Economic Development and Intellectual Property Rights: Key Analytical Results from Economics

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1. Introduction

Economic development is the result of numerous interrelated processes, including the adoption and development of new technologies, the organization of markets to facilitate production and consumption, and the establishment of facilitating institutions (Cimoli, et al, 2014). For countries behind the technological frontier, development is a process of "catching up," featuring a combination of imitation, learning, knowledge absorption, and ultimately innovation. Many and varied elements affect the pace and direction of this evolution, including is the governance of intellectual property rights (IPRs).

Intellectual property laws, and their implementation and enforcement, aim to strike a balance among numerous objectives and constraints that affect the complex processes undergirding economic and social development. These laws determine the scope and strength of IPRs, which in turn may influence the pace and direction of economic activity. In their most direct conception, patents are thought to encourage innovation and deepen technological markets, while raising the costs of potential rivals in imitating new technologies. Trademarks are supposed to sort out information problems in markets where consumers might be confused about the provenance of goods and services, even as they potentially diminish employment in counterfeiting firms. Copyrights are presumed to secure market returns to successful content creators, but may diminish access to cultural and scientific knowledge.

To a considerable degree these basic views dominate received economic analysis of IPRs, as will be evident from the review in this chapter. By focusing on specific incentive impacts of patents or copyrights, economists, at least in theoretical models, are able to isolate their potential effects on development and growth and to identify how those effects may vary with economic

and technological conditions.[1] This approach has unearthed a range of important insights that should be accounted for in any assessment of intellectual property law and regulation.

At the same time, however, IPRs reside in a far broader and more complex economic and social ecosystem than economists can hope to capture with tractable theoretical models or econometric analysis. Thus, for example, development economists point to the roles patents may play in the full "national innovation system," involving infrastructure, investment taxes, R&D subsidies, factor markets, competition rules, educational attainment, and even trade policy, not to mention accidents of history and geography.[2] How such factors interact over time and at different levels of economic development is a frightfully complex issue, making it difficult to say much with confidence about the true significance of IPRs in the development context.

Beyond this general complexity lie the many details of policies and effects that, while extremely important, render straightforward statements about IPRs and economic development all but meaningless. Regrettably, such statements are common where observers have a strong economic or political interest, whether for or against IPRs. Thus, for example, some see IPRs as an unalloyed "power tool for development" (Idris, 2002). Others paint IPRs as largely a mechanism for blocking development of poor countries through sustaining monopolistic rents of existing firms (Stiglitz and Charlton, 2005).

As for economists, even the best among them make the mistake of failing to distinguish among the types of IPRs, which may have quite different impacts on development prospects. Patents and plant variety rights operate differently from copyrights, which in turn are distinct from trademarks and geographical indications. Moreover, these devices feature complex regulatory components that influence their true protective scope, such as compulsory licenses of patents, copyright limitations and exceptions, and parallel trade. Next, economic sectors vary

widely in their interrelationships with IPRs of various types, with pharmaceuticals, chemicals, and biotechnological inventions most dependent on patents and literature, music, software, and digital entertainment goods closely allied with copyrights. Finally, intellectual property rights are national policy constructs and as such their structure and scope are, to some extent, dependent on economic and social conditions in each country. In turn, there is two-way causation between economic activity and the IPRs regime. Such complications should be kept firmly in mind when contemplating the development aspects of intellectual property protection.

Perhaps the greatest challenge in organizing a review chapter is simply deciding which elements to cover among the vast array of development problems that may be affected by IPRs. There are many economic processes that have been related to patents, including innovation, technology diffusion, trade, competition, monopoly power and price-setting. Analysts may be concerned about sectoral issues involving medicines, green technologies, agricultural inputs, software, and e-commerce. They have broader concerns, such as how the productivity of IPRs depends on other policies, their implications for access to scientific and technological information, and barriers they may raise to cultural development.

A judicious treatment is therefore called for to avoid being too shallow in the treatment of too many subjects. Here I focus on three key questions that have been studied closely by economists and about which most may be said with some confidence. First, I overview the political economy of decisions made by countries at different development levels to adopt stronger IPRs and characterize international trade rules in that context. Second, I critically discuss findings on the roles of IPRs in innovation, technical change and technology transfer across borders. Third, I describe major results about how patents may be affecting pricing

decisions and product availability of medicines in developing economies. A final section offers concluding remarks.

2. Endogenous Intellectual Property Regimes

The vast majority of economic theorizing in this area treats IPRs as exogenous, or determined independently outside the economic and social environment. This approach is useful for analyzing how policy changes might influence the behavior of specific firms and industries or alter the well-being of households. It is reasonable to suppose that any individual firm or consumer simply takes such policy changes as given by legislators or trade negotiators seeking to achieve a broad set of outcomes.

Basic tradeoffs

The difficulty, of course, is that intellectual property rights, like taxes and tariffs, are the endogenous outcomes of a policymaking process that depends on a large variety of competing interests, both domestic and foreign. Moreover, these interests change over time because the dynamics of economic growth fundamentally alter underlying circumstances. Focusing for the moment solely on domestic factors, a government devoted to maximizing national welfare would take account of at least the following considerations.[3] First is consumer welfare, which consists of static consumer surplus from having access to existing goods and dynamic benefits from having access to more and newer goods from future innovation. Second is the profits (more accurately, producer rents) of domestic firms, made up of both imitators and innovators or creative content providers. Third would be any spillover benefits or costs of IPRs, such as reduced infection rates from faster access to newer medicines or diminished learning of new technologies through higher-cost imitation or reverse engineering.

From this description two basic and interrelated tradeoffs emerge in policymaking (Maskus, 2000). One is the purely static distribution of welfare between consumers, including input users, and producers of existing goods and technologies. Another is the dynamic tension between current access gains and the benefits from future innovation, incentivized by IPRs. This simple logic underlies the primary political-economy view about economic development and intellectual property. Countries with limited innovation capacity are likely to favor short-term access benefits through weak or absent IPRs. As firms and industries acquire greater capacities to invent new goods, which could be the result of numerous economic and policy factors, interests arise endogenously in strengthening patents and other rights (Chen and Puttitanun, 2005; Ginarte and Park, 1997; Park, 2008a). A variant of this story is that endogenous protection may be U-shaped in economic development, which was demonstrated in an early study (Maskus and Penubarti, 1995).[4] Countries at lowest income levels may favor the ability of moderately strong IPRs to bring more products to their markets from abroad, while having little domestic production capacity that would oppose such a regime. As nations gain more imitative capacity at middle-income levels, however, local firms gain the ability to imitate products, which is facilitated by weaker patents. Beyond some level of real per-capita incomes the emerging innovation interests dominate and the strength of IPRs rises along with development.

That IPRs are expanded in scope as economies grow richer and more technologically capable is consistent with economic history (Odagir, et al, 2010). For example, development of the U.S. pharmaceutical industry was boosted by the vacating of German-owned patents in World War I, with the rights to produce such goods given to domestic firms as compulsory licenses (Moser and Voena, 2012). Switzerland's chemical industry grew from imitating foreign formulations in the absence of domestic patents (Maskus, 2012). These countries now have

highly protective patent regimes. Through the late 1980s Japan's patent system favored widespread technology diffusion through the use of utility models and narrow claims, but that country also now strongly protects novel inventions. South Korea has experienced a similar transition of technology development and IPRs, while the rapid solidification of patent protection in China since 2000 surely reflects the emergence of such high-technology industries as electronics, solar power, and biotechnology.

Two important qualifications to this dynamic must be mentioned. First, because countries vary in their industrial composition, even relatively poor nations may have endogenous preferences for strong components of IPRs, while richer countries may limit them. India, for example, has long protected copyrights due to the importance of its domestic film and publishing sectors. More recently, many developing countries have entertained legislation to protect geographical indications as a potential boost to their agricultural sectors (Maskus, 2012). In contrast, Canada has deployed compulsory licenses in pharmaceuticals and limited the scope of digital copyrights in order to favor consumer access. These stories suggest that attempts to identify the evolution of "appropriate" intellectual property regimes as countries develop inevitably are subject to numerous exceptions (World Bank, 2002: Kim, et al, 2012).

Global tradeoffs

A second and more fundamental qualification is that countries may not be fully free to select their desired IPRs regimes, even where governments are welfare maximizers, in a world of open trade and investment. The primary reason is that a developing country's domestic protection may be inadequate for the interests of international corporations seeking to export or invest there.[5] These companies can press directly for upgraded standards or encourage indirect strengthening via international trade agreements. Thus, for example, the unprecedented

expansion and partial convergence of patent rights since 1995 is largely the result of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) at the World Trade Organization and even stronger demands in subsequent preferential trade agreements (PTAs; Maskus, 2012). It follows that negotiated intellectual property rules, in themselves, likely exceed the individually welfare-optimizing levels within poorer countries.

These considerations were spelled out carefully in landmark theoretical contributions (Grossman and Lai, 2004; Scotchmer, 2004). In determining their own policies (so-called "Nash non-cooperative patent regimes"), governments will take into account the welfare gains from access to goods and the profits of domestic firms, including imitators. They will not consider the profits earned in their markets by foreign firms. There are two critical implications. First, countries with large markets and strong capacities to invent goods with commercial potential will choose considerably stronger protection than will those with small markets and limited inventiveness. Second, these individual policies, by failing to offer incentives to foreign innovators, suffer from a global coordination problem: patent and copyright systems are inadequate to produce the globally optimal level of innovation and growth is diminished as a result. It follows that international agreements to internalize this spillover through more integrated standards can expand global welfare.

This logic offers the key principled justification for a tendency to harmonize international IPRs within TRIPS or even PTAs. Indeed, policymaking in TRIPS and its aftermath have been affected, for measured patent rights in the era after the agreement became higher than their prior Nash levels (Lai, et al, 2008).[6] Note, however, that the TRIPS and TRIPS-Plus patent standards themselves may not be globally optimal, despite their partial convergence, if they settle at weighted-average levels higher than needed to correct the international externalities. Moreover,

because these agreements generated rules that may exceed currently useful levels for developing countries they may diminish welfare there unless their costs are offset by other benefits.

Such questions remain largely unanswered in the economics literature. Indeed, no particular answers could be definitive given the complexity of the subject matter and attendant empirical uncertainties. For example, many have argued that the WTO agreements failed to generate sufficient market access for, and technology transfer to, developing countries to offset the costs of stronger IPRs (Maskus, 2012). However, if one takes account of the likely positive impacts of globalized patent rights on foreign direct investment, even high-level harmonization generates global increases in technology diffusion (Lai and Yan, 2013).

3. Intellectual Property, Innovation and Technology Diffusion

In granting and protecting the exclusive rights embodied in various forms of IPRs, governments attempt to manage these static, dynamic, and international tradeoffs. The fundamental social bargain in patents, for example, is to offer temporary rights to exclude others from using or copying protected technologies and goods in return for disclosure of the patented information. The ability to exclude addresses the dynamic innovation problem by creating a limited monopoly in ideas, permitting originator firms to earn enough profits to pay for R&D costs or to finance the costs of marketing their technologies. Copyrights address the similar problem of promoting creative expression. Whether IPRs actually achieve these goals, and under what circumstances, is a hugely complex question, even among developed economies. In this section I review primary evidence and draw some important lessons.[7]

IPRs and innovation

As suggested above, a primary justification for IPRs is their presumed ability to incentivize invention, innovation, creativity, and knowledge diffusion. These concepts are not easily measured or even explained, especially in poor countries. For example, economists know next to nothing about the economic drivers of artistic creativity and inventive activity in informal sectors in developing countries. The primary measures used by economists are indirect and focused on invention and diffusion, whether input-based (R&D expenditures) or output-based (patents and technology spillovers). These variables, while imperfect, permit a historical and statistical record linking patents or patent laws to innovation, which I review here.[8]

As an initial matter, note that patents are, in principle, neither necessary nor sufficient to induce the optimal degree of innovation. As long argued by innovation scholars, the primary motivation for investments in new goods is the anticipation of making future profits (Schumpeter, 1942; Romer, 1990). The ability to appropriate profits from these inventions may come from many factors other than IPRs, including secrecy, market lead times, the high costs of imitation, and barriers to competition, though the relative importance of such factors, including patents, varies sharply across industries (Cohen, et al, 2000). This explains why the historical anecdotal record supports any view of the necessity of patents. For example, James Watt's fundamental improvement of the steam engine was patented and defended rigorously. The role of patents in this history is alternately described as critical for the invention itself (Rosen, 2010) and unnecessary, in that the patent was procured after the invention was stabilized, and a socially wasteful means of blocking entry *ex post* by others (Boldrin and Levine, 2008).

Anecdotes prove little so we must consider evidence from econometric studies. In this context, innovation historians have fruitfully analyzed detailed data from the past. For example, Chen (2008) studied how 614 major inventions and innovations from 1750-1950 were related to

the existence of patent laws in 14 Western European countries and the United States. These countries introduced their initial patent laws at different times in this period. Chen found a positive and highly significant impact of the existence of a patent law on the number of domestic inventions over this long period, often with a long lag, suggesting that a legal patent regime ultimately supports domestic inventive activity. This evidence must be treated cautiously, however, for a number of reasons. Most importantly, he did not include in the analysis many confounding variables that surely influence national inventiveness, nor did he satisfactorily account for reverse causality between inventions and adoption of patent laws.

In a landmark study, Lerner (2002) compiled information on 177 legal patent reforms in 51 countries over the period 1852-1998. He focused on substantive reforms, such as implementation of patent laws and extensions of patent duration. He estimated how these policy reforms led to changes in home patent applications by domestic residents and foreign applications in the reforming nations, using data normalized by contemporaneous trends in the propensity to patent. The study window ranged five years before to five years after each reform and the regressions included a number of controls. Lerner's results were striking. The volume of both domestic and foreign applications rose after patents were strengthened. However, after normalization only foreign applications increased significantly, while domestic applications actually fell. Thus, in most cases national patent reforms induced far more inward applications than domestic inventions, at least in the short run. Applications by domestic firms were, in fact, crowded out, perhaps by increased competition from abroad. Additional work found evidence of diminishing returns to increasing patent protection over time, meaning that countries with weaker initial regimes saw more patenting after their reforms, and that domestic innovation gains were concentrated in larger and higher-income economies.

Lerner's findings are sobering for policymakers expecting that new and stronger patent laws in the developing world will induce considerably more domestic innovation. This outcome may pertain in large countries with initially weaker patents and rapidly rising incomes, such as China and Brazil. In much of the developing world, however, the impact over several years is likely to be greater growth in incoming patent registrations by foreign firms seeking to protect the new products and technologies they export or transfer. Put into context, this situation is not surprising. Many of the reforms Lerner analyzed were adopted in response to foreign pressure, rather than domestic commercial interests. Thus, TRIPS has substantial historical precedence.

In another important study Moser (2005) looked at whether patent laws alter the sectoral distribution of inventive activity, rather than overall innovation.[9] She compiled data on nearly 15,000 inventions exhibited at either the 1851 world's fair in London or the 1876 world's fair in Philadelphia. Her hypothesis was that inventions in countries without patent laws should be concentrated in industries with other means of appropriation, such as secrecy and lead time, while those from nations with patent laws should be more broadly distributed. This proposition was confirmed: inventions from countries without patents were more likely to be in textiles, food processing and instruments (with low patent intensities), while those from countries with patent laws were more evenly distributed, though significantly higher in machinery. Notably, after the Netherlands abolished its patent law in 1869, the share of Dutch innovations in food processing rose sharply. Moreover, the cross-industry distribution of inventions was significantly different between countries with short versus long patent durations. Thus, it seems that both the existence and strength of patents can profoundly affect the type of goods invented. In turn, legal patent reforms could help determine the evolution of industrial specialization over time.

This historical record is informative but we also wish to study how IPRs influence innovation currently, particularly across countries at different levels of economic development. Econometric analysis of this question is rather recent, mainly because there were no consistent and international measures of patent protection over time until the famous Ginarte-Park (GP) index appeared (Ginarte and Park, 1997). This variable, now extended to 2010 across a comprehensive set of countries, amounts to an adding up of the presence or absence of particular legal provisions in five components of patent laws, generating an index running from zero to five. Its use has been criticized for a number of reasons, including its inability to measure the extent of legal enforcement. As many analysts have noted, the index has increased sharply among developing and emerging economies since 1995, with a considerable degree of harmonization with the most protective countries (Maskus, 2012).

The earliest cross-country studies suffered considerably from an inability to control for missing variables and endogeneity. However, enough well-executed studies have been published recently to support certain conclusions, which primarily suggest that the evidence is far from clear. For example, one important question is whether the effects of patent reforms on innovation activities are different between rich and poor nations. In this context, Schneider (2005) analyzed a sample of 19 developed and 28 developing countries, taking innovation as the number of patent applications residents of each nation registered in the United States from 1970-90. The explanatory variables included the GP index and several national variables that should affect technological change. In the basic regressions Schneider found a positive and significant elasticity of 0.6 between patent applications and patent rights. However, when the sample was divided this positive impact remained only for developed countries, with a highly elastic coefficient of around 2.0. In developing countries the effect was negative, though significant in

only some specifications. We should interpret this finding cautiously, given some econometric problems with the approach, including the failure to deal with causality. However, they suggest that patent laws have limited or even negative impacts on contemporaneous patentable innovation in developing countries. It would be useful to revisit this question to analyze whether there is a longer-lagged effect that may be positive in emerging economies.

Chen and Puttitanun (2005) offered a more sophisticated approach. They used data for 61 developing countries over 1975-2000 and accounted for the simultaneity between IPRs and innovation. The authors found that the GP index had no effect on US patent applications by residents of lower-income countries but the impact was positive and significant for middle-income and emerging economies. Thus, there is an important threshold effect, in that increases in the scope of patent rights seem to induce more innovation only above relatively high levels of GDP per capita. Similar conclusions were reached by Allred and Park (2007a).

While suggestive, the results of aggregate cross-country regressions are of questionable reliability for several reasons. More recently scholars have incorporated firm-level data sets, which increase sample sizes and permit greater focus on strategic aspects of the IPR-innovation relationship. For example, Allred and Park (2007b) related firm-level real R&D expenditures for 2,446 multinational enterprises in 10 industries to their headquarter-nation's GP index in 1990, 1995, and 2000, controlling for firm size, GDP and time and industry fixed effects. They found a strongly positive impact of patent rights on R&D in the developed countries but no effect in developing countries. This evidence indicates that elevated patent laws stimulate R&D in nations where there are both high incomes and significant technological capabilities. However, there is little evidence of such impacts in low-income countries.

A highly notable study is by Branstetter, et al (2006), which analyzed the responses of affiliates of U.S. multinational enterprises to major reforms in patent laws in 16 countries, 14 of which were developing or emerging, between 1982 and 1999. The authors performed an event analysis, considering changes in aggregate resident and non-resident patent filings in a six-year window surrounding the dates of reforms. In their econometric model the patent reforms had no impact on domestic applications. However, the results indicated that reforms had a positive impact on foreign patent applications, both in the short and long run, raising non-resident filings in the average nation by at least 52 percent. Thus, these authors reinforced the basic wisdom that international firms are more responsive to increases in patent rights in developing countries than are domestic firms.

A last important work is by Qian (2007), who analyzed 26 countries that, between 1978 and 2002, implemented laws establishing patent protection for pharmaceutical products and the effects on innovation in that industry. Her primary innovation measure was the log of citation-weighted drug patent applications registered in the United States after legal changes, comparing matched country pairs that differed in whether they adopted reforms. Various national and industry control variables were included in the regressions. Qian found that there were no significant direct impacts of legal changes on U.S. drug-patent applications, even up to ten years later. However, there were important interactions, in that patent reforms in countries with higher educational attainment, per-capita income, and greater measured market freedom significantly increased such applications. Thus, Qian's results offer more evidence that the innovation-inducing impact of IPRs depends on other factors. Low-income economies with limited educational attainment and technical skills are unlikely to see much impact.

This review points out that there are no clear and unidirectional relationships between patent rights and subsequent innovation, however measured. One problem is that the available measures are themselves deeply flawed. For example, definitions and coverage of R&D can vary considerably across countries. Patent applications may not reflect underlying innovation so much as a need for firms to engage in defensive patenting in industries with overlapping claims and cumulative innovation. Moreover, some countries, notably China, see patent applications in themselves as socially desirable and governments may absorb the application costs, resulting in excessively high filings. Another key problem is simply the complex socioeconomics of innovation. Much depends on other factors that vary across countries and industries and over time.

Despite these caveats, a few general conclusions are worth drawing. First, the initial effect of legal revisions in developing countries is to attract more applications from abroad as multinational firms seek to exploit and protect their technologies. Second, even in middle-income countries it takes time for any domestic responsiveness to emerge.[10] IPRs reforms have little, if any, impacts on innovation in poor countries, perhaps because of weak business and investment environments and poor governance institutions, including an inability to enforce such laws.

An important qualification is that virtually all of the available evidence refers to strengthening patent laws, which may simply be irrelevant for innovation in the poorest countries. But innovation and creativity are hardly absent in those countries, even if it resides largely in informal sectors. It would be of great interest to study closely whether, in the post-TRIPS era, new copyright systems have encouraged creative activity in concert with greater

access to the internet, or whether small producers are registering more domestic and international trademarks as they expand their marketing reach.

IPRs and Technology Diffusion

For most developing economies, incoming international technologies are the primary source of new information, productivity gains, and economic growth (Keller, 2004). International technology diffusion is therefore a major determinant of global technical change and increasing such flows is a critical part of economic development policy. It is equally vital to adapt technologies to local conditions and learn how to use and improve them. Countries seeking access to foreign technologies therefore build into their innovation systems the entire policy complex involving skill accumulation, investment, competition, R&D support, and IPRs.

To summarize a complex set of relationships, it is useful to distinguish between market-mediated technology transfer and informal means of diffusion into the broader economy. One major market-based channel is trade in high-technology goods and services. Imported capital goods and technological inputs can directly improve productivity by being placed into production processes. A second is foreign direct investment (FDI) through multinational enterprises (MNEs), which tend to transfer to their subsidiaries newer and more productive technological information (Markusen, 2002). Yet a third is technology licensing, which typically involves the transfer of production or distribution rights, protected by some combination of IPRs, and the associated technical information and know-how. In this context patents, trade secrets, copyrights, and trademarks serve as direct means of information transfer. Licensing of IPRs is overwhelmingly performed via voluntary contracts. However, governments may on occasion issue a compulsory license. Also important is the cross-border movement of engineers and

technicians who transfer knowledge. Evidence from patent citations suggests that there is substantial diffusion through this channel (Hovhanissyan and Keller, 2015).

There are also important non-market means of technology diffusion. The first is imitation, involving efforts to learn the technological or design secrets of an incoming technology, whether by product inspection, reverse engineering, or other task. Imitators pay no compensation to the technology owner, making this an attractive form of learning. However, imitation can be costly and divert investment from local innovation, so its full impacts on development are not straightforward. A related form of non-market diffusion is for technical and managerial personnel to take technical information to a rival firm, which can be particularly significant in industries and locations where cross-fertilization of knowledge is important. Firms also access technology through reading patent applications, which, in principle, offer enough information that a skilled person should be able to use them to invent competing products that do not infringe the original claims. Patents therefore provide both a direct vehicle of technology transfer, through FDI and licensing, and an indirect form through inspection and experimentation.

It is evident that one important factor determining how readily technologies may be diffused through these various channels is the scope of multiple IPRs. On the one hand, patents, trademarks, and enforceable contracts for licensed trade secrets can do much to reduce the information costs and uncertainty of market-based technology transfer (Yang and Maskus, 2001; Hoekman, et al, 2005). On the other hand, if patents have extensive scope, say through broad claims and a ban on experimental use, they can greatly raise the costs of imitation. Similarly, rigorous trade-secrets protection against labor mobility and patent applications that fail to

disclose useful technical information do not support much local diffusion. And, as always, the full effects depend on numerous conditioning factors.

In this context, it is important again to consider the most credible empirical evidence. Regarding patents as a source of technical change, Eaton and Kortum (1996) discovered that the bulk of productivity growth in smaller and less technologically advanced OECD countries came from having foreign inventors patent in their economies, resulting in related technology spillovers. This result likely would hold in small developing nations, which remain overwhelmingly net importers of technology, so long as they build the needed technical capacity to adopt and improve such technologies. Indeed, there is some direct evidence on this point from East Asian developing economies (Hu and Jaffe, 2003). Citations in U.S. patents awarded to Korean and Taiwanese inventors suggested that innovators in both countries discerned and mastered considerable information from recent Japanese and U.S. inventions and were especially reliant on quite recent technologies. Further, there are increasing citations across patents in East Asia, indicating an expanding regionalization of knowledge flows (Hu, 2009).

Recall that the major market-mediated channels of technology transfer include trade, investment and licensing contracts. An important question is whether and how these flows to developing economies are affected by IPRs. This question supports an extensive literature that, while pointing to some ambiguities, generally finds a positive relationship among emerging and middle-income countries. For example, in the first study of the trade impacts of TRIPS reforms, Ivus (2010) analyzed the growth of high-technology exports from 24 OECD countries to 55 developing countries. Taking the 18 countries with relatively larger policy reforms post-TRIPS as the treatment group, she found that high-technology exports to those nations grew significantly faster than low-technology exports after 1994. Her estimates suggested that the rise

in the GP index in this period increased the value of OECD exports of patent-sensitive goods to those countries by 8.6 percent. A more recent study finds strong evidence that such reforms also raise the exports of high-technology goods from middle-income economies (Maskus and Yang, 2016).

Regarding FDI, available evidence also points to positive impacts of patent rights in developing countries. For example, increases in the GP index was a significantly positive determinant of the FDI location decisions of U.S. multinational firms between 1995 and 2000 (Nunnenkamp and Spatz, 2004). Similarly, the extent and enforcement of patents in Eastern European and Former Soviet Union economies positively affected the decisions of European multinational firms to locate production facilities in those countries (Javorcik, 2004). Du, et al (2008) offers related evidence in Chinese provinces, albeit with a questionable measure of patent rights.

Intellectual property protection could affect multiple activities of multinational firms. One prominent study analyzed the impacts on licensing of U.S. parents with affiliates after patent-law changes in 16 developing economies (Branstetter, et al, 2006). The authors found that royalty payments to parents rose by 34 percent on average, mostly reflecting an increased volume of technology sold rather than higher royalty charges. There was also a significant increase in R&D investments at local subsidiaries. Both of these effects, which were much stronger for companies in high-technology industries, implied a substantial growth in reforming economies in the use and development of new technologies.

A later analysis related various measures of affiliate activity in high-technology U.S. multinational companies (Branstetter, et al, 2011). There were significantly positive increases after patent reforms in affiliate sales, net plant and equipment, and employee compensation.

Further, they found that value added in local competing firms rose significantly, by 20 percent on average, especially in technology-intensive sectors. There was also strong evidence that firms in these countries expanded the range ("extensive margin") of their exports to the United States after patent rights were broadened. These results run counter to concerns that stronger IPRs would shut down domestic enterprises. Rather, these policies seem to encourage growth in the most competitive local firms. Again, these findings were for reforms in larger and middle-income economies and there remains no evidence about whether they would apply in smaller and poorer developing countries.

To summarize, the best available evidence supports the claim that patent reforms have positive effects on inward technology transfer through market-based channels. They attract foreign patents, though there is little evidence of a domestic innovation gain for some years. They raise imports of high-technology goods and may also stimulate export growth. Stronger IPRs expand the local activities of multinational firms, while increasing to both affiliated and unaffiliated parties. They particularly stimulate these responses among high-technology firms.

While these are important benefits the conclusions come with major qualifications. First, to date these impacts have been found only in larger and middle-income countries. There is little evidence of such effects in the poorest and smallest developing economies, where patents are not of much relevance for technology transfer or industrial development. Moreover, these positive impacts are subject to important threshold effects in the levels of income and education. Second, the fact that international activities expand does not necessarily imply a stimulus to domestic production. Local firms may have to change product lines or close down if they cannot adapt to the new competitive environment post-reforms, a possibility about which we have little systematic evidence.

A final major qualification is that the evidence reviewed above offers insights only on issues where extensive data exist, which overwhelmingly means such market transactions as exports, investment, and patenting. Adopting stronger IPRs to support such direct and indirect technology markets is surely going to raise such activity, at least in countries that can absorb new information. The subsequent spillovers into local productivity growth can be substantial (Keller, 2010).

These potential gains reflect just one side of a complex process, however. Stronger IPRs also may diminish prospects for imitation and learning from non-market channels, removing a central channel for poorer countries to move up the critical lower rungs of the technology ladder. Indeed, it is difficult to find historical evidence of a now-developed economy that did not take considerable advantage of weak technology protection in the early and middle stages of its development. Examples of those which did include the United States, Switzerland, Japan, South Korea, and China, albeit with different characteristics in each case (Ogadiri, et al, 2010). Unfortunately, systematic data do not exist for studying this fundamental claim because the counterfactual scenarios cannot readily be measured without extensive industrial surveys applied consistently over time in a selection of poor countries, combined with analysis of exogenous events affecting imitation prospects. We are left far short of a balanced depiction of the full roles of IPRs and economic development. This is the primary shortcoming in economic analysis of intellectual property reforms, international technology flows, and innovation, one that needs to be addressed.

In place of that lacuna, however, the literature does offer some important indirect observations about IPRs and technology diffusion. Specifically, since the seminal work of Griliches (1957), agricultural economists have studied how rapidly new crop varieties are

diffused and adopted across countries, based on numerous economic and technical factors. Regarding intellectual property, a thought-provoking study by Goeschl and Swanson (2000) considered the global diffusion of different major crops from 1960-2000. An essential difference between crops is that corn and maize hybrids had automatic "use restriction technologies" because they produced sterile seeds and could not be replanted, while others did not have this feature. Here, the "natural experiment" was that such hybrids were fully protected by a technological form of restriction on diffusion, while others may have been protected by weaker legal regimes of plant breeders' rights or patents, which varied across countries. They found that the strong protection form produced higher levels of technological growth in those industries among primarily developed economies, but materially impeded the diffusion of innovations to developing countries. Thus, to the extent that corn hybridization can proxy for strongly exclusive rights, this result suggests that enhanced IPRs may indeed slow the progress of lower-income economies in approaching the technological frontier.

4. Patents and Access to Medicines

While studying the interplay between patents and innovation is important, it is hardly the only relevant development issue regarding IPRs. More specific issues arise in considering specific economic and cultural sectors. Full chapters could be devoted to the development aspects of IPRs in agriculture, biogenetic resources, environmental technologies, health, education, information technology, and software and digital goods. Indeed, all are the subject of extensive qualitative analyses, often by interested observers.[11] Again, however, systematic evidence from which to draw analytical lessons is largely missing.

One key exception is pharmaceuticals, where issues of patents, market power, pricing and access to medicines loom large. The primary concern in developing economies as they have implemented stronger patent rules is the potential for sharply increased prices, diminished generic competition, and reduced availability of new drugs. Experience in the United States and other developed economies shows that generic products entering at the end of a patent take major shares of the market and drive prices down toward marginal costs (Frank and Salkever, 1997; Reiffen and Ward, 2005).[12] As developing countries register and enforce new drug patents the time of such entry likely will be delayed, perhaps considerably. Generic companies may close down, consolidate or be taken over, generating even less competition and potentially longer waits before new medicines are imitated. Thus, new patent regimes seem likely to raise significant challenges for both health and competition authorities in developing economies.

Recent economic analysis has shed light on a few fundamental issues.[13] First, consider three detailed studies of potential impacts of new patents on drug prices in India, a country with very low prices prior to its new patent law in 2005, extensive data, and a deep generic industry. A study of data before 2005 suggested there was potential for considerable price increases (Chaudhuri, et al, 2006). The authors developed a structural econometric model of the Indian market for quinolones, a family of broad-spectrum antibiotics, such as ciprofloxacin. Using monthly data on prices and sales by firm from January 1999 through December 2000, they estimated a demand system permitting drug substitution across competing products. Using the estimated elasticities, they simulated the impacts of patent protection by eliminating domestic competition in some or all of these drugs. Thus, eliminating just domestic ciprofloxacin would increase prices of three foreign competing drugs by up to 315 percent and also increase prices of related domestic molecules by more than 100 percent. Removing domestic competition in all

four quinolones would raise foreign prices by a factor of between four and six. The associated Indian welfare losses were predicted to be $156 million to $400 million per year. However, the rise in profits to foreign pharmaceutical companies was estimated at just $53 million, suggesting that the large static welfare loss would not be offset by comparable dynamic incentives for innovation.

A more comprehensive analysis used data in India for 155 drugs in five therapeutic groups, including many products with a foreign presence (Dutta, 2011). Using data from 2001-2003, the author estimated a structural model of the market, accounting for a number of important demand and cost features. The model was simulated to compute the potential price effects of providing patents in the 40 goods that had a foreign presence in India and did not face price controls. On average those drug prices would go up by 18 percent, though the effects ranged from 3.5 to 80 percent. However, in another simulation where some patents were accompanied by the elimination of price controls, the price increases were considerably larger. Overall, the author computed a consumer welfare loss of around $380 million per year, with perhaps 8.5 million patients choosing not to buy the drugs.

Thus, simulation analyses based on pre-patent prices predicted notable price hikes in India. However, a more recent study considered impacts on actual prices after the 2005 patent law and found far smaller impacts (Duggan, et al, 2016). The authors developed a database of 6,000 products in around 1,000 molecules, around 1/3 of which were afforded patents by late 2011. They found a modest impact of patents, with prices going up an average of three percent. Much of this increase came in newer molecules, which received stronger protection in the law. This small price effect, however, likely was related to competition: India law permitted existing firms that competed in newly patented drugs to continue to produce under license. For those

molecules with just one producer, prices rose an average of 20 percent. The results point strongly toward the importance of other policies, specifically price regulation and compulsory licensing where possible, to limit the price impacts of patents.

This logic is reinforced in the only study to date of the drug-price effects of TRIPS-related pharmaceutical patent laws across many countries (Kyle and Qian, 2014). The sample covered 60 nations, about 2/3 of which were developing or transition economies, permitting the authors to exploit changes in the implementation timing of such laws among the latter group. They found that drugs on patent have higher average prices than those not patented, as expected. However, the price premiums associated with drugs patented after TRIPS compliance in the middle-income countries were modest and perhaps negative in the poor nations. The authors attributed this outcome to the possible impacts of price controls and other regulations, though they did not test this claim.

Another issue that has attracted attention is the impact of patent availability on the willingness of pharmaceutical companies to launch their new products in different markets. Two recent studies are particularly noteworthy and both point to the same basic conclusion. The first studied the timing of launches of 642 new drugs in 76 countries over 1983-2002, thus covering a period before most TRIPS changes were made (Cockburn, et al, 2016). Controlling for a variety of endogeneity concerns, the authors found that launches were accelerated in countries with longer and broader patents and in countries with health policy institutions and demographic factors that favored profitability. Launches were delayed by price regulations. The second study, undertaken in the TRIPS era, found that the absence of patents significantly reduced the likelihood of a new drug entering a market, while patent availability encouraged faster launches (Kyle and Qian, 2014). An earlier study reached broadly similar conclusions (Kyle, 2007).

A third critical issue for development purposes is whether the adoption in developing countries of pharmaceutical patents and minimum protection standards, as set out in TRIPS, is likely to incentivize more R&D into the particular medical needs of poor nations. That this new regime could have such an impact was a key promise of TRIPS advocates and deserves serious scrutiny. It may be that implementation is too new, and the potential impacts on R&D too delayed by time lags, to reach any conclusions at this point. However, two observations may be made. First, there is one preliminary study of how patent-law changes affected R&D investments from 1990 to 2003 (Kyle and McGahan, 2012). The fact that TRIPS compliance occurred at different times and across countries with different relative disease burdens allowed the authors to study how global disease-specific R&D investments (measured as clinical trials) were affected, distinguishing global diseases from "neglected diseases" of greatest interest in poor regions. The authors found no indications of an increase in clinical trials in neglected diseases after TRIPS, although there were significant increases in investments in global maladies with a large presence in high-income countries. Second, early analysis suggests that major Indian pharmaceutical companies sharply increased R&D and product development in the period surrounding the 2005 patent law (Arora, et al, 2010). That country is now among the largest global suppliers of lower-cost drugs and a number of global pharmaceutical companies have established R&D facilities in India.[14] Thus, the industry is growing and consolidating, perhaps as a result of patenting opportunities. However, the investments to date do not seem to have focused on developing new drugs for neglected diseases.

To summarize, the evidence on patents and pricing power in developing nations is scarce but the emerging evidence points to mixed messages. On the one hand, newly protected patents in countries with limited competition may support markedly higher prices, though this impact

can be effectively countered with well-designed price regulations and licensing regimes. On the other, countries with weak patent scope and extensive price controls suffer lengthy delays before new products arrive in their markets. Thus, policy institutions matter a great deal for access to medicines and health authorities have deep tradeoffs to consider in the wake of TRIPS. Finally, there is little evidence to date that the globalized patent regime is raising incentives for private R&D into the diseases of poor countries. A solution for this last issue, therefore, remains in the purview of public authorities and foundations.

5. Concluding Remarks

It is difficult to characterize the roles intellectual property rights may play in the economic development process, given the great complexity of the issue and the variability of potential impacts across sectors and time. Broadly speaking, the selection of intellectual property regimes is endogenous. We would expect lower-income economies with limited technological capabilities to adopt weaker systems with broad limitations and exceptions. As countries get richer and move into more advanced manufacturing and service sectors interests emerge in deeper protection. Two immediate implications are that international attempts to harmonize IPRs at TRIPS levels or even higher TRIPS-Plus standards may be sub-optimal for many participants. A first-order issue for economists going forward is to investigate whether emerging impacts are harming or helping development prospects, and under what circumstances.

Despite this limited knowledge, economic analysis has made progress in understanding some important development issues and their relationship to IPRs, especially patent laws. In brief, and again noting that circumstances are highly variable across countries, the following

conclusions may be drawn. First, stronger global patents do seem to stimulate marginally more R&D investments, but such effects are concentrated in the developed and higher-income emerging economies. There is no evidence that measurable innovation is growing in lower-income countries, nor is there any suggestion that the new regime has increased private R&D incentives in important products for those markets.

Second, there are strong indications that enhanced IPRs encourage more and higher-quality technology diffusion through market-based channels, including trade, FDI and licensing. The associated spillover gains in domestic productivity should offer a welcome long-term boost to recipient economies. Again, however, this impact is prevalent only in larger and middle-income countries that have a sound basis of intermediate technological skills and education, which are important for absorbing and improving these technologies. Technology transfer to lower-income economies in the TRIPS era has not expanded significantly, raising numerous questions about the reasons for this lack of responsiveness. Moreover, there remains no systematic evidence about how IPRs may be limiting the scope for learning and diffusion through non-market means, including reverse engineering and imitation. This is another first-order area for additional research.

Finally, there are many important questions that could not be covered here and about which we have inadequate information. For example, how are creativity and innovation sustained in poor economies with large informal sectors and is there any real role for IPRs in that context? If product counterfeiting and unauthorized copying of digital products limit development of new products and services in developing economies, how effective are trademarks and copyrights in addressing such problems, and at what social cost? Does the need to invest public resources in administering and enforcing a TRIPS-compliant IPRs regime divert

enough scarce talent to retard growth prospects? Most importantly, what are the key thresholds, in terms of education, science, infrastructure, and factor markets, that developing countries need to achieve before patents and other IPRs help improve the dynamic efficiency of developing countries? A large research agenda remains.

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Endnotes

[1] As will become evident later, satisfactory empirical identification of such effects is far more elusive.

[2] See, for example, the chapters in Odagiri, et al (2010).

[3] It might also care about tax revenues, employment, and other objectives. Alternatively, a government may be self-interested, with legislators seeking to maximize the chances of staying in office or garnering lobbying contributions, calling for a model of political economy along the lines of a tariff-setting model (Grossman and Helpman, 1994). The self-interested approach has not yet been studied in a rigorous empirical model of patent policy formation.

[4]Caution should be exercised in interpreting this U-shaped outcome, however, for to some degree it may reflect simply the legacy of imported colonial laws.

[5] Again, a politically driven system could generate excessive protection even on a national basis if industries seeking strong exclusive rights have more lobbying influence, a situation that arguably has characterized the United States in recent years and underlies domestic debates about copyright limitations and patent scope.

[6] The issue of measurement will be discussed below.

[7] A full review in this essay is impossible, given space constraints. Such reviews may be found in Maskus (2012), Park (2008), and Cimoli, et al (2014). Readers may wish to begin with a review of the broader roles of innovation in economic development, such as Fagerberg, et al (2010).

[8] Copyrights are difficult to assess in this context because they need not be registered to have legal weight. Analysts sometimes measure their importance by the shares of employment or

output in such "copyright industries" as music, publishing, software, and digital entertainment. Two good examples are Pouris and Inglesi-Lotz (2011) and European Commission (2013). This approach says relatively little about the causal effects of copyrights, however.

[9] For additional evidence on the relationship of patent laws to invention, see Moser (2013).

[10] There are exceptions, as technology-oriented firms in South Korea, China, and India quickly expanded their R&D spending and turned to patenting in the wake of domestic reforms (Maskus, 2012).

[11] A partial list of comprehensive books would include Maskus and Reichman (2005), Cimoli, et al (2014), Melendez-Ortiz and Roffe (2009), and Gervais (2007).

[12] There is also the possibility that originator firms suffer large market-share losses upon entry but the prices of their drugs actually rise due to brand loyalty built under patent protection.

[13] There are other critical issues, such as the need for additional public funding to meet global needs for R&D in neglected diseases, the scope for advanced market commitments in new drugs, and the effectiveness of exhaustion-based policy regimes to encourage price differentiation across markets at different income levels. There is little in the way of serious empirical analysis of these matters and I leave them aside to conserve space in this chapter. See Maskus (2012) for a discussion.

[14] India Expands Role as Drug Producer," *New York Times*, 6 July 2010.