6. Protecting Industrial Inventions, Authors' Rights, and Traditional Knowledge: Relevance, Lessons, and Unresolved Issues

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In recent years, international trade flows and foreign direct investment have become increasingly intensive in the use of knowledge and innovation, bringing the issue of intellectual property rights (IPRs) into the mainstream in global trade discussions.[1] Leading up to the Trade-Related Intellectual Property Rights agreement, adopted by WTO members in 1995, was a contentious debate between developed countries that were lobbying for stronger intellectual property rights and developing countries that largely considered such across-the-board upgrading as premature, given their positions as users rather than producers of technological innovations. Subsequent and ongoing negotiations at the global and bilateral levels attempt to address some of these tensions.

Intellectual property rights are a form of domestic business regulation that sets background incentives for innovation and the diffusion of new information into consumption and competition. The interests of innovative businesses need to be delicately balanced with those of the users of new products and technologies.[2] It is possible to establish intellectual property standards that are too weak to support local innovation and product introduction, but it is also possible to adopt standards that are excessively protectionist, limiting the access that consumers and rivals have to new technologies. Both these problems can limit a country's long-term economic growth prospects.

To assist new adopters of IPR protection, this chapter discusses patent, copyright, and traditional knowledge (TK) protection. Patents have been studied in the literature on the economics of innovation for nearly four decades, and the repercussions of patent protection are generally well understood. Patents are usually of relevance for countries importing or creating cutting-edge technologies and innovations, and are becoming relevant more broadly, because the TRIPs agreement mandates stronger patent protection in all its signatory nations. They are discussed in the first section of this chapter, which draws lessons from Korea's dramatic success in patenting.

[†] This chapter draws on background reports prepared by Professor Jaeyong Song, Yonshei University, Seoul, Korea and Professor Timothy Swanson, University College, London, UK. The authors gratefully acknowledge helpful comments from Dr. Myrna Austria and other participants at the seminar at the Institute for Southeast Asian Studies of the National University of Singapore, Fourth Asia Development Forum in Seoul, the Thailand Development Research Institute in Bangkok, and the World Bank office in Jakarta.

[1] There are a host of instruments for protecting different kinds of intellectual property. First, there are patents and trade secrets to protect industrial inventions. Next are copyrights to protect authored works, and trademarks to protect industrial logos and symbols. Finally, geographical indications certify that a product was made in an area that has specific characteristics (such as soil conditions, climate, or design traditions) underlying the quality of the good.

[2] Maskus (2000) discusses these trade-offs extensively.

Copyrights have been studied much less but have recently taken center stage as economic incentives in such areas as software and the entertainment industries.[3] Copyrights affecting the software, publishing, film, and music industries are of relevance to a broad range of middle- to low-income nations. They are discussed in the following section, on the basis of a study of Indonesian firms.

Traditional knowledge, the subject of the final section, happens to be concentrated in lower-income nations, and its protection is generally expected to have direct effects on poverty reduction.[4] As some industrial countries attempt to patent the products they have developed based on traditional knowledge, developing nations perceive themselves as doubly disadvantaged—with their indigenous resources being used without compensation and the resulting products coming to them at a higher price as a result of the associated patents. Protection of traditional knowledge is a relatively new issue in the economics and IPR literature, and the policy dialogue would benefit from analytical work to improve understanding of the conceptual issues underlying this debate.

Explaining Korea's patenting success

Governments often strengthen IPRs in the hope that by establishing exclusive rights to use and sell newly developed technologies they will promote investments in knowledge creation and business innovation, including by foreign investors who will introduce advanced technologies. A rise in innovative activity, or in the amount of productive research and development, signals an acceleration of technological change and a positive outlook for productivity growth. If increases in patenting, and the innovation that gives rise to them, can be attributed entirely to changes in IPR laws, there are important implications for the design of public policy. Specifically, the complementary roles of broader innovation-promoting public policies as well as private corporate sector strategies in facilitating technological catch-up need to be better understood. To throw light on these issues, we examine the determinants of Korea's dramatic success in patenting in the United States.

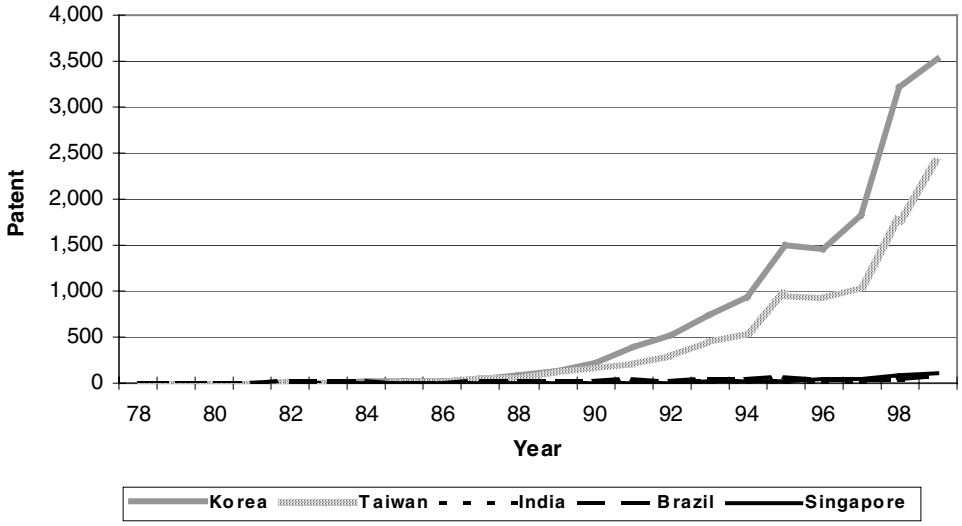
Factors contributing to rise in Korean patenting

The number of U.S. patents filed by Korean firms has risen dramatically in recent years (Figure 6.1).

[3] An essential form of intellectual property protection, copyright provides creative artists and firms the right to control copying and distribution of particular expressions of music, art, film, and literature. Copyrights operate differently from patents, primarily because the former control the use of an idea's expression while the latter control the use of the idea itself. In recent years, copyright protection has been extended in many countries to such industrially useful expressions as software, data compilations, performances, television broadcasts, and satellite transmissions, and it has also been applied to the use of electronic copies downloaded from the Internet. For these reasons, copyrights deserve greater analytical attention than in the past.

[4] For example, if means may be found for villagers in poor countries to register their collective knowledge, whether of medicinal uses for biological materials or other forms, for purposes of licensing its commercial use, substantial royalty income might be generated for them.

Figure 6.1: Comparison of patenting trends, Korea vs. major developing countries, 1978-99
(Registration counts in the U.S. PatentOoffice)



Patenting activity could rise because of either an increase in the *propensity* to patent or an increase in the *ability* to patent. The former may be framed as the demand-side view and the latter the supply-side view. The four factors that might explain Korean patenting success are:

Demand-side factors

- *Fertile technology pull*: In this view, patenting was spurred by a global surge in discovery and innovation in emerging, "patent-intensive" industries such as semiconductors and biotechnology.[5]
- *Friendly court pull:* By making courts more prone to grant and enforce patents, the adoption of a stronger intellectual property protection regime in Korea may have increased the propensity of inventors to seek patent protection.

Supply-side factors

- *Industrial upgrading push*: In this view, upgrading of Korean industry shifted the output mix to more patent-prone, high-technology industries.
- *Corporate management push*: Large Korean business groups (*chaebols*) placed growing emphasis on innovative capabilities, and they improved R&D management and productivity. This view postulates that changes in the corporate management of R&D have contributed to increased patenting activity.

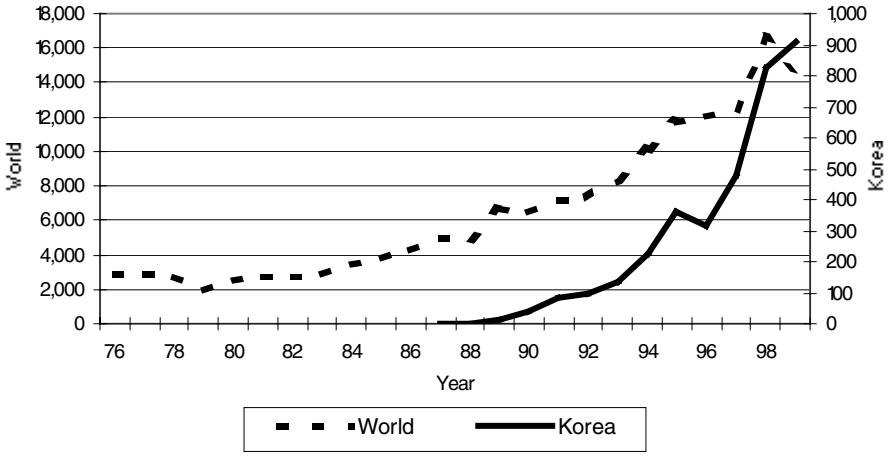
We examine each factor each in turn. The analysis relies on aggregate data on international patent applications by technology class and assignee of patents in the United States; patent citation data of Korean firms; and aggregate measures of research effort. We also use information from in-depth, firm-level interviews.

[5] Patent-intensive industries are those that rely heavily on patenting to protect proprietary knowledge. Reliance on patents varies by industries because, by definition, patents must reveal what they need to protect. Upon revelation, some knowledge is easier to imitate than others, for example, highly coded knowledge (such as chemical formulas) are relatively easy to duplicate once it leaks out.

Fertile technology pull

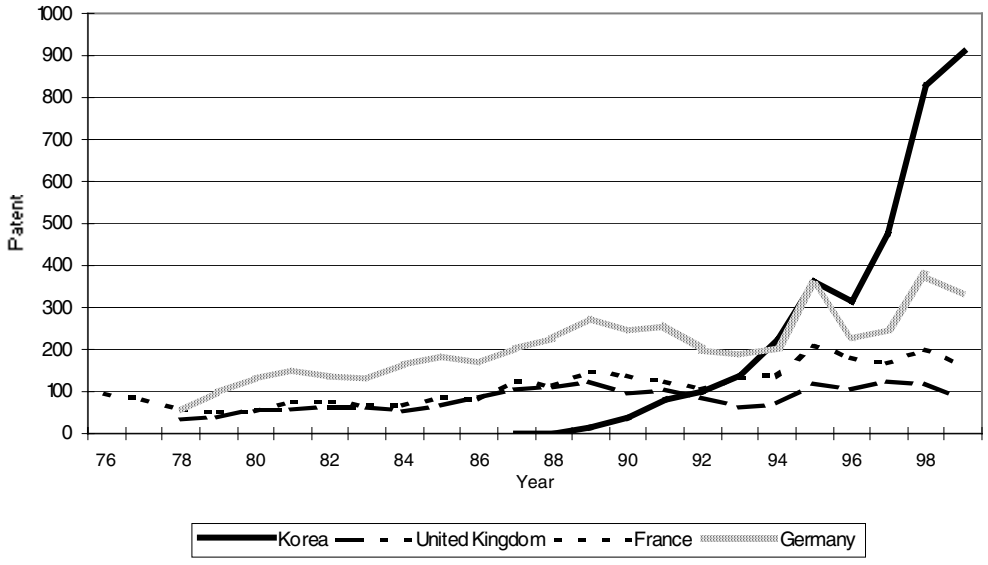
If a surge in innovation is driven by breakthroughs in specific technologies, we should expect to see an uneven increase in patenting across technologies. When the technological revolution is more widespread, we should expect a general increase in patenting activity worldwide. Korean semiconductor patents, in particular, show a growth pattern similar to the general increase in patenting activities in the semiconductor industry worldwide (Figure 6.2).

Figure 6.2: Comparison of Korean semiconductor patents with worldwide semiconductor patents, 1976-99
(Registration counts in the U.S. PatentOffice)



Is Korea simply enjoying the benefits of a worldwide technology explosion in semiconductors? A comparison with other industrialized and industrializing countries suggests, instead, that Korea is an outlier (Figure 6.3).

Figure 6.3: Comparison of Korean semiconductor patents with semiconductor patents of major advanced countries, 1976-99
(Registration counts in the U..Patent Office)



Pair-wise t-tests support this conclusion, showing that Korea's semiconductor patents have proliferated much faster than those of advanced countries such as the United States, Japan, and Germany. However, there was no statistically significant difference between the growth rates of semiconductor patents in Korea and Taiwan..[6]

Friendly court pull

What was the role of intellectual property protection regimes in patenting activities at home and abroad? We examine important changes in IPR protection within Korea to understand whether it increased access to foreign knowledge at home (through foreign patents) and provided a testing-ground for domestic innovators before they attempted patenting abroad. If Korean courts became more patent-friendly, both foreign and domestic firms should find patenting in Korea increasingly attractive and, thus, patent registration data should be relatively uniform across domestic and foreign residents.

Three major changes have affected Korean IPRs since the 1970s[7]:

- 1980-82: Revision of the patent law in 1980 in compliance with the Paris Convention for the Protection of Industrial Property, and the subsequent revision of the patent law in 1982 in compliance with the Patent Cooperation Treaty
- 1986: Revision of the patent law to introduce substance (product) patents for pharmaceutical and chemical materials
- 1995-97: Revision of the patent law in 1995 in compliance with TRIPs as well as to reform the appeals/trials system. The patent law was revised again in 1997 to introduce opposition to the grant of patents after registration.

Indeed, trends in foreign and total patent applications in Korea seem to support the view that IPR changes spurred increases in patenting. Foreign patent applications in Korea had two major inflection points in the 1980s: The first jump took place in 1983 just after the major changes in Korean IPRs in 1980-82. The second jump occurred around 1986-87, just after the introduction of substance (product) patent eligibility for pharmaceuticals and chemicals. In the 1980s, when the major IPR changes were made in Korea, patent applications by foreigners rose faster than those by local residents, although patent applications by the latter also increased steadily. Paired t-tests confirm that between 1983 and 1991, Korea's patent growth rate was significantly faster than that of either Japan or Germany.[8]

Industrial upgrading push

Did improvements in Korean industry shift the output mix to more patent-intensive industries? If so, the industrial composition of Korean patents in both the United States and Korea should more closely match the industrial composition of Korean exports to the United

[6] For the results of these tests, see table 1in the appendix to this chapter, at http://www.worldbank.org/eaptrade.
[7] In essence, these are the changes being requested of most developing countries within the next 2-4 years.
[8] We conducted paired t-tests of the growth rates of Japanese and German patents in Korea and the United States between 1983 and 1991, respectively. These tests confirm that the patent growth rate in Korea was significantly higher than that in the United States for both Japanese patents (t-value of 2.213) and German patents (t-value of 1.835), at the significance level of $p = 0.10$.

States than the industrial composition of U.S. patents at large. Analysis shows that the industrial composition of Korean patents in the United States is very highly correlated with that of Korean exports but not with that of overall U.S. patents. This strongly suggests that Korean patenting in the United States has been influenced more by Korea's industrial upgrading than by specific industry-level propensities for patenting.[9]

The highly significant positive correlation between patenting and exporting suggests that industries that develop strong innovative capabilities (reflected in subsequent patenting) tend to achieve strong revealed comparative advantages and thereby to export more. At the same time, export-driven industries tend to invest more in innovative R&D activities and file for patents abroad more aggressively, both to build and maintain their global competitiveness and to protect their newly developed technologies and products in their main export markets. Thus, export-driven industrial upgrading and patenting through building innovative capabilities seem to be mutually reinforcing trends, even though we cannot infer cause and effect here.

Corporate management push

Increases in patenting activity may have been caused by increases in R&D and its productivity. To test this proposition, we compared the R&D productivity of Korean firms with that of selected advanced countries, using the number of U.S. patents per US$1 billion spent by the country on R&D, allowing for a five-year time lag between R&D investments and patent registrations.[10] Research productivity was lower in Korea than in Japan and the United States, but substantially higher than in Germany, the UK, or France (Table 6.1). U.S. firms have a clear home advantage in patenting in the United States, and the other four countries account for about 70 percent of total U.S. patents of foreign origin. Hence Korea's research productivity, measured by U.S. patent counts per amount of R&D expenditure, seems to be the second highest in the world, just behind Japan's.[11].[12]

Private corporations, particularly the five largest *chaebols*, accounted for most of the Korean patents that were granted in the United States in the 1990s.[13] The increased productivity of R&D in Korea has essentially been driven by the good R&D management and productivity of the five largest *chaebols*, especially the Samsung Group. The largest *chaebols* increased their R&D expenditures dramatically in the 1980s, and in that decade Korea's investments in private sector R&D per unit of gross domestic investment were higher than those of any other country.[14] In 2000, the four largest *chaebol*s—Samsung, LG, Hyundai, and SK—spent

[9] For the results of this test, see table 2 in the appendix of this chapter, at http://www.worldbank.org/eaptrade.
[10] Recent increased in patents per unit of R&D in many developed countries has also been attributed to an increase in "defensive" patenting—innovations that the firm would not normally commercialize and protect, but would do so only to prevent others from patenting it later, thus increasing the portfolio of patents a firm owns to improve its negotiating power in technology purchase deals.
[11] Note: this is likely to be an outcome of a combination of factors such as more patentable inventions per unit of R&D, as well as a higher propensity to patent patentable inventions for the strategic reasons described above.
[12] This is in line with Kim's (1997) finding, that Korea was second only to Japan in the world in terms of the proportion of population filing intellectual property applications.
[13] Among the U.S. patents granted to private Korean corporations, 90 percent were awarded to the five largest *chaebols*, especially the Samsung Group.
[14] At 32 percent, as compared with 16 percent in Taiwan, and 9 percent in Japan. Kim (1997).

4,731 billion Korean won (about US$4 billion) on R&D, and in 2001 their R&D spending continued to increase even in the wake of the global recession.[15]

Table 6.1: Research productivity of selected countries

	U.S. patent counts in 1999	*R&D expenditures (billion US$ in 1994)*	*U.S. patent count/ R&D expenditures*
Korea	3,529	12.8	275.7
USA	75,014	169.3	443.1
Japan	32,666	75.1	435.0
Germany	8,121	37.3	217.7
France	3,150	26.5	118.9
UK	2,351	21.7	108.3

Sources: Patent counts from our U.S. patent database; R&D expenditures from OECD's Main Science & Technology Indicators, 1999.

Over time, R&D investments have become more concentrated in the top 20 companies (Table 6.2). The top five corporate spenders on R&D undertook 31 percent of Korea's R&D spending in 1993. In manufacturing, Korea's top 20 spenders on R&D undertook 64 percent of research spending in 1996. This concentration is significantly higher than comparable figures for the United States, at 43 percent, and Japan, at 44 percent.[16]

Table 6.2: R&D concentration ratio of top 20 companies in Korea (all industries), 1992-98

Year	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
Ratio (%)	49.8	51.7	54.3	57.5	56.5	59.4	65.8

Source: Korea Ministry of Science & Technology.

In 1997, the private sector accounted for 77 percent of Korea's R&D expenditures, and since then the share of private corporations in R&D expenditures has continued to rise. In 2000, private corporations increased their R&D expenditures by 20 percent, while government research institutes and universities increased theirs by only 9 percent and 3 percent, respectively. Private R&D laboratories proliferated, especially in the late 1990s, as the government's policy to nurture high-technology start-up firms began to pay off.[17]

The *chaebols* were also able to hire the best R&D researchers. After they began investing heavily in the high-tech industries, they made strong efforts to lure experienced ethnic Korean engineers from major companies and universities abroad, especially in the United

[15] In 1998, the ratios of R&D expenditures to total sales for the flagship companies of the largest chaebols—Samsung Electronics, Hyundai Electronics, Hyundai Motor, and SK Telecom—were 7 percent, 8 percent, 12 percent, and 12 percent respectively, proportions that were generally comparable to or higher than those of the global leaders in their respective industries.
[16] Korea Ministry of Science & Technology, 1998.
[17] As of February 2002, Korea had 9,208 private R&D labs, up six-fold from 1,435 a decade earlier. Korea Industrial Technology Association.

States.[18] The returned engineers played a key role in speeding up the learning process of Korean companies and enhancing the productivity of their research. Koreans residing abroad also served in R&D posts for Korean companies and as counselors to the Korean government in helping shape the direction of policy support in Korea.

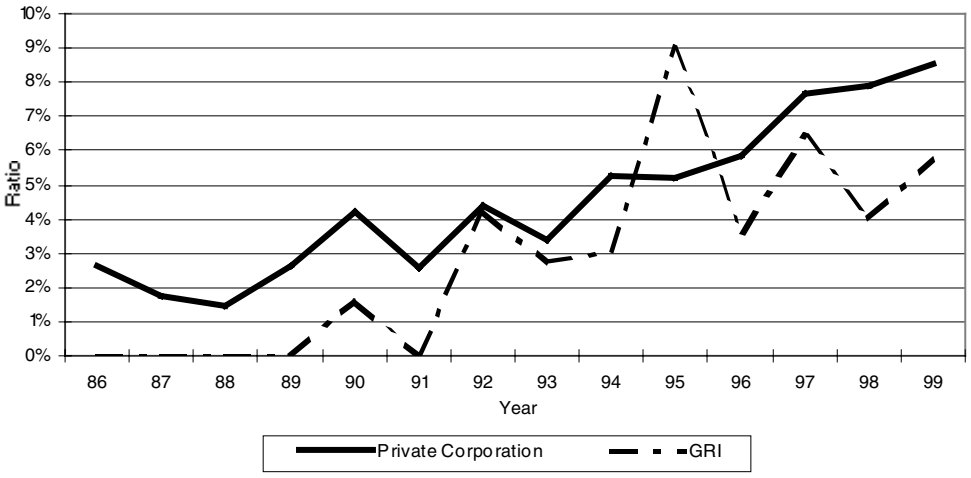
Technology trajectory

How do Korea's firms compare with the world's leaders in the technology fields in which Korea has large numbers of patents? And why has Korea's private sector been so successful in one fast-growing technology field, semiconductors, but not in another, biotechnology, where world patenting is rising dramatically?

Innovation performance: Korean firms and worldwide leaders

Patent citation trends were examined to see whether Korean companies have established their own country-specific or firm-specific technological paths.[19] Among U.S. patents granted to Korean private corporations, the ratio of Korean patent citations to total patent citations has increased steadily, reaching almost 8 percent by 1999 (Figure 6.4). The ratio is substantially lower for U.S. patents granted to government research institutes (GRIs). This result may indicate that private corporations have developed better technological bases or more solid technological paths over time than government research institutes.

Figure 6.4: Citations of Korean patents as a proportion of total patent citations, by types of patent applicants, 1986-99

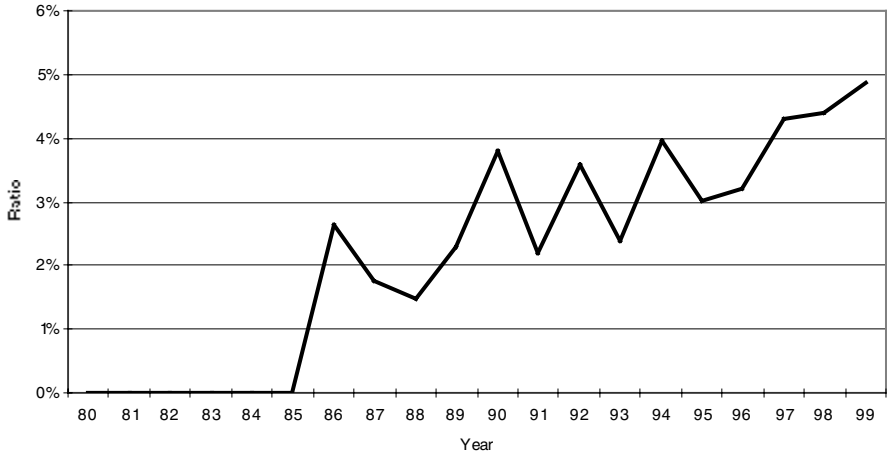


[18] Song, Almeida, and Wu (2001).

[19] In the United States, a patent application is obliged by law to specify any and all of the "prior art" that the applicant is aware of. Thus, it is possible to track knowledge building across people, firms, countries, and regions, and time. Recent studies have analyzed patent citations to trace the sources of original knowledge underlying patented innovations. See Jaffe, Tranjtenberg, and Henderson (1993); Almeida (1996); Almeida, Song, and Grant (2002); Song, Almeida, and Wu (2002).

Next, trends in self-citations were traced to measure the path-dependence of firms and countries in innovations.[20] Generally, the self-citation rate is high for a firm or a country that has developed strong innovative capabilities over time. Self-citation occurs when a patent filed by an organization (or a country) cites another patent from the same organization (or country).[21] The self-citation rate in patent applications by private corporations has risen steadily over time (Figure 6.5). By the late 1990s, half of the patent citations by Korean private firms were self-citations.

Figure 6.5: Self-citation rates of Korean private corporations, 1980-99



The patenting trends of representative Korean companies were compared with those of leading overseas companies in several individual industries.[22] The leading Korean companies are still, in general, substantially behind leading global companies, in terms of both numbers of patents and self-citation rates.[23] The exception is in semiconductors, where Samsung Electronics has emerged as one of the leading innovators in the industry worldwide.

Why semiconductors, not pharmaceuticals?

Compared with the semiconductor industry, Korea's innovation performance has been particularly poor in chemicals and pharmaceuticals (Figure 6.6). Figures on revealed comparative advantage confirm the disparity between the semiconductor and chemical industries in Korea.[24]

[20] Sorensen and Stuart (2000), Rosenkopf and Nerkar (2001), and Song, Almeida, and Wu (2002) have used self-citations to evaluate the extent of path dependence in innovation activities.

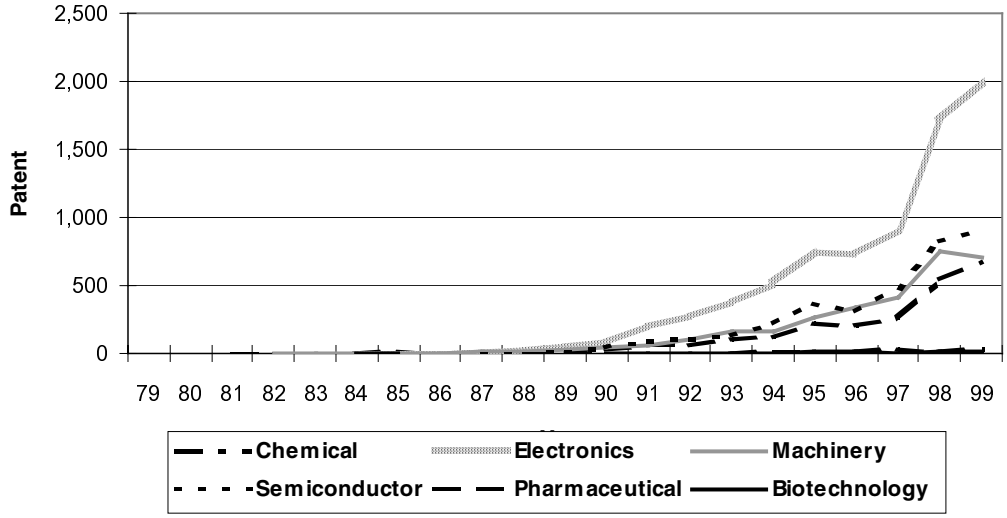
[21] For example, if a patent application granted to Samsung Electronics in 1996 cites a patent granted to Samsung Electronics in 1990, this is regarded as a self-citation. If the ratio of self-citation to total citations is high, it means that a firm or a country has already established its own technological path or trajectory and will tend to pursue subsequent innovations along this path. Song, Almeida, and Wu (2002).

[22] For detailed results, see the appendix to this chapter at http://www.worldbank.org/eaptrade.

[23] This supports the finding that Korea invents in areas whose citation peak is smaller, which may imply newer technologies (Hu and Jaffe (2001).

[24] Revealed comparative advantages for Korea, Japan, and the United States were 275, 253, and 133 in the electronics industry and 21,45, and 170 in the chemical industry respectively.

Figure 6.6: Korean patents granted in the United States, selected industries, 1981-99



Interviews with senior researchers and R&D managers in both industries emphasized that the electronics/semiconductor industry is a more engineering-driven, assembly-oriented industry than chemicals or pharmaceuticals, which are more science-driven. In electronics/ semiconductors, technical progress has been very fast, and companies have often experienced major technological discontinuities that offered good entry opportunities for latecomers like Korea.[25]

By contrast, the chemical and pharmaceutical industries require companies to master cumulative know-how that is mainly acquired by time-consuming trial-and-error learning—a particularly slow process for a country with a relatively short period of industrial experience. Even in firms that are industry leaders, new drugs take several years to develop, entail huge costs, and come with a high chance of failure.[26] And—given the heavily regulated nature of the drug approval and distribution processes—even if Korean companies develop potentially valuable drugs or new chemical entities, they must rely on the multinational pharmaceutical giants for global clinical trials, drug approvals, and worldwide distribution.

Korea's government and companies bet on electronics and IT, which they perceived as easier industries in which to catch up technologically; as a matter of industrial policy, both the amounts of investments and the number of researchers in the

[25] A good example is the Korean advance in emerging digital technologies. Koreans lagged behind Japan and the United States in the conventional analog-based technologies in the electronics industry. However, as the technological base in the electronics industry recently moved to more digital-based technologies, Korean companies such as Samsung Electronics and LG Electronics seized golden opportunities to catch up with industry leaders in Japan, the United States, and European Union by investing in digital technologies heavily early on. For both companies, a substantial number of U.S. patents now comes from technologies related to emerging digital appliances and some of them are more basic product patents than traditional process patents.
[26] It usually takes about 10 years for the discovery, animal testing, clinical trials, and approval of a new drug.

chemical/pharmaceutical/biotechnology industry have been small compared to those in electronics/semiconductors.[27]

Conclusions

Korea's success in innovation has required much more than a tightening of intellectual property rights. Industrial upgrading, exports, a big push in R&D from the *chaebols*, and selective targeting of the semiconductor/electronics industry have all played a role.

Korean firms have become much more innovative in the short span of a decade, but the self-citation patterns of patents registered by Korean firms reveal that most have yet to attain the status of global leaders in technology. The focus thus far in Korea has been on process inventions and not on developing generic technologies. As the innovation process becomes more sophisticated, it may become more difficult for Korea to compete successfully in broader-based inventions. Hence, the next stage of its R&D effort will likely need to focus on inventing standard-setting technologies that can earn substantial royalties in international markets.

In many countries, TRIPs calls for the introduction of stronger patent protection. Given Korea's experience, other countries wishing to boost innovative activity among their private firms should not expect too much from simply adopting a new patent regime, and may wish to design packages of complementary "behind-the-border" policies. Korea has used a variety of instruments for this purpose, many of which could be emulated by developing countries.

Will stronger copyright protection encourage development of copyright businesses in Indonesia?

This section examines the effects of copyright law on business development in Indonesia, using data obtained from field interviews and surveys of copyright-sensitive firms, to draw some general lessons for the design of copyright policy.

From the standpoint of economic development, the main reasons for a developing country to adopt and enforce stronger copyright laws are to encourage creative activity by local artists and firms and to support the transformation of that activity into products for the domestic and export markets. Stronger copyright regimes can generate significant income streams for creative people and firms. At the same time, these new rights may be expected to raise the prices of copyrighted goods by reducing the supply of pirated versions. The price impact hurts consumers, though consumers gain from having higher-quality products and support services on the market. It may also hinder the progress of education and scientific and technical advance. Copyright strengthening may be expected to cut the sales of imitation products over time, and, to the extent that imitators and their employees are domestic, the

[27] According to the Korea Industrial Technology Association, as of December 1999, the number of researchers in the electronics industry was 65,028, or about 38 percent of the researchers in Korea, whereas the researchers in the chemical industry numbered only 15,807. The ratio of R&D expenditures to sales for Korean electronics companies was 4.54 percent in 1997, more than twice the average for manufacturing firms.

impact may be higher unemployment and adjustment costs in the labor market. To the extent that workers in the pirating firms are poor, stronger copyrights can worsen poverty, at least in the short term. In many developing nations, fear of the short-term effects of stronger copyrights on employment and prices is widespread. For stronger copyrights to reduce poverty, they must open new economic opportunities for poor artists to develop, record, and sell their products. Further, mechanisms must be place to ensure that these artists realize higher incomes from exploitation of their works.

Legal structure and enforcement

On paper, Indonesia has a strong copyright regime, and one official has described it as having the strongest compliance with TRIPs in Southeast Asia. The 1997 copyright law is virtually compliant with the WTO Agreement on TRIPs. It will be replaced by a new copyright law in early 2003, which will establish a regime of neighboring rights (consistent with the Rome Convention) and significantly increase the civil and criminal penalties for infringement.[28]

As might be expected, Indonesia's capacity to enforce the copyright law is relatively limited.

- The basic source of the problem is extensive piracy, largely of recorded movies and music. The incentives to copy and distribute such goods are enormous, and piracy has become such a significant industry that even a well-funded enforcement agency would find it difficult to make much of a dent in its scope.
- Funding for the police is extremely low. According to one police official in Jakarta, his department's budget for copyright enforcement is around US$200 per action, but each case costs perhaps US$1,000-$1,500. The police therefore accept payments from complainants (for example, music recording companies) to defray their costs. This practice limits the incentives for legitimate complaints and is questionable from the standpoint of honest and efficient enforcement.
- Very few customs authorities and police personnel work on IPR issues. For obvious reasons, these officials may have higher priorities. The copyright office itself devotes some effort to making raids and raising awareness but is seriously understaffed. And, as is usually the case in developing countries, Indonesia has far fewer qualified judges, prosecutors, and IP lawyers than it needs for effective enforcement. Computerized systems are virtually nonexistent.
- Centralized authorities in Jakarta and Bandung find it impossible to undertake enforcement activities in Indonesia's widely flung urban and rural areas and coastlines.

[28] The new law will also improve procedures for arbitrating and resolving disputes and it clarifies that copyright cases can be appealed in a streamlined fashion to the commercial court. It also increases the authority of the police to undertake enforcement actions on their own initiative. Perhaps most significantly, it makes end-use piracy a criminal offense, with a maximum five-year prison term. Another provision of the new law permits copyright owners from outside Indonesia to retain Indonesian legal representation. Under past law, a complainant had to come to court in Indonesia to make a claim of infringement. Foreign companies (and certainly individual artists) often found this was not worth the time and effort. Indonesia has adopted the World Intellectually Property Organization (WIPO) Copyright Treaty and intends to ratify the WIPO Performance and Phonograms Treaty. Among other things, these changes will make it illegal for Internet users to circumvent electronic protection devices on binary files and transmission protocols.

They rely on local governments to manage the problem, and those governments may have other priorities or interests in weak enforcement.

The government is making some progress in combating piracy. A new law requires registration of compact discs (CD), digital video discs (DVD), and video CDs (VCD) pressing machinery, all of which is imported. The number of copyright enforcement cases increased from 44 in 1999 to 109 in 2001 and 1,999 by early June 2002.[29] Virtually all such cases involve pirated movies and music, with enforcement actions against both production facilities and retail shops.

At the time of writing, no copyright cases have involved software copying. This is probably because of a significant limitation in the law; that to sustain a claim of infringement, complainants must provide original software code to the courts so that the authorities can compare the code to that of the defendant. Many software companies prefer not to reveal their machine language in an environment where it may be released to rivals. However, in two cases in 2001, the local agent for a major foreign software firm sued five firms for having loaded the firm's products into personal computers without authorization. The agent was able to do so under Indonesia's consumer fraud statutes and achieved judgments against all defendants.[30]

Effects of copyright law on specific industries

This section describes the situation of particular copyright industries in Indonesia and the changes that might be made in these industries in the event of stronger copyright enforcement.[31] Across the board, survey respondents overwhelmingly would prefer stronger government efforts to reduce piracy. This is not surprising, as it would remove some costs from the private industry while expanding demand for their products.

Software

In Indonesia, software and databases are protected by copyrights providing protection for 50 years, and computer programs may be patented. According to at least two Indonesian officials, the government views copyrights as an inducement to innovation in software development, an industry it has identified as key for economic growth and recovery. This decision is based on the fact that writing code for programs and games is fairly straightforward and labor-intensive, offering prospects for absorbing large numbers of reasonably well-educated young people into the labor force. Indeed, as several interviewees commented, Indonesia offers a good basis of semiskilled workers for the software industry. Software is seen as a dynamic industry that should experience rising global and domestic demand over the long term, particularly as the Indonesian economy makes greater use of information technologies. The government has established a number of incubator programs

[29] This increase seems to have come at the expense of fewer trademark cases. These data are from the national police force.

[30] The money the agent received from resulting fines was contributed to a program to purchase computers for schools.

[31] Details of the survey results and descriptions of the industries are in the appendix to this chapter at http://www.worldbank.org/eaptrade.

that provide incentives for software developers. The programs are too new to assess but they seem to be well structured for this purpose.

The software industry has considerable scope for expansion in both domestic and export markets. Copyright protection will be one element in realizing this potential. In this relatively young industry, firms perceive the threat of software piracy as a significant entry barrier. Other major entry barriers cited include strong competition, shortages of skilled labor, the existence of dominant producers, and concern over weak copyrights in neighboring countries. For firms considering expansion, the most significant problems are weak telecommunications infrastructure and Internet services, shortages of skilled labor, and concern over unauthorized copying. Of the 25 firms surveyed, 24 indicated an intention to expand output over the next two years. Twenty-two firms cited uncertainty about the economy as a "very important" or "somewhat important" barrier to expansion.

At least over the medium term, better copyright enforcement seems to offer only moderate scope for encouraging additional business activity in software development in Indonesia. Virtually all the survey respondents think piracy is endemic and would like to see stronger efforts to reduce it. Of the small firms surveyed, only one said it would expand its output and investment if rights were strengthened. Medium-sized enterprises would be more likely to expand their activity and develop new products, as would larger enterprises. Presumably, that expansion would increase net incomes for software developers and employees in the industry, even as it reduces employment opportunities in copying.

It is possible to be more optimistic about the longer term. Given the small size of the software industry in relation to Indonesia's economy and population, and the country's human capital resources, stronger copyright protection should improve the software industry's prospects to some degree.[32] However, the industry is unlikely to grow significantly before the economy overcomes its current sources of instability and uncertainty and improves its infrastructure for telecommunications services.

Recorded music

Among the copyright industries in Indonesia, the recorded music industry probably suffers the most damage from poor copyright enforcement. The industry focuses on local cultural and pop music. It is highly domestically oriented and made up mainly of small firms, and, as in software, there are remarkably few companies for an economy of Indonesia's size. The current system yields revenues for a remarkably small number of musicians. A more sophisticated system, including professional rights management and collection societies, should help considerably in this regard. The primary prospect for expanding income opportunities for poor artists lies in the expansion that the recording companies say they would undertake in response to better copyright protection; the companies would also invest more in artist development.

[32] The median estimates from the survey were that there were 230 software firms in Indonesia, employing some 5,800 workers. In contrast, survey work in Lebanon in 1997 estimated that in that country there were perhaps 490 software companies employing around 3,000 workers (Maskus, 2000b). Clearly, the Indonesian market potential is far larger than that of Lebanon.

Virtually all the recording companies said that the government is doing "far too little" to stop piracy, and claimed unambiguously that their businesses would expand considerably if copyright enforcement were more transparent and effective. Both large firms, all 11 of the medium-sized firms, and 9 of the 11 small firms said they would expand, either modestly or significantly. Ten of the small firms and all the medium-sized firms would invest more in developing new songwriters and recording artists. Again, there is reason to believe that the impact would be considerably larger in the long run, given Indonesia's size.

Film

Indonesia's film industry is small but growing. Small film producers are particularly concerned about domestic copying and could benefit from stronger copyright enforcement. As in the recorded music business, the great majority of firms answered that government is doing far too little to reduce piracy. However, the expected impact of stronger copyright enforcement on their activity is not as dramatic as in music. Among the film companies, 9 of 16 said they would attempt to expand modestly or significantly, while 6 of the small firms anticipated no impact or a small contraction. At the same time, 14 of 16 firms (including 6 small firms) said they would invest in more filmmaking capacity in the event of stronger copyrights. Thus, while the signals are somewhat mixed, there seems to be a reasonable suggestion that the film industry would expand as copyrights become more strongly enforced.

Print publishing

Indonesia's publishers perceive considerable amounts of book piracy, but their industry suffers only modest damage and would not expand much as the result of stronger protection. The major problem in starting a print publishing business in Indonesia is felt to be a shortage of finance.

Conclusion

Indonesia's copyright law is TRIPs-compliant and in some ways goes beyond TRIPs requirements. An assessment might usefully be made of whether the extra protection is really appropriate for Indonesia's economy.[33] For some time into the future, enforcement is likely to continue suffering from weak capacity, chronic underfunding, limited access to enforcement procedures, and nontransparency.

As rights become more successfully enforced, there will be scope for expansion and income gains in copyright-sensitive industries. These gains would be felt in the medium term and would need to be assessed against the short-term hardship that would result for the firms and workers who are now engaged in unauthorized copying and distributing. The extent of this hardship cannot be predicted with confidence, but it seems probable that employment in

[33] Indeed, it may be that some aspects of Indonesia's intellectual property regime—in particular, the limitations on fair use and the provisions for patenting software—are over-restrictive from the standpoint of the country's development needs. In software, the tighter copyright law to be introduced in 2003 may substantially limit fair use provisions: In addition to the prior restraint that a user of a computer program may make only one archival copy, educational users of software and printed materials will be permitted only one copy for their use before they are required to attain licenses for multiple copies. The new law outlaws the decompilation (reverse engineering) of computer code.

copying and selling pirated versions of music, movies, and software is significant in the larger cities.

Protecting traditional knowledge: Why and how?

At the time of writing, genetic resources, plants and herbs, and knowledge about their properties are collectively referred to as biologically based traditional knowledge. Other forms of traditional knowledge arise in music, designs, and folklore.

More and more innovations in agriculture and pharmaceuticals draw on traditional or indigenous knowledge, and the market value of pharmaceutical derivatives from traditional medicine has been estimated at around US$43 billion a year worldwide.[34] The trial and error required to bring about a successful innovation can be drastically reduced when TK is consulted. In medical research, bio-prospectors have increased the success ratio of trials from 1 in 10,000 samples to 1 in 2,000.[35] Given that roughly 90 percent of the world's genetic and traditional knowledge is held in developing countries, and roughly an equal percentage of the world's R&D activity takes place in industrial countries, there is scope for mutually beneficial bargains between a gene-rich-technology-poor South and a gene-poor-technology-rich North.

The documentation, ownership, compensation, and exploitation of TK are all obscure. The TRIPs agreement touches upon these issues, but essentially leaves them to interpretation or further negotiations. This is an area where thinking needs to be advanced and policy options strengthened for developing nations. This section outlines the analytical and practical issues that need to be addressed in order to make progress on protecting traditional knowledge or compensating its ownership. It focuses on the case of research and development in the biological sciences.

A framework for R&D in the biological sciences

All technological advances take place in three distinct stages: the primary stage, known as invention, when a new idea is observed or occurs; the secondary stage, when the idea is transformed into an innovation by being embedded in a product or process; and the tertiary stage, when it gets diffused.

In each of these stages there are features peculiar to the biological sciences. In the primary stage, observation and experimentation are needed to capture exogenous information; this calls for a combination of physical, human, and natural capital. In the biological sciences, the dependence on natural capital at this stage is unique, and issues relating to the valuation of the role of natural capital become central. In the secondary stage, traditional and natural capital are combined into physical and human capital. Innovations that are fully embodied in a physical product can be sold, and few externalities exist in appropriating the returns to investment. But innovations that are disembodied—that is, not contained in a physical

[34] Indigenous People, Biodiversity, and Health. COURTS Canada IPBN Factsheet, November 1995.
[35] Prakash (1999).

product but rather held as knowledge, say by a farmer or researcher or by a social system—are subject to such externalities. A large part of biological innovation is disembodied, and, in particular, traditional knowledge is almost always held within social systems. The third stage, diffusion, also varies in character depending upon whether the innovation is embodied or disembodied. When the innovation is embodied, its diffusion takes place through the marketing of the product, albeit at a cost. The diffusion of disembodied innovations is more complicated; it takes place only through the exchange or movement of human capital, and this often means that it takes place more efficiently in a nonmarket setting.

Another very important distinction separates innovation in the biological sciences from that in other sciences. In other sciences, most learning is cumulative, that is, one cycle of invention-innovation-diffusion builds on a previous, related, cycle. The biological sciences are unique in that solutions do not last. For example, it is common to find a pathogen that has become resistant to a drug within a few years, or a pest that has acquired immunity to an insecticide after a few years of application. Not only is a solution virtually certain to lose its effectiveness, but the *way* in which it will do so is almost unpredictable, often sending the researcher back to square one.

Given that much of the new knowledge acquired in the biological sciences results from observation of natural phenomena combined with trial and error—as for example when farmers observe weather- or disease-resistance in certain crops and then hybridize for desirable characteristics—finding new solutions to problems depends on the maintenance of a diverse gene pool where the survival of the fittest can be observed. Hence, the conservation of biodiversity per se holds the key to solving the agricultural and health problems of tomorrow. Because the destruction of biodiversity is irreversible, the preservation of the stock of genetically rich lands and resources is vital. Attention to mechanisms for preserving sources of TK is analogous to the attention devoted in other sciences to providing incentives to innovate through intellectual property rights regimes.

The question at the crux of the debate on TK is that of how to ensure that both the primary and secondary stages of R&D, and their associated capital inputs, receive enough compensation to generate incentives for their continuing efficient operation. How is natural capital to be valued? How are the returns to innovations to be appropriated and apportioned?

About half of the yield gains in agriculture can be ascribed to traditional genetic resources, according to estimates using standard Cobb-Douglas models. But when models have attempted to quantify firms' willingness to pay for such resources, shockingly small values have emerged.[36] The explanation for these small values lies in the potential redundancy of solutions in the biological sciences. The more ephemeral a solution promises to be (and hence the smaller the revenue it promises to yield), the smaller the private investment. Contrasting with the calculus of private firms, public health and food security concerns would dictate that the less durable the solutions, the greater the investment that is needed in R&D. Hence, some form of public intervention is warranted that rests on the understanding that resources that are not valuable now may be valuable later.

[36] For example, a hectare of land in West Ecuador and the Amazon—the biodiversity hot spots of the world—is valued at US$20.63 and US$2.59 respectively. Simpson, R.D., R.A. Sedjo, and J.W. Reid (1996).

Proper arrangements for the appropriation of returns and compensation of contributors are preconditions for an optimal R&D effort and the supply of the factors needed for innovation. Property rights accomplish this. The literature suggests that the property rights assignment matters very much if contracting within the industry is costly, and that property rights should be placed at the levels that most encourage investment in the assets concerned. [37]

Evolution in R&D management

The international R&D management regime for genetic resources has evolved through three eras:

1. *Equal access/common heritage.* This first era emphasized the accumulation of already available information and its widest possible diffusion. The aggregation of traditional knowledge and genetic resources occurred within national academic and governmental institutions, and almost wholly by virtue of publicly funded investments. The emphasis was on the public-good nature of this information, and rapid diffusion was subsidized by means of the universal recognition of the doctrine of free access to collected resources.

2. *Private investment/property rights in end products based on genetic resources.* The second era arose with the recognition that the TK base could be developed and expanded with investments of other forms of capital. Scientific method and physical capital could be combined with natural forms of capital (genetic resources) to create more information and more useful information. Public investors were probably the first movers, but they were rapidly joined by private investors whose involvement required the development of institutions for compensating private investments. In the pharmaceutical industry, these investments could be compensated through existing patent laws. In agriculture, it was necessary to extend IPR law in a new direction—that is, toward the granting of exclusive rights in the use of naturally occurring organisms.

   The concern in this second era of R&D management was to develop property rights in *end products based on genetic resources*; the fundamental notion that naturally occurring genetic resources were common heritage remained undisturbed. The problem was seen as that of compensating other forms of capital (human, physical) that were combined with natural capital (genetic resources) to produce innovative end products, even when those products were biological and hence capable of natural reproduction.

   It became increasingly clear, however, that the useful genetic resource base is not static, and that investment is needed to maintain and expand this base. Thus, the assumption that property right mechanisms should not extend to natural forms of capital was brought into question. Once it was recognized that information in the biological sector must be optimally produced as well as diffused, it became important to move away from the doctrine of common heritage/free access.

3. *Private investment/property rights in base genetic resources.* The third era of R&D management is increasingly concerned with claiming exclusive rights in the *base genetic*

[37] Swanson, T. and T. Goeschl (1999).

resources. Both physical and human capital now focus on analyzing and manipulating the base resources themselves, with the object of developing genetic characteristics that are useful in and of themselves. In this way, the various forms of capital are all combined (natural, human, and physical), with the end product being the understanding or creation of a genetically generated characteristic that is useful in itself. The property right is then claimed in the genetic trait and its claimed use. Thus, the third era of R&D management has moved the property rights debate down a level, to the level of the genetic trait rather than the biological resource.[38]

Traditional knowledge and genetic resources: History of legislation

Historically, traditional knowledge and genetic resources were treated under the doctrine of the common heritage of mankind and based on the belief that plant genetic resources are a heritage of mankind and consequently should be available without restriction.

This changed in the 1930s, when plant breeders first sought to protect the results of their selective breeding programs. In 1961, the International Convention for the Protection of New Varieties of Plants (UPOV) established a harmonized system for international recognition and establishment of plant breeders' rights.

The Convention on Biodiversity (CBD), which came into force in 1992, established the doctrine of national sovereignty over genetic resource inputs, finally abrogating the doctrine of common heritage. It also established an approach to property rights in genetic resource inputs, based on bilateral and so-called benefit-sharing agreements. This bilateral contract approach to property rights in genetic resources has had little impact to date, however, because of the practical difficulties of implementation. Under the terms of the CBD, either the state or the local community that hosts the resource can refuse access on the grounds that it is protecting or preserving that resource, and if it allows an outside party to have access to its genetic resources, it can require an agreement setting out the terms on which access is given. But to do so successfully requires access legislation for the resources, as well as a means for determining among competing rights of ownership and establishing the mechanism for consent and transfer. Few states have adopted and implemented the access legislation required for this task. It is also clear that establishing such claims and providing legal consent would be difficult.

In contrast, the TRIPs agreement attempts a global standardization of IPR regimes. In particular, the agreement requires member states to adopt some form of plant breeders' rights, while it specifically permits countries to exclude from patentability all life forms emanating from essentially biological processes.[39] The wording of the TRIPs agreement

[38] It is now possible to claim a patent in any or all of the following steps toward identifying useful biological activity: genetic sequence; cloning method; expression of protein from sequence; biological activity of protein; and method of action.

[39] Article 27(3)(b) on Patentable Subject Matter states:

"…Members may also exclude from patentability: (b) plants and animals other than micro-organisms, and essentially biological processes for the production of plants and animals other than non-biological and microbiological processes. However, Members shall provide for the protection of plant varieties either by patents or by an effective *sui generis* system or by any combination thereof. The provisions of this subparagraph shall be reviewed four years after the date of entry into force of the WTO agreement."

requires that all member states of the WTO adopt either some form of patent system regarding improved plant varieties, or a *sui generis* regime for the protection of the same. Pressure has mounted for the adoption of uniform systems of IPR in plant varieties and other genetic resources (micro-organisms), and for countries' mutual recognition of the rights they confer in such resources. The TRIPs agreement is essentially silent on the issues of TK.

Thus CBD and TRIPs are in conflict. CBD emphasizes the importance of sovereign rights in indigenous genetic resources and the knowledge associated with them. The TRIPs agreement requires the adoption of IPR systems for improved plant varieties, but not for resources emanating from essentially biological processes.

To reconcile these two approaches would require some manner of recognition of rights to innovations regarding genetic resources, both at the end of the industry and also potentially with regard to some of the base genetic resources used as inputs. Such a regime would incorporate the rights of states that provide the natural inputs (as required under the CBD) and also the final outputs (as required under TRIPs). How might such a regime operate?

Is there an optimal property rights institution?

To be practicable, a system of property rights in the biological sciences must take account of how this diverse (because it depends on so many different forms of capital) and globally dispersed R&D sector is managed. The role of an intellectual property rights regime would be to facilitate R&D management by providing some form of exclusive marketing rights, in order to generate the optimal level of investment in various parts of the industry.

Broadly, the options for IPRs are: property rights only in the primary stage of R&D; property rights only at the secondary stage; and property rights at both the primary and secondary stages. We examine the pros and cons of each in turn.

1. It would be inadequate to have property right institutions pertaining only to the primary stage of R&D (that is, at the level of the products of the natural capital). This is because it would be impossible to capture the benefits emanating from the other (non-natural) forms of capital employed within the sector. These latter are usually employed at a later stage in the industry, and the property right pertaining to the first stage would be incapable of managing the end markets. Also, it is not clear that a property rights mechanism at this level would dramatically increase the levels of investment in reserves. The mechanism selected would need to operate at several different levels (embodied, disembodied, expressed) in order to obviate the rent-dissipating effects of competition between

There are three important points to make regarding this provision. First, under article 27.3(b), signatories must adopt a patent system for microorganisms and must also establish some form of protection for plant varieties. This means that some forms of biological resources must be covered by IPR legislation in member states; some genetic resources are now subject to the international system of IPR. Second, the TRIPs agreement requires that either patent protection be provided to plant varieties or some other effective *sui generis* system. Third, TRIPs establishes a line of patentability between those plant varieties produced by modern methods and those produced by natural or "essentially biological processes."] The latter are not subject to legal protection, while the former must be protected.

suppliers of this information. This might be possible, but only at the cost of introducing distortions (for example, exclusive dealing arrangements) that would introduce their own costs.

2. The sector could be managed with a single property right at the secondary stage of the R&D sector, but this would require substantial amounts of contracting between the secondary and primary stages of the sector. In essence, a single property right at the secondary stage would permit its owner to appropriate the full value of the information inherent within the final product, but complete contracting would be needed to ensure that these rents were distributed efficiently across all of the components of the vertical industry. The diverse and widely distributed nature of the R&D sector makes it costly (although not impossible) to engage in this sort of structured contracting.

3. R&D could also be managed with the placement of a property right mechanism at both the primary and the secondary stages. This would create an institution focused on the efficient distribution of the industry's informational rents, but at the cost of creating multiple levels of monopoly within the same vertical industry. Multiple constrictions on output (to generate rents) will reduce, perhaps severely, the welfare that is generated within the industry. In any event, the introduction of multiple distorting monopolies generates outcomes whose net impact on social welfare is very uncertain. Successive monopolies introduce successive distortions within the industry, which may result in more welfare reduction than enhancement.

The choice between the latter two options depends on their comparative institutional costliness. Having a single property right at the secondary stage (option 2) results in substantial contracting costs, and thus a significant amount of residual inefficiency in the distribution of informational rents within the vertical industry. Having multiple property rights in the single vertical industry (option 3) addresses this problem, but results in successive distortions in the market.

Practical concerns

Even if the conceptual and analytical issues outlined above were somehow addressed, a number of practical concerns would remain in valuation, appropriation, and distribution of returns fromTK.

First, intellectual property rights are individualistic, but TK is normally collectively held and developed by members of an indigenous community over several generations, making it extremely difficult to identify individual inventors of such knowledge. While the fact that the knowledge is passed down over generations should add to its value in principle, the problem arises that the information may be said to exist within the public domain.

Second, patent applicants must supply evidence of a single act of discovery. This will be extremely difficult to establish. The patenting of indigenous practices might be supported if it were possible to provide written documentation of local and traditional practices. TK has usually been passed on orally.

A third problem concerns the description and demarcation of TK within a written application. The specifications for a patent must be written in technical language that demarcates its limits, and establishes the relationship of the innovation to already existing knowledge and innovations. A particular use of a characteristic of a plant or animal may be well known to an indigenous community, but it must be able to be related in a form that will distinguish it from other biochemical or genetic information or usefulness. Much TK is disembodied and subject to the problems of appropriating benefits from disembodied information that were noted above.

Finally, for TK to be protected from unauthorized use, it must first be placed in public registries. In principle, such registries would establish the sources, ownership, and characteristics of the included knowledge. In practice, the operation of registration systems poses at least two complex questions:

- How is TK to be registered? Before any valuation or distribution issues are tackled, TK will need to be documented. Should the burden be on local communities to disclose and register what they know in the event that this knowledge becomes precious to the scientific community in the future? Will communities that do not do so be penalized?
- How will such registers operate? To establish a claim of prior possession and therefore preclude patenting by others, these registers will have to be made public. Putting them in the public domain could of course prejudice the future protection of the knowledge documented in them, and its compensation.

The Philippines being a nation composed of many indigenous peoples has been a leader in instituting legislation for access and compensation of indigenous knowledge (Box 1) and is seen as a laboratory for considering solutions to the problems concerning property rights that are affecting the R&D sector globally.

Conclusions

The historical tendency to treat genetic resources as constant and freely available is an anachronism, and a better approach to management of these resources is needed. Hence, some public intervention is required. Given international externalities, this public intervention should ideally be international. In fact, rights acquired in countries of origin alone will not mean much unless they are extended to major markets where derived and patented products are marketed.

Box 6.1: Protection of Indigenous Knowledge in the Philippines

The Philippines has recently developed and implemented legislation concerning the protection of biological resources. Two noteworthy attempts have been the Executive Order 247 (EO247) adopted in 1995 and the Indigenous Peoples Act of 1997 (IPRA) of 1997.

EO247 covers the prospecting of al biological resources in the public and private domains and requires anyone, whether a national or foreign entity, wishing to access biological resources to enter into a formal research agreement with the government after obtaining informed consent of the appropriate local community.

While this has increased involvement of the indigenous community, the actual practice has been criticized for being a procedural checklist rather than substantive in nature, in that access requires no more than notification to the local community. Also, EO247 does not elaborate precisely benefit sharing with the local communities comes about. Notably, this legislation has been used as a basis for a model law on access and benefit sharing for national systems in Asia by ASEAN.

IPRA gave indigenous peoples rights over their ancestral lands as well as rights to use and develop natural resources found in their ancestral domains by creating an agency called the National Council for Indigenous Peoples, which is responsible for overseeing the issuance of permits for access to indigenous peoples' lands on the basis of prior informed consent. IPRA's intention is to extend the system of controlled access beyond biological and genetic resources to their "sciences, technologies, and cultural manifestations" by recognizing the concept of "community intellectual property rights."

While IPRA remains in its infancy, it is expected to provide impetus for significant changes to IPR law in the Philippines. A number of hurdles relating to implementation need to be worked out—one of the most challenging ones being defining and implementing community-based IPRs.

For details on progress in the Philippines on legislating protection of traditional knowledge, please see http://www.worldbank.org/eaptrade for background papers and technical annexes.

It is therefore appropriate to discuss the protection and compensation of TK in international forums. The TRIPs agreement establishes the principle that some genetic resources should be subject to IPR, but it does not resolve the conflicts between member states; it merely transfers the debate to this new forum. A number of complex problems—conceptual and practical—will need to be sorted out before progress can be made in linking traditional knowledge issues to WTO agreements or other mechanisms for managing R&D in the biological sciences.

The management regime required for R&D in the biological sciences would need to take into account the diverse and widely distributed nature of this activity. A single property right at the secondary stage of the industry is probably not very effective at managing all of the component parts of the remainder of the industry. It is not infeasible to have two property rights, one at the primary and one at the secondary stage, but it is difficult to predict whether the net outcome would improve welfare. The judgment between these two options would depend on comparing the coordination costs of contracting across various parties, when

multiple rights are awarded, with the incentive costs of acquiring adequate supplies of necessary factors, when rights are centrally awarded.

To sum up, the question of property rights in TK is an important problem, but there probably does not exist any best regime as a solution. To compensate communities that holdTK, other institutions should also be considered, such as geographical indications, copyrights, and trade secrets. To select a second best approach to managing R&D in the biological sciences, the comparative costliness of the various approaches will have to be the guide.

Appendix to Chapter 6: Protecting Industrial Inventions, Authors' Rights, and Traditional Knowledge: Relevance, Lessons, and Unresolved Issues

1. Patenting in Korea

Results of analysis

Appendix Table 6. 1: T-tests of annual growth rates of semiconductor patents

(Semiconductor patents granted in the US between 1988 and 1999)

	Paired differences		t-value
	Mean	**Std. deviation**	
Korea – Japan	.2974	.1813	5.681***
Korea – UK	.4176	.2814	5.140***
Korea – France	.3674	.2467	5.159***
Korea – Germany	.3624	.2274	5.522***
Korea – Taiwan (China)	.0235	.2401	.340
Korea – US	.2985	.2437	4.243***

Note: *: p=0.1; **: p=0.05; ***: p=0.01

Appendix Table 6.2: Industrial composition of patents, 1985-90

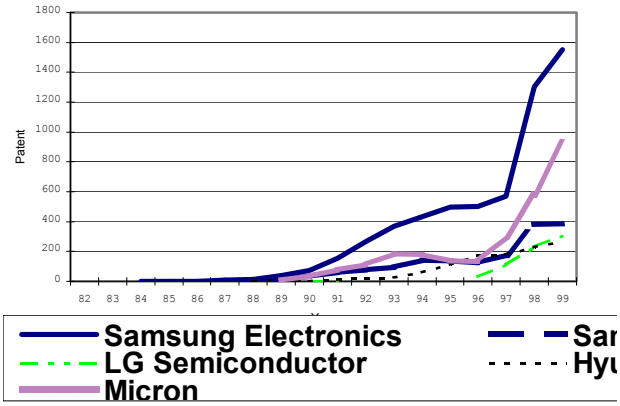
	1985	**1990**	**1995**	**1999**
Korean patents in the US – Korean exports	0.916*	0.918*	0.995***	0.992***
Korean patents in the US – Total patents in the US	0.637	0.484	0.467	0.720
Korean patents in Korea – Korean exports	- 0.562	0.096	0.867**	0.965***

Note: *: p-value = 0.1; **: p-value = 0.05; ***: p-value = 0.01

Patenting trends in Korean firms vs. worldwide industry leaders

In the semiconductor industry, we chose Micron Technologies, the second largest memory chip company in the world behind Samsung Electronics, as the overseas comparison company. We found that patenting trends in major Korean memory chip companies were generally similar to those of Micron Technologies (Appendix Figure 6.1). However, as Appendix Figure 6. 2 shows, Micron Technologies had a markedly higher self-citation ratio (at about 20 percent in 1999) than the Semiconductor Division of Samsung Electronics or other Korean companies, suggesting that Micron has established a more solid technological path.

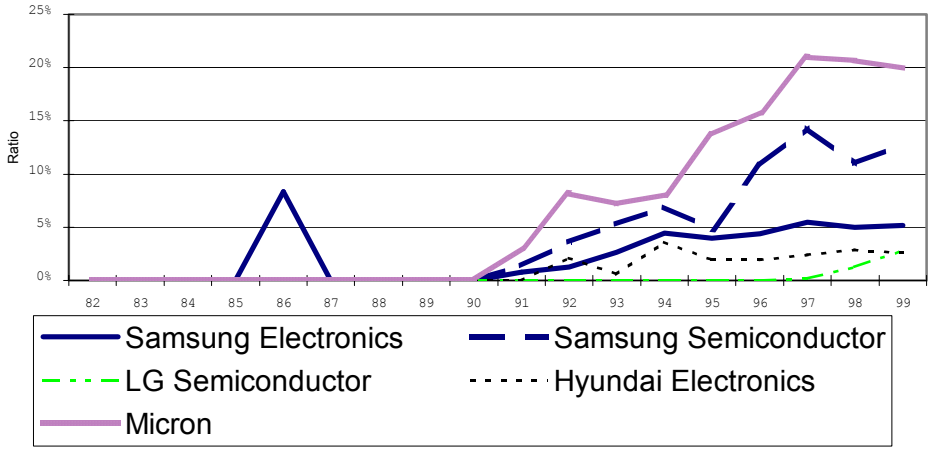
Appendix Figure 6.1: Patenting trends of major Korean semiconductor companies vs. that of Micron Technologies, 1984-99



Note: Samsung Semiconductor refers to the Semiconductor Division of Samsung Electronics. In addition to the semiconductor business, Samsung Electronics has consumer electronics, telecommunications equipment and devices, and PC business. LG Semiconductor and Hyundai Electronics merged into Hynix Semiconductor in 2000.

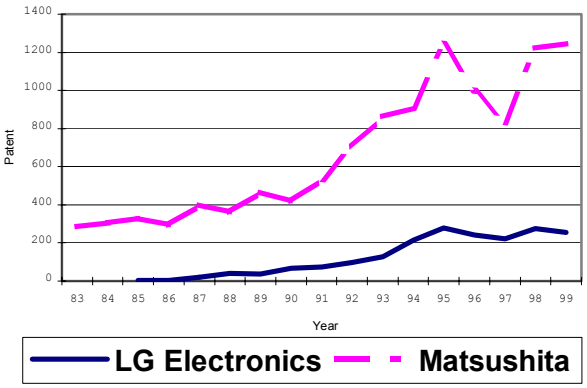
We should also note that the self-citation rate of the patents granted to the Semiconductor Division of Samsung Electronics was more than twice as high as that of the patents granted to Korean firms on average (about 13 percent, compared with about 5 percent, in 1999) or even the semiconductor patents of patents granted to other Korean companies. Samsung's very high self-citation rate in this field, combined with the fact that Samsung has more US patents than any other Korean firm, suggests that the Semiconductor Division of Samsung Electronics has established probably the most solid technological trajectory among all Korean companies.

Appendix Figure 6. 2: Self-citation rates of selected semiconductor companies, 1982-99

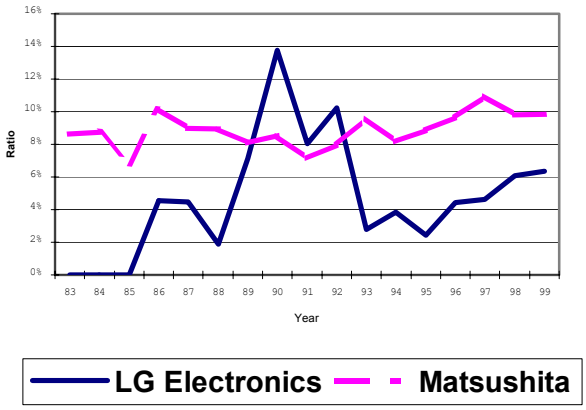


In the electronics industry, LG Electronics, a leading Korean electronics maker, shows much lower patent counts than Matsushita Electric, a global leader in the industry (Appendix Figure 6. 3). And in general LG's self-citation ratio has been lower than Matsushita's (Appendix Figure 6.4).

Appendix Figure 6. 3: Patenting trends of LG Electronics vs. Matsushita Electric, 1985-99

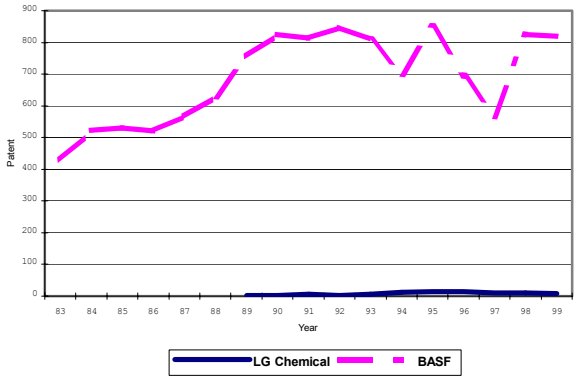


Appendix Figure 6.4: Self-citation rates of LG Electronics vs. Matsushita Electric, 1983-99

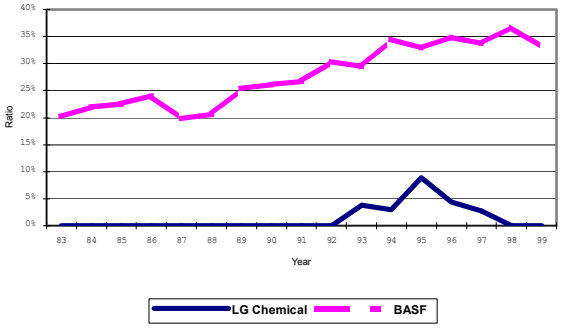


In the chemical industry, the gap between Korean leading firms and global leading firms is much more conspicuous. In Appendix Figure 6.5, the patent counts of LG Chemical, an industry leader in Korea, were very low, at fewer than 50 annually even by the late 1990s, by comparison with BASF, a leading global chemical company, which secured 700-800 patents annually in the same period. And, as shown in Appendix Figure 6, the self-citation ratio of patents granted to BASF was around 35 percent in the late 1990s, whereas the comparable ratio in LG Chemical was very low.

Appendix Figure 6.5: Patenting trends of LG Chemical vs. BASF, 1989-99



Appendix Figure 6.6: Self-citation rates of LG Chemical vs. BASF, 1983-96



2. Copyright in Indonesia

Research approach

The analysis is based on interviews and survey data. First, in May and June, 2002 the author interviewed key participants in Indonesia's creative industries and the government about their views on the adequacy of the copyright system. Second, to obtain more systematic evidence from Indonesian businesspersons, formal questionnaires were administered to 70 firms in four central copyright industries (software, recorded music, film making, and print publishing). The firms include developers, manufacturers, and distributors.[1]

There seems to be substantial employment in copyright-infringing activities in Indonesia, including copying and distributing unauthorized software and entertainment products. The amount of employment (or profits) will affect the political feasibility of effective reforms and the adjustment costs they would generate. For obvious reasons, it was not possible to survey

[1] The questionnaires were implemented by AC Nielsen in Jakarta in July and August 2002.

firms engaged in piracy but interviews of developers, distributors, and government enforcement officials yield rough estimates of the extent of infringement and related employment.

Survey results for specific industries

Software

In this relatively young industry, 25 software firms were surveyed, of which 16 were founded since 1995.[2] Eighteen firms are strictly domestic, and most of these are privately owned. Survey respondents provided a wide range of estimates about the number of software firms in Indonesia and their average sales and employment[3]; their median estimate is that there are 10 large software firms, 70 medium-sized firms, and 150 small firms, with a range over all firm sizes of 32 to 800.

Even taking the high range, this is a remarkably small number of software enterprises for a country of Indonesia's size, and reflects numerous restraints on entry and expansion. Virtually all firms are located in Jakarta and Bandung. Indonesia's domestic market for software is limited by the remarkably low rate of PC use. Annual sales of PCs are running around 400,000 – 450,000 and the total number of computers in use is estimated to be around 1.5 million. Internet use is very much smaller, at least partly because of inadequate and high-cost telecommunications services. As incomes expand and telecommunications become more competitive (the government is currently undertaking further deregulation), demand for PCs and software should rise rapidly.

The industry has three distinct components, each with different business approaches.

The first is a small but growing group of sophisticated software firms that produce programs largely under contract to foreign companies. This is a newer and smaller version of the software export industry in India and, in fact, some of its programming is done under subcontracts from Indian firms. The Indonesian government provides extensive support for this activity. Revenues and employment in these companies are expanding quite rapidly and Indonesian companies, now concentrated in Bali and Bandung, appear to be establishing a solid global reputation for this service. Game software for foreign markets is written largely in this environment.

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[2] More than half of the firms surveyed are medium in size (26-100 employees), while five are small and seven are large on an employment basis. In terms of sales volume somewhat more firms are small, with annual revenues below US $500,000. Seven firms are affiliated to foreign enterprises, either as affiliates or joint venture partners. Only eight of the 25 firms report the existence of a separate research department within the firm and most of these eight are medium in size.

[3] From the survey, median estimates of employment in the software industry are 80 workers in large firms, 50 in medium-sized firms, and 10 in small firms. If we combine the median estimates, survey respondents believe that there are perhaps 800 total employees in large software firms, 3,500 in medium enterprises, and 1,500 in small firms, for a total of 5,800 workers. Again, this is a small level of employment for an economy of Indonesia's size. Note that this estimate does not include employment in firms engaged in unauthorized copying, which cannot be reliably estimated.

The second component consists of a larger number of small and medium-sized enterprises that produce specific applications software for the Indonesian market and occasionally for neighboring countries. Software applications in finance, accounting, engineering, process control, health care, and other areas are designed for such specific purposes that there is little risk that a rival would pirate them for commercial sales. Some firms have distinguished themselves sufficiently to sell a particular program (typically with customization options) to multiple consumers and achieve some degree of economies of scale. Most are small, however, and write programs on a for-hire basis without generating these economies.

The third component is representatives and distributors of global software companies. Some of these distributors represent systems integration programs (such as SAP, Oracle, and PeopleSoft), in which the real value added lies more in installation, training, and service than the software itself. Such programs bear no risk of illegal copying because unlicensed firms would find it difficult or impossible to offer these complementary services. Other distributors represent firms offering operating systems and applications that are widely used in personal computers. As might be expected, one firm dominates this segment of the Indonesian market. Given the size of Indonesia's economy, the sales volume in this market is surprisingly small, at perhaps $100-140 million per year. Undoubtedly there is extensive unauthorized copying of Microsoft Windows, Office, and other products through over-the-counter sales, inclusion of copies on PCs, and file sharing across users. The distributors are most interested in stronger Indonesian copyright protection, claiming that their revenues would be much larger if piracy rates—currently estimated at 95-96 percent—were brought down even moderately. Generally officials in these distributors view Indonesian copyright law as adequate (though concerns are expressed about a phase-in provision of the new law) but enforcement as ineffective.

Does weak copyright enforcement significantly restrain the growth of the software sector? The copyright regime was singled out as an important constraint by the Indonesian software association (ASPILUKI), which actively lobbies for improvements. Many of the association's members are medium-sized producers of applications and game software, some of which is subject to widespread copying. It is likely that weakness in the copyright system limits their incentives to expand production and extend marketing beyond Jakarta or Bandung.

The survey results show that firms perceive the threat of software piracy as a significant entry barrier in the industry. "Concern over unauthorized copying" was listed as a "very important" entry barrier by 17 of the 25 firms surveyed and as a "somewhat important" barrier by another four. Other major entry barriers cited include strong competition, shortages of skilled labor, the existence of dominant producers, and concern over weak copyrights in neighboring countries. For firms considering expansion, the most significant problems are weak telecommunications infrastructure and Internet services, shortages of skilled labor, and concern over unauthorized copying. Twenty-four of the 25 firms surveyed indicated an intention to expand output over the next two years, suggesting that firms in the formal software industry anticipate a growing market. Twenty-two firms cited uncertainty about the economy as a "very important" or "somewhat important" barrier to expansion.

Piracy is widespread for certain types of software but not others. The largest proximate losers are the local distributors of foreign operating systems and standard applications. The price differentials between legitimate copies and pirated copies are quite large and incentives to copy will continue. Households, small enterprises, university students, and government offices commonly copy software for their own uses or sale; PC operating systems, major applications, and games are widely copied, while business-specific applications are not. In some degree, this difference in piracy rates helps explain the product mixes that are offered by Indonesian software firms. Most of the survey respondents specialized in business applications software for niche markets; few attempted to write game software and none was contemplating the development of major applications for the Indonesian market.

At least over the medium term, it would seem that better copyright enforcement offers only moderate scope for encouraging additional business activity in software development in Indonesia. Virtually all respondents think that piracy is endemic and would like to see stronger efforts to reduce it. However, only one of the small firms surveyed would expand its output and investment if rights were strengthened. Medium-sized enterprises would be more likely to expand their activity and develop new products, as would larger enterprises. Presumably that expansion would increase net incomes for software developers and employees in the industry, even as it reduces employment opportunities in copying.

It is possible to be more optimistic about the longer term. Given the small size of the software industry in relation to Indonesia's economy and population, and the country's human capital resources, stronger copyright protection should improve the industry's prospects to some degree. However, the industry is unlikely to grow significantly before the economy overcomes its current sources of instability and uncertainty, and improves its infrastructure for telecommunications services.

Recorded music

The survey covered 25 music-recording companies in Jakarta, 17 of which were formed before 1995.[4] Twenty-one of the firms are domestic and all of these are private. The median estimated numbers of firms in the industry as a whole are 40 small, 12 medium, and five large, for a total of 57 nationwide.[5]

As in software, few firms export their products. The primary export markets are Singapore and Malaysia. Only one of the 25 firms records and publishes music under contract to foreign firms. However, many of the firms buy rights to distribute music, record songs, and include songs in their own recordings. About half the firms indicate that they sell such licenses as well as purchase them. From this perspective it appears that the industry relies considerably on cross-fertilization of music and talent. Respondents estimate that the median royalty rates are around 10-15 percent of sales.

[4] Eleven are small in terms of employment and 12 are medium in size, though if we use a sales measure of size, 16 of the 25 firms are small, with less than $500,000 in annual revenues.
[5] The range of this estimate is from 16 to 165. Estimated median employment per month is 1,460.

Music piracy is seen as a "significant problem" by 19 of the surveyed firms. In all three types of recording media presented—cassettes, CDs, and VCDs—the estimated piracy rate for domestic products is at least as high as for foreign products.[6] Firms see domestic copying as the major source of piracy. All 11 of the small firms, eight of the 12 medium-sized firms, and both of the large firms claim that they must "significantly reduce" their prices in order to compete. Legitimate recordings command only a small price premium over pirated versions in Jakarta, perhaps ranging from a multiple of two to four or five.

All but one of the 25 surveyed firms listed "concern over unauthorized copying" as the most significant impediment to starting and expanding a recording business in Indonesia. Other difficulties they cited include uncertainty about the economy, access to finance, and shortage of skilled labor. Three firms expect to expand business significantly over the next two years, 14 to expand modestly, and eight firms plan no changes or a contraction. If just 25 firms were to double their average employment from 50 to 100, the industry-wide employment would rise by 1,250, or perhaps 85 percent of current employment.

According to representatives of ASIRI, the Sound Recording Industry Association of Indonesia, weak copyrights are a major problem for music publishers. ASIRI has 128 members, including the five international majors, and most are losing money or in imminent danger of bankruptcy. It is impossible to tell how much of this problem reflects competition from illegal copying and how much reflects Indonesia's economic situation.

The ability of a music industry to distribute income to songwriters and performers depends crucially on the effectiveness of its collection society—an institution that determines how much a public user of recorded music (such as a radio station or restaurant) should pay in license fees to individual artists and distributes payments of these fees. Indonesia's one collection society, Karya Cipta Indonesia (KCI), is lauded by its members for its transparency and efficiency[7], but it distributes revenues only to a small number of artists. The survey estimates that the median number of songwriters that receive royalty payments from KCI is 1,000, and the median number of recording artists is 100 (this contrasts with the interview-based estimate of 3,000 artists from the director of KCI).[8] There is substantial scope for expanding the number of small firms and of artists receiving income from recordings as the copyright regime and its supporting institutions are strengthened.

[6] Indonesia does not have a "Napster" problem of electronic copying of music files from the Internet, mainly because there are so few PCs and even fewer Internet users. Indonesian music producers tend not to place their files on the Internet both because bandwidth is inadequate for the purpose and out of concern over illegal copying. But rising use of MP3 technologies for file sharing is a concern among music producers.

[7] Of the 25 firms surveyed, 21 claim they are satisfied with KCI's efficiency in collecting fees, 20 are satisfied with its transparency, and 19 are satisfied with its fairness to songwriters and musicians. No doubt this reflects a substantial selection bias in the survey, because most of the firms are members of the society. Unfortunately, it is impossible to locate firms that would exist (hypothetically) if KCI were even more efficient or inclusive.

[8] The new copyright law proposes to place additional regulations on the operation of KCI and other such societies to be founded in the future, suggesting that there are concerns about their methods of operation.

Film

The survey covered 16 film producers, 11 of which were founded before 1995. Most of these firms are small, whether measured by employment or sales. All are privately owned and only one is in a joint venture with a foreign firm. The median estimates of the number of film producers in Indonesia add to 27, with a range between 13 and 240.[9] Indonesian film producers emphasize the domestic market. Only two firms export movies and only two have licenses from foreign entities to produce or manufacture films. A few firms buy licenses to distribute films (mainly domestic) and none buys rights to manufacture another firm's movies. Licensing among domestic firms does happen and the royalty rates are similar to those in music.

Imports account for a larger share of pirated films than of recorded music. Nevertheless, 15 of the 16 film companies surveyed consider domestic copying to be an important source of piracy. Fourteen listed pirated films as either a "significant problem" or a "modest problem" for their businesses. The perception that piracy is a significant difficulty holds particularly for small firms; these firms have difficulty financing new projects and the prospect of rapid and uncompensated copying may itself be a source of this difficulty.

All 16 of the survey respondents listed "concern over local unauthorized copying" as "very important" or "somewhat important" impediments to starting a business. Other important factors were shortage of finance, strong competition (often from foreign films), and taxation. Thirteen filmmakers are considering a modest expansion in business over the next two years. As to the constraints on expansion in the film business, 10 firms listed concerns about copying as important, but as less of a problem than their uncertainty about the economy and shortage of finance.

Print publishing

This industry is rather small in Indonesia, but larger than the music and film industries. Sixteen firms were surveyed[10], 13 of which were founded before 1995. The firms cover books, newspapers, and periodicals, and all directly employ creative talent such as writers and editors. All are private and one is in a joint venture. Asked to estimate the size of the industry as a whole, respondents provided a median estimate of 185 firms (the range is from 63 to 480), and employment of 2,550.

Publishing is more export oriented than the other industries considered here. Nine of the 16 firms export, mainly to Singapore, Malaysia, and Australia. Three firms write pieces under contract to foreign firms, while four firms publish under such contracts. Licensing among domestic firms for rights to distribute, to produce other firms' publications, and to include other firms' articles in publications is relatively common, with royalty rates of 8-15 percent.

[9] Median monthly employment in the industry is estimated to be 1,125.
[10] Fourteen of these were small or medium-sized by employment, while all were in these categories in terms of sales.

Survey respondents provide median estimates of piracy rates of 30 percent for books and 5 percent for magazines and newspapers. Thus, the industry is insulated from this problem in comparison with software and music. Nevertheless, all 16 firms believe that use of pirated publications by university students and professors is common, and 13 claim that pirated publications present a modest or significant problem for their operations.

The major problem in starting a print publishing business in Indonesia is perceived to be a shortage of finance. Concern over unauthorized copying was listed by 12 of the 16 surveyed firms. As in the other industries, virtually all the publishers find that the government devotes far too little effort to reducing illicit copying. All 16 firms intend to expand business over the next two years. In this context, 13 firms list copying as a "very important" or "somewhat important" constraint on expansion. But asked about the anticipated impact of stronger copyright protection on business expansion, seven out of 16 firms claimed it would have "no impact" and seven said they would undertake "modest expansion". Based on the survey, it seems that the publishing industry in Indonesia is constrained by weak copyrights in some degree but that stronger protection would only modestly encourage its growth, at least in the short term.