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Role of IPR in Research and Development

Intellectual property rights seek to protect knowledge derived from R&D especially by firms involved in collaborations with others to ensure that the knowledge is not expropriated by their potential partners. The lack of intellectual property rights reduces the bargaining power of collaboration partners and increase costs of information for such partners

Inventors who disclose their knowledge to the public may expose themselves to litigation from a rival patenting a competing idea. It is usually difficult to protect the knowledge that inventors disclose in a patent for the first time. Vague intellectual property rights discourage firms to collaborate to the detriment of economic production especially in complex R&D projects that are based on a range of different resources and skills to achieve their outputs.

Without patent protection enforcement mechanisms, developers of new technology may not want to reveal their products as they would lose absolute control over their work.

An appropriate local IPR deters people from imitating the products or technology. As their IPR regime improves, developed countries and developing countries are already complied with TRIPS Agreement, and TRIPS has given an extended time limit to the least developed countries to comply with TRIPS Agreement, thereby inventors will be reluctant to collaborate in countries with loose IPR regimes.

The existence of protective mechanisms over intellectual assets is essential to enhance the competitiveness of organisations especially those working on R&D-related issues as well as to attract potential investors. Therefore, it is essential to balance intellectual property systems to ensure that they provide proper motivation to invest in research and development, while ensuring that the spread and development of research results are not inhibited. Weak IPR regimes lead to low returns for those seeking to innovate.

The existence of IPR laws is important for protecting and managing research results. Countries must enhance awareness on intellectual property laws and their functions at national and international levels to protect patentable inventions in a legal manner

R&D innovations can be protected under the TRIPS Agreement which covers seven forms of intellectual property, namely, patent, copyright, trademark, industrial

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design, geographical indication, lay out design of integrated circuit, and protection of undisclosed information or trade secrets.

Research and Development Stage

Several indicators have been used to measure the efforts of an enterprise in undertaking research and developing innovative ideas. These include expenditure on research and development (R&D), information on innovation, total sales, firm size, innovation strategies, etc. These indicators are directly or sometimes indirectly influenced by IP. The IP tools used during the “conception of an innovative idea” stage continues to be relevant also during this stage. Thus, trade secret continues to be relevant, especially if the enterprise is yet to decide on whether to file a patent application. Keeping trade secrets continues to be relevant during the entire R&D phase, as one would not want the competitors to ever have access to vital information. If used by such competitors it would result in the erosion of competitive advantage, derived from the final product.

During this period, researchers should periodically consult several sources of information that would provide input for the success of their project. Patent documents continue to be a relevant source of information that is often grossly underutilized. Patent documents provide useful information on the state-of-the art, which would enable an enterprise to avoid unnecessary wastage of resources, in terms of money and time, during the R & D process, thereby hopefully reducing the normally high R & D costs. Patent information can also provide useful information, which can lead to product improvement or to design-around inventions, which may help to “short-circuit” the lengthy time frame often required to take a new product to the market.

To sum up, innovation is a process, which begins from the conception of an idea to the launching of a new product/process in the market place. Intellectual property rights can be used effectively to facilitate successful innovation. Innovative technologies stand a better chance of successfully reaching the marketplace if IP is used strategically. Gauging the importance of IP in innovation by merely focusing on patents as input and/or output of innovation, does not do justice to the significant role that can be played by the other tools of IP. A broader approach to the contribution of IP in innovation is therefore needed.

For most developing countries, modernization requires years of public investments in infrastructure, health and education; difficult reforms to encourage the creation of new businesses; and politically-painful measures to open up their markets to foreign producers, often by cutting tariffs and quotas. With globalization, a nation intent on accelerating its modernization can also get access to advanced technologies and business methods, mainly through foreign direct investments (FDI); and more ambitious developing countries then focus on fostering native industries capable of developing innovations. Yet in both developing and more advanced nations,

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firms pursue the research and development (R&D) required to come up with new technologies only if they are certain that their intellectual property (IP) rights will be respected. This study examines the economic impact of India's current IP regime on levels of R&D in India's most advanced industries and the economic benefits that should follow if India strengthens its IP rights and protections. We begin by reviewing the economic impact of IP rights on the development of innovations. While most innovations require costly and risky R&D, nations that invest more in R&D usually experience faster growth and larger productivity gains. One measure of India's prospects for rapid progress, therefore, is the R&D intensity of its key industries, usually defined as the share of an industry's sales or output devoted to R&D. Next, we examine the extent to which a nation's IP regime determines the R&D intensity of its industries. In recent decades, nations as disparate as the United States and India, Germany and China, Japan and Mexico have upgraded their IP rights and protections. In new research, we found clear relationships over time and across many countries between improvements in the IP regimes and the increasing R&D intensity of their leading industries and their overall economies. We also found significant variations across industries within each country, as well as across nations, in how strongly they responded to improvements in IP rights. On balance, we show that R&D intensity increases as IP protections improve over time; and at any particular time, the R&D intensity of industries is greater where IP rights are more strictly protected. The United States has the world's strictest IP regime, based on the leading measure of IP rights and enforcement, the Ginarte-Park (G-P) Index.

Therefore, we conducted a case study of the United States, analyzing the R&D intensity of its industries and how it affects their growth, employment and wages. We identified those U.S. manufacturing industries with above-average R&D intensity -- including computer and electronic products, pharmaceuticals and chemicals, automobile and aerospace, and electronic equipment and components -- and found that from 2000 to 2013, their real value-added increased at more than twice the rate of all U.S. manufacturing. In fact, the value-added of manufacturing industries with below-average R&D intensity actually We gratefully acknowledge the Pharmaceutical Research and Manufacturing Association for its support for the research for this project. The views and analysis are solely those of the authors. contracted over this period. We also found that while overall U.S. manufacturing employment also contracted sharply over this period, the average rate of job loss in non-R&D intensive industries, on average, was more than 50 percent greater than the average rate of job loss in R&D intensive industries. Finally, we found that compensation increased some 65 percent faster in R&D intensive industries than in non-R&D intensive industries. Next, we turned to the R&D intensity of Indian industries. Using Indian Government data, we identified those industries with above-average R&D intensity -- pharmaceuticals and drugs; biotechnology; information technologies; scientific instruments; telecommunications; transportation; and medical and surgical appliances. In fact, the list closely resembles the roster of R&D intensive industries in the United States. We then measured the sensitivity or elasticity of the R&D intensity of these industries to the improvements in India's IP regime from 2000 to 2010, measured by its G-P Index score. The IT, scientific instruments, and transportation industries substantially increased their R&D intensity as India's IP protections strengthened, while the response of drugs and pharmaceutical companies was more moderate. The data also showed that India's medical and surgical instrument firms, biotech companies and telecommunications industry did not respond to the IP improvements by increasing their R&D. Using these findings, we estimated the extent to which India's most IP-sensitive industries would increase their R&D investments, if India upgraded its IP regime. We posit two scenarios. First, India upgrades its IP

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rights and enforcement, as measured by the G-P Index, to the level of China, the world's other very large nation at roughly the same stage of development as India. Second, India upgrades its IP regime to the level of the United States, at the top of the G-P Index. Under the China scenario, we estimate that the share of industry output devoted to R&D would rise from 4.9 to 8.8 percent among Indian IT companies, or by 79.8 percent; from 2.8 percent to 3.4 percent in the scientific instruments industry, or by 21.4 percent; from 1.4 percent to 1.5 percent in the transportation sector, or by 7.1 percent; and from 3.2 percent to 3.5 percent across Indian drugs and pharmaceuticals companies (9.4 percent). Similarly, U.S.-level IP protections would lead to substantially greater R&D commitments in four key Indian industries. We estimate that the share of industry output devoted to R&D would increase from 4.9 percent to 14.6 percent in IT, or by 198.0 percent; from 2.8 percent to 4.1 percent in scientific instruments, or 46.4 percent; from 1.4 percent to 1.8 percent in transportation, or by 28.6 percent; and from 3.2 percent to 3.8 percent in drugs and pharmaceuticals, or 12.5 percent.

We also know from a long line of research that nations with weak IP protections attract little FDI in R&D from multinational companies, so we investigated whether upgrading India's IP regime could increase inflows of FDI in R&D. We found that as India strengthened its IP protections from 2003 to 2009, foreign firms in three industries increased their R&D operations there – automobiles, drugs and pharmaceuticals, and aerospace. We analyzed the elasticity of these increases in FDI in R&D to the improvements in India's G-P Index rating in this period, and applied the findings to our two scenarios for further improvements in India's IP regime. On this basis, we estimate that if India upgraded its IP protections to China's level, inflows of FDI in R&D would increase in the automobile sector from 2.1 percent of its output to 3.0 percent, or by 42.9 percent; and from 1.2 percent to 1.6 percent in the drugs and pharmaceutical sector, or one-third. The response by foreign firms in the aerospace industry was marginal. 4 Similarly, if India adopted U.S. IP rights and enforcement, inflows of FDI in R&D would increase substantially in the two industries: We estimate that the inflows of FDI in R&D would rise from 2.1 percent to 4.3 percent of the output of foreign automobile producers in India sector, or by nearly 105 percent, and from 1.2 percent to 2.2 percent of the output among foreign drugs and pharmaceuticals companies, or 83.3 percent. Finally, we analyzed how increases in R&D affect growth and wages in key Indian industries. This analysis relied on different industry groupings than the preceding analyses, because Indian statistics on value-added, employment and wages by industry are organized differently. Here, we focused on four R&D intensive industries that broadly corresponded to the classifications used earlier: drugs, pharmaceuticals and biotechnology; computers and electronics (IT), machinery and equipment (scientific instruments); and transport equipment (transportation). First, we tracked changes in value-added, employment and wages in those four industries over the period of 2001 to 2007, as India's IP regime improved. We tested the proposition that increases in R&D intensity associated with improvements in IP protections also boost growth and wages, by calculating the sensitivity or elasticity of value-added per employee and wages per employee in each industry to their increases in R&D intensity. We found that among Indian transportation companies, scientific instrument firms, and Indian drugs, pharmaceuticals and biotechnology companies, increases in R&D intensity were accompanied by significant gains in value-added per employee and moderate gains in wages per employee. The value-added response by IT companies was weaker, but their response on wages was stronger. Using this analysis, we estimated the impact of further

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improvements in India's IP regime on the value-added and wages per employee of the four industries. Under the first scenario, in which India upgrades its IP protections to China's level, we estimate that over five-to-ten years, value-added per employee would increase about 22 percent in the transportation industry, 13 percent in the scientific instruments industry, more than 10 percent in the drugs, pharmaceuticals and biotech industry, and just under 4 percent in the IT sector. All of these increases would come on top of each industry's current rising trend of value-added. Such additional improvements in India's IP regime also should boost wages per employee, over time and on top of each industry's current trend of wage increases: We estimated those additional wage gains at nearly 4 percent in the IT industry, 2.4 percent in both the scientific instruments industry and the drugs, pharmaceuticals and biotechnology industry, and 1.6 percent in the transportation sector. As expected, the projected gains are considerably large under the second scenario, in which India adopts U.S.-level IP rights and protections.

We also estimated the impact on value-added and wages of increases in inflows of FDI in R&D. Based on our analysis of the impact of India's IP regime on those inflows, we focused on 5 the automobile and aerospace industries, combined here into a transportation industry grouping, and on the drugs, pharmaceuticals and biotechnology industry group. We calculated the elasticity of each industry grouping's value-added and wages per employee, over time, to the its foreign R&D intensity, and found that value-added responded strongly to increases in FDI in R&D in the transportation sector, and responded more moderately in the drugs, pharmaceuticals and biotech industry. As with native companies, the wage responses to more FDI in R&D were weaker. Finally, we applied those elasticity results to estimate how additional improvements in India's IP regime could affect value-added and wages in these industries. If India adopts IP protections equivalent to China, FDI in R&D should increase sufficiently to lift value-added per employee, over time, by about 16 percent in the transportation sector and by more than 7 percent in the drugs, pharmaceuticals and biotechnology sector. In both cases, these increases would come on top of the industries' existing rates of growth in value-added per employee. As before, the impact on wages is smaller: We estimate that the IP improvements would boost FDI in R&D sufficiently to increase wages per employee, over time, by about 2 percent in the transportation sector and nearly 3 percent in drugs, pharmaceuticals and biotechnology, on top of each industry's current path of wage increases. The second scenario, in which India's adopts the IP regime of the United States, naturally produced larger results. We estimate that under those conditions, value added per employee would increase, over time, by as much as 40 percent in the transportation industry and by more than 18 percent in drugs, pharmaceuticals and biotech; and wages per employee would also increase, over time, by about 5 percent in the transportation sector and by just under 7 percent in the drugs, pharmaceuticals and biotech industry. In summary, the research and analysis presented in this study establish the importance of IP rights in determining how much firms and industries invest in R&D and, as a consequence, how fast an industry grows and the wages it pays. The degree of importance varies from nation to nation and from industry to industry. However, most R&D intensive industries respond to improvements in a nation's IP regime by increasing R&D investment. The analysis shows that India's capacity to foster and promote advanced industries capable of meaningful innovation will depend on India's willingness to improve its IP regime. If it does so, the R&D intensity of many key Indian industries should increase substantially, and their value-added and wages per employee also should rise. The Economic

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Significance of Intellectual Property Rights Since the early-19th century, economists have investigated the roles and importance of various factors that influence economic development and growth. In recent decades, a general consensus emerged that how fast an economy grows at any given time depends on how many people work, how much capital equipment they have to work with, and how the political and social environment promotes or impedes economic activity.² There is also broad agreement that an economy's capacity to increase its growth and productivity depends mainly on its capacity for innovation – its pace in developing new technologies and ways of conducting business; how well its businesses adopt innovations; how effectively its workers deal with innovations, and whether the political and economic environment promotes or impedes these developments. Once economists established the factors that determine how fast an economy grows, they faced new questions about why various nations grow at such disparate rates. It was clear that most successful advanced economies grow more slowly than most successful developing economies; and this pattern led to new theories of “convergence.” These theories posited that over time, the practices and income levels of economies tend to converge, especially across nations with generally free markets, comparable legal protections for contracts and property rights, and similar behavior with regard to saving, work, and fertility. One reason is that firms in developing economies can adopt the innovations developed by firms in more advanced countries without bearing the costs to develop them. It also was clear that some developing economies grow more rapidly than others, as some advanced economies grow faster than others. Much of those differences depend on the quality of a country's institutions: The United States has grown faster than Germany or Japan in recent decades, and China has grown faster than India, in large part because their political and social environments more effectively support and promote economic activity generally and the spread and application of innovations in particular. In this study, we focus on the dynamics that support or impede such innovation, particularly through R&D investments.

Most innovations require substantial R&D, and countries that invest more in R&D, along with education and training, tend to experience faster growth. One measure of an economy's capacity for development and progress, therefore, is the “R&D intensity” of its industries, which is usually defined as the share of an industry's sales or output devoted to R&D. Since R&D is costly and risky, the only economic justification for most firms for bearing its costs – and forgoing more certain returns by using resources in more typical ways -- is the prospect of much larger returns in the future.⁵ Many studies have established that most firms undertake costly R&D if they are confident of earning above-normal profits on any innovations which result.⁶ Moreover, it is axiomatic that such profits are hard to achieve if other companies can copy the innovations of other firms at will and without compensation. Strict IP rights and enforcement, therefore, are usually needed to protect those returns. The link between innovation and IP rights and protections has been well-established in modern economics. In 1997, economists from the World Bank and American University constructed an index of patent rights, the Ginarte-Park (G-P) Index, to help them study the relationships between patent rights in 60 countries and R&D, investment and growth. They found strong, positive relationships, especially in higher-income countries. A subsequent study by Park found that over the period 1980 to 1995, R&D and productivity across 21 OECD countries increased with improvements in patents rights.⁸ Similarly, another study of 32 countries between 1981 and 1990 found that the countries with stronger IP rights were more R&D intensive, as measured by R&D expenditures as a share of GDP. ⁹ Yet another analysis found that improvements in patent protections were strongly associated with higher rates of scientific. ⁷

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discovery, inventions and innovations.¹⁰ Finally, a study of 54 manufacturing industries in 72 countries from 1981 to 2000 found that in countries with strong IP protections, patent-intensive industries grow substantially faster than less R&D/patent-intensive industries. While the preponderance of evidence confirms the economic view that IP rights are vital to the development process for innovative technologies, which in turn help drive growth and economic progress, some critics continue to insist that developing nations with weak IP protections benefit by appropriating the IP of companies from more advanced nations. In fact, numerous researchers have found that the costs to a developing nation of ignoring the IP rights of foreign companies exceed the benefits. In one study, researchers confirmed that innovating firms care about the strength of their patents not only in the place where they develop their innovations, but also in other countries.

Moreover, the economic logic linking the development of new technologies and patent protections in foreign markets pivots on R&D: The prospect that an innovator can earn profits in a larger market directly stimulates R&D spending by expanding the potential customer base and raising the potential rate of return on the R&D. Furthermore, studies also have established that developing economies benefit from respecting IP rights at least as much as advanced economies. One major investigation examined 95 countries from 1960 to 1988 and found that patent rights affect growth in all cases, with the greatest impact in both the high-income countries where most innovations are developed and low income countries where strong IP rights encourage imports of innovations. These results were confirmed by another study of 80 countries over four time periods covering 1975 to 1994.¹⁵ Its' authors found that strong IP protections stimulated growth to an even greater degree in countries with relatively low per capita incomes than in places with high per capita incomes, by encouraging imports and FDI from advanced countries and by promoting native innovation. Other studies have shown that countries with weak IP rights attract less FDI, especially FDI in R&D, and that the investments they attract are technologically less sophisticated.

One recent analysis found that in countries with weak IP protections, foreign companies focus on developing distribution channels for their products, versus countries with stronger IP protections where foreign firms focus on shifting their technologies and sometimes their R&D. A number of researchers also have found that countries that fail to aggressively respect IP rights have more difficulties achieving economic growth through technology transfers. One study looked at how reforms in IP rights in 16 countries over the period 1982 to 1999 affected technology transfers by U.S. multinational firms to their foreign affiliates. The research showed that royalty payments to parent companies for the use or sale of technologies transferred to their affiliates increased at times of IP reforms, as did R&D carried out by their foreign affiliates as a complement to 8 technology imports from parent companies.

These dynamics also inform a World Bank study which found that during periods of IP reforms, the share of global trade comprised of knowledge intensive or high technology products rose sharply. As these studies suggest, foreign-based firms that expect to have their patents respected in other countries are more likely to invest in research that would be particularly beneficial to those countries. More generally, foreign firms often shift some of their R&D to developing countries that respect their IP rights, directly increasing the IP-intensity of those industries in those countries. Such transfers benefit domestic industries in other ways: A 2000 study of investment flows to a number of developing countries found that as a country's IP protections increase and foreign R&D

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operations expand, domestic firms also focus more on R&D and developing other new intangible assets, with significant positive effects on economic growth.

These findings suggest a clear virtuous circle. Countries that respect IP rights encourage both native companies to undertake R&D and foreign firms to undertake FDI in R&D as well as transfer their advanced technologies; and these developments lead to higher growth, which encourages more R&D and FDI. The Impact of Intellectual Property Rights on an Industry's R&D Intensity

Since intellectual property has value, and the recognition and enforcement of the IP rights of a firm or individual protect that value, we should expect to observe a relationship between the provision and enforcement of IP rights and an industry's IP or R&D intensity. In particular, IP rights and enforcement allow a firm or industry to earn greater revenues from the goods or services which embody their IP, which in turn justify the costs entailed to develop the IP and produce the goods or services. Without the rights protected by patents and copyrights, a competitor can reproduce the IP and sell the goods or services which embody it at much lower prices, based on their marginal costs of production without taking account of the R&D investments required to develop the underlying IP. As expected, IP rights and enforcement vary widely across nations; and while most countries have improved their IP protections in recent years, there are countries in which those protections have deteriorated. The G-P Index of patent rights is the most widely used measure of IP protections across nations. A nation's index score is the un-weighted sum of its scores in five areas —, the coverage of its patents, patent direction, patent enforcement, special restrictions on patents, and a country's membership in international treaties protecting IP rights. The G-P Index tracked patent rights in various countries from 1960 to 2005 and in 2010 issued a new version to take account of developments such as the arbitration process created by the World Trade Organization (WTO) and the standards for IP protection established by the "Agreement on Trade Related Aspects of Intellectual Property Rights" (TRIPS), changes in patent operations to conform with agreements such as NAFTA and the European patent convention, and new standards to protect software, biotechnology and other emerging technologies. The G-P Index has consistently found that the United States has the strongest patent rights and protections. Among the countries listed below, patent protections improved in 13 countries from 1960 to 2005, from the United States to India and Mexico, and deteriorated in only three nations (Brazil, Burma and Malaysia).

IPRs protect investments in innovation by granting the innovator a temporary monopoly on the use of the innovation. This prevents rapid imitation that could cut into the innovator's returns and decrease the incentive to innovate. By restricting imitation, however, IPRs arguably raise the cost of the new technology and restrict its availability. This may, in turn, retard further progress in the technology by preventing other firms from developing new innovations or improvements that build on the original innovation in a cumulative way. If the new technology has productivity-enhancing effects when used in economic activity, these too may be retarded by the protection of the original innovation.

Thus, IPRs inherently embody a policy conflict between the objective of providing an incentive to technological innovation and the objective of encouraging the rapid diffusion of new technology and the accumulation of technological knowledge. These competing objectives also represent powerful, competing economic interests—from R&D-intensive and non-R&D-intensive firms at one level, to the industrialized, newly industrialized, and developing countries at another.

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The Enforcement of IP Rights for R&D Investors

Data indicates that firms investing in R&D perform better in regions that have strong enforcement of IP rights that help to mitigate problems associated with R&D protection. When enforcement of IP rights is poor, foreign investors in joint ventures would hesitate to transfer or invest in technology. Good enforcement of IP rights enables greater technology transfer and development by deterring the local partners from illegally appropriating the technology. In addition, foreign partners of joint venture firms in regions with strong enforcement of IP rights will be more forthcoming with resources for projects as well as in providing increased levels of R&D investments and enjoy greater productivity in terms of introducing new products. Countries must have proper legal structure as well as well-developed financial markets to have economic development. Knowledge resulting from R&D activities occur through contractual, namely, patent arrangements in countries which have strong intellectual property rights protection. The gains from firms' investments in R&D will be lost if courts are unwilling to restrain such action through leakage of proprietary information through imitation. This occurs due to the high cost of court action or trial in protecting R&D investments in countries with weak legal protection. Consequently, it curtails an individual firm's R&D activities and will reduce the benefits of firm-specific R&D. Therefore, arbitration should be considered seriously as an option to take control of a dispute. It has plenty of advantages over litigation. The main con of this creature is that parties can select decision maker with expertise in the type of intellectual property, which the dispute is involved. Basically, this is a major advantage of arbitration over litigation. Further, ADR and Mediation consists of single proceeding under the law determined by the parties, while court litigation consist of multiple proceedings under different law with risk of conflicting result which make too many complexity in cross-border cases. IP rights in various contracts throughout R&D project has a vital role. Thus, parties must be prudent in choosing dispute resolutions strategy when negotiating dispute resolution.