1. Keith E. Maskus

Cognitive dissonance in the economics of patent protection, trade and development

I. THE MEASURE OF HOW LITTLE WE KNOW

The exclusive economic rights offered by patents are thought by many scholars and business leaders to be a critical inducement to firms and inventors to invest in research and development.[1] Policy authorities in virtually all developed and emerging countries extoll the importance of strong patent regimes as a foundation of the modern knowledge-based economies they wish to build. Indeed, intellectual property protection is a central component of the knowledge indicators assembled by the World Bank, the World Economic Forum, and other organizations.[2] Consulting those indexes often makes it seem as if a flowering of innovation and technology diffusion simply awaits the enforcement of well-designed and enforceable patents. It is a short step to conclude, in one famous phrase, that intellectual property rights are a 'power tool for economic growth'.[3]

Many other scholars and observers, particularly those from civil society, see the world in a completely different light. To them, patents are a means of sustaining lengthy monopolies over the use of ideas, which

[1] R.M. Sherwood, 'Global Prospects for the Role of Intellectual Property in Technology Transfer', 42 *IDEA: The Journal of Law and Technology* (2002), 27–36.

[2] See the World Bank's Knowledge Economy Index, at https://knowledgepolicy.wordpress.com/2012/06/22/world-bank-knowledge-economy-index-kei-2012-rankings/ and the World Economic Forum's Global Competitiveness Report, at http://reports.weforum.org/global-competitiveness-report-2015-2016/.

[3] This claim was made forcefully by Kamil Idris, a previous Director General of the World Intellectual Property Organization, when the primary objective of that institution was to motivate developing countries to adopt more rigorous protection. See K. Idris, *Intellectual Property: A Power Tool for Economic Growth*, WIPO Publication n. 888.1 (Geneva 2003), available at ftp://ftp.wipo.int/pub/library/ebooks/wipopublications/wipo_pub_888e.pdf.

can materially diminish incentives for investments in competing R&D projects and slow down innovation, especially where knowledge is built cumulatively and in complex interdependent technologies.[4] Moreover, the market power established by patents may support excessive prices and refusals by patent owners to license their knowledge, diminishing flows of technology transfer. The consequence is that patents can be anti-competitive and slow down development and growth prospects in lagging countries.[5] Policymakers in developing countries are now routinely advised by intellectual property skeptics not to adopt strong patent protection or to scale back what they already have implemented.

These deep differences thrive in the absence of serious empirical evidence about the roles of patent rights in R&D, innovation, technology diffusion, product development and growth. In one sense the lack of clear evidence is astonishing: if the whole purpose of patents is to incentivize knowledge creation and diffusion, how can it be that scholars do not have strong data to demonstrate the truth of this claim? In another sense it is unsurprising: the mechanisms by which intellectual property rights might build technology markets are complex and vary greatly by socioeconomic circumstances, making it extremely difficult to search for strong causal patterns in imperfect innovation data. Locating systematic impacts on growth and development is harder still.

Economists who search dispassionately for such evidence, whether positive or negative, occupy a strange position in this debate. Serious scholarly evidence that could shed systematic light on these deep questions is much in demand. At the same time, the political and economic interests arrayed on both sides of the patents–development divide are deeply entrenched and would not welcome findings that run counter to their views. It is a recipe for real cognitive dissonance as scholars look for elusive proof or rejection of claims that cannot be readily demonstrated or discarded.

My purpose in writing this chapter is to offer insights on why this evidentiary task is so difficult and what could be done better to advance the search for at least replicable knowledge in this area. It is also to take economists, including myself, to task for failing to study some of the deeper, yet no less important, aspects of the relationships between patent

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[4] M. Boldrin and D.K. Levine, *Against Intellectual Monopoly* (Cambridge, Cambridge University Press 2008).

[5] M. Cimoli, D. Giovanni, K.E. Maskus, R.L. Okediji, J.H. Reichman and J.E. Stiglitz, *Intellectual Property Rights: Legal and Economic Challenges for Development* (Oxford, Oxford University Press 2014).

protection and economic activity. Serious empirical literature in this area truly is in its infancy.

II. THE CHANGED PATENT LANDSCAPE

Patents have been awarded and enforced for centuries, evolving from royal monopoly grants designed to import a basic foreign technology to today's intensely legal documents requiring substantive examination, offering conditional rights, and inviting costly litigation in technological fields of enormous complexity.[6] There have been hundreds of cases in history where countries enacted discrete and substantive reforms of their patent laws. There have also been major episodes of international cooperation in protecting industrial property, such as adoption by industrially oriented economies of the 1883 Paris Convention. The tendency toward increasing legal globalization accelerated with the 1994 Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) at the World Trade Organization, with policy changes implemented over time in the vast majority of countries. Even TRIPS has not been enough for advocates of strong patents, with the United States and the European Union demanding ever-stronger standards in their recent preferential trade agreements (PTAs).[7] The recently negotiated Trans-Pacific Partnership (TPP), if approved legislatively by its members, will usher in the strongest legal rules yet in a multilateral trade agreement.[8]

Accordingly, we are living through an era of unprecedented reforms in patent laws, in particular, and in intellectual property rights more generally. The former almost uniformly involve tighter and more harmonized patent protection around the world through increases in coverage, duration and scope. So-called 'TRIPS-Plus' provisions in US-led PTAs have, for example, established considerably stronger norms of protection for pharmaceuticals, agricultural chemicals, and biologic

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[6] Though they are quite different, similar statements could be made about the history of copyrights and their many legal cousins. In this essay I set them aside simply because there are even less data and systematic economic evidence about their development effects than is the case with patents. A parallel review certainly would be of interest.

[7] K.E. Maskus, *Private Rights and Public Problems: The Global Economics of Intellectual Property in the 21st Century* (Washington DC, Peterson Institute for International Economics 2012).

[8] The United States withdrew from the TPP at the behest of President Trump but it remains under consideration by other signatories.

medicines, involving long periods of test data exclusivity, patent-term restoration, second-use patents, and other terms favorable to patent owners.

Inevitably, analysts attempt to quantify such changes for a variety of reasons. For example, the annual survey of the World Economic Forum (WEF), published in its *Global Competitiveness Report*, summarizes in an index the opinions of corporate leaders about the adequacy of IPRs in a wide range of countries. Any such index risks substantial errors in measuring underlying protection. Because these WEF indexes are strictly qualitative they are not readily comparable over time or across countries, making their use as explanatory variables in statistical studies highly suspect.

More widely used is the famous GP index of the scope of national patent laws developed originally by Ginarte and Park.[9] The primary concern here is that the GP index is constructed simply from a count of the presence or absence of specific laws and standards. It pays little attention to the effective enforcement of patent rights, nor does it consider the impacts of litigation or specific court rulings. Nonetheless, this index, which ranges from zero to five, is widely used by economists and political scientists to measure recent reforms and to study the impacts of patent laws on innovation and technology transfer.[10]

The GP index is primarily useful as a consistent indicator across countries of policy changes. Thus, Table 1 offers perspective on the recent globalization of patent laws across country groups, broken down by income, and individual nations between 1990 and 2010. This period encapsulates the negotiation and implementation of TRIPS and nearly all ratified PTAs with intellectual property chapters. In the top panel countries are split into low-income (LI), lower-middle-income (LMI) and middle-income (MI), upper-middle-income (UMI) and high-income (HI), based on per-capita real income levels in 2003. The figures show that the 33 poorest countries raised their statutory patent rights by about 55 percent, on average. Many of these countries have not yet fully implemented their legislative compliance with TRIPS.

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[9] J.C. Ginarte and W.G. Park, 'Determinants of Patent Rights: A Cross-National Study', 26 *Research Policy* (1997), 283–301.

[10] It is worth noting that the upper bound of five is itself problematic for econometric work because it may overstate an apparent convergence in patent rights between developing and developed countries. This factor has not been addressed in any statistical studies. K.E. Maskus, *Private Rights and Public Problems: The Global Economics of Intellectual Property in the 21st Century* (Washington DC, Peterson Institute for International Economics 2012).

Table 1 Changes in the GP patent-rights index

Income level	1990	2000	2010	% Rise	Sample
LI	1.72	2.24	2.67	55	33
LMI & MI	1.54	2.91	3.30	115	44
UMI	2.01	3.36	3.84	91	13
HI	3.33	4.33	4.40	32	24
Countries	1990	2000	2010	% Rise	
India	1.03	2.27	3.76	264	
China	1.33	3.09	4.21	216	
South Africa	3.03	3.75	3.88	28	
Brazil	1.28	3.43	3.43	169	
Mexico	1.02	3.22	3.75	266	
S. Korea	3.69	4.13	4.33	17	
Taiwan	1.26	3.29	3.74	198	
Singapore	2.04	4.01	4.21	106	
Israel	2.78	3.96	3.96	43	
Hungary	2.12	3.88	4.33	105	
Portugal	1.67	3.96	4.33	474	
Jordan	0.58	2.70	3.30	160	
Japan	3.88	4.67	4.67	20	
USA	4.68	4.88	4.88	4	

Notes: LI (low income) covers countries with 2003 GNI per capita (PPP) less than $2,500; LMI (lower middle income) and MI (middle income) covers the income range $2,500 to $11,000; UMI (upper middle income) covers the income range $11,000 to $20,000; HI (high income) covers countries with 2003 GNI per capita (PPP) greater than $20,000.

Sources: Computed by the author from J.C. Ginarte and W.G Park, 'Determinants of Patent Rights: A Cross-National Study', 26 *Research Policy* (1997), 283–301; W.G. Park, 'Intellectual Property Rights and International Innovation' in K.E. Maskus (ed.), *Intellectual Property, Growth and Trade* (Amsterdam, Elsevier 2008), p. 289 et passim; personal updates by Walter Park; World Bank, *World Development Report 2005: A Better Investment Climate for Everyone* (Washington DC, World Bank 2005).

Legislative reforms were proportionally much greater in the LMI and MI categories, sufficing to more than double the average GP index. Several such nations, such as Brazil and China, have long caused particular headaches for multinational companies by pairing weak patent protection with reasonably advanced capacities of local enterprises to imitate

technologies. Much like the 19th-century 'New World' rising powers, such as the United States and Australia, the policy preference for copying and improving international goods and technologies was seen as an important path to industrial development.[11] The UMI countries also enacted significantly stronger patent rights, nearly doubling the average GP value. Finally, the high-income countries on average saw a modest rise in their average legal patent rights, suggesting that TRIPS and other factors did not require the richer economies to change their laws very much.

The second panel lists data for countries of illustrative interest. India, China, Brazil and Mexico all had very low GP indexes in 1990, which grew dramatically for different reasons. India implemented some changes in patent regulations by 2000 but its largest increase came with its new patent law in 2005. This law made pharmaceutical products eligible for patents, extended coverage to biotechnological inventions, and lengthened the patent term. Pushed by the United States, China began an extensive reform program in the early 1990s. These reforms accelerated in China's preparation to join the WTO in 2001. Brazil adopted its new patent regime shortly after TRIPS was approved, without waiting for its permitted phase-in period to expire. Finally, Mexico adopted much-stronger patent rules in 1995 upon joining the North American Free Trade Agreement. The IPRs provisions in NAFTA were, in fact, the foundation for much of the language in TRIPS.[12]

Israel, Singapore, South Korea and Taiwan all present interesting histories. During this period these countries transformed their economies into developers and producers of high-technology goods and business services.[13] Israel started from a higher level of protection and put in additional major changes just after it joined TRIPS. Singapore enacted significant reforms in the 1980s, as did South Korea, albeit under considerable American pressure. Taiwan also responded to external pressure in the 1990s but continued to strengthen its patent rules through 2010. All four countries now have rigorous intellectual property laws and are highly innovative, as measured by R&D expenditures and patent

[11] R.P. Suttmeier and X. Yao, 'China's IP Transition: Rethinking Intellectual Property Rights in a Rising China', *National Bureau of Asian Research, NBR Special Report 29* (2011).

[12] K.E. Maskus, *Intellectual Property Rights in the Global Economy* (Washington DC, Institute for International Economics 2000).

[13] Penetrating discussions of these and other key countries may be found in H. Odagiri, A. Goto, A. Sunami and R.R. Nelson (eds), *Intellectual Property Rights, Development, and Catch-Up* (Oxford, Oxford University Press 2010).

applications taken out at home and abroad. Note that this is not a statement about causality, though advocates of strong patent laws would see it that way.

The next set of countries illustrate a few cases (of many) in which regimes were changed largely due to the entry of nations into regional trade agreements. Portugal and Hungary were required to adopt far stronger patent laws in order to integrate their IPRs regulations with the rest of the European Union. In 2001, Jordan entered into a free trade agreement with the United States, requiring many TRIPS-Plus standards. This raised Jordan's GP index from the lowest value (0.58) in the table in 1990 to 3.30 in 2010. With respect to IPRs, this agreement was called the 'gold standard' by US policymakers for some time.

Finally, I include Japan and the United States to make a last point. These countries had high levels of protection throughout the period, although Japan markedly raised its patent scope with a major reform in 1998. The United States registered the smallest rise in the GP index, with no increase after TRIPS.[14] Together with the earlier data, these figures demonstrate that recent policy shifts have brought patent standards in the emerging countries much closer to those of the advanced economies. Indeed, the data emphasize the substantial upward policy convergence, a major global transformation that, by some measures, was stronger than associated trade liberalization in this time frame.[15] Overall, then, there is no question that the last few decades ushered in the most significant international policy changes in patent laws in history.

III. THE LOW-HANGING BRANCHES DON'T BEAR MUCH FRUIT

Surely such a fundamental and global policy change should leave easily discovered traces of positive impacts on the very processes it is supposed to incentivize: R&D investments, innovation and cross-border transactions in technology markets. Economists have worked hard to unearth such signals with available data and econometric tools, focusing on the

[14] Again, treat this statement with caution, for the maximal GP value is capped at 5. Moreover, there have been several important recent court rulings in the United States, which have effectively limited some of the more protectionist elements of patent policy.

[15] K.E. Maskus, *Private Rights and Public Problems: The Global Economics of Intellectual Property in the 21st Century* (Washington DC, Peterson Institute for International Economics 2012).

relatively straightforward questions of innovation and technology transfer. Depending on the questions asked, the evidence ranges from 'weak and inconclusive' to 'mixed, but suggestive'. Readers may be surprised by that, given that advocates of strong protection are uniformly certain in their stated views about the positive incentive effects of patents. It is instructive to explore the sources of this disconnect.

A. Patents and Innovation

Economists routinely model patents as the key driver of innovation.[16] It is important to understand, however, that patents are neither necessary nor sufficient to induce, or even increase, innovative activity. Rather, the primary reason firms invest in new goods is the expectation that doing so is likely to raise future profits. There are many market factors that affect expected profits, including market size, lead times, imitation costs, secrecy, and barriers to competition. Patents are a factor also, though their effectiveness both depends on market circumstances and varies widely across sectors. Moreover, it is straightforward to imagine circumstances in which patents deter competitive innovation and sustain monopoly rents. Thus, anecdotes may be derived from history to support any claim about the importance of patents.[17] Complex examinations of post-war experience in numerous countries fail to find robust patterns pointing to the ability of patent reforms to stimulate domestic innovation.[18]

Seen in this light, it is less surprising that economists have not found convincing and systematic cross-country econometric evidence of an upswing in innovation since TRIPS began 21 years ago. Answers are elusive for at least three reasons. First, measuring innovation is itself a difficult task. The most common statistic is patent applications, but patents vary widely across countries and industries, and over time, in their technological and economic importance, making satisfactory comparisons difficult. R&D expenditures are also notoriously hard to compare across countries because of differences in definitions of what they cover, tax treatments and other elements.

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[16] S. Scotchmer, *Innovation and Incentives* (Cambridge MA, MIT Press 2004); C. Greenhalgh and M. Rogers, *Innovation, Intellectual Property, and Economic Growth* (Princeton NJ, Princeton University Press 2010).

[17] M. Boldrin and D.K. Levine, *Against Intellectual Monopoly* (Cambridge, Cambridge University Press 2008).

[18] H. Odagiri, A. Goto, A. Sunami and R.R. Nelson, *Intellectual Property Rights, Development, and Catch-Up* (Oxford, Oxford University Press 2010).

Second, much of the policy and outcomes data are highly aggregated, making analysis of inherently microeconomic innovation decisions suspect. Regarding patent protection, for example, analysts might use the GP index as an explanatory variable, but it exists only at five-year intervals and is simply one measure of the legalized patenting environment. Even more problematic are survey-based variables, such as the annual index of IPRs protection from the WEF. These are subjective indicators that cannot meaningfully be compared across nations or be assessed in their impacts on industries. Moreover, all such measures are inherently endogenous, in that policies respond to economic pressures. Without careful (and so far unsuccessful) work to control for this factor it is doubtful that a positive correlation between patent laws and innovation can be interpreted causally. A frequently used alternative is simply to incorporate a dummy variable that switches from zero to one in the year a patent reform was made. Again, to infer causality in that context when so many other economic variables may change contemporaneously is unlikely to be convincing.

Finally, as noted already, there are many factors that influence investment decisions, implying that aggregate cross-country and cross-industry regressions are unlikely to generate robust evidence. This is especially a risk when analysts select a reduced-form regression approach, in which certain macro variables are included and others are excluded on the basis of simple intuition, rather than hard-edged theory.

These problems may be illustrated briefly by considering some prominent papers in this area.[19] Schneider[20] analyzed a sample of 19 developed and 28 developing countries, measuring innovation as the number of patents residents of each nation applied for in the United States from 1970 to 1990. The explanatory variables included the GP index and several intuitive national determinants of technological change. Schneider found a positive and significant elasticity between US patent

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[19] This discussion is highly selective in order to highlight certain methodological points. For comprehensive reviews see P. Moser, 'Patents and Innovation: Evidence from Economic History', 27 *Journal of Economic Perspectives* (2013), 23–44; W.G. Park, 'Intellectual Property Rights and International Innovation', in K.E. Maskus (ed.), *Intellectual Property, Growth and Trade: Frontiers of Economics and Globalization* (Amsterdam, Elsevier 2008); K.E. Maskus, *Private Rights and Public Problems: The Global Economics of Intellectual Property in the 21st Century* (Washington DC, Peterson Institute for International Economics 2012).

[20] P.H. Schneider, 'International Trade, Economic Growth and Intellectual Property Rights: A Panel-Data Study of Developed and Developing Countries', 78 *Journal of Development Economics* (2005), 529–547.

applications and domestic patent rights. However, this impact was positive only for developed countries, and was negative and largely insignificant in developing countries. These results surely were fragile in that no attempt was made to address policy endogeneity. Indeed, Chen and Puttitanun used data for 61 developing countries over the period 1975–2000 and partially addressed the simultaneity between patent legislation and innovation.[21] In their work 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. They interpreted the finding to imply the existence of an important threshold effect, in that stronger patents seem to induce more apparent innovation only above relatively high income levels.

Yet consider the analysis by Qian, who studied 26 developing countries that implemented laws establishing patent protection for pharmaceutical products between 1978 and 2002. Her main innovation measure was the log of citation-weighted drug patent applications registered in the United States after these legal changes.[22] Her approach improved on the prior ones by comparing matched pairs of similar countries, one of which adopted reforms (a 'treatment' group) and the other of which did not (a 'control' group). She also included other national and industry R&D determinants in the regressions. Qian found that there were no significant direct impacts of domestic reforms on drug patent applications, even within ten years. However, there were again evident threshold effects, because patent revisions in countries with higher educational attainment and per-capita income, and greater measured market freedom, significantly increased such applications compared to the control group. Low-income economies with limited educational attainment and technical skills saw no such impact.

Thus, there is some evidence of a pro-innovation impact of patent reforms, if only in countries that meet certain socioeconomic conditions. However, whether such results from aggregated data are robust remains an important question. One way to improve on this approach was

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[21] Y. Chen and T. Puttitanun, 'Intellectual Property Rights and Innovation in Developing Countries', 78 *Journal of Development Economics* (2005), 474–493.

[22] Y. Qian, 'Do National Patent Laws Stimulate Domestic Innovation in a Global Patenting Environment? A Cross-Country Analysis of Pharmaceutical Protection, 1978–2002', 89 *Review of Economics and Statistics* (2007), 436–453.

advanced by Branstetter et al.,[23] who introduced microeconomic, firm-level data.[24] Specifically, they studied how measures of economic activity, in the affiliates of US-based multinational enterprises, enacted in the years after major patent reforms in 16 large emerging economies. They discovered that royalty payments to parents rose by 34 percent on average, largely due to increased volumes of technology acquired rather than higher royalty fees. There was also a significant rise in R&D investments at local affiliates. Both of these effects were much stronger for companies in high-technology industries, which might be considered a treatment group in this context. There was also evidence that locally owned competing firms increased their value added and exports in the same period. These findings constitute a reasonably strong indication of both a pro-innovation and technology-transfer impact, which are important to find in micro data. However, the only variable measuring policy reforms was the dummy for the reform years and beyond. The ability to link policy changes directly to firm-level responses remains frustratingly elusive.

Advocates of the stronger IPRs ushered in by TRIPS promised that they would not only spur greater local innovation but also incentivize additional R&D into technologies of greatest societal need, most specifically in essential medicines to treat maladies found disproportionately in the poorest countries. Unfortunately, just one serious study has addressed this question and it must be regarded as preliminary given the time lags involved in the adjustment of R&D programs in pharmaceutical companies. Specifically, Kyle and McGahan analyzed whether global R&D investments in disease-specific clinical trials were affected by the timing of compliance with TRIPS pharmaceutical patent rules over the period 1990 to 2003.[25] For this purpose, they distinguished between global and 'neglected' diseases, expecting to see a stronger impact in terms of the latter due to increasing TRIPS adherence. In fact, there was no statistical evidence of a rise in clinical trials in neglected diseases, though there was a significant increase in R&D aimed at global illnesses with a large patient load in developed economies. In another vein, Arora et al. found that large Indian pharmaceutical companies invested significantly in R&D and new product development in the period surrounding the

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[23] L. Branstetter, R. Fisman, C. Fritz Foley and K. Saggi, 'Does Intellectual Property Rights Reform Spur Industrial Development?', 83 *Journal of International Economics* (2011), 27–36.

[24] Branstetter et al., ibid, 27–36.

[25] M.K. Kyle and A.M. McGahan, 'Investments in Pharmaceuticals Before and After TRIPS', 94 *Review of Economics and Statistics* (2012), 1157–1172.

introduction of the new patent law in 2005.[26] However, such investments to date have not aimed at developing new drugs for neglected diseases.

This question of whether TRIPS and other international IPRs agreements have sufficiently increased private incentives for R&D in underfunded solutions for poverty-related social problems has first-order importance, including in areas beyond medicines.[27] The initial evidence is pessimistic but the issue deserves close scrutiny in far more studies than we have seen to date.

B. Patents and Technology Diffusion

The statistical record is more positive regarding the second area in which patent reforms are supposed to deliver benefits, the international spread of technologies and products through such market channels as international trade, foreign direct investment (FDI) and licensing. To many economists it is not surprising that more evidence may be found here. The primary reason is that innovation springs from many sources and the uncertain promise of gaining a patent may not be considered important by R&D investors *ex ante*.[28] However, once an invention exists and has been shown to be useful, its originators seek protection from infringement and copying as they deploy it in different markets. For a variety of reasons, patents, trade secrets and trademarks are particularly important in terms of protecting proprietary information across borders.[29] In consequence, there is likely to be a more direct relationship between patent rights and international technology transfer than between patents and innovation.

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[26] A. Arora, L. Branstetter and C. Chatterjee, 'Strong Medicine: The Impact of Patent Reform on the Indian Pharmaceutical Industry', in I.M. Cockburn and M.J. Slaughter (eds), *Factors Affecting the Location of Biopharmaceutical Activities* (Chicago, University of Chicago Press, forthcoming).

[27] K.E. Maskus, *Private Rights and Public Problems: The Global Economics of Intellectual Property in the 21st Century* (Washington DC, Peterson Institute for International Economics 2012).

[28] This view is consistent with survey results in Cohen et al. (2000), where patents were not rated as important in stimulating R&D programs outside of pharmaceuticals, chemicals, and life sciences. W.M. Cohen, R.R. Nelson and J.P. Walsh, *Protecting their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (Or Not)* (Cambridge MA, National Bureau of Economic Research, Working Paper 7552, 2000).

[29] K.E. Maskus, 'Encouraging International Technology Transfer', International Center for Trade and Sustainable Development, Project on IPRs and Sustainable Development, *Issue Paper 7* (2004), Geneva.

Thus, while the early evidence was not conclusive, recent studies find strong support for the view that patent reforms encourage more trade, FDI and licensing, particularly in high-technology goods of the greatest patent sensitivity.[30] For example, Ivus analyzed the growth of high-technology exports from developed to developing countries, comparing changes in the GP index before and after TRIPS.[31] Specifically, for the treatment group she considered those countries that were not British or French colonies, and which therefore had to adopt stronger patent revisions because of TRIPS. Regressing the growth of bilateral patent-intensive exports from 24 OECD countries to 55 developing economies in the pre- and post-TRIPS periods, she found that high-technology exports to reforming countries grew significantly faster than low-technology exports after 1994. These results suggested that the rise in the GP index in this period added about $35 billion (in 2000 prices) to OECD exports of patent-intensive goods to developing countries, or 8.6 percent in the annual value of such trade. Further, this impact was almost entirely in price-adjusted volumes rather than increased prices.

Using a comprehensive sample of countries, Delgado et al. studied how implementation of (at least) the TRIPS patent rules affected both aggregate and sectoral imports and exports.[32] Again, measuring the extent of such compliance is difficult to do and the authors simply identified those dates at which conformity was established in the law, switching on a dummy variable after that time. Arguing that TRIPS could be considered an exogenously imposed policy constraint for most developing economies, the authors discovered a significant and positive causal effect of legislative patent changes on exports from rich to poor countries in particular patent-intensive goods, including pharmaceuticals and information technology products. Similar results exist in Maskus and Yang

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[30] Again, this is a highly selective review to make key points; see W.G. Park, 'Intellectual Property Rights and International Innovation', in K.E. Maskus (ed.), *Intellectual Property, Growth and Trade: Frontiers of Economics and Globalization, Vol. 2* (Amsterdam, Elsevier 2008) and K.E. Maskus, *Private Rights and Public Problems: The Global Economics of Intellectual Property in the 21st Century* (Washington DC, Peterson Institute for International Economics 2012).

[31] O. Ivus, 'Do Stronger Patent Rights Raise High-Tech Exports to the Developing World?', 81 *Journal of International Economics* (2010), 38–47.

[32] M. Delgado, M. Kyle and A. McGahan, 'Intellectual Property Protection and the Geography of Trade', 61 *Journal of Industrial Economics* (2013), 733–762.

(2016), including evidence of a pro-export impact across all manufacturing goods among middle-income countries.[33]

The ready availability of detailed international trade data makes them useful for studying such impacts. To get at issues of FDI and licensing satisfactorily, however, requires microeconomic data to understand how strategic decisions are made by MNEs. In this context, Javorcik (2004) considered how patent rights affected the 1995 composition of firm-level FDI inflows from 1,400 global companies into several countries in Eastern Europe and the former Soviet Union.[34] She estimated a model of both the decision to invest and the type of investment, distinguishing between production facilities and distribution. This analysis tested whether firms choose not to produce in locations with weak patents. Javorcik found convincing evidence that stronger rights brought in significantly more production facilities in patent-sensitive sectors than in other industries. This is largely consistent with the positive effects of patent reforms on inward licensing and other technological activities of US MNEs found by Branstetter et al.[35] Nagaoka (2009) also found significant increases in technology contracting between Japanese parent companies and their overseas affiliates as a function of local patent rights.[36]

Another form of technology diffusion that has attracted analytical interest is how patent rights have influenced decisions of global pharmaceutical companies to launch new products in various markets. Two important recent studies reach the same basic conclusion. The first analyzed the timing of launches of 642 new drugs in 76 countries over the period 1983–2002, thus covering a period before most TRIPS changes were made.[37] Controlling for a variety of simultaneity concerns, the authors found that market entry was quicker in countries with patents of broader legal scope. The second study, undertaken in the TRIPS era,

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[33] K.E. Maskus and L. Yang, 'Patent Rights, Access to Technologies, and the Structure of Exports', University of Colorado at Boulder, Working Paper (2016).

[34] B.S. Javorcik, 'The Composition of Foreign Direct Investment and Protection of Intellectual Property Rights: Evidence from Transition Economies', 48 *European Economic Review* (2004), 39–62.

[35] L. Branstetter, R. Fisman, C. Fritz Foley and K. Saggi, 'Does Intellectual Property Rights Reform Spur Industrial Development?', 83 *Journal of International Economics* (2011), 27–36.

[36] S. Nagaoka, 'Does Stronger Patent Protection Facilitate Technology Transfer? Some Evidence from Licensing Contracts of Japanese Firms', 24 *Journal of Technology Transfer* (2009), 128–144.

[37] I.M. Cockburn, J. Lanjouw and M. Schankerman, 'Patents and the Global Diffusion of New Drugs', 106 *American Economic Review* (2006), 136–164.

found that the stronger patent rights significantly raised the probability that a new drug would be launched in a market.[38] Both of these studies are notable for their careful attention to model specification and use of detailed micro-level drug data. Together they suggest that, while recent reforms may not have increased international incentives to expand R&D in medicines, they are important for attracting new drugs.

IV. RAISING THE VEIL ON PATENTS, TRADE AND DEVELOPMENT

A reasonable summary of what economists have learned through empirical research would be the following. First, the evidence for any increase in innovation in developing countries, or greater investments in essential medicine research, which could be attributed to recent patent globalization is inconclusive at best. Second, this shift in the policy regime seems to have enhanced prospects for international technology transfer through formal market mechanisms, a process I have elsewhere described as an improvement in the 'plumbing' of the international system.[39] However, this finding applies only in middle-income emerging economies, not in the poorest countries. Third, stronger standards offer some promise of faster access to new drugs in countries that newly recognize pharmaceutical patents.

These results are interesting but ultimately disappointing, in my view, for several reasons. First, it is difficult to attach strong confidence to them because many of the studies rely on national or highly aggregated data, making causal interpretations problematic. Even those which analyze microeconomic outcomes data employ crude measures of policy changes, typically just a dummy variable beginning in the year of a legal change or TRIPS compliance. With that approach it is hard to control for relevant contemporaneous factors, even with a judicious selection of treatment countries or industries. It is even more problematic to analyze the cumulative impacts of multiple factors that jointly could affect such relationships, an issue that economists have yet to approach even analytically.

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[38] M.K. Kyle and Y. Qian, *Intellectual Property Rights and Access to Innovation: Evidence from TRIPS*, Cambridge, Massachusetts, National Bureau of Economic Research, Working Paper 20799 (2014).

[39] K.E. Maskus, *Private Rights and Public Problems: The Global Economics of Intellectual Property in the 21st Century* (Washington DC, Peterson Institute for International Economics 2012).

Second, such findings beg the obvious question: how do such effects actually operate? For example, suppose one finds that differences in national patent regimes affect decisions to export to specific markets. We would like to know what specific features of those differences matter, why they matter, and if the effects vary across products. Similarly, imagine that we find evidence that local firms in emerging countries export more and newer goods some years after a patent reform. This tells us very little about how those firms actually increased their export capacities, which may have been due to increased access to foreign technologies, stronger rates of technology spillovers, easier access to export finance when a firm owns patents, or diminished competition as other domestic firms were forced out of the market.

Third, even at the aggregate policy level analysts have not seriously studied the conditions under which patent-law revisions might be effective in inducing growth. There are hints of such differences in the available literature but this has not been the focus of research, particularly in poor nations. How important, for example, is it for countries to have flexible labor-market policies to manage employment displacement when IPRs are changed? Does a stronger patent regime require relatively developed capital markets to encourage risk-taking? Are elevated patent standards most likely to work when a country sustains relatively high trade barriers in order to preserve domestic markets for new technologies? We know next to nothing about such questions.

The final concern is the most fundamental. This research has not yet addressed most of the major questions that really animate much of the debate about intellectual property rights and their impacts on economic and social development. The apparent reason is simply data availability. Economists so far have acted rather like the proverbial drunkard who looks for his keys under the streetlight, despite having dropped them elsewhere, because that's the only place he can see. For their part, economists seek patterns in data covering international trade and patent applications, since they are easily accessible. But this approach can only indirectly inform us about such fundamental development questions as how patents affect competition and market entry or exit, influence public pharmaceutical expenditures and patient health status, or endanger diversity of plant-genetic resources.

Perhaps these observations mean that economic analysis of patents, trade and development is in its infancy and we only need to wait for more and better work to be done with updated versions of available data. In my view, however, the analytical problems are deeply structural and require considerably more concerted effort at original data collection, measurement, and theoretical and econometric analysis. To put it differently,

economists and data-gathering institutions such as the World Bank and the OECD need to work harder at these questions, which is easier said than done. Thus, I conclude this essay with some thoughts on where research efforts and investments could most fruitfully be made.

A. Enhanced Microeconomic Data Linkages

Given the difficulties in establishing causality, there is a strong need for greater international integration of microeconomic databases in order to link firms with the technologies (patents) they develop and license and their inputs, productivity and trade decisions. For example, the international patent classification (IPC) database is organized along lines that make it difficult to link patent ownership to specific industrial and product classifications.[40] To gain a deeper sense of how patent ownership and licensing interact with firm-level investment, employment and trade, including the development of international supply chains, requires a closer data connection that bridges international differences of definition.

B. Linked National Surveys

Most industrialized countries, and some emerging economies, undertake a periodic innovation survey of domestic firms and the local operations of international companies. Such surveys describe in summary form how firms invest in R&D, employ technical inputs, register patents and trademarks, and develop new products and services. These are not readily comparable across countries, a situation that could be improved with more standardization. Moreover, they are generally not undertaken in many developing countries, making even a rudimentary understanding of innovation in those markets difficult to achieve. Resolving each of these shortcomings could do much to expand our analytical scope.

A greater need, however, is for such national surveys to be more closely tied to parallel instruments asking about competition conditions, financial markets and pricing. For example, it is not generally possible with available data to relate the shrinkage or closure of domestic firms to patent ownership and assertion by international firms after a country

[40] Lybbert and Zolas (2014) outline a complex mapping between the IPC and the Standard International Trade Classification based on probabilistic matching, but it is difficult to implement. T.J. Lybbert and J.N. Zolas, 'Getting Patents and Economic Data to Speak to Each Other: An "Algorithmic Links with Probabilities Approach" for Joint Analysis of Patenting and Economic Activity', 43 *Research Policy* (2014), 530–542.

reforms its IPRs regime. In this context, our understanding of the technology-diffusion effects of patent reforms is one-sided in that it considers only market transactions among surviving firms. It may be that the net amount of technology learning is diminished by patenting due to increases in imitation costs or exit of infringing firms. This, again, is a first-order question in development economics, about which we have no systematic evidence.

Similarly, without linked competition, innovation and pricing surveys in pharmaceuticals it is so far impossible to state with confidence how new patent laws are affecting the survival of generic firms and the prices faced by public-health procurement agencies and patients. Neither is it possible to explain the reasons why price impacts may be weak or strong.[41] Another example would carefully link patent grants to subsequent investment financing decisions to discover the interconnections between technology and financial markets. In a related vein, international firms engage heavily in 'transfer pricing' of intangible assets, such as patents and brand values, in order to minimize global tax liabilities. Carefully studying the interaction between tax policies, intellectual property rights and FDI location decisions across countries and over time would greatly help our understanding of the full effects of legal reforms.

C. Quasi-exogenous Policy Experiments

While such data linkages would be of great help, the most rigorous means of establishing causality is to study episodes in which a policy was changed independently of the interests of affected actors and assign those actors to random samples of treatment and control groups. Thus, for example, to establish the importance of water quality for health one might study an intervention in which one city introduced a cleaner water supply and the other did not, looking for long-term impacts on health status. In the patents area a natural split of firms or products would be into those that are sensitive to patent protection and those that are not, assuming one can satisfactorily define sensitivity.

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[41] To illustrate, Duggan et al. closely analyze detailed medicine prices in India after the 2005 patent law, finding relatively little impact. However, they are at a loss to explain whether this is due to surviving competition, price controls or other factors, meaning that the results cannot readily be extended to other countries; see M. Duggan, C. Garthwaite and G. Aparajita, 'The Market Impacts of Pharmaceutical Product Patents in Developing Countries: Evidence from India', 106 *American Economic Review* (2016), 99–135.

One obvious difficulty is that a reform of patent laws may not be entirely exogenous to the preferences of firms, who may have lobbied for the change in the first place. A second is that such a change is a national policy applying to all sectors, even if some are more patent-intensive than others. Consequently, it is difficult to identify reform effects from other contemporaneous national or international macroeconomic factors. To date, economists have only loosely addressed these issues. First, some have argued that TRIPS was imposed exogenously on developing countries, which would not otherwise have adopted its patent standards.[42] This view is reasonable but can only be partially accurate given the presence of international firms, supply chains, and domestic high-technology companies in most countries. Second, economists have used measured patent intensities of firms or industries as a quasi-control group, arguing informally that they should be the most affected.

This approach is dissatisfying and should be replaced, where possible, with detailed analysis of specific and exogenous policy changes. For example, no one has yet studied the innovation or trade effects of particular patent standards, such as eligibility, examination lags, citation requirements, opposition procedures or compulsory licensing, which vary widely across countries and likely are exogenous to international firms. Neither has anyone taken advantage of significant judicial decisions about patent scope set down across countries, which may be considered exogenous outside the identity of the litigants themselves.[43] It might be possible, for example, to correlate judicial or administrative decisions about patent scope across districts within major developing economies to trace the impacts on patenting and competition.

One exceptional example of such analysis using trademark enforcement was produced by Qian (2008).[44] She collected original data from Chinese footwear producers from 1993 to 2004, a period in which provincial government enforcement efforts were reduced due to an

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[42] O. Ivus, 'Do Stronger Patent Rights Raise High-Tech Exports to the Developing World?', 81 *Journal of International Economics* (2010), 38–47; M. Delgado, M. Kyle and A. McGahan, 'Intellectual Property Protection and the Geography of Trade', 61 *Journal of Industrial Economics* (2013), 733–762.

[43] This was the approach taken by Hall and Ziedonis (2001) in a successful study of innovation in the US software industry after programs were rendered patentable. B.H. Hall and R.H. Ziedonis, 'The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979–95', 32 *RAND Journal of Economics* (2001), 101–128.

[44] Y. Qian, 'Impacts of Entry by Counterfeiters', 123 *Quarterly Journal of Economics* (2008), 1577–1609.

exogenous shift of resources to combating toxic food scares. Through stratified random sampling she identified and measured the effects of increased competition from counterfeiters on the prices, qualities and other market outcomes of authentic footwear. Qian found that brands receiving diminished enforcement protection differentiated their products by investing in higher quality. They also engaged in more self-enforcement by linking with licensed retailers to control their sales and setting higher prices to signal legitimacy in the marketplace. Thus, in this particular instance, reduced IPRs protection induced more defensive innovation. Many more studies of this kind, using other episodes of shocks in enforcement or infringement, would be valuable in tracing the contours of patent protection in economic development.

D. Panel Surveys

Such investigations would be highly useful but are naturally limited by the scarcity of specific and exogenous policy events. Moreover, they are not likely to get at many of the key development questions mentioned above. Thus, a final, and most fundamental, approach would be for researchers, international organizations and foundations to undertake systematic surveys over a sufficiently long time period of relevant actors, randomly selected, that are affected by patent laws. Such actors could include, among others, high-technology firms, suppliers, hospitals, farmers and universities. If constructed well and applied consistently, surveys could offer direct quantitative information about how agents respond to patent reforms, taken in the context of different competitive markets, trade orientation, pricing regimes, and other relevant factors. They could even shed light on the nature of product innovation in the poorest countries, a process about which there is little codified knowledge.

V. CONCLUDING REMARKS

Despite their best efforts, trade and innovation economists have achieved relatively little in producing confident and significant results about the economic effects of the globalization of patent rights. This is unfortunate but largely understandable given the absence of clear and consistent data about development issues deeper than sectoral trade and FDI.

The research agenda outlined here is ambitious and expensive, but necessary to pursue if we are to say much about the fundamental roles of patents in development and how those roles vary across countries, time periods and general socioeconomic contexts. Serious understanding of

these processes has escaped identification for centuries. The major policy reforms outlined above, along with the potential for collecting and linking large data sets and applying frontier techniques to them, offers real scope for finally resolving some of these issues. If economists are serious about this question, and scholars in other fields wish to benefit from more systematic evidence rather than speculation and anecdotes, we must get on with it.