	1985	0.4	0.9	0.3	0.2	0.3	0.3
	1990	0.4	0.8	0.3	0.2	0.2	0.2
	1993	0.2	1.7	0.4	0.2	0.2	0.7
Japan	1965	2.4	0.3	-	8.2	5.1	6.8
	1975	1.8	0.3	-	4.8	3.7	4.9
	1985	1.9	0.4	-	2.8	1.8	2.1
	1990	2.1	0.5	-	2.6	2.1	2.0
	1993	1.7	0.5	-	1.9	1.9	3.4
NICs	1965	1.6	0.2	0.4	3.2	21.5	2.9
	1975	4.0	0.4	4.1	2.2	5.6	3.0
	1985	2.3	0.4	2.3	1.6	3.1	4.0
	1990	2.1	0.4	2.0	1.6	2.3	2.2
	1993	1.4	0.4	1.6	1.4	1.4	2.0
ASEAN	1965	0.1	0.1	0.7	6.1	30.5	0.9
	1975	2.9	0.4	2.9	3.4	9.2	1.9
	1985	2.2	0.4	2.3	2.1	5.0	3.8
	1990	2.2	0.4	1.7	2.2	3.3	2.2
	1993	1.6	0.5	1.4	1.5	2.3	1.4
Philippines	1965	1.3	0.7	15.8	7.0	4.6	-
	1975	0.3	0.2	7.7	5.7	10.9	-
	1985	2.0	0.4	4.5	2.8	4.4	-
	1990	3.0	0.4	3.1	2.5	2.2	-
	1993	2.0	0.6	2.0	1.9	1.3	-

[a]The intensity of trade index is the share of one country/region's exports going to another country/region divided by the latter's share of world imports (net of the first country/region's imports). It exceeds unity where trade specialisations are complementary or where resistances to trade are lower than average.

Source: International Economic Data Bank, The Australian National University, based on United Nations Trade Statistics, 1995.

Table 3.5 **Trade intensity indices[a] of selected countries and regions in technology intensive goods, 1965, 1975, 1985, 1990 and 1993**

From		To					
	Year	USA	EU	Japan	NICs	ASEAN	Philippines
USA	1965	-	0.7	1.8	0.9	0.7	2.1
	1975	-	0.6	1.6	1.6	1.9	2.4
	1985	-	0.6	1.8	1.0	1.7	7.4
	1990	-	0.5	1.9	1.0	1.4	2.2
	1993	-	0.6	1.7	0.9	0.9	1.6
EU	1965	0.6	0.8	0.4	0.2	0.4	0.3
	1975	0.4	0.9	0.3	0.2	0.3	0.3
	1985	0.3	1.0	0.3	0.2	0.2	0.6
	1990	0.2	0.9	0.3	0.2	0.2	0.2
	1993	0.4	1.5	0.4	0.2	0.2	0.4
Japan	1965	4.4	0.3	-	5.7	3.4	4.6
	1975	2.1	0.4	-	4.3	3.6	5.4
	1985	1.9	0.5	-	2.4	1.5	2.5
	1990	1.9	0.5	-	2.1	1.8	1.4
	1993	1.8	0.5	-	2.1	1.8	2.7
NICs	1965	4.4	0.5	0.3	2.5	11.6	1.7
	1975	4.1	0.4	2.5	1.8	4.0	1.9
	1985	2.2	0.4	1.8	1.1	1.7	2.7
	1990	1.8	0.4	2.2	1.1	1.4	1.3
	1993	1.7	0.4	1.4	1.6	1.8	2.2
ASEAN	1965	0.1	0.0	0.4	8.5	30.0	0.7
	1975	3.3	0.4	1.7	3.1	9.5	2.3
	1985	2.1	0.4	1.8	2.0	4.3	3.8
	1990	2.1	0.4	1.1	1.8	2.1	0.8
	1993	1.7	0.4	1.8	1.7	2.9	2.3
Philippines	1965	1.2	0.0	12.4	14.2	12.2	-
	1975	3.6	0.3	4.2	3.2	2.8	-
	1985	2.2	0.6	2.2	2.3	3.9	-
	1990	2.9	0.5	1.0	1.8	1.3	-
	1993	2.3	0.4	3.3	2.1	1.4	-

[a]The intensity of trade index is the share of one country/region's exports going to another country/region divided by the latter's share of world imports (net of the first country/region's imports). It exceeds unity where trade specialisations are complementary or where resistances to trade are lower than average.

Source: International Economic Data Bank, The Australian National University, based on United Nations Trade Statistics, 1995.

Third, although exports of the majority of the product lines considered are dominated by the industrial countries, evidence shows that the ASEAN and the newly industrialising countries are catching up in the export of technology-intensive goods and goods with intellectual property embodied. Furthermore, trade-intensity indices reveal that the pattern of trade in these types of goods has changed in recent years. Exports of these goods coming from the newly industrialising countries and the ASEAN to the industrial markets have increased since 1965.

Technical assistance agreements and licenses.

A more direct way in which intellectual property can be accounted for in international commerce is through license fees and royalties for its use. This kind of payment can be made within firms; a parent company can charge fees from its foreign affiliates for the use of technology or a specific brand name. Direct trade in intellectual property can also be between unaffiliated firms through the sale of technology and licenses to produce and distribute under a particular trademark franchise or copyright (Maskus 1990). Irrespective of the choice between the above types of direct trade in intellectual property (foreign direct investment and unaffiliated sales), the structure of a country's intellectual property protection will surely influence the profitability of each form of international exploitation. For example, the provision of limited foreign protection on patents may push firms to choose foreign direct investments over licensing, because reliance on trade secrets under the control of the home country will prove to be more effective in appropriating rents on technological information. The trend of technology trade in industrial countries is shown in table 3.6. The balance of technology trade is defined as the difference between receipts of royalties and license fees earned by the reporting country for the use of their technology and payments made for importing technology information from the rest of the world. While this is a narrow measure of direct trade in intellectual property, it is the most readily available indicator. The United States is a clear leader in this trade, making it the most significant global exporter of technology services among industrial countries. Some additional insights on the composition of technology trade in services of the United States are provided in table 3.7. This confirms that the United States is a substantial net exporter of technology to both industrial and developing countries: however, trade transactions with the former dominate. A large proportion of US trade in intellectual property is intra-firm rather than inter-firm in nature (Santikarn 1984; Maskus 1990).

Similarly, intra-firm technology trade transactions are commonly observed in the technology trade of ASEAN countries. Since in the 1970s, in Thailand, 75 technology contract recipients were being served by the 50 largest suppliers of technology and 71 per cent of these recipients are affiliates of the companies making transfers. In 1981, 73 per cent of total technology payments were intra-firm (Santikarn 1984). In the Philippines, 637 out of 1298 (49%) contracts filed at the Bureau of Patents Trademarks and Technology Transfer from 1979 to 1991 were contracts of foreign subsidiaries or foreign majority owned companies. However, licensing agreements between the parent company and its subsidiary have significantly declined in recent years.

Table 3.6 **Technology trade of industrial countries, 1965, 1970, 1975, 1980, 1985,** in million US dollars

Country/Year	Receipts	Payments	Balance[a]
USA			
1965	1534	135	1399
1970	2331	225	2106
1975	4300	473	3827
1980	6860	768	6092
1985	..	..	8500
Japan			
1965	17	166	-149
1970	59	433	-374
1975	161	712	-551
1980	378	1439	-1061
1985	..	..	-200
United Kingdom			
1965	138	131	7
1970	273	255	18
1975	493	484	9
1980	..	..	..
1985	..	..	200
West Germany			
1965	75	166	-91
1970	119	306	-187
1975	308	729	-421
1980	..	..	..
1985	..	..	..
France			
1965	169	215	-46
1970	344	357	-13
1975	1313	1035	278
1980	..	..	..
1985	..	..	..

[a]Balance is the difference between receipts and payments.

Sources: Organisation for Economic Cooperation and Development, 1989. *OECD Science and Technology Indicators Report No.3*, OECD, Paris.

Santikarn, M. 1984. 'Trade in technology: ASEAN and Australia', *ASEAN Australia Economic Papers*, 8:1-57.

Table 3.7 **US receipts and payments of royalties and fees associated with foreign direct investments and unaffiliated foreign residents, 1979 and 1987[a]**, in million US dollars

Year/Region	Net Receipts		Net Payments		Balance	
	Number	Share[b]	Number	Share[b]	Number	Share[b]
Foreign Direct Investment-Related Affiliates						
1979						
Industrial Countries	3885	80.0	497	95.2	3388	78.2
Developing Countries	969	20.0	25	4.8	944	21.8
Total	4854	100.0	522	100.0	4322	100.0
1987[c]						
Industrial Countries	6753	95.3	853	101.2	5720	94.4
Developing Countries[d]	327	4.7	-10	-1.2	337	5.6
Total	6900	100.0	843	100.0	6057	100.0
Unaffiliated Foreign Residents						
1979						
Industrial Countries	923	83.8	234	97.1	689	80.0
Developing Countries	179	16.2	7	2.9	172	20.0
Total	1102	100.0	241	100.0	861	100.0
1987						
Industrial Countries	1839	86.7	554	98.4	1285	82.4
Developing Countries	283	13.3	9	1.6	274	17.6
Total	2122	100.0	563	100.0	1559	100.0

[a]FDI-related affiliates and unaffiliated foreign residents excludes Communist countries
[b]Balance is the difference between receipts and payments.
[c]For 1987, the breakdown of unaffiliated receipts and payments was estimated.
[d]A negative entry means that US affiliates' payments to LDC parents were less than US affiliates' receipts from LDC parents.

Source: Maskus, K. 1990. 'Normative concerns in the International Protection of Intellectual Property', *The World Economy*, 13 (3):379-409.

The net balance position of developing countries which are engaged in technology trade with the United States verify the status of developing countries as strong importers and weak exporters of intellectual property (table 3.7). The interest of the United States in the direct trade in intellectual property is evident. Strengthening intellectual property right property right protection in developing countries would protect foreign technical assistance agreements and licensing of process inventions which in the current state of technology transfer agreements can easily be adapted and applied by local subsidiary firms.

3.2 Perceived Economic Effects of Intellectual Property Right Protection: The Case of Developing Countries

Positive effects of improved patent protection

Efficient property rights and economic growth. Rapp and Rozek (1990) suggest that there is a causal linkage between economic development and the presence of efficient property rights, including intellectual property rights. In all studies of growth and its determinants, both human capital accumulation and technological change are identified to be crucial factors. Economic growth requires increases in productivity growth which in turn require technological innovation. Innovation creates the possibility for an economy to increase production of goods as well as allow the development of a more diversified range of products. Yet innovations are the outcome of a sustained individual or group effort in order to create new products or to find other efficient means of producing existing products. It is a key hypothesis that, when inventors retain the rights to the output of their inventive effort, the incentive to devote time and resources to innovation is increased; thus, proper assignment of property rights brings forth innovations that provide increases in productivity and ultimately lead to economic growth.

In support of the above hypothesis, Rapp and Rozek (1990), find that a country's level of economic development correlates closely with its level of patent protection. Another interesting finding is that a significant relationship exists between economic modernity[4] and intellectual property protection; countries with stronger patent protection experience more rapid economic development. As argued by the author, this is because a well developed patent right system enhances the rate of innovation and investment in innovative activities.

Encourage domestic innovation. One argument for strengthening protection of intellectual property rights is that increased protection stimulates indigenous innovation even in developing countries. A country's share of the world market for a specific product or service depends on the resources devoted to R&D, to generate new process and new products (Fagerberg 1988). Empirical studies undertaken in industrial countries indicate that patent protection is an important factor that stimulates R&D activity. Mansfield (1986) conducted a survey of firms in the United States to assess the impact of patenting on innovation. He found that at least half of the patented innovations in the sample would not have been introduced without patent protection. The sample was heavily weighted towards the drug industry. Another study by Levin et.al (1987) showed similar results and suggested that patent protection had increased its significance to US firms and that a limited number of industries still overwhelmingly accounts for this increasing significance.

There is little empirical evidence on the effects of intellectual property protection in developing countries. Would patent protection induce domestic firms to undertake research and development activities in developing countries? The development of indigenous entrepreneurial ability is dependent

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[4]The measures of modernization used in the model include variables like per capita domestic variable, percentage of household with electricity, percentage of households with water, presence of a social security system, infant mortality rate, percentage of workforce in agriculture, proportion of physicians to total population, etc.

on other considerations too such as industrial structures, education levels of the workforce and the general policy environment.

Generate appropriate technology. One argument for introducing stronger patent protection of intellectual property rights is that it would generate technological innovations suited to the needs and resource-base of developing countries. A weak system of intellectual property right protection discourages research activities that require large research outlays (Mansfield 1989). For the benefit of developing countries for example, inventors in the industrial countries would need the incentives to develop technologies suitable to market requirements and relative factor prices in developing countries. There is very little empirical evidence to suggest this. Theoretical analysis along these lines are discussed by Diwan and Rodrik (1990). The study suggests that the share of developing countries in global consumption would have to be large in order to realise some gains from strengthening intellectual property protection which induce foreign innovation directed towards the markets of developing countries.

Facilitate technology transfer. Strengthening intellectual property protection could facilitate technology transfer. A weak system of intellectual property protection is a major disincentive to transfers of technology to developing countries. An OECD survey identified problems related to intellectual property protection as significant barriers to licensing in developing countries (Frischtak 1989). A recent survey done (Mansfield 1993) indicates that intellectual property protection in developing countries may affect the decision of US based manufacturing industries to license their technology abroad (See Appendix 3.1).

Foreign direct investments. The protection of intellectual property rights is linked to foreign direct investment decisions in developing countries.

Foreign firms generally avoid investing in areas where intellectual property protection is inadequate (OECD 1989). Other studies show that although weak protection of intellectual property rights is identified as a problem, investment decisions are complex and other considerations are more important such as the general economic condition (Frischtak 1989).

The effect of intellectual property right protection on the transfer of technology as part of foreign direct investment by US firms was examined by Mansfield (1993). Using random sample of 100 major firms in six industries (chemical and drug, transportation equipment, electrical equipment, machinery, food and metals), the survey shows that protection of intellectual property rights in host countries is relevant to some but not all types of the firms' investment decisions (see table 3.8). Protection of intellectual property rights was more relevant for decisions to invest in research and development facilities than for investments in sales and distribution outlets. Variations across industries were evident. While firms in the chemical and drug industry reported a major role for intellectual property rights in their investment decisions, firms in the food industry considered patent protection to be of minor significance. Many US firms believe that protection of intellectual property in India and Nigeria was too weak to permit them to invest in joint ventures with local partners or to transfer their most effective technology to wholly owned subsidiaries (see Appendices 3.2 and 3.3).

Table 3.8. **Percentage of US firms in six industries where strength of intellectual property rights protection has strong effects on direct investments, 1991**

Industry[a]	Type of Investment					
	Sales and Distribution Outlets	Rudimentary Production and Assembly Facilities	Facilities to Manufacture Components	Facilities to Manufacture Complete Products	Research and Development Facilities	Meai
Chemical and Drugs	19	46	71	87	100	65
Transportation Equipment	17	17	33	33	80	36
Electrical Machinery	15	40	57	74	80	53
Food	29	29	25	43	60	37
Metals	20	40	50	50	80	48
Machinery	23	23	50	65	77	48
Mean	20	32	48	59	80	48

[a]The number of firms in the sample in each industry is chemicals, 16; transportation equipment, 6; electrical equipment, 35; food, 8; metals, 5; machinery, 24. However, not all firms responded to all questions.

Source: Mansfield, E. 1993. 'Unauthorized use, of intellectual property: effects on investment, technology transfer and innovation', Chapter 5, in M. Wallerstein, M.E. Mogee and R. Schoen (eds), *Global Dimensions of Intellectual Property Rights in Science and Technology*, National Academy Press, Washington.

Trade considerations. Conforming with the TRIPs agreement should protect developing countries from the possibility of trade sanctions. This is important for export-oriented economies being studied here.

Negative effects of improved patent protection

Administrative Costs. The administrative costs of adopting the TRIPs agreement is one argument used against the reform in developing countries. Brazil, for example, spends US$ 30 million per year to maintain the National Institute of Industrial Property, the agency responsible for patents, trademarks, computer software registrations and regulations for technology transfers (Primo Braga 1990c). Even so, this institute has a backlog of claims/applications. This is common in developing countries where patent offices receive thousands of patent applications, filed mostly by foreigners, particularly from the United States and Japan. The number of examiners is usually small. In the Philippines, the examination and evaluation period for granting patents can take from 2 to 15 years. These delays in the processing of patent applications reduce the period of effective patent protection in most developing countries.

The administrative costs of strengthening protection of intellectual property rights will not be trivial for developing countries. Alternative ways of improving the system, however, could reduce the financial burden. Suggestions include: (1) the charging of user fees; (2) using international cooperation such as the Patent Cooperation Treaty and the Patent Documentation Center to reduce processing and (3) the networking of patent offices with agencies in industrial countries (Primo Braga 1990c).

Increase technological dependence. Strengthening the protection of intellectual property in developing countries is often criticised on the grounds that it would increase their technological dependence (the dependency concept). Inherent in this is the view that technology transferred from industrial countries, through direct investment or licensing, represents the perpetuation of an inequitable distribution of income. The dependency concept has been challenged by others (Lall 1975 and Balassa 1986). In a world characterised by growing trade and international investment, it may be ineffective to equate technological dependence with self reliance (Primo Braga 1990c).

Increase in royalty payments. Another concern about technological dependence of developing countries is that increased royalty payments are a drain on the current account, and protection of intellectual property rights would exacerbate the problem. The patent statistics show only a small proportion of patent grants are held by domestic nationals in developing countries. Increased payments for foreign technology may be justified from the point of view of developing countries, but the long term impact of patent reforms on the balance of payments is difficult to forecast. The potential effects of foreign investment flows and exports of technology affects the forecasts (Primo Braga 1990c).

Increase in prices. Some developing countries argue that TRIPs could increase prices and make technological diffusion more costly (Subramanian 1994; Nogues 1993). Price changes are difficult to forecast in countries with high levels of protection and many price distortions. A study of audio, video and software products suggests that in some countries the increase in prices would be substantial (a doubling of prices) (MacLaughlin, et al 1988). Welfare losses and rent transfers from the pharmaceutical industry of a selected group of developing countries as a result of strengthening patent protection have been analysed by Maskus and Konan (1994) based on alternative scenarios. The worst case in terms of price increase and welfare losses occurs when a domestic competitive industry becomes a foreign-owned monopoly as a result of patent protection. Results from this case generate dramatic increases in prices, varying from 25 to 67 per cent and report substantial consumer losses which exceed the gains to the monopolist. These results however, as pointed out by the authors may be unrealistic and relies heavily on very restrictive assumptions. The impact on prices and consumer losses are significantly reduced if one assumes in the pre-reform stage that the dominant foreign firm faces competitive imitators and producers of generic drugs that are close substitutes of the patented drugs. Moreover, the economic significance of price effects should be properly evaluated along with other factors, such as quality and informational spillover benefits to consumers (Primo Braga 1990c).

Misallocation of resources. Another perceived negative effect of increased patent protection in developing countries is that it may lead to resources being misallocated if too much incentive results that could lead to wasteful and repetitive research and development activities. Combined with existing trade distortions in developing countries, such reforms may lead to potentially inefficient investments (Nogués 1990a).

3.3 Conclusion

This chapter has considered the divergent interests of the industrial and developing countries in the protection of intellectual property rights. The industrial countries as substantial producers of intellectual property want intellectual property protection to be strengthened in developing countries for three reasons: (i) to protect products they export directly to developing countries; (ii) to protect products made in developing countries by subsidiary firms and licensees and (iii) to protect technical assistance agreements and licensing of process inventions.

Strengthening intellectual property right protection have both positive and negative repercussions in developing countries. The most important gain is better access to advanced technologies which is very essential if developing countries are to foster new industries that can compete in the competitive international market. This benefit however, do not come without costs, at least in the short run.

Appendix 3.1 **Percentage of major US firms reporting that intellectual property right protection is too weak to permit licensing their newest or most effective technology, by industry and country, 1991**

	Industry[a]						
Country	Chemicals[b]	Transportation Equipment	Electrical Equipment	Food	Metals	Machinery	Mean
Argentina	62	0	26	12	0	29	22
Brazil	69	40	29	25	0	73	39
Chile	47	20	22	12	0	25	21
Hongkong	33	20	38	12	0	14	20
India	81	40	38	38	20	50	44
Indonesia	73	20	33	25	0	37	31
Japan	12	20	17	0	0	0	8
Mexico	56	20	28	25	0	36	28
Nigeria	73	20	32	38	20	25	35
Philippines	47	40	34	12	0	24	26
Singapore	25	40	24	12	20	0	20
South Korea	38	20	34	12	40	29	29
Spain	6	0	14	0	0	14	6
Taiwan	44	40	55	25	20	36	37
Thailand	73	80	36	12	0	25	38
Venezuela	62	20	21	12	0	26	24
Mean	50	28	30	17	8	28	27

[a]The number of firms in the sample in each industry is chemicals, 16; transportation equipment, 6; electrical equipment, 35; food, 8; metals, 5; machinery, 24. However, not all firms responded to all questions.

[b]The chemical industry includes pharmaceuticals.

Source: Mansfield, E. 1993. 'Unauthorized use, of intellectual property: effects on investment, technology transfer and innovation', Chapter 5, in M. Wallerstein, M.E. Mogee and R. Schoen (eds), *Global Dimensions of Intellectual Property Rights in Science and Technology*, National Academy Press, Washington.

Appendix 3.2 **Percentage of US major firms reporting that intellectual property right protection is too weak to permit them to invest in joint venture with local partners, by industry and country, 1991**

	Industry[a]						
Country	Chemicals[b]	Transportation Equipment	Electrical Equipment	Food	Metals	Machinery	Mean
Argentina	40	0	29	12	0	27	18
Brazil	47	40	31	12	0	65	32
Chile	31	20	29	12	0	23	19
Hongkong	21	20	38	12	0	9	17
India	80	40	39	38	20	48	44
Indonesia	50	40	29	25	0	25	28
Japan	7	40	10	0	0	0	10
Mexico	47	20	24	25	0	17	22
Nigeria	64	20	39	29	20	24	33
Philippines	43	40	31	12	0	18	24
Singapore	20	40	24	12	20	0	19
South Korea	33	20	21	12	25	26	23
Spain	0	0	10	0	0	4	2
Taiwan	27	40	41	25	20	17	28
Thailand	43	80	21	12	0	20	31
Venezuela	40	20	19	12	0	20	18
Mean	37	30	28	16	7	21	23

[a]The number of firms in the sample in each industry is chemicals, 16; transportation equipment, 6; electrical equipment, 35; food, 8; metals, 5; machinery, 24. However, not all firms responded to all questions. Some firms reported they had too little information and experience regarding particular countries to provide this information. For these countries, firms of this sort are excluded. The number of firms that had to be excluded for this reason is generally very small.

[b]The chemical industry includes pharmaceuticals.

Source: Mansfield, E. 1993. 'Unauthorized use, of intellectual property: effects on investment, technology transfer and innovation', Chapter 5, in M. Wallerstein, M.E. Mogee and R. Schoen (eds), *Global Dimensions of Intellectual Property Rights in Science and Technology*, National Academy Press, Washington.

Appendix 3.3 **Percentage of US major firms reporting that intellectual property right protection is too weak to permit them to transfer their newest or most effective technology to wholly owned subsidiaries, by industry and country, 1991**

Country	Industry[a]						
	Chemicals[b]	Transportation Equipment	Electrical Equipment	Food	Metals	Machinery	Mean
Argentina	44	20	21	12	0	14	18
Brazil	50	40	24	12	0	39	28
Chile	47	20	21	12	0	27	21
Hongkong	21	20	38	12	0	14	18
India	81	40	38	38	20	41	43
Indonesia	40	20	31	25	0	23	23
Japan	0	0	14	0	0	0	2
Mexico	31	20	21	25	0	22	20
Nigeria	67	20	25	25	20	23	30
Philippines	47	40	28	12	0	17	24
Singapore	12	40	21	12	0	0	14
South Korea	31	20	28	12	40	22	26
Spain	0	0	7	0	0	13	3
Taiwan	19	40	41	25	0	35	27
Thailand	60	80	31	12	0	18	20
Venezuela	50	20	18	12	0	18	20
Mean	38	28	25	15	5	20	22

[a]The number of firms in the sample in each industry is chemicals, 16; transportation equipment, 6; electrical equipment, 35; food, 8; metals, 5; machinery, 24. However, not all firms responded to all questions.

[b]The chemical industry includes pharmaceuticals.

Source: Mansfield, E. 1993. 'Unauthorised use, of intellectual property: effects on investment, technology transfer and innovation', Chapter 5, in M. Wallerstein, M.E. Mogee and R. Schoen (eds), *Global Dimensions of Intellectual Property Rights in Science and Technology*, National Academy Press, Washington.

Chapter 4

Results from Theory: The Implications of Intellectual Property Protection in Developing Countries

This chapter reviews the theoretical literature to obtain some guidance on the economic implications of patent protection for developing countries. It covers traditional analysis of patent protection and recent theoretical models that analyse the impact of patent protection in a North-South framework. One major limitation of the latter models is that they have failed to take explicit account of both positive and negative effects of stronger patent protection in developing countries. While such a shift in policy would allow rent payments to be extracted from technology users in developing countries, and be transferred to technology producers, mostly residents of industrial countries (rent effect), the former can still benefit through increased access to newly developed technologies, which is vital for development (production effect). To address this limitation, a model along these lines is introduced and comparative analysis based on it shows that the welfare impact of increased patent protection in developing countries depends on which effect dominates. Developing countries gain if the improved access to foreign technology is channelled efficiently to improve production techniques. In these circumstances, the benefits outweigh the costs. However, loses are possible if the cost effect dominates and full benefits are not derived from the new technologies.

4.1 Early Studies

Concerns about protection of intellectual property rights date back to the 19th century. Early debates on intellectual property focused on the broad implications of monopolies (Machlup and Penrose 1950). In the second half of the 19th century, the debate became more intense and three main arguments supported the protection of intellectual property rights: natural law thesis, the monopoly thesis and the 'exchange for trade secret thesis' (Primo Braga 1990a).

Natural law thesis is based on the notion that the idea is the property of the creator because it is the manifestation of the creator's personality or self (Hughes 1988). The monopoly thesis argues that special incentives like patent protection are necessary to encourage innovators and capitalists to engage in research and development activity which is socially desirable. The last argument regards patent protection as an important function of knowledge creation which is beneficial to society's welfare.

Despite criticism from those who oppose protection of intellectual property and the inconclusiveness of the academic debate in this area during the 19th century, patent protection was adopted by many nations. International agreements for the protection of intellectual property at the world and regional levels were introduced. The Paris Convention (1883) dealt with patents and trademarks and the Berne convention (1886) dealt with copyrights.

Interest in the economics of intellectual property was revived in the 1950s. The new literature stressed the ambiguity of patent protection under different circumstances. However, like the earlier debates the analyses remained basically descriptive and failed to come up with an appropriate theoretical framework from which to analyse the implications of intellectual property right protection.

J.A. Schumpeter (1934) set the stage for the modern economics of technical change. His contribution was the traditional view that a monopoly structure is conducive to innovation. Arrow (1962) put forward a contradicting view that competitive environments would give greater incentives to innovate. However, in proving his point Arrow recognised the role of patents in encouraging innovation. His recognition and treatment of the incomplete appropriability of information became the fundamental modern economic theory on intellectual property.

> *Information obtained should, from a welfare point of view, be available free of charge (apart from the transmission costs). This ensures optimal utilisation of information but provides no incentive for investment in research... In a free economy, inventive activity is supported by using the invention to create property rights. To the extent that it is successful, there is an underutilisation of investment. The property rights may be in the information itself, through patents and other similar legal devices, or in the intangible assets of the firm if the information is retained by the firm and used only to increase its profits* (cited by Primo Braga 1990a).

This provided economic theory with a unifying approach to intellectual property. It laid the basic groundwork for theoretical studies into the implications of patent protection as an allocator of resources. Recognising the interaction between the present allocation of knowledge and its future production have led some economists to look for second best solutions; thus, the optimal term of patent protection became a major topic of research.

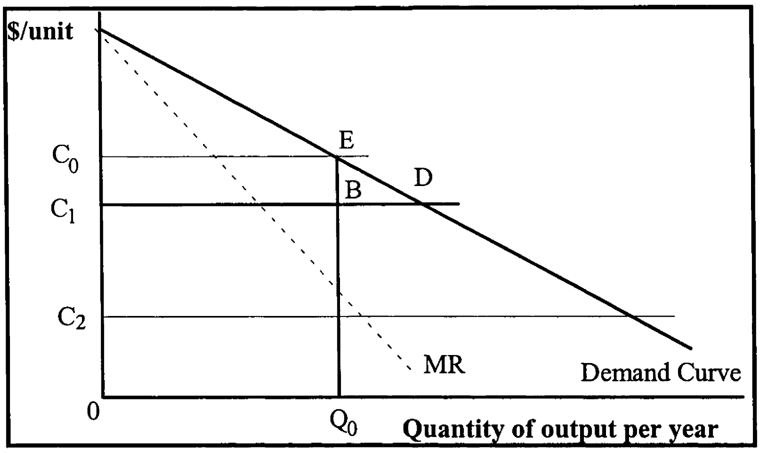
4.2 The Theory of Optimal Patent Life

William Nordhaus (1969) made a significant attempt to bring economic theory into patent policy. His basic inquiry was how much protection should be accorded to inventors and innovators? Nordhaus' work was revised by Scherer (1984) who added flexibility to the model.

The Nordhaus model was concerned with process innovation. Following Arrow, he initially assumed that production takes place under perfect competition, with constant costs and price of $0C_0$ (figure 4.1 below). One firm in the industry undertakes innovation which reduces costs from $0C_0$ to $0C_1$. When an innovating firm secures a patent on the innovation, it can either drive other firms from the market, producing the original output and enjoy a monopoly rent of EC_0C_1B or it can license the patent to existing producers charging a royalty payment that extracts the same rent.

Nordhaus noted that even though a patent implies some sort of monopoly power, it does not allow the patent holder to charge a price above $0C_0$. In addition, if demand is not very elastic in the neighbourhood of the competitive price, the optimal post-invention price and quantity under a patent monopoly will be identical to those in the pre-invention equilibrium. Nordhaus called the above case *run-of-the-mill,* representing inventions that reduce costs of production but are insufficient to induce a price reduction or output expansion. This is unlike the case of drastic cost reductions (at $0C_2$) where it would be to the advantage of the innovating firm to reduce price and expand output.

Figure 4.1
Output and quasi-rent effects of innovation



Source: Scherer, F.M. 1984. *Innovation and Growth: the Schumpeterian perspectives*, MIT Press, Cambridge, Massachusetts.

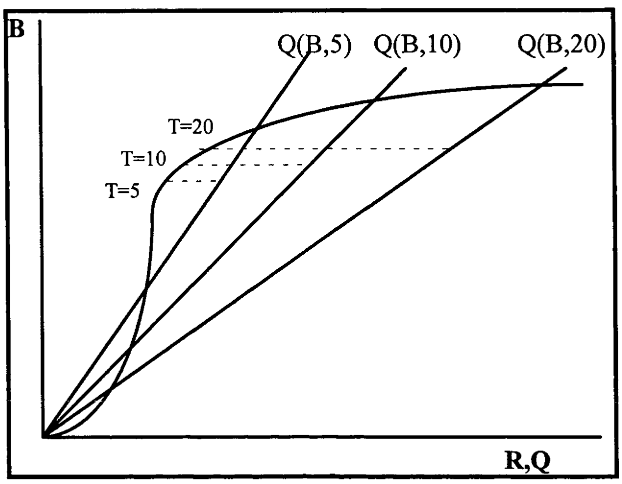
To introduce an invention that reduces production cost, research and development expenditures would be incurred. For any given task of production there exists at some time an invention-possibility frontier (IPF) that relates the percentage unit production cost reduction to the outlays incurred by the firm on research and development.

In Nordhaus' original paper, a very simple IPF function was considered; $B = \beta R^{\alpha}$, where R represent research and development expenditures and α is assumed to be less than 1, implying diminishing marginal returns to innovation. Scherer (1984) revised this assumption and argued that an inflected function for B(R) should be more appropriate because at the onset it is reasonable to assume that there is increasing returns to research effort and after which the function exhibits diminishing returns.

For simplicity, Nordhaus generally focused on the case of *run-of-the-mill* inventions so that the annual monopoly rent to the patent holder is a linear function on the percentage cost reduction B(R). For a given patent life i.e. T=T*, the monopolist's total discounted quasi-rent function Q(B,T*) is represented by a straight line.

The patent life is a government policy variable, and in the model as the government increases the life of the patent, the years that the patent recipient can command monopoly rents increases; i.e. the quasi rent function shifts to the right (see Figure 4.2).

Figure 4.2
Innovation and patent life



Source: Scherer, F.M. 1984. *Innovation and Growth: the Schumpeterian perspective*, MIT Press, Cambridge, Massachusetts.

This model presents several significant comparative static results. First, the larger the elasticity of demand in the neighbourhood of the pre-invention and post-invention equilibrium, the shorter is the socially-optimal life of the patent. Second, if a given cost reduction is relatively easy to achieve (the IPF curve is steeper and ceteris paribus the equilibrium induced level of cost reduction is larger), the shorter the socially-optimal equilibrium life should be. Third, the area of the welfare triangle rises quadratically with increases in B(R), while the patent holder's monopoly rent rises only at a linear rate with B(R).

An immediate policy implication of this model is that a uniform policy of long-lived patent protection is not optimal since different industries, different technologies and different market demands require different optimal-patent lives. Another significant implication is that, *run-of-the-mill* cases, the losses from monopoly are smaller than the gains from innovation. From this it can be presumed that patent grants which are too long are better than those which are too short, so long as trivial innovations could be prevented from receiving patents (Nordhaus, 1972).

4.3 Patent Races

The industrial organisation literature has been enriched by numerous insights regarding a firm's incentive to innovate under market structures ranging from monopoly with blockaded entry to pure competition (Scherer and Ross 1990). The emphasis since the 1980s has focused on the use of game theory to incorporate research and development dynamics into the economic models. In these models, research and development rivalry can be compared to a race for a patent. The intuition behind this is that innovation has both winners and losers. The first to innovate gains an advantage over its rivals (Dasgupta and Stiglitz 1980, Harris and Vicker 1985).

In the Dasgupta and Stiglitz model (1980b) the structure of the game ensures that at most one firm would engage in research and development. The mere threat that an industry leader in research and development is prepared to incur additional research outlays if any potential entrant appears is a sufficient signal to warn its rivals. In a model with several time periods, Harris and Vicker (1985a; 1985b) suggest that expenditures of the leading firm in the first period can be a sufficient signal that it will surely win the race. And the rivals having observed this will decide to withdraw. Thus, the leading firm could proceed at its own pace without fear of competition.

One major disadvantage of the models discussed above is that they fail to account for uncertainty and risk. There are two possible sources of uncertainty: one is on the value of payoffs and the second is the completion time (Hay and Morris 1991). The two cases assume that the firm with the largest payoff would win because it would set its research budget to pre-empt its rivals. On the other hand, Fudenberg et al. (1983) posed an alternative inquiry into identifying the circumstances into which pre-emption would not take place. When there is imperfect information, a firm cannot monitor its rival's research and development activities correctly; hence, it is possible to expect a follower to steal a march and eventually become an industry leader.

Another possibility is that in a race that involves several stages of research, even though one firm is ahead in the current stage, a follower may be able to jump ahead at a latter stage. This possibility was explored by Grossman and Shapiro (1987) using a monopoly model with two stages.

A third possibility is that the *winner takes all* assumption may be too strong and the non-innovating firm may derive benefits from innovations by other firms. The intuition behind this is that the spillover effects of research and development may weaken the incentive to win the patent race. Dasgupta (1988) argued that if spillover effects are sufficiently large, firms will prefer to be followers, and as a result will not invest in research and development. The outcome instead of being a race will be a waiting game where each firm will hope that others innovate. Licensing represents the formalisation of spillover, and it ensures that some benefits to the rival firms are returned to the innovating firm in the form of license fees. This has two implications for the patent race. First, firm who wins the race will get the license fees, and second, licensing offers a strategic advantage to the technological leader. By issuing licenses to the follower, the leader dissuades the follower from conducting its own research and development activities. Katz and Shapiro (1987) formulated a model along these lines where the losers can share the benefits of innovation either through imitation or licensing.

Sah and Stiglitz (1987), assumed that firms are not restricted to conduct only one project. The analysis shows that how one characterises a firm's choice has a strong influence on the conclusions drawn from economic analyses of research and development.

Aoki (1991) attempted to explain industry dynamics through innovative activity by firms. She argued that, in research-intensive industries (like pharmaceutical and highly technical electronic industries), the continuous introduction of new products from research and development investments is a critical factor for the survival of the firm. In such an environment, firms invest in research and development not only to gain profit but also to maintain the level of their technology and knowledge. A firm's research and development behaviour then is based on dynamic considerations, and this behaviour itself will generate the dynamics of the market.

4.4 International Welfare Implications

The demand for analyses of the implications of intellectual property protection in a North and South trading context has increased over the last few years, a result of the inclusion of intellectual property in the GATT multilateral negotiations. In this area of research, four theoretical studies stand out as suitable frameworks for evaluation. Three studies employ a partial equilibrium framework (Chin and Grossman 1988; Diwan and Rodrik 1991 and Deardorff 1992) and Helpman (1993) provides an analysis using a dynamic general equilibrium model of two regions, North and South. The former represents the point of view of the industrial countries while the latter refers to the developing countries.

Chin and Grossman

The model (1988) adopts a linear quadratic Cournot duopoly in an integrated world, with one firm in the North and one firm in the South, to analyse the welfare impact of patent protection in a 2-country trading system (North and South). It is assumed that only Northern firms can innovate and that resources have to be devoted to research and development. On the other hand, the Southern firm can practice reverse engineering at negligible cost.

The innovating firm in the North can reduce the cost of production by Δ if they spend Δ^2/α. Both firms can produce some homogeneous goods at constant marginal cost but final marginal cost in the South depends on whether or not the South is willing to enforce patent protection. At every price, it assumed that a fraction ($1/\phi$) of demand comes from the South.

The modelling of patent protection is restricted to the case of a simple binary choice between protection and no protection. Chin and Grossman's comparative static results suggest that if the South does not protect the intellectual property rights of the North, the market structure becomes a symmetric duopoly, with common costs in the two markets. However, if the government in the South actually prevents local firms from infringing patent rights of the North, three equilibria may arise, depending on the effectiveness of research and development in reducing production costs. If the parameter, γ, which describes the effectiveness of research and development activity in the North, is relatively small, the Northern firm will be modest and asymmetric duopoly will characterise the final stage of competition. If the North's research and development activity is highly effective, the innovating firm in the North will find it optimal to lower its cost, so much so that it will enjoy an unrestricted monopoly position in the product market. For intermediate values of γ, the Northern firm will act strategically to induce exit by its rivals.

Strategic predation can occur when the final position in the product market is one of monopoly. However, the Northern firm will find itself restricted to choose a level of research and development expenditures that is sufficiently large to guarantee non-positive profits for its rivals.

Having analysed the repercussions posed by the two alternative regimes of protection and no protection in the South on the behaviour of the two firms, Chin and Grossman (1988) then examines the level of welfare in each country. This is done by computing the difference in the level of welfare with protection and without protection. Welfare comparison in the first case, where the effectiveness of research and development in the North is low, suggests that if a duopoly outcome results under protection and if the South's share of world consumption is relatively small, the Southern residents achieve higher national welfare when intellectual property rights are not protected. Within the range of parameter values which would capture a monopoly position (when γ is relatively high), if property rights are recognised, protecting foreign intellectual property right can benefit the South only when the research and development activity is high and the South has much to gain in consumption from the fruits of the North's research efforts. In the last case, where the range of parameter values for which strategic predation is the outcome of patent protection, a Southern share of less than 88 per cent is a sufficient condition for the South to prefer non protection of intellectual property.

Comparing the welfare level of the North with protection or without protection of intellectual property rights in the South implies that the North unambiguously benefits if the South protects foreign intellectual property. This result is not dependent on research and development productivity or market structure.

Conflict between the interests of the South and the North is illustrated by the results of welfare comparisons. If the Southern country is small compared to the innovating North, the country would benefit more from not protecting foreign intellectual property. But welfare comparisons in the North reveal that it would benefit from protection.

Diwan and Rodrik

Like Chin and Grossman's (1988) model, the Diwan-Rodrik (1991) model tries to investigate the issue of intellectual property rights, emphasising the conflict of interests between the North and the South. The limitations of the Chin and Grossman model are probably the strong point of this one. For example, Chin and Grossman's model failed to account for differences in technological needs and tastes between countries. Other differences highlighted in the paper are (i) the Diwan and Rodrik model allows for a continuum of potential technology with a different distribution of preferences in the region; this allows for more flexibility in the interpretation as between product or process innovation; (ii) the model also allows for the free entry of Northern firms into the research and development sector, unlike Chin and Grossman's model which is characterised by duopolistic competition; (iii) the Diwan-Rodrik model offers more choice in terms of patent protection rather than concentrating on the simple binary choice of protection and no protection; and (iv) the Diwan and Rodrik model assumes that markets of the North and South are segmented owing to the differences in the patent laws of the two regions. The inclusion of all these desirable features is not without cost. In exchange for all these, the Diwan and Rodrik model does not get into the details of strategic interaction between Northern and Southern firms competing in oligopolistic markets.

The assumptions of the basic model are: First, only Northern firms can innovate. This assumption may not be too restrictive provided the firms in the North have a strong comparative advantage in research and development. Second, an unlimited spectrum of potential technologies exist, indexed in the model by a continuum variable $\phi \in (-\infty, \infty)$. The range of discovered technologies on the other hand is characterised by a lower bound ϕ_L and an upper bound ϕ_U which are endogenous. Third, consumers are differentiated by taste. Consumers in the North and the South have preferred sets of technology. Finally, there is a fixed cost required to develop each technology. Marginal cost of innovation in this model does not play an important role and is ignored in the analysis. Expansion of the range $[\phi_L, \phi_U]$ tends to increase costs as resources used in the innovation process are bid up. Cost then is represented as $c = c(\phi_L - \phi_U)$ with c'>0 and c">0. The purpose of this is to illustrate the reality that resources allotted to research and development are limited.

Aggregate consumer welfare in the North is represented by

$$U_N(\phi_L, \phi_U) = \int_{-\infty}^{\infty} U(\phi)B(\phi)d\phi = \int_{-\infty}^{\infty} B(\phi)d\phi \qquad (4.1)$$

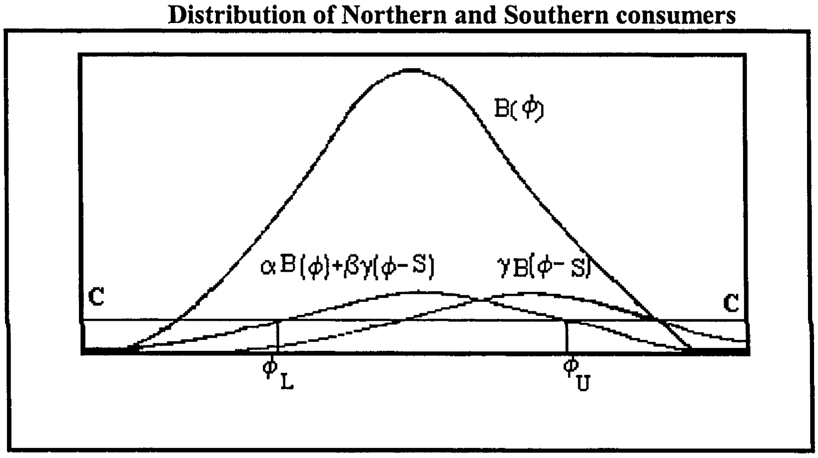
where B is a continuous distribution function representing the distribution of Northern consumers. For simplicity, it is assumed that $B(\phi)$ is a single peaked symmetric distribution which is normal.

Consumers in the South have the same parameters but the distribution is centred on a mean to the right of that of the North (see Figure 4.3). The mass of Southern consumers is assumed to be a fraction, γ of those of the North ($\gamma < 1$). Aggregate consumer welfare in the South is represented to be

$$U_S(\phi_L, \phi_U) = \gamma \int_{-\infty}^{\infty} B(\phi - S)d\phi \qquad (4.2)$$

The pricing behaviour of the firm in this model is linked with the patent law observed in the particular region. Suppose an innovator faces immediate competitors who could imitate the same technology by incurring unit cost α, which can be thought of as the unit cost incurred by imitators if they are brought to court. The strategy of the incumbent innovating firm is to then charge a price equal to the unit cost of the potential entrants. This removes the profit incentive to enter. Following the logic of this assumption α somehow parameterises the restriction of the prevailing patent laws in the North $\alpha \in [0,1)$. Analogously, this role is played by β in the South where $\beta \in [0,1)$.

Figure 4.3
Distribution of Northern and Southern consumers



Source: Diwan, I. and Rodrik, D. 1991. 'Patents, appropriate technology and North-South trade', *Journal of International Economics*, 30 (12): 27-47.

Total Northern profits are then given by

$$\Pi(\phi_L, \phi_U) = \int_{\phi_L}^{\phi_U} [\alpha B(\phi) + \beta\gamma B(\phi - S)]d\phi - [\phi_U - \phi_L]c \qquad (4.3)$$

Social welfare in the North or the sum of consumer benefits and profits can be written as

$$W_N(\phi_L, \phi_U) = \int_{\phi_L}^{\phi_U} [\ B(\phi) + \beta\gamma B(\phi - S)\ ]d\phi - [\phi_U - \phi_L]c \qquad (4.4)$$

$$W_S(\phi_L, \phi_U) = \int_{\infty}^{\infty} (1-\beta)B_S d\phi = \gamma \int_{-\infty}^{\infty} (1-\beta)B(\phi - S)d\phi \qquad (4.5)$$

The second term in the expression represents the transfer of profits from the South to the North: it is therefore subtracted from the Southern welfare.

Comparative static results show that patent protection will have a positive effect in the North; however, this will occur at the expense of some products that are particularly suited to Southern requirements. On the other hand, increased patent protection increases the innovations, that are more appropriate to Southern needs (those on the right hand of the distribution). The likelihood that this result occurs varies positively with three factors: (i) the degree to which existing innovations mirror Northern requirements; (ii) the diversity in tastes between the two regions and (iii) the magnitude of the cost increases as the range broadens.

The second part of the Diwan and Rodrik's paper considers welfare analysis of assigning different rates of patent protection in the South. The findings are that (i) a global planner assigning greater weight to South's welfare would require a higher level of patent protection in the North; (ii) in an uncoordinated equilibrium, a reduction in taste differences between the two regions would reduce patent protection in the South and (iii) again in an uncoordinated equilibrium, an increase in the relative market size of the South would increase Southern patent protection. Northern patents, on the other hand, are found to be insensitive to these changes.

The authors emphasised one important implication of the arguments presented which would be vital in the North and South negotiations on the conflict of intellectual property rights. The North and South can take different turns in different product lines. In products where taste differences between the two regions are not extremely large (like computer softwares and textbooks), the South has a greater incentive to free ride. But in products where taste differences are evident like in the case of some pharmaceutical and agricultural innovations, the South can gain more if it strengthens patent protection.

Deardorff

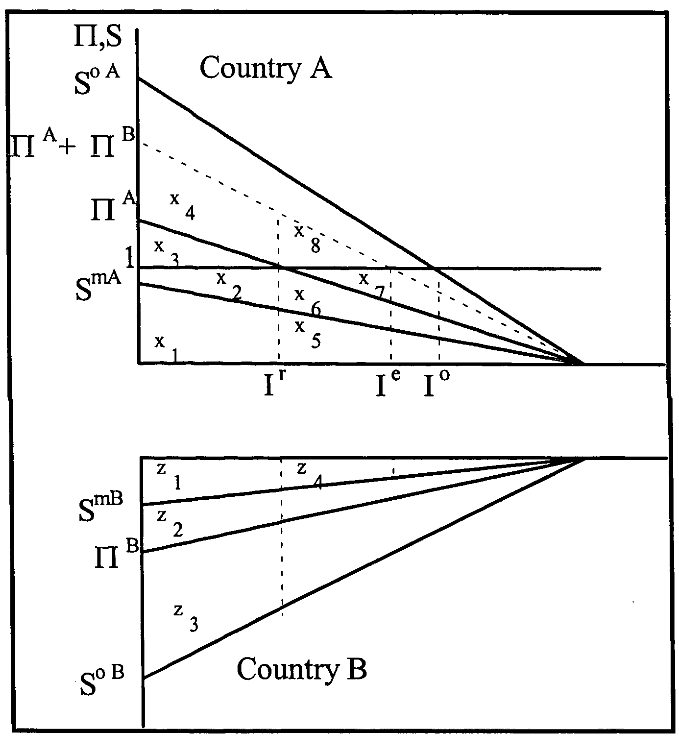
This simple theoretical model examines the welfare effects of extending patent protection from the country where invention takes place to another country that is only a consumer of the invented products. Inherent in the model therefore, is the assumption that only the North can innovate and that information on how to produce the good becomes freely available worldwide once an invention is discovered. For simplicity, the demand for invented goods is assumed to be linear and identical for all consumers and the function relating to optimal surplus is linear as well.

The model starts with the very simple case of a single invention in a single country where consumer demands for the invented good are identical. It shows that the effect of a patent grant to inventors is to change production from a perfectly competitive case to a monopoly condition, where equilibrium output decreases, price increases and a deadweight loss results. However, the patent holder earns a profit which provides some returns on the cost of invention. Unfortunately, often even this return may not be enough to compensate the inventor for his efforts. If one considers the ex ante problem of whether the invention is worth doing from the society's point of view, it is clear that the invention is worth the cost to society as long as the optimal consumer surplus exceeds the opportunity cost of research and development. Since only a fraction of the optimal consumer surplus accrues to the patent holder when protection is provided, it could be expected that some worthwhile inventions will not be created even in a regime of patent protection. Patenting therefore, in this case is an imperfect method of fostering inventions in two respects. First, it leads to monopoly distortions of consumer choice and second, it fails to encourage all worthwhile inventions. The latter result is reinforced in the model because it is assumed that if there is patent protection granted to inventors, then production will take place under monopoly. The level of invention that would then result under the regime of patent protection will be where the monopoly profits from the marginal invention is equal to research cost. This level is much less than the optimal level of invention which should include all inventions that yield an optimal consumer surplus greater than the cost of research. In the model this is represented as the level of inventions at which the optimal consumer surplus per dollar is greater than 1. Figure 4.4 below illustrates this point where Π, S and I stand for profit, consumer surplus and level of inventions respectively in Country A where consumer demand for invented goods are identical. The optimal level of invention to society is given by I^o, however, even with patent protection, the level of inventions is restricted to I^r.

Restricted patent protection. Consider a case of restricted patent protection (i.e. protection only in country A and no protection in country B) wherein monopoly profits would only be earned in country A. From the point of view of the innovating firm, the optimal level of invention is given by I^r where the marginal per dollar profit in country A intersects the horizontal line 1. Gross profits for country A in this case are given by the area $x_1+x_2+x_3$ while consumer surplus is area x_1. Given the cost of invention being the area x_1+x_2, the net gain to country A is the area x_1+x_2. In this case, where there is no patent protection in country B, consumers can free ride; thus receiving the optimal consumer surplus, represented by the area, $z_1+z_2+z_3$.

Extended patent protection. Figure 4.4 also shows the effect of extending patent protection to country B, which is only a consumer of the product invented in country A. In this case, Country A will also be entitled to earn monopoly profits in country B. This will stimulate inventive activity and investment in country A; thus, the level of invention increases from I^r to I^e where total profits from the two sources from the marginal invention just covers the cost of research. Total profits for country A is represented in the top panel by line $\Pi^A+\Pi^B$. Consumer surplus in Country A expands to include x_5, while profits now include x_5+x_6 which is earned from the domestic market and $x_4+x_7+x_8$ which is earned from county B.

Figure 4.4
Welfare effects of patent protection



Source: Deardorff, A.V. 1992. 'Welfare effects of global patent protection, 59: 35-51.

On the other hand, consumers in B, earn a smaller consumer surplus under monopoly (S^{mB}) as a result of patent protection. This is given by the area z_1+z_4.. The monopoly pricing brought about by patent protection causes Country B to lose a substantial portion of their consumer surplus, relative to the regime of no patent protection.

It is clear (Figure 4.4) that country A, the innovating country unambiguously gains from extending patent protection to country B. Consumers in Country A gain from the availability of more invented products and the monopolistic inventors gain profits in both markets.

Helpman

Helpman (1993) considers the debate between the North and South on the protection of intellectual property right in a model using a dynamic general equilibrium framework, in which the North innovates new products and the South imitates. Welfare evaluation of strengthening intellectual property protection is provided by considering the effects of protection on (i) the terms of trade, (ii) interregional allocation of production, (iii) available product choice, and (iv) intertemporal allocation of consumption spending. The analysis proceeds in two stages. The first considers a case of an exogenous rate of innovation and focuses on the first two welfare components. The second proceeds by endogenising the rate of innovation while looking at the four components. Moreover, the model also considers the impact of tightening intellectual property right protection in developing countries in the presence of foreign direct investment.

Exogenous rate of innovation. The model assumes that the North innovates and introduces new products at a constant exogenous rate,

$$g = \dot{n}/n \tag{4.6}$$

where n is the number of products which society knows how to produce. The South on the other hand, engages in reverse engineering and imitates Northern products at the exogenous rate

$$m = \dot{n}^S / n^N \tag{4.7}$$

where n^S represents the number of products that the South knows how to produce while n^N refers to the number of products not yet imitated by the South.

The policy of strengthening intellectual property protection in the South is interpreted in the model to be a decline in the rate of imitation. Thus,

$$m = \widetilde{m} - \mu \tag{4.8}$$

where the value of μ is zero when the South reverse engineer, however, μ increases as intellectual property protection in developing countries is tightened.

Individuals in the two regions are assumed to have identical preferences and that consumers allocate spending only across the available invented products in the market. Moreover, the Northern firm can charge a monopoly price to a product which has not been imitated and that wages are higher in the North than in the South. Therefore, because welfare is higher the higher the real spending, an increase in the proportion of goods manufactured in the North hurts consumers in both regions with a fixed nominal expenditure.

Welfare effects in this case are examined based on the impact of patent protection on the interregional allocation of production and the terms of trade. In both these channels, it is clear that the South would lose from strengthening patent protection. Such a policy would shift products away from developing countries and into the industrial countries. If this happens, demand for factors of production declines in less developed countries and increases in the latter. The industrial countries' terms of trade improves and the terms of trade in developing countries worsens.

Does the North necessarily gain from strengthening patent protection? The result may be ambiguous because Northern consumers loses as a result of the interregional allocation of production, however, they gain from the improvement in terms of trade. The model then reconciles these two effects and identifies that for economies in a steady state, there always exists a feasible range of imitation in which strengthening intellectual property hurts both regions. There is however, also a range in which such a policy regime benefits the North and hurts the South. The former occurs when the rate of imitation is relatively small.

Endogenous Innovation. This case examines the impact of strengthening intellectual property protection on the rate of innovation. The result suggests that the reform would initially raise the rate of innovation but the rate of innovation subsequently declines. Moreover, the initial acceleration of innovation is insufficient to compensate southern residents for its loses as a result of the changes in the interregional allocation of production and the decline in the terms of trade.

Finally, the model indicates that the South also loses from tighter intellectual property protection, even in the presence of direct foreign investment. The reason for this is that while the Northern multinationals lessen the negative impact of tighter intellectual property protection on the South's terms of trade, they do not eliminate the negative welfare impact brought about by the reallocation of manufacturing that brings about higher prices for a large fraction of products.

4.5 Toward a Model on Intellectual Property Protection: The Opposing Effects on Developing Countries

The models of the international welfare implication of patent protection are in broad agreement. Strengthening patent protection in developing countries would have a negative repercussion on their welfare. All these models failed to recognise however, that there are two opposing forces at work in a regime of stronger patent protection. Such a shift in policy would raise the cost of acquiring new technologies which may be welfare reducing for developing countries. However, there are also benefits in the form of increased access to foreign technology which may be vital to improve production techniques in these countries. The welfare impact then of increased intellectual property protection on developing countries would depend on which effect would dominate.

Assume a duopoly in an integrated world economy where one firm operates in the industrial North and the other is a locally owned firm in the developing South. The former firm is indexed as *N* while the latter is indexed as *S*. This model assumes that only firm *N* can innovate (it is engaged in research and development activities in order to lower production costs) while firm *S* practices reverse engineering. This assumption is consistent with available international data on research and development and invention patents. Moreover, patents data in a developing country like the Philippines reveal that the majority of it represent grants to foreign nationals and corporations in developed countries like the United States, Japan and Germany.

Demand

For simplicity, assume that both firms are faced with a linear demand function for good Y. The inverse demand function is then given as

$$P = \alpha - \gamma Y \qquad \gamma > 0 \tag{4.9}$$

where γ is the elasticity of demand and Y refers to world output which is equal to the combined output of the two firms ($Y = Y^N + Y^s$).

Cost function of the Northern firm

The Northern firm maximises profit based on the following cost specification where Y^N is output and ϕ^N is the firm's research and development effort.

$$X^N(Y^N,\phi^N) = R(\phi^N)C^N(Y^N) + D(\phi^N,\beta^S,\beta^N) \qquad (4.10)$$

$$C^N > 0,\ C^N{}_{Y^N Y^N} \geq 0,\ 0 < R(\phi^N) < 1,\ R_{\phi^N} < 0,\ R_{\phi^N \phi^N} > 0$$

$$D_{\phi^N} > 0,\ D_{\phi^N \phi^N} \geq 0,\ D_{\beta^S} < 0,\ D_{\beta^N} < 0,\ D_{\phi^N \beta^S} < 0,\ D_{\phi^N \beta^N} < 0$$

There are two components of the firm's cost function: the production cost, C^N and the cost of undertaking research (D). The first component describes the production technology in which costs may be lowered as a result of the firm's research and development activities (R). Output may exhibit constant marginal cost while the marginal productivity of research and development efforts exhibits diminishing returns. This follows the assumption made by Nordhaus (1969) on the invention possibility frontier wherein the benefits from research exhibit diminishing returns.

The second component is independent of output and considers the costs incurred from the firm's research and development activities which may be affected by the strength of patent protection in both regions proxied by β^N and β^S for the North and South respectively. Research and development effort may exhibit constant or increasing marginal cost, while the impact of increased patent protection on the marginal cost of research and development is negative, indicating that a stringent regime of patent protection effectively lowers the burden of research and development expenditures from the point of view of innovators. The intuition behind this is that a regime of stronger patent protection in both regions would enable the innovating firm in the North to extract some rents from other users of its developed technology (which can be its counterpart firm in the South or other industries in the North). This parameterisation allows some degree of flexibility into the model to assess the impact of stronger patent protection in the innovating industrial countries because analysis is not constrained to the simple binary choice of protection and no protection.

Southern firm's access to foreign technology

The Southern firm can gain access to foreign technology, T^F developed in the North through licensing agreements. Technology made available to the Southern firm is an increasing function of the northern firm's research and development effort and the degree of patent protection in the South (see 4.11 below). The justification for the latter is that the innovating firm in the North would be reluctant to make new technologies available to the Southern firm if the latter does not provide some form of protection to the former's intellectual property rights. This is consistent with the results of a survey conducted by Mansfield (1993) which indicated that a considerable percentage of US firms find that intellectual property right protection in developing countries is too weak to permit them to transfer their newest and most effective technology to developing countries.

$$T^F = G(\phi^N, \beta^S) \qquad (4.11)$$

$$T^F{}_{\phi^N} > 0, \quad T^F{}_{\beta^S} > 0$$

Cost function of the Southern firm

The Southern firm's cost function (4.12) is very similar to that of the North's except that instead of engaging in formal research and development activities to lower production cost $C^S(Y^S)$, the firm engages in reverse engineering activity (V), the success of which is determined by the firm's reverse engineering efforts (ϕ^S) and the use of foreign technology made available by the northern firm (T^F). In this model, it is assumed that although the southern firm does not formally engage itself in formal research and development activities, its innovative effort is limited to the modification and adaptation of new and existing technologies. Thus, reverse engineering here is broadly defined broadly to also cover activities related to the efficient use and assimilation of technology made available by the Northern firm.

$$X^S(Y^S,\phi^S) = V(\phi^S,T^F)C^S(Y^S) + E(\phi^S,T^F) \qquad (4.12)$$

$$C^S{}_{Y^S} \geq 0,\ C^S{}_{Y^SY^S} \geq 0,$$

$$0 < V(\phi^S,T^F) < 1,\ V_{\phi^S} < 0,\ V_{T^F} < 0,\ V_{\phi^S\phi^S} > 0,\ V_{T^FT^F} > 0,\ V_{\phi^ST^F} < 0$$

$$E_{\phi^S} > 0,\ E_{T^F} > 0,\ E_{\phi^S\phi^S} > 0,\ E_{\phi^ST^F} > 0$$

Following Taylor (1993), the first component of the Southern firm's cost function relates to production while the second is associated with the costs incurred by the firm as a result of its reverse engineering activities. Again these costs are independent of production levels. Increases in both output and reverse engineering effort may come at increasing cost, but reverse engineering activities, undertaken by the firm can lower the first of these components. The second component, the cost of reverse engineering activities, E is parameterised to be an increasing function of the firms effort and technology imports from the North. From the point of view of the southern firm, it will practice reverse engineering as long as the benefit from such activity outweighs the cost, $[C^S(Y^S) - V(\phi^S,T^F)C^S(Y^S)] > E(\phi^S,T^F)$.

Profit maximisation by the Northern firm

Following the Cournot duopoly model, firm N treats the parameters of the other firm as constant ($\overline{Y^s}$) when maximising profit. For the innovating firm there are two decision variables, namely: output and the level of the firm's research and development effort.

$$\underset{\{Y^N,\phi^N\}}{Max}\ \Pi^N = P(Y^N + Y^S)Y^N - R(\phi^N)C^N(Y^N) - D(\phi^N, \beta^N, \beta^S) \quad (4.13)$$

Differentiating 4.13 with respect to the decision variables gives the first order conditions:

$$\Pi^N{}_{Y^N} = \alpha - \gamma \overline{Y^s} + 2\gamma Y^N - R(\phi^N)C^N{}_{Y^N} = 0 \quad (4.14)$$

$$\Pi^N{}_{\phi^N} = -R_{\phi^N}C^N(Y^N) - D_{\phi^N} = 0 \quad (4.15)$$

Equation 4.14 equates marginal revenue to the marginal cost of production. After simple manipulation it can be seen that marginal revenue for the Northern firm is equal to

$$MR^N = P(1 - \frac{1}{\varepsilon^D(Y) / X^N}) \quad (4.16)$$

where ε^D is the elasticity of demand and X^N is the share of Northern output to total output (Y^N / Y). The denominator in 4.16 can be referred to as the elasticity of the demand curve facing the northern firm. The smaller the market share the more elastic the demand curve it faces (Varian 1989). Similarly, equation 4.15 equates the marginal gain from research and development efforts of the innovating firm to its marginal cost from which the optimal level of research and development could be derived.

The second order conditions of profit maximisation require that the principal minors of the relevant Hessian determinant alternate in sign

$$|H| = \begin{vmatrix} \Pi_{YY} & \Pi_{Y\phi} \\ \Pi_{\phi Y} & \Pi_{\phi\phi} \end{vmatrix} \qquad \Pi_{YY} < 0 \text{ and } |H| > 0.$$

The Hessian matrix for the model can be derived from the first order conditions to yield:

$$|H^N| = \begin{vmatrix} -2\gamma - R(\phi^N)C^N{}_{Y^NY^N} & -R_{\phi^N}C^N{}_{Y^N} \\ -R_{\phi^N}C^N{}_{Y^N} & R_{\phi^N\phi^N}C^N(Y^N) - D_{\phi^N\phi^N} \end{vmatrix} \quad (4.16)$$

For the first order condition to be satisfied it is assumed that $\Pi^N_{Y^YY^N}\Pi^N_{\phi^N\phi^N} > (\Pi^N_{Y^NY^N})^2$. This is equivalent to saying that the profit function is sufficiently concave in output quantities and research and development effort.

Profit maximisation for the southern firm

The profit function for firm *S* is given in 3.30 below

$$\underset{\{Y^S,\phi^S\}}{Max}\ \Pi^S = P(Y^S + Y^N)Y^S - V(\phi^S, T^F)C^S(Y^S) - E(\phi^S, T^F) \qquad (4.17)$$

For the southern firm, the decision variables include output, Y^S and the level of reverse engineering effort, ϕ^S. Differentiating 4.17 with respect to the decision variables would generate the first order conditions.

$$\Pi^S_{Y^S} = \alpha - \gamma \overline{Y^N} - 2\gamma Y^S - V(\phi^S, T^F)C^S_{Y^S} = 0 \qquad (4.18)$$

$$\Pi^S_{\phi^S} = -V_{\phi^S}C^S(Y^S) - E_{\phi^S} = 0 \qquad (4.19)$$

Equation 4.18 has the standard interpretation as in 4.14. However, 4.19 equates marginal revenue from reverse engineering to its marginal cost. Equilibrium values for the southern firm's output and level of reverse engineering could be derived from 4.18 and 4.19 respectively.

The second order condition is obtained from 4.18 and 4.19 to yield H^S

$$|H^S| = \begin{vmatrix} -2\gamma - V(\phi^S, T^F)C^S_{Y^SY^S} & -V_{\phi^S}C^S_{Y^S} \\ -V_{\phi^S}C^S_{Y^S} & -V_{\phi^S\phi^S}C^S(Y^S) - E_{\phi^S\phi^S} \end{vmatrix} \qquad (4.20)$$

As in the case of firm *N*, we need to impose that $\Pi^S_{Y^SY^S}\Pi^S_{\phi^S\phi^S} > (\Pi^S_{Y^SY^S})^2$ to ensure that the second order condition of profit maximisation is satisfied.

Comparative Static Analysis

This section reveals some comparative static aspects of the model. The idea is to find out how a change in any parameter will affect the equilibrium position and, in particular, he optimal values of the choice variables: $Y^{N*}, Y^{S*}, \phi^{N*}$ and ϕ^{S*}. Using the implicit function theorem, the model can show the impact of changes in some exogenous variables on the equilibrium output of the two firms, the research and development effort of the innovating firm and the reverse engineering effort of firm *S*. An important consideration here is to show the impact of strengthening intellectual property protection on the equilibrium output and reverse engineering effort of the firm in the developing country.

•*Firm in the North.* Totally differentiating 4.14 and 4.15 yields

$$F^{N1} = -\left[2\gamma + R(\phi^N)C^N{}_{Y^N Y^N}\right]dY^N - R_{\phi^N}C^N{}_{Y^N}d\phi^N = 0 \qquad (4.21)$$

$$F^{N2} = -\left[R_{\phi^N\phi^N}C^N(Y^N) + D_{\phi^N\phi^N}\right]d\phi^N - R_{\phi^N}C^N{}_{Y^N}dY^N - D_{\phi^N\beta^S}d\beta^S - D_{\phi^N\beta^N}d\beta^N = 0 \qquad (4.22)$$

Holding all other variables constant, the impact of strengthening patent protection on the Northern firm's equilibrium output and reverse engineering effort could be represented below as

$$\frac{\partial Y^{N*}}{\partial \beta^S} = \frac{\begin{vmatrix} 0 & -R_{\phi^N}C^N{}_{Y^N} \\ D_{\phi^N\beta^S} & -R_{\phi^N\phi^N}C^N(Y^N) - D_{\phi^N\phi^N} \end{vmatrix}}{\left|H^N\right|} > 0 \qquad (4.23)$$

$$\frac{\partial \phi^{N*}}{\partial \beta^S} = \frac{\begin{vmatrix} -2\gamma - R(\phi^N)C^N{}_{Y^N Y^N} & 0 \\ -R_{\phi^N}C^N{}_{Y^N} & D_{\phi^N\beta^S} \end{vmatrix}}{\left|H^N\right|} > 0 \qquad (4.24)$$

Equation 4.23 implies that equilibrium output of firm *N* would increase if patent protection in the South is strengthened. Moreover, equation 4.24 suggests that if patent protection is strengthened in developing countries, research and development effort of the innovating firm in the North will increase. This is because increased patent protection in the South enables the innovating firm in the North to recoup some of their R&D investments, thereby, encouraging more research and development activities which at the same time enhances production. From this, it follows that an exogenous increase of patent protection in the South would raise the profit of the innovating firm in the North..

•*Firm in the South.* Totally differentiating 4.18 and 4.19 will give

$$F^{S1} = -\left[2\gamma + V(\phi^{S}, T^{F})C^{S}{}_{Y^S Y^S}\right]dY^{S} - V_{\phi^S}C^{S}{}_{Y^S}d\phi^{S} - C^{S}{}_{Y^S}V_{T^F}T^{F}{}_{\beta^S}d\beta^{S}$$
$$-C^{S}{}_{Y^S}V_{T^F}T^{F}{}_{\phi^N}d\phi^{N} = 0 \qquad (4.25)$$

$$F^{S2} = -\left[V_{\phi^S\phi^S}C^{S}(Y^{S}) + E_{\phi^S\phi^S}\right]d\phi^{S} - V_{\phi^S}C^{S}{}_{Y^S}dY^{S} - V_{\phi^S T^F}T^{F}{}_{\beta^S}C^{S}(Y^{S})d\beta^{S})d\beta^{S}$$
$$-V_{\phi^S T^F}T^{F}{}_{\phi^N}C^{S}(Y^{S})d\phi^{N} = 0 \qquad (4.26)$$

$$\frac{\partial Y^{S*}}{\partial \beta^{S}} = \frac{\begin{vmatrix} C^{S}{}_{Y^S}V_{T^F}T^{F}{}_{\beta^S} & -V_{\phi^S}C^{S}{}_{Y^S} \\ V_{\phi^S T^F}T^{F}{}_{\beta^S}C^{S} + E_{\phi^S T^F}T^{F}{}_{\beta^S} & -V_{\phi^S\phi^S}C^{S}(Y^{S}) - E_{\phi^S\phi^S} \end{vmatrix}}{|H^{S}|} < or > 0 \qquad (4.27)$$

$$\frac{\partial \phi^{S*}}{\partial \beta^{S}} = \frac{\begin{vmatrix} -2\gamma - V(\phi^{S}T^{F})C^{S}{}_{Y^S Y^S} & C^{S}{}_{Y^S}V_{T^F}T^{F}{}_{\beta^S} \\ -V_{\phi^S}C^{S}{}_{Y^S} & V_{\phi^S T^F}T^{F}{}_{\beta^S}C^{S}(Y^{S}) + E_{\phi^S T^F}T^{F}{}_{\beta^S} \end{vmatrix}}{|H^{S}|} > or < 0 \qquad (4.28)$$

From the point of view of the southern firm, the exogenous impact of stronger patent protection on the equilibrium values of output and reverse engineering effort of the Southern firm would have two opposing repercussions, the increase in marginal benefit due to lower production cost because access to foreign technology is increased and the rise in the marginal cost of reverse engineering as a result of rent payments to inventors. Thus, the result is indeterminate and would depend on which effect dominates. This is illustrated in 4.27 and 4.28 by the indeterminate sign of $\Psi = T^{F}{}_{\beta^S}(V_{\phi^S T^F}C^{S} + E_{\phi^S T^F})$. The first term in parenthesis refers to the production effect of having more technology available for the southern firm as a result of increased patent protection, while the latter refers to the rent effect which makes technology under such a regime more expensive because it will increase royalty payments to innovators.

Proposition 1. If $/V_{\phi^S} C^S{}_{Y^S} E_{\phi^S T^F} / > / C^S{}_{Y^S} V_{T^F} \Pi_{\phi^S \phi^S} + V_{\phi^S} C^S{}_{Y^S} V_{\phi^S T^F} /$ then $\frac{\partial Y^{S*}}{\partial \beta^S} < 0$. The left hand side refers to the marginal cost effect of increased patent protection while the right hand side represents the marginal benefits gained by the southern firm as a result of increased patent protection. The former considers the negative impact of patent protection on the reverse engineering activities of the firm. Stronger patent protection will increase the marginal cost of reverse engineering activities because foreign technology would be more expensive. The benefits, on the other hand include the reduction in the marginal cost of production due to the availability of more advanced foreign technology and the increased productivity of the firm's reverse engineering efforts. Similarly, if

$$/V_{\phi^S} C^S{}_{Y^S} E_{\phi^S T^F} / > / C^S{}_{Y^S} V_{T^F} \Pi^S{}_{Y^S \phi^S} + V_{\phi^S} C^S{}_{Y^S} V_{\phi^S T^F} / \text{ then } \frac{\partial \phi^{S*}}{\partial \beta^S} < 0.$$

Proposition 1 indicates that if the negative cost effect dominates, then equilibrium output and reverse engineering would decrease, thus profit also decreases as a result of stronger patent protection.

Proposition 2. Alternatively, if $/V_{\phi^S T^F} C^S / > / E_{\phi^S T^F} /$ then $\frac{\partial Y^{S*}}{\partial \beta^S} > 0$ and $\frac{\partial \phi^{S*}}{\partial \beta^S} > 0$. Proposition 2 demonstrates an alternative scenario for developing countries regarding patent protection. If the positive production effect dominates over the negative cost effect then equilibrium output and reverse engineering effort would increase as a result of stronger patent protection. Moreover, given that equilibrium output of the Northern firm increases as well, the original Cournot equilibrium world output will be exceeded, reducing product prices and benefiting consumers as well.

Implication

The model suggests one important implication of increased patent protection among developing countries. Such a policy may be transformed into an effective mechanism that could work for their own advantage. This could be done through the appropriate selection and efficient use of foreign technology which would be otherwise unavailable, to improve production techniques. In this case, the benefits could outweigh the increased cost of acquiring the "standard" technology which would previously have been reverse engineered. This result however, is more likely to happen if a country has achieved a considerable technological capability as in the newly industrialising countries (NICs) who are capable of efficiently assimilating acquired foreign technology. On the other hand, for countries with limited production and technological capability, the negative cost effect is likely to dominate over the benefits, thus increased patent protection is more likely to reduce welfare of these countries at least in the short run.

The above implications of the model raises questions on the conditions under which the net benefit from strengthening intellectual property protection would accrue to developing countries, Because of individual idiosyncracies there is no single prescription applicable to all developing countries; however, the critical elements could be identified. These elements include: (i) technological capability, (ii) an appropriate structure of incentives for investment and production and (iii) the existence of institutions that effectively support industrial and innovative activities.

Technological capability. Patent protection is designed to increase the supply of commercially viable innovations globally. The increase in the supply of new ideas however, would be irrelevant if physical investment on new technologies is not made or if there is no trained workforce that could assimilate and apply these new technologies; thus, the ability and skills of a country to set up and operate industries over time would largely determine the impact of stronger patent protection in developing countries. In order to take advantage of the positive impact of stronger patent protection, developing countries need to have the ability to muster the financial resources and effectively absorb and assimilate new technologies.

Incentives. The effectiveness of patent protection as an instrument to strengthen the technological capabilities of developing countries is enhanced if there is a competitive environment where firms perceived innovative activities as vital for their survival; thus, the structure of incentives in production and investment would affect the outcome of a shift toward stronger protection in these countries.

Incentives arising from market forces and from government policies affect the pace of physical and human capital accumulation as well as the extent to which inputs are exploited in production (Lall 1992). In developing countries, the outcome of a regime of stronger patent protection will be affected by the incentives brought about by the country's industrial, trade as well as macroeconomic policies.

A good industrial policy that promotes technological development is one that ensures that domestic firms operate in a competitive environment. Firms facing competition are likely to face greater incentives to innovate because of the perceived threat to their position if new competitors are first to develop new products and processes.

In terms of trade policy, allowing imports in the country increases the pressure on domestic firms to manufacture better quality products made available at the least possible price. Similarly, by encouraging exports, it exposes domestic firms to international competition and opens up new market opportunities.

Macroeconomic policies, both fiscal and monetary will certainly affect the decision of firms to undertake innovative activities. Interest rate along with other policies affecting the country's financial sector will have an impact on the number of players in the finance market and the extent of competition which in turn impacts on the cost and availability of finance. Likewise, inflation and exchange rate movements will also influence the decisions of domestic and multinational corporations to innovate. Moreover, taxation policies will also influence the profit considerations of R&D activities.

Institutions. In addition to the legal framework supporting property rights and industrial activity, institutions will play an important role in providing technological information services, R&D centers, testing services and product standards, education and training (Lall 1992 and WB 1987).

For developing countries, a strong information system is important in upgrading existing technologies and enabling firms to get access to new technologies. Likewise, establishing a closer link between research and the country's industrial sector would facilitate the transfer of technology to industry. Public R&D institutes in South Korea served as useful transfer agents of technology by undertaking joint research projects with industries. Thus, enabling them to have enough technical knowledge that aided them in identifying foreign technology and its suppliers as well as providing them with bargaining power in negotiating technology transfer (Kim and Dahlman 1991).

With increased competition in the world market, firms in developing countries should improved the quality of goods produced for both local and export markets by establishing product standards and providing testing services. WB (1987) emphasizes the importance of norms and standards in aiding the diffusion of technology in developing countries. Norms and standards facilitate interchangeability and compatibility and enable firms to translate quality into something quantifiable. Moreover, the development of a standard calls for a procedure to be followed to attain such standard which in effect provides an implicit way of technological diffusion.

An important component of a country's technological capability is its technical human capital resources. The technical competence of an industrial workforce could be greatly improved through education offered by various formal and in-firm training services. Lall (1992) compared technological capabilities of many developing countries and concludes that South Korea and Taiwan's larger technical skill endowments compared to other developing countries explain their ability to handle more complex industrial technologies.

4.6 Conclusion

The theoretical literature on intellectual property protection has progressed remarkably since the 1950s. The main thrust of early studies justifies the protection of intellectual property based on the notion that reliance on market incentives alone is not enough to ensure optimal investment on research and development. Thus, protection aims to stimulate innovative activities by creating transitory rights to enable the inventor to appropriate some returns for his invention.

In recent years, increased attention to the economic implications of intellectual property has been demanded as a result of the inclusion of intellectual property in the GATT and the TRIPs agreement. Since then the focus of theoretical models on intellectual property had shifted toward the economic implications of patent protection on a North-South context, the former being producers of technology while the latter being technology users.

Majority of these models are in broad agreement that intellectual property protection would most often benefit the North and put developing countries at a disadvantage. They have failed to recognise, however, that a regime of patent protection from the point of view of developing countries will have two opposing effects. Firms in the developing countries could benefit from the increased access to new technology necessary to improve their production techniques. However, the increase in rent payments from the South to the North could be welfare reducing. The net effect then is entirely dependent on which effect dominates.

Chapter 5

Technological Capability and Philippine Economic Performance

The preceding chapter has discussed the critical elements necessary for developing countries to take advantage of the positive effects of patenting. These elements include (i) technological capability, (ii) incentives and (iii) institutions. These elements will be examined in this chapter.

The country's technological capability and economic performance is assessed vis-à-vis other East Asian countries. The control group includes ASEAN and East Asian newly industrializing countries.

Patent protection is designed to increase the output of innovations with potential commercial use and application, by creating property rights to enable the inventor to appropriate returns on his invention. Consequently, patent policy aims to induce innovations (domestic and foreign) necessary for a country's development. Like any other policy, however, its effectiveness is enhanced by other policies like the creation of a competitive environment where there is demand for innovations to improve production or to create new products and policies that increase the availability of trained manpower capable of using the innovations efficiently. This chapter reviews the technological capability, economic performance and policies of the Philippines from the early 70s to the early 90s which have implications on the likely impact of stronger patent protection in the country. Performance of the Philippines will be assessed vis-a-vis other east Asian countries. The control group include ASEAN and newly industrialising countries.

5.1 Technological Capability of the Philippines

Technological capability has three important components: production, investment and innovation (World Bank 1987). Production capability refers to the ability to operate technologies efficiently i.e. being able to produce goods at the lowest possible cost. Investment capability could be defined as a country's ability to choose the right investment projects that would generate economic activity and yield the maximum return possible. Finally, innovation capability consists of activities related to creating and putting new technologies effectively into economic practice .

Total factor productivity (TFP) growth could be decomposed into improvement in technical efficiency and technical progress. To the extent that changes in total factor productivity indicate how much of production growth is derived from the efficient use of inputs rather than on the physical increases in the quantity of inputs then it could be used as a proxy for production capability. Newly industrialising countries have high TFP growth rates (Table 5.1). This increased efficiency came from the better utilisation of installed capacity with existing technology, as well as the adoption and incorporation of new technologies. The Philippines has one of the lowest records (next to Indonesia) which indicates poor production capability.

Table 5.1 **Total factor productivity growth rates in selected east Asian countries, 1960-90**

Country	1960-90	1975-90
NICs		
Hongkong	4.7	4.3
Republic of Korea	2.4	3.3
Singapore	3.1	2.2
Taiwan	3.9	4.1
ASEAN		
Indonesia	0.8	-0.7
Malaysia	2.2	1.08
Philippines	1.0	0.2
Thaila nd	2.6	2.6

Source: Thomas, V. and Wong, Y. 1993. *The Lessons of East Asia: government policy and productivity growth, is East Asia an exception*, The World Bank, Washington, D.C.

At the micro level, the Philippines' poor production capability is also evident. It is however showing signs of improvement in recent years. Table 5.2 summarises the results of various industry studies in the Philippines carried out to evaluate the impact of trade policy reform. The ratio of domestic resource cost to shadow exchange rate was used to indicate efficiency in production. A value of less than one indicates that the industry is relatively efficient and conversely, a value greater than one indicates that the firm is relatively inefficient. The result exhibits a wide dispersion of productivity differences among various manufacturing industries. Moreover, while the ratio of domestic resource cost to shadow exchange rate indicates that most of the industries covered are relatively inefficient, the level of inefficiency has generally been declining in recent years. This reduction in inefficiency is mainly attributed to the effects of trade liberalization (Pineda 1997 and Tecson 1996) undertaken since the early 1980s.

Table 5.2 **Philippines: domestic resource cost/shadow exchange rate ratios, by manufacturing industry and end-use classification, 1983, 1988 and 1992**

PSIC	Industry	Domestic Resource Cost/Shadow Exchange Rate[a]		
		1983	1988	1992
	Consumer Goods			
311	Food	1.6	1.1	1.2
312	Other food	1.3	1.0	1.3
313	Beverages	1.9	1.2	1.1
314	Tobacco	1.7	1.2	1.3
322	Apparel	0.9	1.0	1.0
324	Footwear	0.9	1.1	1.0
332	Furniture & Fixtures exc. Metal	0.9	0.9	1.2
386	Furniture & Fixtures, Metal	4.1	2.7	3.9
	Intermediate Goods			
321	Textiles	4.9	3.5	1.6
323	Leather Products	1.3	1.6	1.4
331	Wood Products	1.1	1.4	1.4
341	Paper Products	2.8	1.9	1.3
342	Printing, Publishing	2.7	1.9	1.0
351	Industrial Chemicals	2.2	3.1	1.1
352	Other Chemicals	1.7	1.2	1.0
353	Petroleum Refineries	1.5	1.8	1.2
354	Coal and Petroleum Products	2.0	0.6	0.6
355	Rubber Products	2.1	0.9	1.0
356	Plastic Products	2.6	1.2	1.6
361	Pottery and China	6.6	1.3	1.6
362	Glass Products	2.6	1.6	1.8
363	Cement	3.4	3.1	1.7
369	Other Non-Metal Mineral Products	6.6	1.8	1.6
	Capital Goods			
371	Iron and Steel	1.7	2.3	1.2
372	Non-Ferrous Metal Basic Products	1.3	1.7	1.1
381	Fabricated Metal Products	2.6	1.8	1.8
382	Machinery except Electrical	2.8	1.4	1.2
383	Electrical Machinery	2.9	3.9	1.2
384	Transport Equipment	2.4	1.4	1.6
385	Professional and Scientific Equipment	1.1	2.7	1.5
	Total Manufacturing	1.7	1.5	1.2

Sources: Pineda, 1997. 'Effects of the Uniform Five Percent Tariff on Manufacturing', *PIDS Discussion Paper Series No. 97-16.*

Tecson, 1996. 'Philippine Manufacturing Industries and the Effects of Trade Policy Reforms on Structure and Efficiency', *Catching up with Asia's Tiger*, Vol II, Philippine Institute for Development Studies, Makati, Manila.

The incremental capital output ratio (ICOR) in Table 5.3 gives a rough measure of investment capability.[1] High ratios indicate inefficiency i.e. costly investment per unit of output derived from the investment. Furthermore, differences in ICORs reflect the capital intensiveness of industries in a particular country. Among east Asian economies in table 5.3, the Philippines has the highest ICOR, indicative of the country's poor investment capability. This is associated by Austria (1992) and the World Bank (1987) to the poor selection of projects, high cost and inefficient embodiment of the technology in projects and the poor choice of appropriate technology. In the Philippines, there are numerous accounts of comparatively poor technology choice and white elephant projects, in both the private and the public sector. In the private sector, most of the problem firms now comprise the majority of the non-performing portfolios of the Development Bank of the Philippines and the Philippine National Bank. On the other hand, in the public sector, the poor performance of public enterprises is demonstrated on their continued reliance on budgetary transfers from the national government (World Bank 1987).

Indicators of innovative capability in this study include: input measures such as research and development expenditures and the number of scientists and engineers engaged in research and development activities; and an output

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[1] ICOR measures the productivity of additional capital. In the simple Harrod Domar Growth Model (One Sector Growth Model), ICOR is assumed to be fixed and only changes in efficiency, rather than in technology can change the ratio which does not reflect reality. Later in the neoclassical models, ICOR becomes a variable and determined by the availability of savings and factor prices.

As a measure of the productivity of new investments across countries, it is important to recognize that it has some limitations. First industrial countries like the United States, and Japan tend to have higher ICOR primarily because capital is less expensive to labour. For most developing countries however, the differences in ICORs have little to do with differences in the relative scarcity of capital. The differences are more likely a result of the differences in the efficiency among countries with which capital and other inputs are managed. Second, large downturns in the economy can sometimes distort the relationship between new investment and the incremental increase in output (World Bank 1987).

measure using patents data. These measures however, should be treated with caution because of their limitations. For the research and development expenditures data, the definitions may vary across countries and it only take into account expenditures on formal research and development, not including ideas that come out during the course of production or other informal technological effort which is common in developing countries. Informal technological effort is very difficult to capture in an aggregate indicator. On the assumption that all measures of technological effort (formal or informal) are likely to be correlated, the expenditures data on formal research and development will be used as an indicator of innovation capability. Patent applications and grants to domestic residents on the other hand, may be an understated measure of innovation output because not all inventions gets patented. However, it is the most readily available indicator.

Table 5.3 **Incremental capital output ratios[a] in selected east Asian countries , 1975, 1980 and 1991**

Country	1975	1980	1991
NICs			
Hongkong	1.6	3.4	5.6
Republic of Korea	1.8	4.2	8.3
Singapore	5.7	4.7	7.0
Taiwan	2.1	5.5	3.3
ASEAN			
Indonesia	2.6	2.7	4.8
Malaysia	2.0	4.4	4.7
Philippines	2.9	7.8	1263.4[b]
Thailand	2.9	4.3	5.6

[a]ICOR is computed as the ratio of investment as a proportion of GDP in a given year to the growth of GDP in the following year.
[b]Figure for the Philippines is high because GDP growth rate for 1991-92 is too low.

Source: Author's calculation and basic data from the International Economic Data Bank, The Australian National University, based on World Bank Data, 1994.

The Philippines engages in relatively less formal technological effort than its Asian neighbours (Table 5.4). The share of research and development spending to GDP is negligible. Also, the government accounts for around 66 per cent of total research and development expenditures while, private industry accounts for only 16 per cent. The rest is for higher education and other non profit organisations. This is in direct contrast to the newly industrialising countries and Thailand, where the productive private sector accounts for the bulk of research and development expenditures. This reflects the increased effort of the productive sectors of the rapidly growing export-oriented economies to keep up with the increased competition in the international market. A classic example of this transformation is the Republic of Korea, which experienced a complete reversal in its shares of research and development spending. Prior to the country's take off, the government accounted for the majority of the research and development expenditures. But by the late 1980s, the private sector had become a major investor in research for its development.

Table 5.4 **Research and development indicators[a] in selected east Asian countries, 1970 and 1986**

Country	Applied R&D/GDP (in per cent) All Sectors		Applied R&D/Value Added (in per cent) Agriculture		Applied R&D/Value Added (in per cent) Industry		Scientists & Engineers Engaged in R&D in 1986	
	1970	1986	1970	1986	1970	1986	Total	Per 1,000 Workers in Mfg.
NICs								
Republic of Korea	0.5	1.8	0.4	0.6	1.4	4.0	32,117	11.9
Singapore	0.1	0.5	..	..	0.3	1.3	2,401	9.4
ASEAN								
Indonesia	0.1	0.3	0.3	0.4	0.2	0.6	24,895	5.6
Philippines	0.2	0.2	0.4	0.2	0.3	0.5	4816	1.09
Thailand	0.3	0.3	0.9	0.6	0.2	0.6	..	..

[a]R&D expenditures for industry is computed to be the difference between total R&D expenditures in agriculture.

Sources: Evenson, R. 1990. *Strengthening Protection of Intellectual Property in Developing Countries*, World Bank Discussion Paper 112, The World Bank, Washington.
International Economic Data Bank, The Australian National University, based on World Bank Data, 1991.

The ratio of scientists and engineers engaged in research and development to total employment in the manufacturing sector shows the Republic of Korea still leads the ASEAN and the newly industrialising countries. Again, the Philippines came bottom of the list.

The same conclusion is drawn from using patents data as a measure of innovative capability. Two measures of innovative output namely invention and utility patents are presented in Table 5.5. The former covers formal technological effort. The latter reflects adaptive innovations. Utility patents are a useful proxy for informal technological effort since they have a lower invention requirement. In practice, inventions covered by utility patents do not require novelty vis-a-vis international inventions but only vis-a-vis national or regional inventions (Medalla, Mikklesen and Evenson 1982). Among the ASEAN and the newly industrialising countries, only the Philippines and the Republic of Korea provide protection for such inventions.

Table 5.5 **Invention and utility patent applications and grants to domestic residents[a] in selected east Asian countries, 1990**

Country	Invention Patents per Million Population in 1990		Utility Patents per Million Population in 1990	
	Applications	Grants	Applications	Grants
NICs				
Hongkong	3.7	4.0	..	..
Republic of Korea	211.7	59.5	481.5	112.9
ASEAN				
Malaysia	5.2	1.3	..	..
Philippines	2.4	0.5	6.0	3.1
Thailand	1.3	0.1	..	..

[a]1990 invention patents data and 1989 utility patents data.

Sources: World Intellectual Property Organisation, ***World Industrial Property Statistics***, 1990.
International Economic Data Bank, The Australian National University, based on World Bank Data, 1994.

5.2 Overall Economic Performance

Economic performance follows the same pattern as technological capability, the Philippines is the weakest among the control group. Its lack of technological capability has been associated with slower industrialisation. In terms of economic growth, the country has been out-performed by its Asian neighbours (see Table 5.6). The Philippines achieved high growth rates in the 70s but the economy slowed down in the beginning of the 1980s. 1986-89 was a period of recovery after experiencing negative growth rates during the political crisis of the early 80s. That spurt of growth was also short lived as adverse shocks like the coup attempt of 1989, the earthquake of 1990, the Gulf crisis in August of 1990 and the continued power shortages which constrained domestic capacity since 1991 all appeared to reduce confidence.

The Philippines poor technological capability has hampered development in two respects. First, it constrained the growth of the Philippine manufacturing sector, which accounts for a quarter of its gross domestic product in 1992 (see Table 5.7). Average growth rate for over two decades has been very low compared to the other ASEAN and the newly industrialising countries principally due to poor productivity performance (Austria 1992).

Table 5.6 **Average annual growth rate of real GDP in selected east Asian countries, 1961-92**, in percent

Country	1961-1970	1971-1980	1981-1990	1991-1992
NICs				
Hongkong	9.4	9.5	7.9	5.0
Republic of Korea	8.4	8.7	9.2	4.7
Singapore	8.9	7.0	7.6	5.8
Taiwan	9.7	9.8	6.4	6.5
ASEAN				
Indonesia	3.9	7.2	5.7	6.3
Malaysia	6.5	7.9	6.0	7.9
Philippines	5.2	6.2	1.8	0.0
Thailand	8.2	6.7	8.0	7.3

Sources: International Economic Data Bank, The Australian National University, based on World Bank Data, 1994.
Asian Development Bank, ***Key Indicators of Developing Asian and Pacific Countries,*** various issues.

Secondly, technological backwardness hindered the diversification of domestic manufacturing toward the production of more sophisticated products. While its Asian neighbours have diversified away from traditional industries, manufacturing in the Philippines has remained predominantly traditional (Table 5.8).

Table 5.7 **Selected east Asian countries: industrial performance in manufacturing, 1963-92,** in per cent

Country	Manufacturing as a proportion of GDP, 1992	Average Growth Rate of Manufacturing		
		1963-1973	1974-1983	1984-1992
NICs				
Hongkong	14.7	8.5	8.0	..
Republic of Korea	32.0	20.0	13.2	11.2
Singapore	27.9	17.0	7.0	7.8
Taiwan	32.9	16.4	12.9	..
ASEAN				
Indonesia	21.0	6.1	14.7	11.8
Malaysia	28.8	6.6	9.2	11.2
Philippines	25.1	8.1	2.3	0.0
Thailand	28.3	13.0	7.9	11.2

Sources: International Economic Data Bank, The Australian National University, based on World Bank Data, 1994.
Asian Development Bank, ***Key Indicators of Developing Asian and Pacific Countries,*** various issues.

Table 5.8 **Structure of industrial manufacturing activity in selected east Asian countries, 1970, 1980 and 1990,** in per cent

Country	Traditional Goods[a]			Capital Goods[b]		
	1970[c]	1980	1990	1970[c]	1980	1990
NICs						
Hongkong	54.3	44.2	21.6	13.7	19.1	22.1
Republic of Korea	40.4	30.3	20.0	11.2	15.6	32.2
Singapore	19.2	10.4	7.0	14.9	30.3	52.5
Taiwan	39.3	30.3	25.8	16.0	19.4	29.9
ASEAN						
Indonesia	79.2	46.4	41.8	1.8	12.8	11.3
Malaysia	31.0	35.7	21.6	6.9	17.6	33.2
Philippines	44.7	37.4	54.0	8.0	10.3	11.6
Thailand	56.7	51.7	48.9	9.6	11.67	13.4

[a] Traditional industries include food processing, beverages, tobacco, textiles and clothing.
[b] Capital goods just consider machinery, electrical machinery and transport equipment.
[c] 1973 for Hongkong and 1976 for Taiwan.

Source: International Economic Data Bank, The Australian National University, UNIDO, 1994.

5.3 Technology Policy in the Philippines

The Philippine economy is the weakest performer in Southeast Asia. The review on the technological capability, economic growth and industrial performance highlighted that it is lagging behind its neighbours in almost all indicators considered. This is surprising for a country that was rated next to Japan in the 1950s, with better prospects than the Republic of Korea in the 1960s. What has gone wrong in the Philippines? What are the factors that contributed to the poor technological capability and industrial performance of the Philippines relative to its Asian neighbours? Poor technology policies have clearly not helped.

Technology acquisition.

Developing countries can gain access to new technology in several ways. They can encourage direct foreign investment to bring in technology, it can purchase elements of needed technology through licensing agreements, it can import capital goods, or it can develop its own. The importance of new available technologies in inducing technological capabilities of a country raises concern on appropriate policies necessary to facilitate acquisition of foreign technology, diffusion, and development of own innovative activities.

•*Foreign direct investment.* The Philippines has taken active steps to attract foreign investment as a source of technology transfer. The country is in theory open to direct foreign investments, although there are restrictions on the maximum degree of foreign ownership. Foreign investment is allowed in all areas of economic activity. However, industrial investment is regulated once foreign equity participation exceeds 30 percent of capital stock, in which case approvals are required from the Board of Investment (World Bank 1987). In the 1990s, the commitment of the government to attract foreign investment is manifested with the enactment of the Foreign Investment Act of 1991. The new system drastically reduced the areas where foreign investment is not allowed.

The distribution of foreign direct investments among industrial sectors appear to favour less traditional industries (Table 5.9), although a large share is in "unclassified industries". This somehow manifests an achievement in the area of managing foreign direct investment where it was geared toward less traditional industries where it has greater contribution to the economy in terms of acquiring new technology. That foreign direct investment has gone to sectors where it has greatest potential to contribute to new technology acquisition manifests an achievement.

Table 5.9 **Selected east Asian countries: distribution of foreign equity investment in manufacturing, by industry, 1975, 1985 and 1991, in percent**

Industry	1975	1985	1991
Chemicals	11.6	26.5	25.6
Food	12.0	22.1	17.0
Basic Metals	15.0	10.6	9.8
Textiles	8.2	4.4	5.0
Transport Equipment	3.0	7.9	7.3
Petroleum	13.8	6.2	5.0
Metal Products	12.7	2.6	2.6
Others	23.8	19.8	28.1
Total	100.0	100.0	100.0

Source: Board of Investment, Department of Trade and Industry, Philippines, unpublished data.

Compared with its neighbours, the Philippine policies toward foreign direct investment are open and reasonable. However, foreign investment inflows in recent years have been declining and not keeping up with other countries (Table 5.10). Portfolio investment in 1990 decreased 61 per cent from the preceding year. There are a number of factors which affect investment decisions of prospective investors but a favourable investment environment is a major consideration. Investment incentives in the Philippines are by and large competitive but, it has lagged behind in the implementation of major policy reforms such as deregulation of industries and the lessening of bureaucratic procedures that face the potential investor. Poor economic performance is also a major disincentive to foreign direct investment.

Table 5.10 **Selected east Asian countries: foreign direct investment as a percentage of GDP, 1975, 1985 and 1992**

Country	1975	1985	1992
NICs			
Hongkong	0.0	0.8	0.3
Republic of Korea	0.2	0.2	-0.2
Singapore	4.5	4.6	9.3
Taiwan	0.2	0.4	-0.3
ASEAN			
Indonesia	1.5	0.4	1.4
Malaysia	3.6	2.2	7.8
Philippines	0.6	0.0	0.4
Thailand	0.2	0.4	1.8

Source: International Economic Data Bank, The Australian National University, based on World Bank Data, 1994.

•*Technology transfer.* The transfer of technology to the Philippines is regulated by the Bureau of Patents, Trademarks and Technology Transfer (BPTTT) which is attached to the Department of Trade and Industry. Since the 1970s, control levels have been implemented to reduce foreign exchange disbursements, because of balance of payments problems; in 1984 disbursements were cut by around 96 percent when the balance of payment crisis were at its height (Appendix 5.1).

The BPTTT facilitates technology transfer agreements with foreign nationals or companies for the use and exploitation of patents and trademarks, technical know-how information and technical services. Under the Bureau's rules and regulation the enterprises applying for technology transfer agreements must submit audited financial statements, proof of patent or trademark registration and information about the supplier of technology along with the application form. The Bureau examines the application and makes decisions (normally within 60 days) based on the appropriateness of technology and reasonableness of the payment. It evaluates the restrictive business clauses demanded by technology suppliers, such as limits on exports, access to new technology and 'tied purchases' of inputs from the technology suppliers to make sure that domestic industries will not be disadvantaged. If the contract is approved, the firm gets a Certificate of Registration which is necessary for foreign exchange remittances and to qualify for government payments. In the Philippines, there is a general provision that royalty payments are set at five per cent of sales and the duration of technology transfer agreements is set at five years.

From 1979 to 1991, the Bureau registered 1298 agreements. In 1990, it estimates that the projects made possible by the imported technology generated 21 billion pesos worth of exports and generated 75,000 jobs. The Technology Transfer Registry also recorded export sales of licensed products contributed around US$ 6 billion to foreign exchange earnings. The licensed products penetrated export markets as a result of improved quality arising from technology transfer.

In terms of assets transferred, there has been a strong preference for bundles rather than single elements of technology transfer (Table 5.11). Among the single elements, knowhow is the most prevalent type of asset transferred. It involves training and personal interaction between technology recipients and suppliers.

Table 5.11 **Philippines: distribution of types of asset transferred in technology transfer agreements , 1979-91,** in percent

Types of Asset Transferred	Shares
Patents, trademarks, knowhow	26.6
Patents, trademarks	0.9
Patents, knowhow	5.7
Trademarks, knowhow	24.3
Patents	0.1
Trademarks	9.5
Knowhow	17.6
Consultancy	9.5
Software	2.5
Management	1.6
Distributorship	0.7
Total	100.0

Source: Bureau of Patents Trademarks and Technology Transfer, Philippines, unpublished data.

The distribution of technology transfer agreements among Philippine manufacturing industries, indicates that the transfers of technology were concentrated in non-traditional industries as was the case with foreign investments (Table 5.12). In particular, technology transfer agreements are most common in the chemical and drug industries which require sophisticated technology.

Table 5.12. **Philippines: industry distribution of technology transfer agreements, 1980, 1985 and 1992,** in percent

Country	1980	1985	1992
Food and Beverage	13.1	14.5	18.3
Chemical and Drugs	20.5	38.2	45.2
Basic Metals and Metals Products	8.2	10.9	4.3
Electrical Machinery	18.0	14.5	9.7
Transport Equipment	13.8	10.9	2.2
Others	26.2	11.0	20.3
Total	100.0	100.0	100.0

Source: Bureau of Patents Trademarks and Technology Transfer, Philippines, unpublished data.

•*Capital good imports.* The importation of capital goods with embodied technology is an important source of foreign technology. Technical assistance from the equipment manufacturer is also important although it is not registered as a formal technology transfer. The importation of capital equipment has generally been less restrictive than final good imports. Nevertheless, the Philippines, like Indonesia and Thailand has relied less on technology imports than the newly industrialising countries (Table 5.13). The relatively unrestricted access to imported capital goods in the Philippines, may have reduced the need for this mode of technology transfer. This is in direct contrast to the experience of the Republic of Korea in the 1960s when it relied heavily on capital good imports as part of its early industrialisation efforts. Through reverse engineering South Korea has developed its own local and export-oriented capital goods industry. Capital goods import has been low in recent years.

Table 5.13 **Selected east Asian countries: capital good imports[a] as a proportion of gross domestic investment, 1975, 1985 and 1992,** in per cent

Country	1975	1985	1992
NICs			
Hongkong	49.6	94.2	134.1
Republic of Korea	33.4	39.4	24.9
Singapore	94.1	109.1	174.8
Taiwan	40.7	52.9	57.5
ASEAN			
Indonesia	23.3	14.8	26.6
Malaysia	46.8	63.8	109.0
Philippines	26.2	16.3	36.8
Thailand	28.7	28.9	37.6

[a]Includes machinery and transport equipment.

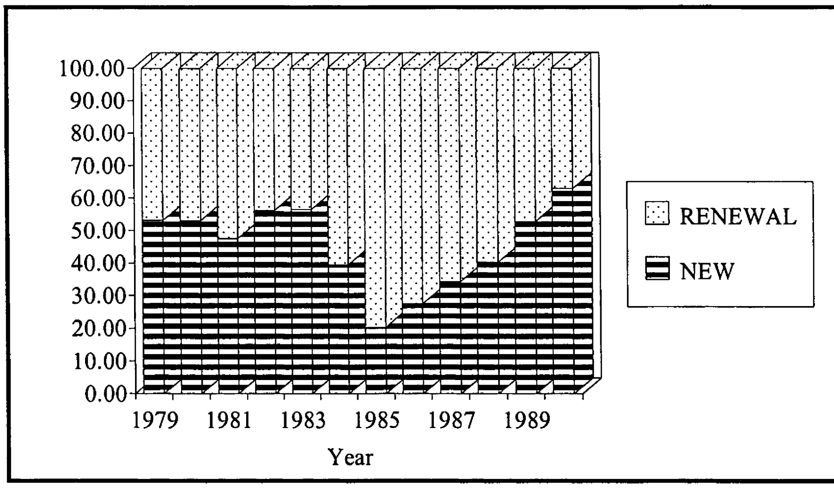
Sources: International Economic Data Bank, The Australian National University, based on World Bank Data, December 1994.
International Economic Data Bank, The Australian National University, based on United Nations Trade Data, February 1995.

Diffusion

In the Philippines, various institutions have been set up in order to facilitate the diffusion of technology, both at the international and national levels as part of its science and technology master plan. However, two factors have hampered technological diffusion: the lack of information about available technology because of poor access to international networks and the lack of capacity in domestic firms to use the information available. The Technology and Livelihood Resource Center (TLRC) formerly known as the Technology Resource Center) claims to be linked to international databanks. But long delays in getting information discourages most firms from using it (World Bank 1987). TLRC is more active in the diffusion of national technology but it is limited to agriculture, home industries and small enterprise (World Bank 1987). Other government institutions do not provide good information services.

A serious problem is the failure to make the most of technology transfers. An indicator of this is the proportion of agreements in a given year that represent contract renewals, implying that transfers are not efficiently absorbed and used to satisfy local needs (Figure 5.1 and Appendix 5.3). At the micro level, engineering firms provide a perspective into the problem of diffusion. Technology transfer in this sector has been limited to fabrication or assembly of a product without little regard to explaining why the product has to be put together in a particular way. This practice limits the local manufacturers' understanding of the standards and tolerances built into the product, the quality and components used, the strength specification and other design features which the original design team sought to maximise performance and minimise the cost of the product (World Bank 1987). Without this knowledge, diffusion of technology even within a firm is limited.

Figure 5.1
Philippines: distribution of technology transfer agreements classified as new or renewal, 1979-90



Source: Bureau of Patents, Trademarks and Technology Transfer, Philippines, unpublished data.

Human capital stock and own R&D

One important element for technological development is technical skills in the workforce which depends on training and skill standards. Data on educational attainment are shown in Table 5.14. Primary education in the control group are at similar levels (i.e. above 95 percent) in recent years. Variations between ASEAN members and the newly industrialising countries appear in secondary education. Secondary education in the Philippines is the highest among the ASEAN countries apart from Singapore, because basic education policy is effective.

For higher education, the Republic of Korea is at the top with 32 per cent coverage, which is comparable to other industrialised countries. The Philippines is second after the Republic of Korea. 22 percent of higher education enrolments in the Republic of Korea were in the technical education, engineering, architecture, mathematics and computer related courses in 1988. The Philippines had a similar proportion, registering around 20 percent in 1985.

Table 5.14 **Educational attainment in selected east Asian countries**

Country	Numbers Enrolled in School as a percentage of Age Group[a]						Adult Literacy Rate[b]
	Primary		Secondary		Higher Education		
	1965	1985	1965	1985	1965	1985	1990
NICs							
Hongkong	103	105	29	69	5	13	88
Republic of Korea	101	96	35	94	6	32	96
Singapore	105	115	45	71	10	12	87
Taiwan	97	100	38	91	7	13	83
ASEAN							
Indonesia	72	115	12	37	1	4	77
Malaysia	90	99	28	53	2	6	78
Philippines	113	114	41	63	19	26	90
Thailand	78	97	14	30	2	20	93

[a]1965 and 1983 for Indonesia and the Philippines.
[b]1983 for Taiwan and 1989 for Honkong.

Sources: Asian Development Bank. 1991. ***Key Indicators of Developing Asian and Pacific Countries.***
Lall, S. 1990. *Building Industrial Competitiveness in Developing Countries*, OECD Publication, Paris.
World Bank. 1986. ***World Development Report,*** The World Bank, Washington.
International Economic Data Bank, The Australian National University, based on World Bank Data, 1994.

While the Philippines has one of the highest potential stocks of scientists and engineers among Asian developing countries (Table 5.15), this record is not evident in the actual proportion of scientist and engineers engaged in research and development. This may be indicative of the quality of local training. Most engineering schools only have bachelor's programs; in 1992 only one offered graduate studies in engineering.

To encourage domestic innovation in the private sector the Philippine government created the Philippine Invention Development Institute to help local inventors obtain patents and to put inventions into commercial use. The absence of substantial government programs to support technology-related initiatives in industry, coupled with the lack of competitive market pressure because of protection, has constrained the research and development efforts of Philippine industries. The government accounts for the majority of research and development expenditures in the Philippines. Publicly funded research and development activities, however, do not provide much returns to the economy because its output has been unresponsive to the needs of domestic industries. Most of the outputs from these publicly funded researches do not give commercial returns, which diminishes the technology links between the public and the private sectors (World Bank 1987).

Table 5.15 **Selected east Asian countries: potential scientists and engineers versus actual scientists and engineers engaged in R&D**

Country	Year	Potential Scientists and Engineers per Million Population	Year	Actual Scientists and Engineers Engaged in R&D per Million Population	Scientists and Engineers Engaged in R&D as a percentage of Potential Stock
NICs					
Hongkong	1986	26,458.7		..	..
Republic of Korea	1986	8,706.0	1986	1,142.4	13.1
Singapore	1980	14,303.6	1981	488.9	3.4
Taiwan		..		..	..
ASEAN					
Indonesia	1980	1,305.5	1982	116.0	8.9
Malaysia	1982	1,793.1		..	..
Philippines	1980	36,646.5	1984	100.0	0.3
Thailand	1975	471.8		..	..

Sources: United Nations Educational, Scientific and Cultural Organisation. 1990. Statistical Yearbook, UNESCO, Paris.
Lall, S. 1990. *Building Industrial Competitiveness in Developing Countries*, OECD Publication, Paris.
World Bank. 1987. *The Philippines: issues and policies in the industrial sector*, Volume 2, The World Bank, Washington.

The Department of Science and Technology[2] is the main institution responsible for science and technology in the Philippines. As a consequence of the country's poor R&D efforts, with its implications for productivity growth, a Presidential task force was set up in August 1988 to draw up the Science and Technology Master Plan (STMP). The plan generally sets out the desired goals and objectives for the science and technology sector[3] to achieve technological development. The objectives include the modernisation of

[2] Formerly known as the National Science and Technology Authority.

[3]The science and technology sector consists of the Department of Science and Technology system, other government agencies, private sector, and colleges and universities undertaking science and technology activities.

productive sectors, upgrading of R&D activities and the development of science and technology infrastructure. To achieve these objectives, the main policies and strategies to be employed are: (i) generation and active diffusion of employment-oriented and high value-added technologies, (ii) emphasis on developmental research and development for commercial purposes, (iii) proper selection and acquisition of essential and appropriate technologies, (iv) adaptation, absorption, and mastery of imported technologies, (v) dissemination of appropriate technology, (vi) increasing accessibility to science and technology information and services, (vii) establishing research and development priorities, development of local materials and indigenous technologies, (viii) stimulation of private sector participation, (ix) development of high quality science and technology manpower, (x) expansion of science and technology education and training and (xi) the development of science and technology institutions. While these policies are commendable, the country's development of technological capability requires more efficient coordination between science and technology institutions. In the past, the Philippine government had set up various institutions to facilitate the development of the country's technological capability. While these institutions achieved a number of objectives, evidence shows that its success is always incomplete as the Technology and Livelihood Resource Center and the Philippine Invention Development Institute. The effectiveness of these government agencies would be enhanced if there is proper coordination among science and technology institutions and industry, each working in an integrated system with the industrial sector. In particular, the Department of Science and Technology and its attached agencies need to work closely with the Department of Trade and Industry and the education sector to strengthen technology information services and technology infrastructure.

5.4 Trade and Industrial Policies

The Philippines could be considered as a middle-income country with a small open economy. The country's present industrial structure has been essentially been the same as it was in the 1970s when it was characterised as a dualistic economy. A small proportion of the labor force is employed in the capital-intensive manufacturing sector behind protection barriers and the remainder of the population is absorbed by the less productive agricultural and urban service sectors (Table 5.16).

Table 5.16 **Philippines: structure of employment and output, 1985 and 1992**

Sector	Share of GDP, in percent		Share in Total Employment, in percent		Output Per Worker, in Million Pesos	
	1985	1992	1985	1992	1985	1992
Agriculture	24.6	21.7	49.0	45.4	0.01	0.03
Manufacturing	25.2	24.5	9.7	10.6	0.07	0.13
Services	40.3	45.0	36.8	38.5	0.03	0.06

Source: National Statistical Coordination Board, 1993. *Philippine Statistical Yearbook*, National Statistical and Coordination Board, Manila.

This structure has not been effective in generating productivity growth. The sluggishness of productivity growth in the Philippines is largely attributed to the many industries that have remained dependent on small domestic markets (World Bank 1987; 1993). The population is relatively large but the majority of its population is poor (Table 5.17). Less of their income is spent on sophisticated manufactures (Krugman 1990).

Table 5.17 **Per capita income of selected east Asian countries, 1985, 1990 and 1992,** in current US dollars

Country	1985	1990	1992
NICs			
Hongkong	6,120	11,950	15,360
Republic of Korea	2,340	5,450	6,790
Singapore	7,800	12,400	15,730
Taiwan	3,113	7,905	10,154
ASEAN			
Indonesia	580	560	670
Malaysia	1,980	2,360	2,790
Philippines	540	730	770
Thailand	810	1470	1,840

Sources: International Economic Databank, The Australian National University, United Nations Industrial Organisation, 1994.

The disadvantages and limitations of inward-oriented industrialisation is well documented in the trade literature (Cody, et al. 1980; Hughes 1988; World Bank 1993). This is exacerbated when the market is small as in the case of the Philippines because the size of the market limits specialisation. The car industry in the Philippines illustrates this point. The size of the domestic market is too small to enable the firm to attain efficient scale of production. In 1980, there were five car producers and annual production was placed at 26,000 units. Eight years later in 1988, only two producers were left and production declined to 10,800 units; average output per firm was on average 5,400. This is far behind industrial countries where an average producer produces 200,000 units annually in an individual assembly plant (Krugman 1990).

The experience of the newly industrialising economies provides a good solution for the Philippine economy. The solution is to specialise in a limited range of goods for export, rather than producing the full range for domestic consumption. Recognising that an export-oriented industrialisation is a critical pillar of economic development, the Philippines attempted to shift toward export promotion early in the 1970s. Export expanded significantly following the enactment of Export Incentives Act (Year) and the creation of export processing zones. The structure of exports also changed in the 1970s when non-traditional exports, like garments and electronics produced on a consignment basis, grew remarkably (Tecson and Nohara 1987). The increase in the share of export in GDP and the share of manufactures in total exports is shown in table 5.18. This indicates a significant transformation of the economy toward export promotion. However, the achievements are superficial. Despite some improvement in the Philippine export performance in recent years, outward orientation in its industries remains an illusion.

Table 5.18 **Philippines trade and outward orientation, 1975, 1985 and 1992,** in percent

Indicator	1975	1985	1992
Exports as a percentage of GDP	14.9	14.9	18.7
Imports as percentage of GDP	25.4	17.7	29.5
Manufactures Share to Total Exports	17.7	56.8	73.0
Commodity Share of Manufactured Exports			
Electrical Machinery[a]	0.6	10.6	19.0
Clothing[b]	8.4	10.1	11.9

[a] Electrical machinery includes 7221, 7222, 7231, 7232, 7241, 7242, 7249, 7250, 7262, 7291, 7292, 7293,7294, 7295, 7296, 7299 of the Standard International Trade Classification

[b] Clothing includes 8411, 8412, 8413, 8414, 8415, 8420 of the Standard International Trade Classification

Sources: International Economic Data Bank, The Australian National University, based on World Bank Data, 1994.
International Economic Data Bank, The Australian National University, based on United Nations Trade Data, 1995.

Non-traditional exports are dominated by labor-intensive assembly activities which ease the unemployment problem of the country but, this production is very import intensive. These industries add just a small fraction of value added to imported components, then re-export them. For example, the semi-conductor industry in 1987 accounted for 10 per cent of total exports, which appears to be significant (Table 5.19). In reality, its contribution to employment and value added was minimal.

Table 5.19 **Philippines: semi-conductor industry, 1987**

Indicator	Value, in Million US dollars	Percentage Contribution to Philippine Economy	Percentage of Manufacturing
Exports	586	10.2	15.9
Imported Inputs	447	0.4	
Value Added	139	0.1	1.6
Employment (in thousands)	29		1.4

Source: Krugman, P., Alm, J., Collins, S., and Remolona, A. 1992. ***Transforming the Philippine Economy, APO Production Unit, Inc., Quezon City.***

The production of low value-added manufactured exports has little effect in restructuring the manufacturing industry. Much of the production of such goods takes place in export processing zones where linkages with the rest of the economy are weak. Imports for the promoted export industries are duty free, which means that inter-industry transactions are low, and there is a bias against potential domestic supplier of inputs. This is the reason why, despite the expansion of non-traditional exports like garments and electronics, the product shares of different industries in the manufacturing sector have changed little. The structure of industry remains more or less the same between 1970 and 1991 (Table 5.20).

The lack of structural transformation in Philippine industries, even in recent times, is explained by the maintenance of protectionist trade policy. The Philippines adopted an import-substitution regime in the 1950s. The country began to shift toward promoting exports in the 70s; however export promotion policies have done little to offset the bias against exports brought about by currency overvaluation and import tariffs. Moves toward liberalising trade began to be observed in the early 1980s but lost political momentum with the balance of payments crisis of 1983 to 1985.

Estimates of average effective protection rates for the key sectors of the economy (Table 5.21) show the protectionist orientation of trade policy. In spite of claims of outward orientation, trade and industry strategy has remained the same. It discourages exports and perpetuates inefficient industries through excessive protection. Consequently, it diminish any motivation to innovate or seek new technologies.

Table 5.20 **Philippines: product shares manufacturing, 1970, 1980 and 1991,** in percent

Industry	1970	1980	1991
Food	30.0	36.3	22.6
Beverages	5.0	3.2	7.1
Tobacco	6.6	4.5	3.4
Textile	5.9	4.5	4.3
Footwear and wearing apparel	3.8	4.4	4.7
Wood and cork products	4.2	2.9	3.5
Furniture and fixtures	0.7	0.5	1.2.
Paper and paper products	2.9	0.8	2.6
Publishing and printing	2.2	1.4	1.2
Leather and leather products	0.2	0.3	0.2
Rubber products	1.4	1.3	2.2
Chemical products	7.9	10.2	10.9
Petroleum and coal	7.2	5.9	12.3
Non metallic mineral products	4.2	2.5	4.0
Basic metals	4.2	3.7	4.2
Metal Products	3.1	4.5	4.3
Machinery	1.5	3.1	1.0
Electrical Machinery	3.0	5.0	6.7
Transport Equipment	4.2	3.8	2.3
Miscellaneous	1.4	1.1	0.8
Total	100.0	100.0	100.0

Sources: National Statistical Coordination Board, *Philippine Statistical Yearbook*, various issues. International Economic Data Bank, The Australian National University, based on United Nations Industrial Organisation, 1994

Table 5.21 **Philippines: average effective rates of protection[a], 1985, 1986 and 1988,** in per cent

Sectors	1985	1986	1988
Agriculture and Primary	21	15	15
Exportables	-7	-1	-1
Importables	82	51	51
Manufacturing	73	60	56
Exportables	-5	-1	-1
Importables	107	87	80
All Sectors	49	39	37
Exportables	-7	-4	-4
Importables	102	81	75

[a] The average ERP by major sectors was computed using the free-trade value added as weights. The ERP measure uses price comparisons rather than book rates and includes effective protection from tariffs, indirect taxes and quantitative restrictions.

Source: Medalla, E. 1990. *An Assessment of Trade and Industrial Policy, 1986-1988*, Philippine Institute for Development Studies Working Paper No. 90-07, Makati, Manila.

Investment policies in the Philippines have also distorted technology choice by encouraging capital intensive industries. By favouring import-substituting industries, technological efforts are geared to product development rather than to cost reduction of production. The Board of Investment (BOI) provides a system of investment incentives (tax holidays, duty free imports of capital goods) which promotes capital-intensive manufacturing. A comparison of the capital intensities between producers for the domestic market and export producers shows that an export-oriented industry tends to generate employment more than an inward-looking industry (Table 5.22).

Table 5.22 **Philippines: characteristics of BOI approved investments, 1982 and 1988**

Indicator	1982	1988
Domestic Producers:		
Value (in Million Pesos)	102.5	48.0
Capital-labor ratio	1,783.0	560.0
Export Producers		
Value (in Million Pesos)	25.9	63.7
Capital-labor ratio	149.0	154.0

Source: Krugman, P., Alm, J., Collins, S., and Remolona, A. 1992. ***Transforming the Philippine Economy, APO Production Unit, Inc., Quezon City.***

Export promotion depends on a realistic and competitive exchange rate. The history of exchange rate policy in the Philippines is a record of delayed responses, followed by large fluctuations in the exchange rate. Devaluation follows the emergence of a balance of payment crisis (Dohner and Intal 1989). Real exchange rate indices of different countries show the Philippines' real exchange rate, using 1970 as base year, was on average, 6 percent above the 1970 rate in the early 1980s (Table 5.23). In 1990 the peso in real terms had depreciated by 30 percent since 1970. Other ASEAN countries, however, allowed much larger depreciations. In Thailand the depreciation was around 46 percent, in Malaysia 49 percent and in Indonesia 64 percent (Krugman 1992).

Table 5.23 **Real exchange rate indices in selected east Asian countries:, (1970=100)**

Year	Philippines	Malaysia	Thailand	Indonesia
1970	100.0	100.0	100.0	100.0
1980-1982	106.4	79.7	80.9	89.9
1989	72.3	52.9	56.4	35.7
1990	69.9	51.4	54.4	35.7

Source: Krugman, P., Alm, J., Collins, S., and Remolona, A. 1992. ***Transforming the Philippine Economy, APO Production Unit, Inc., Quezon City.***

In retrospect, prolonged periods of trade protection policy in the Philippines has negatively impacted the degree of technological acquisition in the country.

First, limiting competition with imports through the use of tariffs and other import restrictions has reduced the need for technological acquisition. Tariff and other non-tariff barriers have raised the domestic price of imports, enabling local producers of import substitutes to operate at higher prices relative to free trade prices, thereby increasing their profitability and stifling the pressure for firms to adopt 'best practice' technology. The absence of foreign competition has allowed domestic firms to enjoy excess profit while producing at sub-optimal levels. This then gives domestic producers an incentive to spend more time in rent-seeking activities to ask for more protection instead of finding ways to cut cost and improve production techniques.

The country's textile manufacturing industry has been a classic example in on the impact of trade protectionist policy on the motivation of firms to innovate. Since the 1950s the industry enjoyed high effective rates of protection. Austria (1996) found that even in 1983 when the country had promoted non-traditional exports like clothing and apparel, the effective rates of protection for textile primary and secondary industries still remained high at 90.6 per cent and 111.8 per cent respectively. It is not surprising then to see that prior to the reform in the late 1980s, more than 70 per cent of the firms in the textile industry (both primary and secondary) are considered as very inefficient based on DRC- SER ratio Austria (1996).[4] The inefficiencies in production coupled with the lack of motivation of firms to invest in research

[4] The definition used more than 1.5 in DSR-SER ratio is classified as highly inefficient.

and development activities negatively impacted the industry's competitiveness. The lack of incentive to innovate became apparent when most firms in the industry did not take advantage of the *Textile Modernization Program* (TMP).

The main objective of the TMP is to rehabilitate the industry by addressing some of its operating and structural problems. The program implemented in 1982 to 1985 was funded by the World Bank and loans were made available for firms that want to improve their technological capability. The program however, did not succeed since only a handful of firms in the industry availed of the loan, thus, the loan was returned to the World Bank in 1984 (Austria 1996; WB 1987).

Second, too much protection hindered firms from being introduced to international best practice. The Philippines aiming to generate more export revenues in the 1970s, develop intermediate parts manufacturing and save foreign exchange implemented localization programs for motor vehicles, consumer electronics and diesel engines. Participating firms were required to use locally produced inputs in the production of final consumer goods. In the case of the motorcycle industry for example, foreign exchange was allocated for completely–knocked down imports. The allocation however of foreign exchange was based on the firm's market share and the satisfaction of the local content targets. While the local content requirement benefited the suppliers, the Philippine experience had shown that it came with a high cost to society and after more than two decades of pursuing the local content program, the promise of export generation, the development of intermediate parts manufacturing, and efficiency in saving foreign exchange was not completely fulfilled (Pineda 1996).

The Philippine motorcycle industry demonstrates the failure of a protection-led-export-promotion policies. This failure is attributed to the narrowness of the domestic market, the input constraint that penalized the export sector and the foreign exchange undervaluation resulting from pervasive protection (Krugman 1990). If local inputs are competitive with imports then the local content requirement is unnecessary. However, in the Philippines the local inputs for motorcycle parts are more expensive and are of inferior quality. With no free access to a lower-priced or higher quality inputs, domestic firms were not introduced to best- practice technology. Worst of all, there are claims from industry sources that domestic producers are not making money from exports because the locally produced goods are uncompetitive in the international market (Pineda 1996). The restrictive trade regime had limited the country's ability to exploit a full range of technological possibilities which largely depends on a broader range of inputs than what was produced locally.

Third, trade protection policies suppressed competition even among domestic firms and as a result have negatively impacted technological acquisition. Policies like quantitative restrictions, import licensing and various incentive programs made available to selected firms in specific industries have allowed domestic firms to exercise market power and have bred an oligopolistic market structure. In the absence of competitive pressures, firms were not force to adopt 'best-practice' technology and have engaged in rent-seeking activities instead of improving production efficiency.

The lack of competition is evident in the high degree of concentration that characterized Philippine manufacturing industries (Lindesy 1977; de Dios 1986; Tecson 1996) . Such concentration which resulted from too much protection allowed incumbents to have excess profits resulting from higher prices and lower output than what would have prevailed in a more liberal trade regime. Quantitative restrictions and import licensing have been a powerful entry barrier into industries and have limited the access of firms to foreign technology. Moreover, since the 1950s, the government enacted various legislations that granted priviledges and incentives to selected firms in specific firms which then dampened down the competitive pressure to innovate and adopt superior technology.

Fourth, imports of capital goods that embody new technology was discouraged by a protective trade regime in the Philippines. The access of firms to capital good imports was limited through the use quantitative restrictions and import licensing. Worst of all, the use of bureaucratic discretion in allocating the import licenses discriminated the entry of certain firms . In the Philippines, such restrictions tend to put small and medium sized firms at a disadvantage since they do not have the financial capability and the political clout to influence the direction of decision making (Tecson 1996). The country's chronic balance of payment problem further exacerbated the negative technological implications of a protective regime. Since foreign exchange constraints need to be imposed during balance of payment crises and allocation is again kept in the hands of the bureaucrats, some firms were denied access to imported inputs and capital goods and equipment. (Tecson 1996).

In an attempt to reform the protective structure it has built around its industries for over three decades of postwar industrialization, the Philippines since the early 1980s embarked on trade liberalization programs (Tescon 1996). The first major reform was implemented through the Tariff Reform Program (TRP1-1981 to 1985) and the Import Liberalization Program in 1980. The former was designed to lower very high tariffs and even off the dispersion of the levels of protection among and within industry sectors while the latter aimed at lifting import restrictions or regulations. The trade liberalization efforts was however cut short due to the balance of payment crisis in 1983. By the end of 1985, the number of restricted items was back to its original level in 1980.

With a new administration in 1986, the Import Liberalization program was again resumed and by the end of 1988, the number of restricted items dropped from 1802 lines in 1985 to 609 commodities in 1988. Recently liberalization measures were further expanded to include the removal of import restrictions on new motor vehicles, used trucks and buses, lifting of quantitative restrictions on sensitive agricultural products except rice and the liberalization of importation and exportation of petroleum products.

In the early 1990s, the second phase of the tariff reform program (1991-1995) got implemented through E.O. 470 which resulted to the elimination of the 40 per cent tariff, the decline in the number of lines with 50 percent tariff (from 1,172 to 208) and the increase in the number of lines with 30 percent tariff from 973 to 1,962 lines. After E.O 471, tariffs clustered around the 10, 20 and 30 percent levels (Pineda 1997).

Despite all setbacks, the trade liberalization in the Philippines have reduced the number of items subject to import restrictions (from 1,829 in 1983 to 609 in 1988). The average effective protection rate in the manufacturing sector declined from 42.8 per cent in 1983 to 28.3 percent in 1988. Moreover, the continuing trade reform in the 1990s has further decreased the average effective protection rate of the manufacturing sector to 20.7 per cent in 1992. The items subject to import restriction for both manufacturing and agricultural sectors further declined from 10.8 per cent in 1988 to 2.9 per cent in 1992 (Pineda 1997).

The impact of the above trade reforms on the manufacturing sector was examined in two related studies by Tecson (1996) and Pineda (1997). The former examined the impact of the reform in 1983 and 1988 while the latter analyzed the effects of the trade reform using 1992 NSO establishment data. Both studies indicate that trade policy reforms since the late 1980s have promoted efficiency and improved resource allocation in Philippine manufacturing. The average DRC/SER ratio for the entire Philippine manufacturing sector declined from 1.7 in 1983 to 1.5 in 1988. The ratio further declined to 1.2 in 1992, indicating a reduction in overall manufacturing inefficiency (Table 5.2).

Compared to 1983, efficient industries expanded while inefficient industries contracted in 1988. Moreover, the proportion of efficient establishments rose from 43 per cent in 1988 to 49 per cent in 1992 and the share in production of the efficient industries went up from 52 per cent in 1988 to 61 per cent in 1992.

On sectoral efficiency, Tecson (1996) found that efficient import substitution has taken place in most consumer good industries however these industries expanded at the expense of intermediate and capital goods sectors. Since these are input sectors, their inefficiencies adversely impacted the downstream industries that use them as inputs. This is in direct contrast to the Philippine ASEAN neighbours where industrialisation has been characterized by a structural change in the direction of the growing capital and intermediate good industries. The contraction of these sectors in the Philippines was largely responsible for the high degree of import dependence of its industries (Tecson 1996). In 1992 however, Pineda (1997) found that there was a significant improvement in the efficiency of the capital and intermediate good sectors in response to the trade liberalization program of the government. The average DRC/SER ratio of intermediate good sector declined significantly from 1.9 in

1988 to 1.2 in 1992 while that of the capital good sector fell from 1.5 in 1988 to 1.2 in 1992.

While all these declining inefficiencies suggest that the Philippines is responding positively to the trade reform, more work still needs to be done in order to reform the negative effects of more than three decades of protectionist policies on the Philippines' technological capability. The government's current commitment to further trade liberalization and implement another uniform 5 per cent tariff by 2004 is a step towards the right direction in creating a more liberal trade regime that is conducive to innovation and growth.

5.5 Macroeconomic Policies

Like trade and industrial policies, macroeconomic policies in the Philippines have done little to foster innovative activity in Philippine industry. Inappropriate fiscal and monetary policies have distorted technological choice and have undermined the efficient allocation of resources.

The poor revenue collection record of the government, coupled with expansionary fiscal policies in the 1970s, has caused the government to run large deficits. To finance these deficits, the Philippines' government borrowed from world financial markets in the 1970s when the real interest rates were considerably low but floating. Lenders had few worries about sovereign risk. Because of the relative ease of borrowing and the wrong signals sent to markets, government spending went unrestrained and large capital outlays went into ill-advised projects which made little contribution to output or export.

Early in the 1980s, when foreign loans dried up and real interest rates rose sharply foreign debt became a severe burden. Because investment went to projects with low rates of return, debt service costs fell on the budget deficit. The government then turned to domestic borrowing which raised interest rates at home and money creation to finance its deficits. The increased interest rates crowded out private investment while high inflation created an unstable economic climate and distorted relative prices.

Financial and monetary policies in the Philippines failed to channel savings into investments with high productivity. Policy sustained a financially repressed system, where interest rates were regulated, below the market rate. Credit rationing followed because demand for credit exceeded the supply. Moreover, the low real cost of capital gave firms the wrong price signals, hampering the efficient allocation of resources based on the productivity of capital. In the Philippines, credit rationing is achieved using expensive collaterals as a criterion for credit allocation, rather than the expected returns to capital. This type of rationing process resulted to rent-seeking activities, practiced mostly by favoured industries which were protected by the protectionist industrial and trade regime.

5.6 Conclusion

The Philippines is one of the weakest performers in Asia. Its technological capability is lagging behind its Asian neighbors. This coupled with its poor macroeconomic and industrial policies failed to create an environment that is conducive to innovate or take advantage of new technology. If such policy orientation continues then it would diminish the gains associated with a regime of stronger patent protection.

While policies affecting technology in place, the prolonged periods of trade protection policies and inappropriate macroeconomic policies distorted both technological choice and the allocation of resources in the economy.

They failed to provide the competitive environment necessary to promote innovation. Any benefits from stronger patent protection depend on changing these policy settings. The five year transitional period prescribed in the TRIPs agreement gives the Philippine government an opportunity to correct its past mistakes. The recent commitment of the government to further promote trade liberalization efforts is a step in the right direction.

Appendix 5.1 **Philippines: outward remittances for copyrights and patent royalties, 1970-1991,** in million US dollars

Year	Copyrights and Patent Royalties
1970	3
1971	3
1972	3
1973	5
1974	10
1975	11
1976	11
1977	16
1978	17
1979	18
1980	19
1981	24
1982	23
1983	23
1984	1
1985	26
1986	20
1987	31
1988	27
1989	37
1990	38
1991	56

Source: Central Bank of the Philippines, unpublished data.

Appendix 5.2 **Philippines: number of technology transfer agreements, classified as new or renewal, 1979-90-**

Year	New	Renewal
1979	42	37
1980	77	68
1981	38	42
1982	50	39
1983	57	44
1984	30	46
1985	13	51
1986	22	58
1987	24	46
1988	33	49
1989	77	69
1990	114	67

Source: Bureau of Patents, Trademarks and Technology Transfer, Philippines, unpublished data

Chapter 6

Technical Efficiency and Innovation

Over the past forty years, attention has been given by economists and development planners to the importance of technological innovation in the achievement of productivity growth. Empirical studies indicate that improvements in technology account for a large proportion of productivity growth. The seminal study by Solow (1957) concluded that only a small proportion of US non-farm output per capita was explained by increases in capital intensity, while a significant proportion of this growth was associated with improved production practices and equipment, and the increased ability of the labor force. In a similar exercise, Denison (1973), confirmed that improved workforce education and advances in scientific knowledge were significant contributors to per capita output growth. These models have been criticised because the approaches were crude (Mansfield 1988). The contribution of technological change to output growth is equated with the residual, that increase in the output left when all increases in input have been allowed for. Because it is a residual, it contains other factors which may not have been measured among inputs. It does not isolate the effects of technological change alone. Subsequently, such a theme became the foundation of new growth theories (Lucas 1988; Grossman and Helpman 1990b) which attempted to explain determinants of long run growth based on investments in human capital and new technologies.

While there is a large empirical literature linking productivity growth and technological innovation in industrial countries, little is known about this phenomenon from the point of view of developing countries. This chapter examines technical efficiency in Philippine manufacturing industries and relates it to various industry-specific determinants. In doing so, the aims are: (i) to establish the relationship between technical efficiency and innovation or advances in technological know-how in Philippine manufacturing industries; and (ii) to find whether patenting has a role in Philippine manufacturing.

A two-stage approach is adopted to the analysis. The first stage deals with the measurements of technical efficiency in various industries. These technical efficiency estimates are then used in the second stage in analysing some of its determinants. The stochastic frontier production function approach using the random coefficient regression model of Kalirajan and Obwona (1994) will be employed to measure potential output of industries from which technical efficiency estimates would be generated.

6.1 Technical Efficiency: Definition and Measurement

Technical efficiency as a concept expresses the degree to which observed output approaches the maximum possible, for a given level of input. In this study, technical efficiency estimates indicate the ability of an individual industry to produce the maximum allowable output based on a given combination of input levels and the technology, irrespective of demand and prices. Following this definition, technical efficiency in Philippine manufacturing industries will be measured as the ratio of the observed production level to the potential level which may or may not have been achieved by a particular industry. Inherent in this definition is the requirement that a standard of performance be first established against which the success of other industries will be assessed.

Two alternative techniques are available to estimate potential output: (i) data envelopment analysis (DEA) and (ii) the stochastic frontier production function (SFPF). The former was developed by Charnes et al. (1978) and constructs the convex hull of observed input and output observations for a given set of firms using mathematical programming techniques. The convex hull is then used to represent potential output (Kalirajan and Obwona 1994). The latter approach (SFPF), on the other hand, relies on statistical techniques and potential output is derived from estimates of production function parameters.

6.2 Stochastic Frontier Production Function

Constant slope-variable intercept approach

The stochastic frontier production function introduced by Aigner et al. (1977) and Meeusen van Broeck (1977) was an expansion of the deterministic production frontier designed to relieve excessive sensitivity to outliers. The stochastic production frontier is expressed as

$$Y_i = X_i\beta + E_i \tag{6.1}$$

and $$E_i = V_i - U_i \tag{6.2}$$

where Y_i denotes output of the production function for the i^{th} sample industry; X_i is a vector of associated inputs with Y_i; β is a vector of coefficients to be estimated and the composed error term E_i.

The error term in the model is divided into two components: V_i, the symmetric error term and U_i, the asymmetric error term associated with technical inefficiency in production. The former is assumed to be independent and identically distributed as $N(0,\sigma_v^2)$ and independent of U_i. The latter is assumed to be a non-negative random variable obtained by the truncation of the normal distribution at zero. In this model potential output is measured as the level of output when the inefficiency term (proxied by the random variable

U_i) is zero. It is to be noted that frontier production functions of this type are referred to as 'neutral shift' because the relevant coefficients, β, other than the intercept term β_0 are held constant in the measurement of potential output.

The conventional constant slope variable intercept assumption of the stochastic production frontier may sound restrictive in some respects, primarily because observation-specific production behaviour varies across firms or industries. When taken into account, this could cause a non-neutral shift of the frontier. In line with this limitation, a stochastic frontier production function using a random coefficient approach has been proposed in the literature which would be used in this study. This alternative method then allows potential output to be modelled using the application of inputs regardless of its levels.

Random coefficient regression approach[1]

The random coefficient regression model describing a production function for a particular industry can be written as

$$Y_i = \beta_{oi} + X_i\beta_i \qquad (6.3)$$

where $\beta_{0i} = \overline{\beta_0} + \varepsilon_i$

$$\beta_i = \overline{\beta} + \nu_i \qquad (6.4)$$

where the error terms, ε_i and ν_i are assumed to have the following characteristics:

$E(\varepsilon_i) = 0; E(\varepsilon_i^2) = \sigma_i^2; E(\varepsilon_i\varepsilon_j) = 0; E(\nu_i) = 0; E(\nu_i\nu_i') = \Psi$ for $i = j$; and $E(\nu_i\nu_i') = 0$ for $i \neq j$.

[1]This section draws heavily from Kalirajan and Obwona (1994). The author would like to thank Dr. Kalirajan for his valuable suggestions and Marios Obwona for giving me access to the use of the program TERAN which computes technical efficiency based on the random coefficient regression model.

X_i and β_i are $K \times 1$ vectors for each observation and β_i applying to a particular observation is the outcome of a random process with mean vector $\overline{\beta}$, and covariance matrix Ψ. In this study, all variables (Y for output and the X's for inputs) are in natural logarithms.

Combining 6.3 and 6.4 and writing everything in matrix notation the model becomes

$$Y = X\overline{\beta} + \omega_i \tag{6.5}$$

$$\omega_i = \varepsilon_i + X_i \nu_i \tag{6.6}$$

where ω_i is called the composite disturbance term. The first variable in the X-matrix is 1 to represent the intercept term. It is assumed that both disturbance terms have zero means and that $E(\varepsilon_i \nu_i)$ is equal to zero for all i and k.

For the full sample observation, ω_i will have a mean vector of zero and a variance-covariance matrix equal to

$$\Omega = \begin{bmatrix} \sigma_1^2 + X_1 \Psi X_1' & 0 & 0 & 0 & \cdots & 0 \\ 0 & \sigma_2^2 + X_2 \Psi X_2' & 0 & 0 & \cdots & 0 \\ 0 & 0 & \sigma_3^2 + X_3 \Psi X_3' & 0 & \cdots & 0 \\ \vdots & \vdots & \vdots & \sigma_4^2 + X_4 \Psi X_4' & \ddots & \vdots \\ 0 & 0 & 0 & 0 & \cdots & \sigma_n^2 + X_n \Psi X_n' \end{bmatrix} \tag{6.7}$$

Estimation procedure follows Swamy's (1970) approach of applying Aitken's generalised least squares to 6.5 in order to get estimates of $\overline{\beta}$ with a minimum variance:

$$\hat{\overline{\beta}} = (\mathbf{X}'\Omega^{-1}\mathbf{X})^{-1}\mathbf{X}'\Omega^{-1}\mathbf{Y} \tag{6.8}$$

and with covariance matrix given by

$$\Omega_{\hat{\overline{\beta}}} = (\mathbf{X}'\Omega^{-1}\mathbf{X})^{-1} \tag{6.9}$$

One major problem with the feasible Aiken method is that estimation of 6.5 using 6.8 requires that 6.7 and 6.9 be known. In order to deal with this problem Swammy and Mehta (1975) proposed to estimate Ψ using an interactive procedure beginning with an initial estimate based on the data set. Convergence is reached (after several iterations) when stable values of $\overline{\beta}$ and Ψ are obtained.

The applicability of the model to the data set is checked following Breusch and Pagan (1979) assuming normality. The test statistic is computed by repeatedly applying least squares regression and the appropriate null hypothesis is $H_0{:}\Psi = 0$. Regression of this null hypothesis suggests that the use of the random coefficient regression model is valid.

Estimates of the frontier coefficients, $\hat{\beta}_0^*$, $\hat{\beta}_1^*, \hat{\beta}_2^*, \ldots \hat{\beta}_K^*$ are chosen from the individual response coefficient among different firms: however, one important consideration is that it should reflect the 'best practice' technique. In this model, the parameters of the frontier can be written as

$$\hat{\beta}_j^* = \max_i \{\beta_{ij}\}, \ j = 0,1,2,\ldots K. \qquad (6.10)$$

After identifying the parameters of the frontier, the potential output of the i^{th} industry can be calculated as

$$Y_i^* = \hat{\beta}_0^* + \sum_{j=1}^{K} \hat{\beta}_j^* X_{ij}, \qquad i = 1,\ldots,n \qquad (6.11)$$

Using (6.11) as estimates of potential output, technical efficiency of individual industries can be calculated as the ratio between the actual observed output (in levels) of an industry divided by potential output (in levels).

$$TE_i = \frac{\exp(Y_i)}{\exp(Y_i^*)} \qquad i = 1,\ldots n \qquad (6.12)$$

6.3 Estimating Technical Efficiency of Philippine Industries Using the Random Coefficient Regression Approach

Assuming a Cobb-Douglas technology, the production function to be estimated is given below as

$$\ln Y_i = \beta_{0i} + \sum_{j=1}^{2} \beta_{ij} \ln X_{ij} \quad i = 1,\ldots n \tag{6.13}$$

where Y_i, the output variable is measured using value added data; X_{i1} is the number of employed workers; X_{i2} is capital; and n is the number of firms in the industry.[2] Moreover, β_{0i} the intercept term for the i^{th} firm is equal to $\overline{\beta}_0 + \varepsilon_i$ and β_{ij} represents the actual response of the output of firm i to the method of application of input j. Finally, ε_i refers to white noise.

The unit of analysis in this study is the manufacturing establishments, classified at the four digit Philippine Standard Industrial Classification (PSIC). This study employs 79 four-digit industries to estimate technical efficiency in 10 manufacturing industries at the three digit level in the Philippines, observed from 1985 to 1988. The four to five digit level industries approach has often been used in the empirical literature to compute for industry technical efficiency due to the unavailability of firm level data[3] (Torii 1992; Yoo 1992; Harris 1992; Torii and Caves 1992). A summary of the list of industries included in this study is given in Table 6.1. Only three digit industries which have at least 5 corresponding 4-digit sub-categories are included in the study, each observed in four time periods. The minimum requirement of at least 5

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[2] The applicability of the Cobb Douglas Production Function was tested using the Ramsey RESET (Regression Specification Error Test) Test. This comes as an option in the *autoreg* procedure in SAS. The results indicate that at the 5 per cent level of significance, only one (food industry in 1987) of the forty estimated equations had a misspecification problem. Since the use of the Cobb Douglas form of technology is valid for most of the industries, it was the production function that was used to estimate technical efficiency.

[3] Firm level data are often not available due to confidentiality requirements as in case of Australia, the Philippines and in many other countries.

sub-industries is imposed by TERAN, the program used to compute technical efficiency (Kalirajan and Obwona 1994).

Table 6.1 **Philippines: list of industries covered in this study, 1985-88**

Industry	PSIC	Number of 4-digit PSIC Industries
Food	311, 312	17
Textiles	321	7
Wood	331	7
Furniture	332	5
Non-Metallic	361, 362, 363, 369	6
Chemical Industries	351, 352	8
Metals and Metal Products	371, 372, 381	13
Machinery	382	5
Electrical Machinery	383	6
Transport Equipment	384	5

Source: the Author's.

The data is drawn from the annual survey of large manufacturing establishments in the Philippines, undertaken by the National Statistics Office. For consistency, only firms employing 20 or more workers are considered. Output is measured as value added at current prices deflated by implicit price indices based on 1985 prices. Labor input in this model is represented by the total number of paid employees in each industry. A capital stock series at constant prices for each individual industry was constructed as a proxy for capital services in the model. The data were constructed using the perpetual inventory approach (Austria 1992; Hooley 1985).

The NSO survey publishes two statistics which can be used in computing the capital stock data: fixed assets and investment expenditure. Some studies estimate capital stock simply by adjusting the depreciated values of fixed assets. This poses a major problem because since 1970, it has been a standard accounting procedure to value fixed assets at replacement cost, not at original cost. Estimates of which reflect the subjective evaluations so fixed asset values are not standard across firms. Even the date of reappraisals is not uniform so it is not clear whether the assets are being expressed at replacement cost of year t, or year t-1 (Hooley 1985). To overcome these problems, a capital stock series was constructed from the investment expenditure data at constant 1972 prices, using the perpetual inventory method,

$$K_t = (1-\delta)K_{t-1} + I_t \tag{6.14}$$

where K_t is the capital stock, δ is the depreciation rate and I_t is the investment expenditure in each period for each industry. The depreciation rate varies between industries and is obtained from the survey based on the ratio of depreciation cost to the book value of asset. The average depreciation rate is 10 per cent.

Equation 6.14 requires an estimate of the initial capital stock. This is done using the formula below where γ is the estimated growth rate and δ is the depreciation rate.

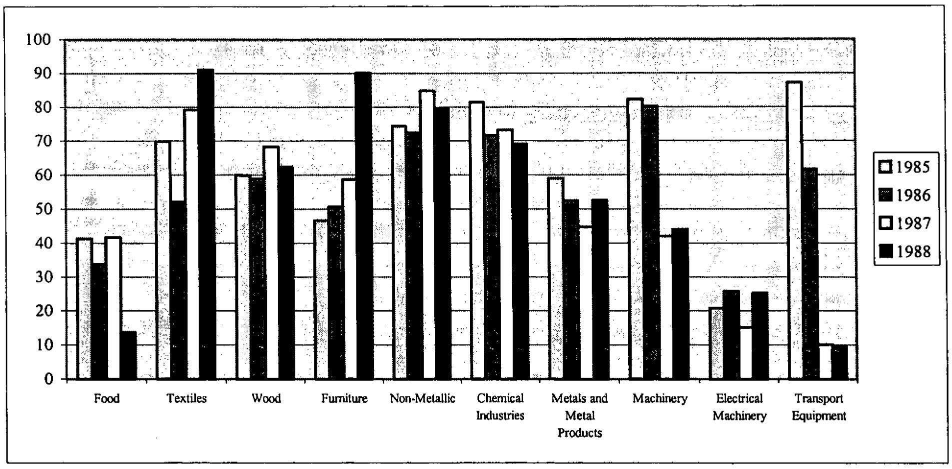
$$K_o = {I_0}/{\gamma} + \delta \tag{6.15}$$

On the basis of the Breusch-Pagan LM test, the null hypothesis, $H_0{:}\Psi = 0$ was rejected at the 5 per cent level in all the 10 industries; thus, lending support to the use of the random coefficient regression model (Appendix 6.1). Estimation was by done using the 4-digit level PSIC in each industry, in each time period. The parameters were estimated using weighted least squares to take into account the presence of heteroscedasticity.

Technical efficiency estimates in this study are given in percentages. A technical efficiency estimate of 70.9, for example, suggests that the industry is around 71 per cent efficient relative to its potential output, which is based on the coefficients of the 'best practice technique' in the sample. Overall, estimates generated in this study show wide variability across industries over time (see Figure 6.1 and Appendix 6.2). The results indicate that none of the manufacturing industry in the Philippines is technically efficient. Grouping these industries by end-use classification indicates that Philippine manufacturing is most inefficient in the capital good sector.[4] The mean technical efficiency estimate of the consumer good sector represented by the food and furniture industry is 63 per cent over a four year period. For texile, wood, non-metallic and chemical industries which could be considered as intermediate good industries, the mean technical efficiency over the four year period is 72 per cent. However, the capital goods sector which is composed of metal products, machinery, electrical machinery and transport equipment registered the lowest mean technical efficiency estimate of 45 percent over a four year period. The capital good sector being relatively inefficient raise concern about the country's long run development since this sector affect other downstream industries that uses its output. As Tecson (1996) noted, the structural weakness of the Philippines' manufacturing sector as shown by the shrinking intermediate and capital goods sector is largely responsible for the country's high degree of import dependence to run its industries.

[4] Manufacturing industries by end-usage is classified as consumer, intermediate or capital goods. Consumer goods include food beverage, tobacco, apparel, footwear and furnitures. The intermediate goods sector on the other hand is consist of textile, leather, wood, paper, printing, chemicals and non-metallic products. Finally, capital goods include metals, machinery, transport equipment and professional equipment (Pineda 1997;Tecson 1996).

Figure 6.1
Technical Efficiency Estimates



Source: Author's estimation based on random coefficient approach.

Some caveats regarding the technical efficiency estimates. While the random coefficient approach facilitated the identification of a benchmark potential output in a given sample, comparison of performance are made in relation to the dominant observation in the sample; thus, an industry may be inefficient but since most firms are closer to the degree of efficiency of the *'best practice'* firm, the industry's technical efficiency may be high. This explains why textile industry in the study despite being documented as an inefficient industry in the Philippines (Pack 1987) appear to be more efficient than the electronic industry which include electronics and is one of the biggest exports of the country. Second, as indicated by Stevenson (1980) and Caves (1990) different assumptions about firm-specific effects make comparisons from different studies on technical efficiency less meaningful. For example in the case of stochastic frontier approach, imposing the assumption of constant returns to scale may cause the mean response coefficients to be intractable. This is because even when the condition of constant returns to scale is imposed on the response coefficients ($\overline{\beta_j}$'s), the possibility that $\sum \beta_j^* \rangle 1$ can not be ruled out due to the relationship that $\beta_j^* = \{\max \ \beta_i + v_{ij}\}$ (Kalirajan and Shand 1994). Other authors (Kalaitzandonakes et al 1992, Gong and Sickels 1992) who tried to compare results of technical efficiency estimates using various approaches found that efficiency varied widely when the data envelopment approach (DEA) and the stochastic frontier approach were used in the estimation procedures. Moreover Button and Weyman-Jones (1992) showed that in many cases the stochastic frontier approach and the DEA not only yielded different estimates but also provided different distributions of efficiencies among observations for the same data set. Based on all these comparative studies, Kalirajan and Shand (1994) suggest that efficiency measurement is determined by the choice of functional forms considered to represent the production technology. The data envelopment approach of measuring technical efficiency may be appropriate if the underlying technology is generally weak while information on scale and substitution possibilities is best handled by the stochastic frontier production function approach.

6.4 Determinants of Technical Efficiency: An Econometric Analysis

In recent years, increased attention has been placed on policies to enhance productivity growth in various industries. What factors and policies can account for the level of technical efficiency and explain industry differences over time? Farrell (1957) argues that any given production process may be inefficient because of two reasons: (i) either the production process is technically inefficient, i.e. it employs a larger bundle of inputs than the minimum required to obtain output or (ii) it could be allocatively inefficient, choosing the wrong combination of inputs given their relative prices and marginal productivities. To the extent that the technical efficiency estimates presented in the preceding section can be used as a proxy for allocative efficiency, then efficiency differences in industry may depend on incentives driven by innovation, capital, trade and industrial policy.[5]

Innovation. Technology in this study covers all known techniques for producing goods and services. Innovation or inventive activity, on the other hand, refers to efforts to discover new techniques of production which are major determinants of productivity growth. Patents granted in the Philippines are used as a measure of industry-specific technological advances over time. This definition of innovation sheds light on whether patenting in a developing country like the Philippines improves technical efficiency and productivity growth, as claimed by advocates of intellectual property right protection.

It is generally accepted in most empirical studies (Griliches 1984; 1990) that innovations is positively associated with productivity growth; however, with regard to technical efficiency the sign predictions may be ambiguous (Caves 1992b). Innovation can offset inefficiency by increasing the rate of technical progress or it can lift the frontier and give appearance of inferior technical efficiency on average.

Capital Policy. Increases in investment open new opportunities for firms to acquire new embodied technology that helps to improve productivity performance. Rapid capital accumulation has been identified as one of the principal engines of growth in successful East Asian countries. These economies have improved their respective capital markets and allocation in

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[5] Firm performance is generally evaluated based on its economic efficiency which has two components-technical and allocative efficiency. The former refers to the ability of firm to produce the maximum possible output from a given technology and bundle of inputs while the latter is the ability of the firm to equate its specific marginal value product with its marginal cost. Most analysis of efficiency measurement have focused on allocative efficiency estimates primarily because neo-classical theory presupposes full technical efficiency. Kalirajan and Shand (1994) however, stresses the importance of technical efficiency in the achievement of economic efficiency. They argued that if technical inefficiency exists in a firm, there is a high probability that it will exert an influence on allocative inefficiency and thus have a cumulative negative effect on economic efficiency.

through: (i) the regulations that aimed to improve the project selection of private banks; (ii) the creation of financial institutions, particularly long-term credit (development) banks and (iii) directing credit to specific sectors and firms (World Bank 1994).

Trade and Industrial Policy. The experience of the newly industrialising countries in recent years has highlighted the role of international trade in productivity growth (World Bank 1993; Hughes 1992). Increased market competition from trade induces industries to perform better because foreign competition put pressure on domestic firms to adopt better technologies in order to survive. Nishimizu and Robinson (1984) found that export expansion leads to productivity due to economies of scale and incentives from competition. This finding is also consistent with Hooley's (1984) study on Philippine manufacturing industries which found a positive association between export expansion and total factor productivity growth. Moreover, he also finds that tariff protection is negatively associated with productivity. More recently, Pineda (1997) and Tecson (1996) found that improved allocative efficiency in Philippine manufacturing may be linked to the country's trade liberalization program that began in the early 80s. Increased import penetration and reduced concentration of manufacturing industries as a result of the tariff reduction programs have allowed the domestic market environment to become more conducive to competition than before the institution of the program.

The determinants of technical efficiency will be analysed using the log-linear regression model .

$$\ln TE_{it} = \delta_0 + \sum_{j=1}^{K} \ln Z_{it} + U_{it} \qquad i = 1,2,\ldots 10; \quad t = 1,\ldots 4; \qquad (6.16)$$

where TE refers to the mean technical efficiency estimate of 10 major industries discussed previously. Z represents the six industry specific explanatory variables namely: (i) patents grants, (ii) annual gross investment as a proportion of capital stock, (iii) industry exports, (iv) import penetration ratio, (v) tariff rate weighted by imports, (vi) the average size of establishments in the industry. U stands for the error term of the regression model.

Data

Patents as an indicator of technological advances in the industry. What do patent statistics really indicate? A number of studies have looked into the sources of growth and the rate of technological change yet there remains no adequate yardstick to measure technical change. To this Griliches (1990) asserts

> *"...that in this desert of data, patent statistics loom up as a mirage of wonderful plenitude and objectivity. They are available, they are by definition related to inventivesness, and they are based on what appears to be an objective and only slowly changing standard."*

In this study patent grants to both foreign and domestic residents have been used to measure innovation and technological advances specific to the industry.

Using patents data as a measure of innovation has, however, a number of limitations: (i) not all inventions get patented, (ii) the quality of inventions varies significantly, and (iii) the standard with which to classify patents is not well defined. To deal with the first and second, it is important to recognise that patent counts do not always provide an exhaustive list of advances in technology. Thus, using this as a proxy variable underestimates the number of technological advances made in a particular industry. Patent grants are used instead of patent applications to rule out minor or repetitive inventions and thus, solely concentrate on a minimal quantum of inventions which has passed the scrutiny of the patent office on the criteria of technical significance, utility and marketability.

In dealing with the last problem, the sub-class system of the International Patent Classification (IPC) is used to concord the patents data with the Philippine Standard Industry Classification (PSIC) which is based on the International Standard Industry Classification (ISIC). Assignments of patents to a particular industry was based primarily on where it is more likely to be of 'use'. Appendix 6.2 shows the industry classification of patents data that have been constructed to carry out this study. Basic data on patent grants were obtained from the voluminous records of the Bureau of Patents Trademarks and Technology Transfer in the Philippines. Cumulative patent grants over a five year period were used in the model as a proxy for innovation.

Investment as a proportion of capital. Data on current gross investments were taken from the survey of manufacturing establishments undertaken by the National Statistics Office. The series were deflated by the gross domestic investment deflator to yield an investment series at constant 1985 prices which was later divided by the capital stock series.

Exports. Exports data at three digit level ISIC in current US dollars were obtained from the UN Commodity Trade Statistics and supplied from tapes by the International Economic Databank (IEDB) at the Australian National University.

Import Penetration Ratio. This is defined to be the ratio of imports to consumption. Consumption, on the other hand is defined to be the value of production plus the value of imports less exports. This data were also drawn from UN Commodity Trade Statistics and United Nations Industrial Development Organisation and supplied by the International Economic Databank (IEDB) at the Australian National University.

Tariffs. It would be most appropriate to use the effective rate of protection, but estimates are unavailable for all industries and all time periods covered. Data on tariffs were obtained from the Tariff Commission of the Philippines, classified by products under the Philippine harmonised system of classification. The author reclassified this by industry using product descriptions and weighted the series using import data (see Appendix 6.3).

Size of average establishment in the industry. This is defined to be the ratio of number of employed workers to the number of firms in the industry. Data have been obtained from the survey of manufacturing establishments undertaken by the National Statistics Office.

Estimation: issues and methods

Industry as well as time series data have been pooled to estimate the parameters in 6.14. The analysis covers 10 manufacturing industries and 4 time periods (1985 to 1988 inclusive). For the econometric method, there are a variety of models to choose from, the differences among which relate to assumptions made about the disturbance vector.

Pooled regression models. A summary of the possible taxonomy of models dealing with time series and cross-sections is given in table 6.2. Model 1A is a straight forward application of ordinary least squares where it is assumed that the intercept and the slope coefficients are common across all industries and over time. The classical assumptions on the residuals should hold in this case: U_{it} being identically and independently distributed with mean equal to 0 and variance σ_u^2.

Following Johnston (1984), model 1B allows for a variety of specifications, depending on the assumptions made about the error term. For example, one can relax the assumptions in Model 1A and allow for cross-sectional heteroscedasticity and timewise autoregression or a cross-sectionally correlated and timewise autoregressive model. Solving these models usually calls for the application of generalised linear regression (GLS).

Table 6.2. **Taxonomy of time series, cross section models**[a]

Model	Assumptions about		
	Intercept	Slope Coefficient	Disturbance Term
1A	Common for all i,t	Common for all i,t	$E(uu') = \sigma_u^2 I_n$
1B	Common for all i,t	Common for all i,t	E(uu') = V
2A	Varying over i	Common for all i,t	Fixed Effects
2B	Varying over i	Common for all i,t	Random Effects
3A	Varying over i,t	Common for all i,t	Fixed Effects
3B	Varying over i,t	Common for all i,t	Random Effects
4	Varying over i	Varying over i	$E(uu') = \sigma_u^2 I_n$ or E(uu') = V

[a]*i* refers to the cross-sectional unit and *t* refers to time.

Source: Johnston, J., 1984. ***Econometric Methods***, 3rd edition, Mc Graw Hill Book Company, New York..

Model 2 relaxes the assumption that the intercept term for each cross-sectional unit is the same, however, it retains the assumption that slopes are common. Model 2A, is known as the fixed effect model, where the effects in the cross-sectional units are captured by an intercept term, α_i. This is done by adding binary dummy variables to capture the fixed effects of each cross-sectional unit. This model can generate 'within' group estimates of the parameters based on within group deviations ($Y_{it} - \overline{Y_i}$ and $X_{it} - \overline{X_i}$). Model 2B on the other hand , is known as the random effects or the error component model. This approach assumes a single constant term for all cross-sectional units however, the individual intercepts are added up in the error term; thus, U_{it} becomes

$$U_{it} = \alpha_i + \varepsilon_{it} \tag{6.15}$$

where α_i and ε_{it} are assumed to be drawn at random from $N(0,\sigma_\alpha^2)$ and $N(0,\sigma_\varepsilon^2)$ respectively. In this case α_i is seen as an increment (which can be positive or negative) to the common α.

Model 3 is an extension of Model 2. However, it allows the intercept terms to vary across 2 dimensions (time and in the cross-sectional units considered). Again the fixed and random approaches are available. The fixed effect approach requires the inclusion of dummy variables for the time periods (bearing in mind that only $m-1$ dummy variables are needed to avoid a singular data matrix). Finally, model 4 allows some flexibility of variation in both the intercept and the vector slope coefficients. This model has a random effects version which can be extended to allow time specific as well as unit specific error components (Johnston 1984).

Fixed vs random effects. A benchmark is needed to evaluate the appropriateness of fixed and random effects models. The literature is weak in this area. In fact it has been suggested that the standard distinction between fixed and random effects models is erroneous (Greene 1991). The fixed effect model, from a practical standpoint, is costly in terms of losing some degrees of freedom. However, the random effects model has one major limitation in that it has to satisfy the condition that the individual effects are uncorrelated with the other regressors in the model, otherwise the regression coefficient becomes biased and inconsistent. Kmenta (1986) suggests that if there is any doubt about the correlation of the two, a test should be carried out. A possible test for the orthogonality of the random effects and the regressors was devised by Hausman (1978). Under the null hypothesis for this test, which is

$H_0{:}\,E(X'\varepsilon) = 0$, the generalised least squares estimator of the coefficients of the random effect model should not be significantly different from the least square estimator of the coefficients in the fixed effect model.

In this study, the empirical model is estimated using two alternative pooled regression models: model 1B. The random effect model is preferred over the fixed effect model due to the narrowness of the sample size. The loss of the degrees of freedom brought about by the inclusion of dummy variables is costly. Initial estimates also suggest that the fixed effects are uncorrelated with the explanatory variables.

Diagnostic testing suggests that the disturbances in the estimated equation specified in 6.14 are autoregressive and heteroscedastic. This is expected when dealing with pooled data analysis and to deal with this problem a cross-sectional heteroscedastic and timewise autoregressive model (Model 1B) was adopted with the following characteristics:

$$E(U_{it}^2) = \sigma_i^2 \qquad (6.16)$$

$$U_{it} = \rho_i U_{i,t-1} + \varepsilon_{it} \qquad (6.17)$$

Both $U_{it} = \rho_i U_{i,t-1} + \varepsilon_{it}$ are assumed to be drawn from $N(0,\sigma_{ui}^2)$ and $N(0, \sigma_{ui}^2 / 1-\rho^2)$, respectively. Upon recognition of the presence of timewise autocorrelation and cross-sectional heteroscedasticity, the sample observations have been subjected to a double transformation where the first was designed to remove autoregression and the other to remove heteroscedasticity. For simplicity, the author assumed that ρ has the same value for all the cross-sectional units ($\rho_i = \rho_j = \rho$).[6] In doing so the variance-covariance matrix becomes

$$\Pi = \begin{bmatrix} \sigma_1^2 Z & 0 & \cdots & 0 \\ 0 & \sigma_2^2 Z & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \sigma_{nl}^2 Z \end{bmatrix} \tag{6.18}$$

$$\text{where } Z = \begin{bmatrix} 1 & \rho & \rho^2 & \cdots & \rho^{T-1} \\ \rho & 1 & \rho & \cdots & \rho^{T-2} \\ \vdots & \vdots & \vdots & & \vdots \\ \rho^{T-1} & \rho^{T-2} & \rho^{T-3} & \cdots & 1 \end{bmatrix} \tag{6.19}$$

In order to find consistent estimates of all elements of 6.18 the following procedures were undertaken. First, the ordinary least squares method was applied to the pooled data set ($N \times T$ observations) and from the residuals an estimate of ρ was obtained as:

$$\hat{\rho} = \frac{\sum_i \sum_t e_{it} e_{i,t-1}}{\sum_i \sum_t e_{i,t-1}^2} \tag{6.20}$$

Second, the dependent and the independent variables were transformed using

$$Y_{it}^* = Y_{it} - \hat{\rho} Y_{i,t-1} \text{ and } X_{it}^* = X_{it} - \hat{\rho} X_{i,t-1} \quad \text{for t=2,..T.} \tag{6.21}$$

In order to maintain the original sample size of the dataset, the Prais and Winsten method (Greene 1991) was applied to the first observation of each cross-sectional unit.[7]

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[6]It is important to note that an AR(1) scheme's stability requires that $/\rho/ < 1$. Assuming then that ρ is common to all cross-sectional units diminishes the possibility of obtaining ρ estimates beyond the permissible range.

[7]This is done by applying the formulae $Y_{i1}^* = \sqrt{1-\hat{\rho}} Y_{i1}$ and $X_{i1}^* = \sqrt{1-\hat{\rho}} X_{i1}$ to the dependent and independent variables respectively.

The third step is the ordinary least squares estimation of the entire model based on the transformed variables. From the results the estimated residuals, $\hat{U}^*_{it}$ can be obtained. These are later on used to estimate the variance (σ^2_{ui}) of $\hat{U}^*_{it}$ which is given below as

$$\hat{\sigma}^2_{ui} = \frac{1}{T-K} \sum_{t=1}^{T} \hat{U}^2_{it} \tag{6.22}$$

where K refers to the number of variables in the model.

The next task, removing heteroscedasticity, is done by applying weights to the transformed variables in 6.21. The weights used are $\hat{\sigma}_{ui}$, derived from 6.22. And the last step is the estimation of the weighted variables using ordinary least squares . $\hat{U}^{**}_{it}$ from the last regression model is asymptotically nonautoregressive and homoscedastic.

Results

The estimated pooled regression coefficients of the determinants of technical efficiency in Philippine manufacturing are summarised in Table 6.3.

The result shows a positive association between the volume of innovation and technical efficiency. Except for electrical machinery, industries with many patent grants also have high technical efficiency. The chemical and drug industry for example, is highly concentrated (not too many firms) and patents are usually taken out by oligopolists; therefore, the spread of productivity is smaller. Patenting in this case ensures that productivity of most firms in the industry is high. This suggests that patent enforcement which encourages research and development activities (both at the domestic and international level), increases available technologies necessary for the operation of a particular industry.

Table. 6.3 **Estimated coefficients based on two alternative models**

Variable	Estimated Coefficient	T-Statistics
Cross-sectionally Heteroscedastic and Timewise Autoregressive Model (1B)		
Cumulative 5 year patent grants	0.14	4.47
Investment as a proportion of capital stock	2.20	5.33
Exports	0.001	0.02
Import penetration ratio	-0.02	-0.34
Tariffs	-0.11	-3.49
Size	-0.14	-0.41
Time trend	-0.38	-1.18
Random Effects Model (2B)		
Cumulative 5 year patent grants	0.14	4.57
Investment as a proportion of capital stock	0.53	2.20
Exports	0.12	3.38
Import penetration ratio	0.08	2.24
Tariffs	-0.08	-4.15
Size	-0.11	-0.70
Time trend	-0.07	-0.54

Source: Author's estimation

The level of technical efficiency in Philippine manufacturing has also largely been explained by its capital formation. This further emphasises the role of capital policy in attaining productivity growth in the country. Investment increases in industry can speed up the rate of the introduction of new technologies that is embodied in capital and the rate of technological progress as well.

The result also suggests that trade as well as competition policies has a positive role in attaining efficiency in Philippine manufacturing. Hooley (1985) also found a significant relationship between exports and TFP growth, suggesting a positive impact of outward looking policies on productivity growth. Moreover, a positive association with the import penetration ratio offers support to the notion that on balance exposure to foreign competition induces efficiency. The sign of the variable tariffs being negative is also consistent with economic theory. Protection is expected to have a negative impact on the industry's technical efficiency because it reduces foreign competitive pressure.

The size of an average firm in the industry has been added as an explanatory variable in the model as a proxy for economies of scale. Empirical studies suggest that there are significant scale economies as firms progress from small to medium size. This was found to be a significant variable in Hooley's study (1985) on the determinants of TFP growth in Philippine manufacturing industries. In this study however, it is an insignificant variable.

6.5 Conclusion

Productivity and innovation is one area of research where studies from the point of view of developing countries are seen to be deficient. This study attempts to address this by examining the relationship between technical efficiency and innovation in various manufacturing industries in the Philippines. The innovation variable used covers not only domestic innovation but also foreign inventive activity specific to a particular industry. Representing innovation in this way then allows us to draw some conclusions regarding the role of patenting in Philippine manufacturing. The finding that inventive activity significantly affects efficiency in Philippine manufacturing suggests that a developing country like the Philippines gains as well from the research and development efforts of other countries; thus patenting as a policy which encourages innovation may have positive effects on productivity growth.

It should also be emphasised that a number of other policy measures significantly affect technical efficiency in Philippine manufacturing. In particular, it was found that increases in capital investments is positively correlated with technical efficiency. This suggests that technology embodied in new capital can improve an industry's performance. Furthermore, the empirical analysis also confirms the role of openness to trade in achieving productivity growth.

The empirical analysis put forward in this study has some limitations attached to it. One of its strengths lies is the measurement of technical efficiency, and the observation of considerable interindustry differences in technical efficiency over time. However, the lack of theoretical model that provides formal underpinnings for the determinants of technical efficiency limits confidence in the set of variables included in this study. Other variables like the concentration ratio[8], taking into account how industry structure (whether the industry as a whole is oligopolistic or perfectly competitive) affects technical efficiency in Philippine manufacturing may have been included in the model but data availability is a major problem.

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[8]Caves and Barton (1990) suggests a negative correlation between the concentration ratio and technical efficiency. Inefficiency can appear when there are only few producers in the industry because: (i) the absence of strong competition allows other inefficient producers to survive; (ii) that when there are only few firms in the industry; (ii) fewer resources will be devoted to experimenting new ways to improve production; and (iii) imperfect competition generates inefficiency when partial collusive bargaining in oligopoly induce rent-seeking.

Appendix 6.1 **Breusch-Pagan LM test**

Industry	1985	1986	1987	1988
Food	8.0	38.8	19.0	26.2
Textiles	7.0	11.1	6.9	7.7
Wood	10.4	11.2	17.4	15.9
Furniture	9.8	9.8	10.8	11.6
Non-Metallic	8.0	12.8	10.4	8.0
Chemical Industries	6.3	6.3	8.8	9.4
Metals and Metal Products	8.2	6.4	11.7	8.5
Machinery	13.7	9.7	12.8	9.1
Electrical Machinery	8.5	8.3	11.4	8.6
Transport Equipment	9.9	12.6	12.4	9.4

Source: Author's estimation based on random coefficient approach.

Appendix 6.2 **Technical efficiency estimates of Philippine industries using the random coefficient approach**

Industry	1985	1986	1987	1988
Food	41.3	33.8	41.6	13.7
Textiles	69.9	52.1	79.2	91.0
Wood	59.9	58.9	68.4	62.4
Furniture	46.6	50.6	58.7	90.1
Non-Metallic	74.4	72.4	84.8	79.5
Chemical Industries	81.4	71.7	73.3	69.1
Metals and Metal Products	59.0	52.4	44.7	52.6
Machinery	82.3	80.2	42.0	44.0
Electrical Machinery	20.8	25.8	15.2	25.3
Transport Equipment	87.1	61.7	10.1	9.7

Source: Author's estimation based on random coefficient approach.

Appendix 6.3 **Concordance between the Philippine Standard Industry Classification (PSIC) and the International Patent Classification (IPC)**

Description	PSIC	IPC
Food and Beverage	311+312+313	A21+A22+A23+C12+C13
Tobacco	314	A24
Textile	321	D01+D02+D03+D04+D05+D06
Wearing Apparel	322	A41+A42
Leather	323	C14
Footwear	324	A43
Wood and Cork	331	B27
Furniture and Fixtures	332+386	A47
Paper and Paper Products	341	B31+D21
Printing and Publishing	342	B41+B42+B43+B44
Industrial Chemicals[a]	351	B01+B02+B03+B04+B05+B06+ B07+C01+C02+C05C07+C08+ A01N
Other Chemical Products[b]	352	C09+A61K+C11+A61+B08
Petroleum	353+354	C10
Plastic, not elsewhere classified	356	B29
Non Metallic Mineral Products[c]	361+362+ 363+369	B28+C03+C04
Basic Metals and Metal Products[d]	371+372+ 381+382	B21+B22+B23+C21+C22+ C23+C25+C30+B25+B26
Machinery except electrical[e]	382	B24+F01+F02+F03+F04+ F15+F16+F17
Electrical Machinery[f]	383	H01+H02+H03+H04+H05+ F21+F22+F23+F24+F25+F28+ G06+G07+G08
Transport Equipment	384	B60+B61+B62+B63+B64
Professional and Scientific Instruments[g]	385	G01+G02+G03+G04+G05

[a]This classification includes basic industrial chemicals, inorganic acids, alkalies, inorganic salts and compounds, organic acids, fertilisers, synthetic resins, man-made fibers, pesticides, etc.

[b]This classification includes paints, varnishes, lacquers, drugs, medicine, soap, cleaning preparations, perfumes, other chemical products not elsewhere classified.

[c]This classification includes pottery, china, earthenware, glass, clay, cement, etc.

[d]This classification includes iron and steel, non-ferrous metals and fabricated metals.

[e]This classification includes engines, turbines, machines, etc.

[f]This classification includes electrical appliances, generators, radio, television, gramophone, signalling and detection equipment, wiring devices, ranges, batteries, etc.

[g]This classification includes quantity and controlling instruments, photographic instruments, watches, etc.

Source: Autor's classification based on

National Statistics Office, 1987. *Annual Survey of Establishments: manufacturing*, National Statistics Office, Manila.

World Intellectual Property Organisation, 1984. *International Classification*, Vol. 9, WIPO, Geneva.

Appendix 6.4 **Concordance between the Philippine Standard Industry Classification and the Harmonised System of Tariff Classification**

Industry	Harmonised System Chapter
Food and Beverage	16,17,18,19,20,21,22
Tobacco	24
Textile	50,51,52,53,54,55,56,57,58,59,60
Wearing Apparel	61,62,63
Footwear	64
Wood and Cork	44,45
Furniture and Fixtures	94
Paper and Paper Products	47,48
Printing	49
Industrial Chemicals	28,29,30,31
Other Chemicals	32,33,34,35
Petroleum	27
Plastic	39
Non-Metallic Minerals	68,69,70
Basic Metals and Metal Products	72,73,74,75,76,77,78,79,80,81,82,83
Machinery	84
Electrical Machinery	85
Transport Equipment	86,87,88,89

Source: Author's classification based on

National Statistics Office, 1987. *Annual Survey of Establishments: manufacturing*, National Statistics Office, Manila.

Tariff Commission, 1990. *Tariff and customs codes of the Philippines: harmonized commodity descriptions and coding system*, Vol. 1, Philippine Tariff Commission, Quezon City.

Chapter 7

Inventive Activity in Philippine Manufacturing: Its Nature and Determinants

This chapter looks into the general nature and determinants of domestic innovation in the Philippines. The demand for domestic innovation and foreign technology is analysed and treated as being jointly determined by characteristics of Philippine manufacturing industries, domestic prices and the supply of purchasable foreign technology. The latter variable is included in the analysis to find out how domestic innovation (which is generally adaptive respond to upstream inventions from the industrial countries) respond to upstream inventions in the industrial countries. If the relationship is strong and positive, then a regime of stronger patent protection in the Philippines will benefit the country because it will increase the supply of international inventions which complements adaptive innovation in the Philippines.

7.1 Nature of Inventive Activity in Philippine Industry

This section uses two rough measures of inventive activity: the research and development expenditures and patent statistics. The former provide a more accurate measure of inventive effort. It is not available in time series however. Despite a number of limitations, patent statistics provide some interesting insights as to the nature of inventive activity in the Philippines.[1]

Like many developing countries, research and development activities in the Philippines are meagre compared to industrial countries. Research and

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[1]See chapter 6 for the limitation of patent statistics as indicators of innovation.

development expenditures account for less than 1 per cent of the country's gross national product (see table 7.1). Moreover, in figure 7.1, estimates of research and development expenditures by sector suggest that the government accounts for more than 60 per cent of formal research and development expenditures in the Philippines, while private industry accounted for only 20 per cent. It is inventive activity in private sector, particularly in manufacturing, that forms the main focus of this study.

Table 7.1 **Philippines: R&D expenditures as a percentage of GNP, 1980-90**

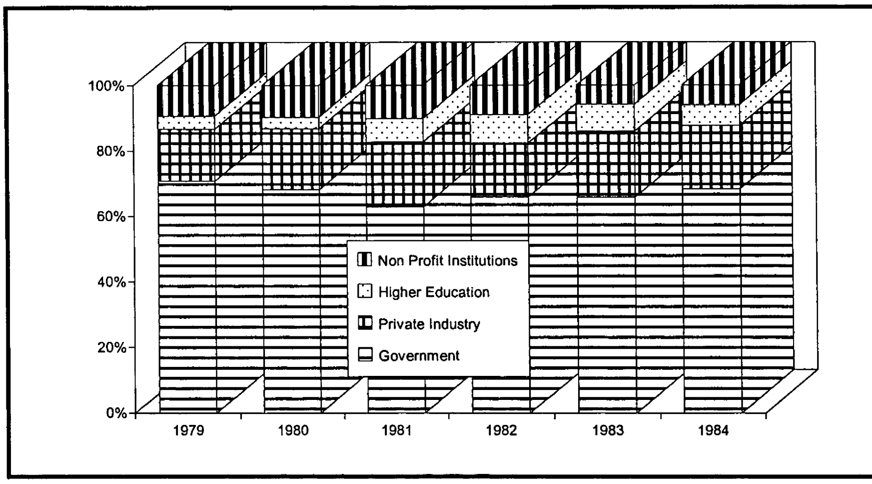
Year	as a proportion of GNP[a]
1980	0.26
1981	0.17
1982	0.19
1983	0.14
1984	0.12
1985	0.10
1986	0.10
1987	0.10
1988	0.10
1989	0.11
1990	0.11

[a]Estimates for 1985 to 1990.

Source: Department of Science and Technology. 1990. Science and Technology Master Plan, Department of Science and Technology, Manila.

Research and development expenditures in Philippine manufacturing is meagre. Formal research and development activities in Philippine manufacturing in the 1990 survey of establishments shows this clearly (National Statistics Office 1990). Only 11 per cent of all establishments surveyed were engaged in research and development activities. In manufacturing, at least, research and development is financed through companies' funds and the share of government and foreign funds is negligible.

Figure 7.1
Philippines: sectoral distribution of R&D expenditures, 1979-84[a]



[a]This is the latest data available at the time of writing.

Source: National Science and Technology Authority, *R&D Expenditures and Manpower in Private Industry*, various issues.

Research and development expenditures in industry can be classified into three main activities: basic research, applied research and experimental development.[2] The first refers to basic or fundamental research work undertaken primarily for the purpose of acquiring new knowledge about certain phenomenon, without any particular use in view. Applied research, deals with original investigation undertaken in order to acquire knowledge, but where the effort is directed toward a practical aim. Finally, experimental development, pertains to the systematic activity of drawing on existing knowledge gained from research and/or practical experience aimed particularly at producing new products or improving existing products and devices.

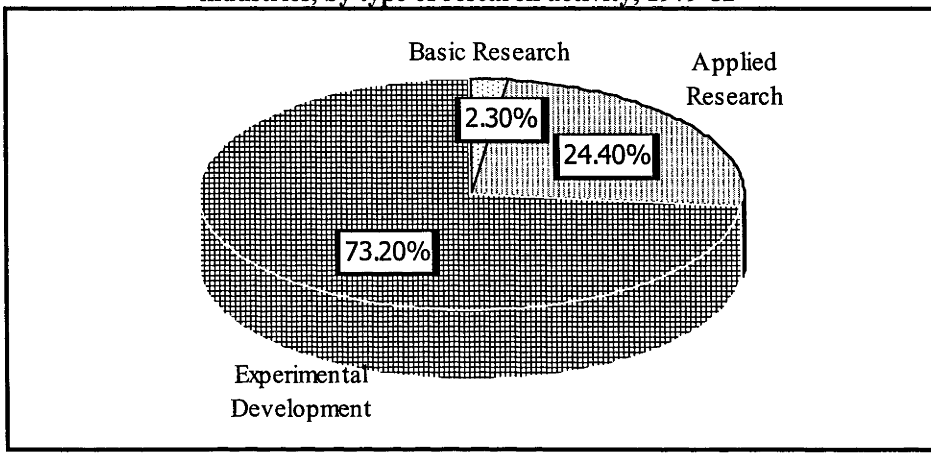
The average percentage distribution of research and development expenditures by type of research based on surveys conducted by the National Science and Technology Authority[3] in 1979, 1980, 1981 and 1982 show that

[2]Definition of each of these activities is based on that adopted by the UNESCO general conference in Paris (27 November 1978).

[3] This office is now called the Department of Science and Technology.

manufacturing industries are generally engaged in experimental development, which emphasises adaptive innovation rather than the search for basic of fundamental knowledge (Figure 7.2). This type of innovative activity is geared towards product development rather than process improvement.

Figure 7.2
Philippines: Distribution of average R&D expenditures in manufacturing industries, by type of research activity, 1979-82[a]



[a]This is the latest data available at the time of writing.

Source: National Science and Technology Authority, *R&D Expenditures and Manpower in Private Industry*, various issues.

How do invention patent statistics relate to inventive activity in Philippine industry? A survey done by Griliches (1990) on the relationship of research and development activities and patenting in developed countries confirms a positive association. In the absence of data on research expenditures, the readily available data on invention patents can therefore, be used as proxy. It is not appropriate, however, because research and development activities in developing countries are primarily informal and adaptive in nature.

Statistics on invention patents are summarised in table 7.2. It is clear that the majority of patents granted in Philippine manufacturing represent grants to foreign nationals. Of the few patents granted to domestic residents, only a handful are recognised in other countries. This indicates that invention patents originating from domestic residents in the Philippines have lower transferability abroad than those originating from industrial countries, like the United States, Japan and Germany.

Table 7.2 **Philippines: manufacturing invention patents granted[a], 1960, 1970, 1980 and 1990**

Year	Number	Percentage Domestic	Percentage Foreign
1960	117	5.13	94.87
1970	519	3.47	96.53
1980	810	7.90	92.10
1990	990	2.22	97.78

[a]Patent statistics were classified based on the international standard industry classification using the subclasses of the International Patent Classification. See Appendix 6.3.

Source of basic data: Bureau of Patents, Trademarks and Technology Transfer

There is one form of innovative activity that is prevalent in the Philippines, however. This is in the area of adaptive inventions: in assimilating and modifying inventions imported from industrial countries. In the patent record, this activity is covered under petty or utility patents. Utility patents have a lower invention requirement than the traditional invention patents (Medalla, Mikklesen and Evenson 1982). The protection offered for this type of invention is only five years, much shorter than the 17 years granted to invention patents.

A summary of utility patents granted to domestic residents in Philippine manufacturing is given in table 7.3. Domestic nationals account for 98 per cent of total utility patents granted in the Philippines. While chemical or biogenetic technology inventions dominate invention patent statistics, the majority of utility patents are granted for mechanical technology. The major advantage of protecting such adaptation through petty patents is that it broadens the invention base by providing incentives for small firms to undertake innovative activity (Deolalikar and Evenson 1989; 1990; Mikklesen 1984; Medalla, Mikklesen and Evenson 1982).

Table 7.3 **Philippines: domestic utility patents[a], 1979-90**

Industry	Number (1979-1990)	Sectoral Share (as a percentage of total)
Food and Beverage	72	3.43
Tobacco	14	0.67
Textile	48	2.29
Wearing Apparel	46	2.19
Footwear	40	1.91
Wood	14	0.67
Furniture	356	16.96
Paper Products	11	0.52
Printing	87	4.14
Industrial Chemicals	176	8.38
Other Chemical Products	119	5.67
Petroleum	14	0.67
Plastic	17	0.81
Non-Metallic Minerals	42	2.00
Basic Metals and Metal Products	97	4.62
Machinery	289	13.77
Electrical Machinery	491	23.39
Transport Equipment	165	7.86

[a]Utility patent statistics were classified based on the international standard industry classification using the subclasses of the International Patent Classification. See Appendix 6.3.

Source of basic data: Bureau of Patents, Trademarks and Technology Transfer, Philippines, unpublished data.

7.2 Determinants of Inventive Activity in Philippine Industry: An Econometric Analysis

The foregoing suggests that the Philippines tends to underinvest in inventive research and development activities. Although the level of inventive activity in the country is low, the previous chapter indicates that it is related to technical efficiency and hence in productivity growth. The importance then of innovative activities in attaining productivity growth raises concern over the determinants of inventive activity in Philippine industry.

The approach used in this study is similar to that adopted by Deolalikar and Evenson (1989) for India. It is different from earlier studies, which have examined inventive activity in industrial countries by virtue of its demand system framework.

An input demand system is derived from a cost function of the i^{th} industry given below:

$$C^i = C^i(w^i{}_j, Y^i) \tag{7.1}$$

where $w^i{}_j$ refers to input prices and Y^i is output of industry i.

On the assumption that all prices are parametric, the factor demands can be derived from the cost function by Shephard's Lemma:

$$x^i{}_j = \frac{\partial C^i}{\partial w^i{}_j}(w^i{}_j, Y^i) \tag{7.2}$$

where $x^i{}_j$ is the j^{th} factor demand of industry i. From (7.2) it is clear that demand for each factor depends on factor prices and the level of output.

There are five inputs used in this econometric analysis: labor, capital, intermediate inputs and technology, divided into foreign and domestic. Some justification is required for treating technology as a variable input. Normally, it is viewed as fixed investment, however, both domestic technology production and technology purchases in Philippine manufacturing exhibit some elements of variability.

Many of the contractual agreements embodying technology transfer to Philippine industry are relatively short term and change rapidly. Most of the technology transfer agreements have been of the independent type. Of all agreements recorded from 1979 to 1990, half involved technical collaboration. Statistics also indicate that there is a declining trend of licensing agreements between parent companies and their subsidiaries. Technology purchases vary across industries. The pharmaceutical industry has the highest number of registered agreements, and these are mostly collaborative. (see if you can insert)

Domestic inventiveness in the Philippines is adaptive in nature, which is largely supported by a law protecting utility patents. Inventions of this sort may have an investment component. However, the time period over which there is a positive service flow from the investment is relatively short because 'follow-on' inventions erode the rents associated with any given invention (Deolalikar and Evenson 1989).

For estimation purposes, an ad hoc specification for the input demand is used. Other explanatory variables, foreign inventiveness, foreign capital share and time trend have been added to equation (7.2). The latter is included to show the trend rate of change of the dependent variables. The input demand equation to be estimated is thus:

$$x^i_j = \beta_{i0} + \sum_{j=1}^{n} \beta_{ij} w^i_j + \beta_{iY} Y^i + \beta_{iS} FS^i + \beta_{iP} FP^i + \beta_{iT} T + U^i_j \qquad (7.3)$$

where w^i_j refers to input prices, Y^i refers to industry output, FS^i measures foreign capital participation, FP^i is a proxy variable for the supply of foreign innovations specific to the industry, T is a time trend variable and U^i_j is the error term. All the variables in the model are in natural logarithms so that the estimated coefficients may be interpreted as elasticities.

Of particular interest is the sign of β_{iP}, the coefficient of foreign patents in the demand for local technology. β_{iP} in this equation expresses the responsiveness of domestic innovation to the supply of foreign inventions. Deolalikar and Evenson (1989; 1990) suggest that this parameter could be positive or negative if the measurement of innovations (both domestic and foreign) uses patent statistics. To the extent that foreign firms or residents patent their inventions in the Philippines, to block domestic firms from reinventing the same product or process, the effect would be negative. However, patenting by foreign firms or residents may also have a positive effect on domestic innovations through the disclosure of inventions.

Philippine firms can learn from this and modify and patent an adapted version in the Philippines.

The sample industries included in this study are observed in 11 time periods from 1979 to 1990. They are divided into three groups namely: light industries, chemical and drug, and engineering industries. The industries included in each of these broad categories are listed in table 7.4. Both time series and cross sectional data are been pooled within each of the three groups.

Table 7.4 **Broad industry classification used in this study**

Light	Chemical and Drug	Engineering
Food and beverages	Industrial Chemicals	Basic Metals
Tobacco	Other chemicals	Metal Products
Textile	Petroleum	Machinery
Wearing Apparel		Electrical Machinery
Footwear		Transport Equipment
Wood		
Furniture		
Paper		
Printing and Publishing		
Plastic		
Non-metallic Products		

Source: Author's classification.

The Krause system of classification (Tyers and Philips 1984) was used in assigning to the three broad categories. Technology-intensive industries based on the Krause classification were divided into two categories, chemical and drug which are highly intensive in imported technology and engineering industries which rely more on domestic technology. Light industries, cover all other industries which are not technology-intensive based on the Krause classification.

The characteristics of each of the three industry groups are shown in Table 7.5. On average, light industries employ more labor relative to the other two industries while chemical and drug industries are intensive in capital and imported technology. The foreign equity share is highest in this industry.

Domestic patenting, on the other hand, is concentrated in the engineering sector.

Table 7.5 **Means of production inputs and foreign share of production in Philippine industries, 1979-90**

Variables[a]	Light Industries[b]	Chemical & Drugs[c]	Engineering[d]
Labor (in thousands)	211.7	173.3	174.8
Capital (in Million Pesos)	7.4	34.4	7.0
Intermediate Inputs	5.8	127.2	4.3
Technology Imports[e]	10.8	116.3	41.4
Domestic Patents[f]	35.8	125.2	146.6
Foreign Share	6.0	20.2	11.2
Sample Size	132	36	48

[a] All variables except for foreign share have been divided by the total number of firms in the industry; therefore the means refer to the average firm in the industry.
[b] Light industries include food and beverage, tobacco, textile, wearing apparel, footwear, wood, furniture and fixtures, paper, printing and publishing, plastic, and non-metallic mineral products.
[c] Chemical and drug industries include industrial chemicals, other chemicals, and petroleum.
[d] Engineering include metals, machinery, electrical machinery and transport equipment.
[e] Number of foreign licensing agreements multiplied by 1000
[f] Number of utility patents granted multiplied by 1000

Source: Author's calculation.

Data

All industry data are taken from the Annual Survey of Establishments conducted by the National Statistics Office (NSO) for large industries. The definition of *large firms* changes occasionally. In 1988 the definition of large establishments was changed from firms employing twenty or more workers to firms that employ fifty or more workers. The coverage of the published data contains inconsistencies. Statistical releases sometimes cover all establishments (both small and large), at other times is released only for large firms. A special tabulation of the industry data was requested from the National Statistics Office (NSO) to cover only large firms employing twenty or more workers.

A capital stock series at 1972 prices for each individual industry was constructed using the perpetual inventory method (Austria 1992: Hooley 1985).[4] This approach is discussed in more detail in chapter 6.

The number of paid employees according to the survey is used to measure labor input. Compensation data, deflated by the GDP deflator are used as a proxy for real annual wages at 1972 prices.

The value of output in each industry at current prices is from the survey of establishments. This was deflated by industry-specific price indices to obtain a series at constant 1972 prices. The series for intermediate inputs was derived from the difference between gross value of output and value added at constant 1972 prices.

Since 1988, the survey of establishments have included the percentage of foreign capital participation in their questionnaires. Unavailability of data in earlier years, means this variable only varies across industries in the estimation and has no time component. Foreign capital participation is averaged across the three year period, 1988-1990.

Utility patents granted to Philippine residents are used as a proxy for local inventive activity. Utility patents, despite their limitations, provide a good proxy for adaptive inventions which are characteristic of domestic innovative activity in the Philippines. Two problems are associated with using utility patents as a measure of inventive output: classification and quality. Classifications problems arise from allocating utility patents to an industry. To overcome this problem, the author used the subclass system of patent

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[4] The formula used to compute for the capital stock series using the perpetual inventory method is given by $K_t = (1-\delta)K_{t-1}+I_t$ where K is capital, δ is the depreciation rate and I is investment. The initial capital stock is computed as $K_0 = I_0 / (\gamma+\delta)$ where γ is the average growth rate of capital

classification and assignment to a particular industry is based on the industry of *use* rather than the industry that produced it. The problem is that the quality of the underlying inventions vary from patent to patent, differing in both technical and economic significance. Many patents are only minor improvements and have little economic value. However some prove to be extremely valuable. In order to minimise this limitation, the author just considered utility patents that has been granted rather than applications.

Data on utility patents were classified only according to the standard International Patent Classification (IPC). It was necessary to reclassify them using the IPC sub-classification codes to obtain consistency with the industry production data and its Philippine Standard Industry Classification. Appendix 6.3 provides a record of industry description along with its corresponding PSIC and IPC classification. The data were obtained from the voluminous records of the Bureau of Patents, Trademarks and Technology Transfer in the Philippines.

The number of foreign technology agreements in the Philippine industry is used as a proxy for foreign technology input. This measure of foreign technology is not sensitive to quality differentials in technologies purchased across industries. The data set was obtained from the records of technology transfer agreements monitored by the Bureau of Patents, Trademarks and Technology Transfer.

The cumulative number of patents granted to foreign nationals over the past five years in the Philippines was used as a proxy for the supply of international inventions and technology. This is a relevant explanatory variable as far as domestic and foreign technology is concerned since demand for foreign technology may be constrained by supply of internationally available technologies. Because Philippine inventive activity involves modification and adaptation of existing technologies , the international supply is significant. The databases on the IPC classification are taken from records of the Bureau of Patents Trademarks and Technology Transfer. These patent statistics are reclassified to obtain a series consistent with PSIC (See Appendix 6.3).

The data on prices are available for only three inputs: labor, capital and intermediate inputs. Hence, in the estimation process only three inputs have price elasticities. The price index of materials and fuel from the Philippine Statistical Yearbook is used as a proxy for prices of intermediate inputs. e .

The series for the price of capital was derived using the approach of Mendoza and Warr (1992). The price of capital goods is defined as:

$$\rho = (r + \delta)z \qquad (7.4)$$

where r is the discount rate, δ is the depreciation rate and z is the asset price. The weighted average interest rate on money market transactions is used as the discount rate and the implicit price index for gross capital formation is used as a proxy for asset price. Data were obtained from the Central Bank of the Philippines and various issues of the Philippine Statistical Yearbook.

Estimation issues and procedures

Because industry-level variables represent totals over different numbers of firms in each industry, all dependent and independent variables (except the data on prices and foreign equity), are divided by the number of firms in the industry. This has two advantages: first, it allows the results to be interpreted for an average firm in the industry; second, it removes a potential source of heteroscedasticity in the residuals of the demand equations.

To deal with the pooled data set, a covariance model is adopted. The covariance model allows each industry to have its own intercept.. This is incorporated into the model by the introduction of dummy variables into the regression equations. Adding dummy variables isolates individual industry-shift effects, while assuming a high degree of similarity between technologies within each of the three industry groups.

The demand equations are were estimated using the Zellner's or seemingly unrelated regression (SUR) method to take into account the interdependence of the error terms and the symmetry restrictions across equations. All prices are divided by the price of intermediate inputs to impose homogeneity of degree zero in prices. The symmetry restriction is only applied to capital and labor demand equations.

Results

The results are summarised in Table 7.6. These show the estimated own and cross price elasticities of input demands and report the effects of output and other determinants on an industry's demand for variable inputs. The empirical results are generally consistent with predictions from production theory. Three of the six own price elasticities have the wrong sign, and they are insignificant. The 'own price effect' of labor is insignificant, except for light industries. The weakness of the wage effects could be attributed to the trend in real wages, which tends to be flat over time. Another interesting result based on the estimates is that capital and labor have a complementary relationship for an average manufacturing firm in the Philippines. This result persists in all three industry groups and is statistically significant.

Technology imports are more responsive to prices than domestic patenting. A rise in wages stimulates an increase in technology imports in both light and engineering industries. This suggests that technology imports in these industries are of the labour-saving type. Moreover, in the case of light industries, an increase in the price of labour also decrease the demand for domestic innovation implying that labour and domestic inventive effort are complementary. A wage increase then will not only decrease the quantity of labour employed but also lead to a decrease in the relative importance of domestic innovation in production as firms search for other labor saving technology abroad to reduce cost. This is consistent with earlier findings about domestic innovation in the Philippines being of the blue-collar type that is heavily concentrated on product modification rather than process improvement (Deolalikar and Evenson 1989 and the WB 1987). The World Bank (1987) further argues that this largely stems from the main motivation of R&D which is product diversification rather than cost reduction. Such R&D orientation is typical for countries with relatively high protection and relatively little competition.

Both technology purchase and domestic innovation respond positively to international inventions in the engineering industries. Similarly, domestic innovation is found to be strongly correlated to foreign patenting in the chemical and drug industries. This indicates that technology-intensive firms respond positively to an increase in the supply of upstream inventions abroad lending support to the positive disclosure effect of patenting. However, the opposite is observed in the light industries where at the 5 per cent level, the elasticity of domestic innovation with respect to international inventive activity is negative. This suggests that the negative blocking effect tend to dominate in the case of light industries. This negative effect may be due to the presence of more product invention in these industries and patenting then works in the interest of foreign firms because foreign national obtain patent to block local residents from imitating and copying. The challenge then for the government is to find alternative means to enhance innovation in these industries.

Foreign ownership has little effect on domestic patenting except in the case of the chemical and drug industries. This implies that encouraging foreign direct investment in the chemical and drug sector will have a positive impact on domestic innovation in these industries.

All inputs have positive output elasticities which are statistically significant for the three basic input variables. The output variable in this model could be used as a proxy for the average firm size, which is a vital interest in the study of innovation in industrial countries. The general finding from these countries, with the exception of the chemical industry is that the relationship between the number of patents granted and firm size is an inverted *U*. Beyond a certain size, firm size does not have a positive influence on inventive effort (Scherer 1965; Johannison and Lindstorm 1971; Kamien and Schwartz 1975; Deolalikar and Evenson 1989, 1990). Empirical estimates in this study, however, suggest that firm size, although the relationship is positive, does not significantly affect domestic innovation, except in the chemical and drug industry.

Table 7.6 **Empirical estimates**[a]

Industry		*Elasticity of*				
	with respect to	Labor	Capital	Intermediate Inputs	Technology Imports	Domestic Patenting
Light	Price of labour	-0.109	-0.106	0.017	0.815	-0.771
		(-2.86)*	(-4.23)*	(0.26)	(2.28)*	(-2.11)*
	Price of capital	-0.106	-0.015	-0.044	0.480	0.193
		(-4.23)*	(-0.44)	(-0.92)	(0.02)	(0.75)
	Foreign Patents	0.023	0.096	-0.019	-0.143	-0.314
		(1.12)	(3.63)*	(-0.59)	(-0.83)	(-1.77)*
	Foreign Share	-0.995	-5.650	-2.618	-3.433	-8.19
		(-2.69)*	(-11.77)*	(-4.40)*	(-0.00)	(-0.00)
	Output	0.609	0.687	0.752	0.536	0.253
		(13.96)*	(11.96)*	(10.87)*	(1.47)	(0.68)
	Time Trend	-0.009	-0.017	-0.023	0.174	-0.20
		(-1.62)	(-3.19*)	(-2.46)*	(3.48)*	(-3.92)*
Chemical and Drug	Price of labour	0.329	-0.047	-0.522	0.376	0.034
		(0.84)	(-1.85)*	(-2.58)*	(-0.39)	(0.05)
	Price of capital	-0.047	0.005	0.036	0.812	-0.704
		(-1.85)*	(0.17)	(0.24)	(1.14)	(-1.41)
	Foreign Patents	0.239	-0.078	0.468	0.779	3.044
		(0.60)	(-1.82)*	(2.58)	(0.91)	(5.08)*
	Foreign Share	0.53	-1.290	2.17	4.418	9.358
		(3.19)*	(-7.12)*	(2.84)*	(1.23)	(3.70)*
	Output	0.249	0.691	1.597	0.22	1.079
		(10.04)*	(25.83)*	(14.11)*	(0.42)	(2.89)*
	Time trend	0.002	0.003	-0.150	-0.12	-0.388
		(0.27)	(0.63)	(-5.60)*	(-0.98)	(-4.38)*
Engineering	Price of labour	0.167	-0.082	-0.456	0.640	-0.157
		(0.29)	(-2.13)*	(-1.60)	(1.70)*	(-0.43)
	Price of capital	-0.082	-0.104	0.031	-0.127	-0.018
		(-2.13)*	(-1.93)*	(0.17)	(-0.53)	(-0.080)
	Foreign Patents	0.187	0.236	0.22	1.10	0.885
		(2.87)*	(2.64)*	(0.88)	(3.50)*	(2.94)*
	Foreign Share	0.302	-0.695	-0.435	-1.969	-0.599
		(2.12)*	(-3.45)*	(-0.76)	(-2.79)	(-0.88)
	Output	0.457	0.575	0.829	0.013	0.081
		(10.29)	(9.84)*	(4.55)*	(0.059)	(0.37)
	Time trend	-0.047	-0.019	-0.162	-0.091	-0.212
		(-3.91)	(-1.31)	(-3.09)*	(-1.36)	(-3.30)*

[a]Figures in parenthesis are T-statistics of the estimated coefficient. * indicates that the variable is significant at the 5 per cent level.

Source: Author's estimation.

7.3 Conclusion

This chapter has discussed the nature of inventive activity in Philippine industry and analysed the determinants of the demand for innovations in Philippine manufacturing. The characteristics of inventive activity in Philippine manufacturing are generally consistent with the findings of earlier studies. That is, domestic innovation in developing countries is generally adaptive. One important policy implication is that the recognition and active enforcement of utility or petty patents would benefit most developing countries, because it stimulates adaptive innovation. Two other studies support this conclusion. Dahab (1986) and Mikklesen (1985) conducted studies on agricultural implements in Brazil and the Philippines, respectively. Both concluded that patenting of utility models stimulated adaptive inventions in these countries and enabled domestic firms to increase their competitiveness with multinational firms, whose inventions they adapted to suit the home market.

The second part of the chapter dealt with identifying some determinants of domestic innovation in Philippine industry. An econometric analysis of the decisions of Philippine firms to invest in their own technology production and to purchase foreign technology (through licensing agreements) showed they jointly determined by certain characteristics of Philippine industries, factor prices and the supply of purchasable foreign technology.

The result that foreign patenting is significantly and positively associated with adaptive innovation in the chemical and drug, and engineering industries, but is inversely associated with domestic patenting in light industries, suggests that the uniform policy of providing protection for all products and process inventions in all industries may not be beneficial for developing countries in terms of stimulating domestic inventions. The estimated elasticities imply that in contrast to the technology-intensive industries, domestic innovation in light industries tends to be inhibited by foreign patenting. The negative effect may be due to the presence of more product inventions in these industries. In this case patenting works in the interest of foreign firms because firms obtain patents in the Philippines to block local residents from imitating and copying their technology. One policy implication is for developing countries to tailor patent protection offered to foreign inventions based on economic characteristics and significance of the underlying invention on the domestic economy. For example, the practice of limiting patent protection to process inventions may be considered in this case. However, this may not be possible under the new TRIPs agreement. The challenge then for governments of developing countries, like the Philippines, is to find alternative policy instruments to enhance domestic innovations in these industries.

Chapter 8

Conclusion

The opening of the World Trade Organisation (WTO) signalled a definite shift toward stricter intellectual property protection at a global level. From the point of view of developing countries, the TRIPs agreement under the administration of the WTO would require significant changes in their respective IPR regimes and practices.

Such a shift in policy would have two opposing effects on the welfare of developing countries. A negative effect is expected as a result of rents being transferred from the developing countries (the technology users) to the industrial countries (who are generally regarded as knowledge producers). However, there are areas that the former could explore from which some benefits could be derived. These areas include trade, foreign direct investment and increased access to new technologies. The main task then of developing countries is to transform a regime of stronger patent protection into an instrument responsive to their technological development needs to ensure that the benefits would outweigh the costs.

In the case of the Philippines, however, the country's current technological capability may undermine the benefits that could be derived from strengthening intellectual property protection. Evidence suggests that the country's production, investment and innovation capability are lagging behind its other Asian neighbours. Moreover, the country's past record shows that it failed to maximise benefits derived from technology transfer agreements.

A policy of increased patent protection is basically designed to encourage innovative activity with potential commercial use and application. From this it is clear that it is a policy designed to affect the supply of available technologies needed for a country's development. Its effectiveness however, is enhanced in a competitive environment where there is demand for such innovations. The Philippine experience shows that while policies for technological acquisition are generally in place, policies addressing the demand side failed to foster a competitive environment that is conducive to innovation. Trade and industrial policies predominantly remained bias against exports and together with macroeconomic policies have distorted technological choice and have undermined the efficient allocation of resources among firms. With all these setbacks in the Philippine economy, the expected benefits derived in a regime of stronger intellectual property protection is diminished. An immediate policy concern for the government is to re-direct its policy orientation towards the creation of a more competitive environment. The transition period prescribed in the TRIPs agreement before its full implementation in five years could be used by the government to correct or lessen all the distortions created by its past policies to ensure that while some losses are inevitable from such a policy regime, the benefits from it are maximised.

Will the benefit of patent protection outweigh the cost of patent protection in the Philippines? While the study did not attempt to quantify the cost of strengthening patent protection in the Philippines, the findings of the empirical chapters of the thesis suggest that on balance, the Philippines has a lot to gain from better access to advanced technologies which a regime of stronger patent protection could bring. The associated costs from stronger patent protection like an increase in the administrative and enforcement costs, increase in payments for foreign technology and the displacement of pirates would be less than the benefits if the Philippines would be able to take advantage of innovations fostered by higher R&D investments at the local and international level and greater technology and foreign direct investment flows.[1] It is important to note that the patent office also generate significant revenues including foreign exchange through fees; thus, the burden of higher administrative cost may be reduced if such a shift in policy would result to more applications. Moreover, given the increasing rate of technological change worldwide, increased access to new technology can open up new opportunities and possibilities that would be beneficial for the development of the Philippines. Furthermore, as the country adopts a more liberal trade policy and reduce barriers to foreign competition, better access to new technology is necessary to improve productivity of its industries and effectively benefit from the more efficient reallocation of resources brought about by the integration of the world economy.

The model developed in chapter 4 suggests that strengthening patent protection in a developing country like the Philippines would have some costs and benefits attached to it. The main cost is that technology (embodied in a

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[1]Another perceived cost to developing countries that has recently raise concern is on the patenting of animals, plants and genes. The developing countries are home to a vast majority of plants and animal species that could be turned into new drugs and crops. Under the current system, developing countries fear the possibility that some unscrupulous firms in the industrial countries may use patent laws and deny them of the commercial use of indigenous materials. To address this issue some developing countries like Cost Rica have laws exempting genes from patenting. Others are introducing laws requiring all those applying for intellectual property protection of a plant variety to declare the source and prove that they have the consent of the native users as well as make arrangements to share the eventual rewards of commercialization. Brazil is one country that is currently pushing to have this written into TRIPs; however the United States is strongly opposed to such change. The fuss over biopiracy shows that developing countries are not opposed to a proper patent regime, they merely want to set up a patent system that would take care of their needs. If the current system does not work then new models would probably be needed to cover this type of products (The Economist 2001).

product or process) would be acquired at higher prices relative to a system of weak patent protection where there is free riding. It is important to recognise however, that while free riding may be beneficial in some cases in the short run, it may have some negative implications in the country's long run development. For a limited range of industries, firms may be able to incorporate new products or process that may have been available through a weak system of intellectual patent protection but there is simply a great deal of technology that can not be filched much less developed without the willing cooperation of innovators. Sherwood (1993) argues that any benefit derived from free riding are more than offset by the damage it could do to a country's technological infrastructure as a result of a weak intellectual property system. There are opportunities that may be foregone as a result of a weak patent protection which for a country like the Philippines need for its development. These opportunities include the encouragement of domestic research, the training of local personnel, better access to more advanced technologies and the attraction of foreign direct investments and joint venture programs.

The empirical part of the thesis examines two aspects of Philippine manufacturing that may be affected by patenting: technical efficiency and domestic innovation. In chapter 6 it was found that from the point of view of Philippine industry, a positive correlation exists between technical efficiency and patenting. This suggests that the availability of industry-specific innovations (both internal and external) leads to higher productivity growth in Philippine manufacturing. Thus, a patent policy designed to gain access to new technologies is beneficial to the Philippines.

The impact of patenting on domestic innovation was examined in Chapter 7. While patenting does not appear to stimulate domestic innovation in light industries, Philippine non-traditional industries like engineering and chemical and drug industries significantly benefit from an increased supply of available technology which a patent policy can bring. This positive impact of patenting on domestic innovation is also consistent with some of the findings in developing countries like Mexico and Columbia who recently reformed their patent laws (Sherwood 1993). After reforming its patent laws in 1991, Mexico's patent office received a large number of patent applications filed by domestic nationals. Columbia on the other hand, adopted copyright software protection in 1989 which led to an increase in the registration of application software packages from domestic residents. Many of these software applications help run local manufacturing firms.

Aside from the above benefits, chapter 3 also shows that there are other areas that could be explored from which benefits from patent protection could be derived. These areas include trade and foreign direct investment. An analysis of trade in intellectual-property and technology intensive goods shows that despite the dominance of the industrial countries in such trade, exports of these products coming from the fast growing economies of Asia are catching up. In the case of the Philippines, fostering these new industries is critically dependent on access to advanced technologies which for most part can not be pilfered. For high-technology products, foreign companies need to be attracted to local plants and share their expertise to local producers. But such sharing would rarely occur in a regime of weak protection. Thus, the Philippines would benefit more by advancing intellectual property protection rather than putting it off.

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