1

The International Intellectual Property System from an Economist's Perspective

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ABSTRACT

The globalized system of protection for intellectual property rights continues to evolve, from the TRIPS Agreement and WIPO treaties to modern regulation-based preferential trade agreements. All these mechanisms require substantive strengthening of intellectual property (IP) rights, particularly in emerging and developing countries. This chapter surveys evidence on how these policy reforms have affected key economic variables, ranging from early studies of growth, research and development, and innovation to new research on trade, foreign investment, and production and knowledge networks. The evidence regarding growth and innovation does not paint a clear picture, largely due to difficulties in measurement and estimation. Considerably more research, especially at the microeconomic levels, is needed to understand the channels through which innovation is encouraged or discouraged. Recent work on how detailed trade flows and firms react to rigorous and globalized protection has unearthed numerous subtleties in the microeconomics of IP, trade, and technology transfer. This research is becoming highly granular. For example, the status of patent rules in importing countries affects the decisions of foreign firms to patent and export to those locations. Another point is that preferential trade agreements with "TRIPS-Plus" IP standards tend to expand the export of detailed, patent-sensitive goods to external countries. Patent laws also influence the development of global innovation networks.

TABLE OF CONTENTS

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A. INTRODUCTION

The modern international intellectual property (IP) system has been under continuous construction since the inception, in 1995, of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) at the World Trade Organization (WTO). As one of the foundational accords establishing the WTO, TRIPS requires all member countries to meet its minimum IP standards, which are considerably more comprehensive and prescriptive than those involved in prior international agreements. TRIPS obligations are enforceable under the WTO system of settling disputes. In essence, the agreement set a policy benchmark that greatly internationalized the protection of IP rights (IPRs) as its requirements were implemented over the succeeding years.[1]

Twenty-seven years later, the IP system has achieved even greater globalization through additional norm-setting in treaties of the World Intellectual Property Organization (WIPO); bilateral investment treaties among nations; and – especially – the many bilateral, regional, and "mega-regional" preferential trade agreements (PTAs) that feature elevated "TRIPS-Plus" protective standards. Prominent among the last category are the recently renegotiated North American Free Trade Agreement, the Comprehensive and Progressive Agreement for Trans-Pacific

[1] For extensive descriptions and analysis, see, among many treatments, Deere (2008), UNCTAD (2005), WIPO (2004), and Maskus (2012).

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Partnership, and the Comprehensive Economic and Trade Agreement between the European Union and Canada. Together, such initiatives have considerably extended the scope of international IP protection, both in terms of coverage and substantive standards as well as with regard to enforcement requirements. They have also established a complex system of rules that are simultaneously overlapping and potentially fragmented across countries. Broadly put, the majority of poor countries are bound minimally by TRIPS, with which they sometimes struggle to comply, but remain outside the elevated system constructed via PTAs among developed and key emerging countries.

Policy reforms on this vast scale must inevitably have important economic impacts, and searching for those impacts through extensive data analysis has become a large sub-specialization within economics. Research in this area is challenging for several reasons.

First, IPRs – including patents, copyrights, trademarks, trade secrets, and numerous variations on those themes – are themselves complex policy interventions that may generate cross-cutting incentive and disincentive effects. Their purpose is to address information problems and market failures that operate both statically and dynamically. In this inherently distorted environment, policies that may enhance innovation in one set of socioeconomic circumstances can diminish competition in another. Consequently, even the manner in which a research question is framed depends on specific national and temporal conditions.

Second, IPRs are (usually) national regulations facing all forms of economic activities and sectors, unlike product-specific or sectoral taxes, subsidies, and tariffs. Cutting specific taxes directly reduces costs and would almost inevitably expand the taxed activity – such as output, trade, and investment. In contrast, increased patent scope or copyright duration has differential effects across countries and industries, with those effects being highly dependent on local conditions such as the endowments of skills, depth of financial markets, and efficacy of the judicial system. In that context, it is challenging to make theory-based accurate predictions about how national, let alone global, IP reforms may affect measurable economic activity.

Third, data limitations are endemic in this area, particularly across countries at different levels of economic development. For example, we would like to know how IP reforms affect innovation incentives and outcomes. Patent statistics offer an obvious outcome measure, but simply counting patent applications or grants fails to recognize their considerable heterogeneity, while much innovation in poor countries is not patented. Investments in research and development (R&D) are the corresponding input measure, but such data rarely exist beyond the developed and key emerging economies. Moreover, innovation should be measured at the microeconomic or firm level, and such datasets remain scarce, although they are gradually increasing in scope and availability. Little wonder, then, that much of the empirical research on incentive effects has centered on international trade, for

which data are comprehensive and reasonably consistent internationally. But even that solution runs into its own research problems, such as the technical difficulty of detecting microeconomic impacts from national reforms that happen sporadically. Beyond that, the data limitations become severe: how do we consistently and appropriately measure competition, prices, and markups, as well as entry and exit across countries?

Most challenging, however, is the essential difficulty of assigning causality from IP reforms to, first, these microeconomic factors and, second, macroeconomic concepts such as economic growth, sectoral reallocation, and inequality. All of these are critical issues about which we have little solid information and need more research. The primary reason causality is so difficult to detect is that there are many complex confounding factors that must be accounted for, not least the fact that IP policy may be endogenous to those changes. It is evident that IP policy exists and evolves in a milieu of other conditions that affect technological and cultural change and which is itself often path-dependent.[2]

Despite these problems, economists have made progress in studying particular questions and improving our understanding of how the evolving IP system influences economic outcomes, particularly at the microeconomic and sectoral levels. Research also has shed light on the ways in which such effects are conditional upon other economic factors. This chapter is a progress report on this research, with an emphasis on the most recent and current studies in international trade, investment, and strategic IP use. The international focus reflects my comparative advantage in studying trade, foreign investment, and technology transfer, the areas of my own inquiry. In fact, however, these areas have attracted the most research attention by empirical economists largely because of the relatively thick data sets and the likelihood that IP will leave detectable traces in trade flows. For completeness, I supplement the review with comments on important recent findings in the areas of innovation and pricing. The final portion of the chapter sets out useful directions in which this research agenda should move.

Readers may wonder about the suitability of a chapter that reviews economic analyses of the effects of IP reforms and related policies in a volume centered on the theme of public international law of IPR. One reason for this inclusion is that legal scholars in this area sometimes make strong claims based largely on intuition or common sense, without reference to available evidence. It is important, therefore, to bring to the attention of those scholars the many complex factors that matter for the economic outcomes of international IP reforms. A second reason is to alert policymakers to the impacts, both wanted and unwanted, of changing the global IP system. Sometimes the consequences are as intended, but often they are not; furthermore, indirect effects can be dominant. The studies analyzed here should

[2] See Odagiri et al. (2010).

therefore inform future deliberations about IP regulation and international IP treaties.

B. COMMENTS ON IP REFORMS, INNOVATION, AND ECONOMIC GROWTH

Implicit in the discussion above is the idea that it is next to impossible to make credible claims that global IP reforms in the post-TRIPS era have materially affected international investments in R&D, invention, or literary and artistic creativity. The investment variables, if measured (poorly) at the national or broad sectoral levels, are macroeconomic; they vary primarily with the business cycle, expectations, taxes and subsidies, education, competition, and a host of other socioeconomic conditions. For example, real business expenditure on R&D among OECD countries showed no clear upward trend break after TRIPS implementation and only recently returned to shares of gross domestic product (GDP) that existed prior to the 2009–2010 financial crisis.[3] Neither can strong assertions about effects on aggregate economic growth be supported by rigorous empirical research in the presence of compounding factors across countries. Moreover, IP standards and enforcement, even in this time of effective harmonization, remain sufficiently endogenous to economic conditions that identifying aggregate causal effects is challenging. The protection of IP is a regulatory incentive that is presumably important in some contexts. However, finding its traces in aggregate data has not been achieved satisfactorily, in my view.

I. *Growth Regressions*

Despite these limitations, it is worth reviewing a few recent studies in order to highlight some conclusions that are intriguing and could support further debate and research. Consider first how patent laws interact with real GDP growth. Falvey et al. (2006) studied this question using a panel of eighty countries over discrete five-year periods between 1975 and 1994, the pre-TRIPS period. The authors noted the standard arguments that the innovation gains from stronger patent rights – in terms of both new products and technology diffusion – could be offset by higher imitation costs and reduced static competition. These impacts should vary among countries at different levels of economic development and technological capabilities. The authors estimated a standard growth equation in which average real growth in GDP per capita, for each country and within each period, was regressed on several variables: initial GDP per capita, gross domestic investment, population growth, degree of secondary education in the economy, ratio of exports to GDP, average inflation rates, a measure of IP protection, and country- and time-specific fixed

[3] See WIPO (2019).

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effects. The IP variable was the widely used Ginarte–Park (GP) index, which essentially counts the number of patent provisions in each country's national laws (Ginarte and Park, 1997).

In their basic estimation, Falvey et al. (2006) found no impact of IP protection on economic growth, which is unsurprising in light of the problems discussed above. Instead, they argued that if there were such a relationship, it would likely depend on threshold effects in how IP protection interacts with initial GDP per capita. In fact, they found evidence of two thresholds. In countries with real per-capita incomes below $671 (in 2005 prices) and those with incomes above $10,289, a rise in patent rights significantly increased GDP per capita across the time periods. Countries in the middle-income ranges experienced no effect, positive or negative. It should be noted that the estimated effects, while significant, were economically small. The authors interpreted their findings to mean that poor countries can achieve income growth through the ability of IPRs to attract foreign investment and new products from abroad, whereas rich countries gain from increased technological innovation. In contrast, the middle economies see any inward diffusion benefits offset by lower domestic imitation and competition.[4]

While these results are intriguing, as is the absence of any negative effect of IP on growth, the study exemplifies the econometric difficulties in aggregate growth estimation. No attempt was made to control for endogenous changes in the GP index, while simple fixed effects were insufficient to control for other factors that could drive these results. In short, the paper does not reliably demonstrate a causal effect. Moreover, the approach sheds no light on what precise economic mechanisms could drive the varying growth impacts, if in fact they exist.[5]

Hu and Png (2013) offered a better design by studying panels of about fifty manufacturing industries across about seventy countries, in five-year periods from 1981 to 2000, thereby bringing in a disaggregated sectoral focus and a period overlapping the early TRIPS era. Their basic specification regressed the growth in real value added at the sector–country level on several variables: initial value added, an interaction between sectoral patent intensity and national patent rights, and country and industry fixed effects. Their measure of "effective patent rights" was the product of the GP index and a national measure of contract enforcement, the Fraser Institute's index of legal systems and property rights. The logic is that GP fails to incorporate IP enforcement and interacting it with the Fraser index – assuming it applies *mutatis mutandis* to patents – should better capture the effective scope of

[4] This finding is reminiscent of the U-shaped relationship between GDP per capita and patent rights first noted in Maskus and Penubarti (1995).

[5] See also Gold et al. (2019), in which economic growth was regressed on an extended index of IP protection. In the authors' basic specification the relationship was positive and significant, but they found additional results that seem inconsistent with an IP–growth connection. For example, they found limited evidence of increased usage of IP rights after reforms, which raises questions about how policy changes actually flow through to growth.

protection. Industry-level measures of patent intensity were taken from US data and assumed to be constant across countries. The variable of interest was the interaction term: it should be that manufacturing industries with higher patent intensity grow faster than other industries in countries with strong patent rights.[6]

This expectation was born out in the study. The coefficient of the interaction variable was positive for all periods but statistically significant only for 1991–1995 and 1996–2000. Moreover, the size of this coefficient grew over time, offering some suggestion that in the TRIPS era, we may be seeing stronger manufacturing growth effects. Using 1990 figures, Hu and Png (2013) computed that a one-standard-deviation increase in effective patent rights (roughly, the difference between the regimes in Turkey and Singapore) would raise value-added growth by 0.75 percentage points, a large effect in the context of an average growth rate of around three percentage points. This effect was strongest for the most economically advanced countries. The results withstood a battery of robustness tests.

The study is noteworthy largely for its focus on detailed industries and the finding that if patent rights matter for output growth, that is true mainly for high-patent sectors and developed economies. However, the paper can be criticized for not dealing adequately with endogeneity, and it does not permit inferences about overall economic growth effects beyond manufacturing.

A more nuanced approach was taken by Kim et al. (2012). They studied the thorny question of whether different forms of technology protection, specifically invention patents versus utility models, have different effects on innovation and economic growth in developed and developing economies. For this purpose, they specified a "knowledge production function" in which the stock of knowledge (cumulated ideas) depends on the number of patents registered at the US Patent and Trademark Office (USPTO), which in turn depends on legal rights to protect the patents. The production function was specified as a growth equation, in which increases in per-capita income in each nation depend on lagged knowledge and IP applications, along with physical and human capital stocks, population growth, and fixed effects. This function was estimated together with an equation for patenting – itself a function of lagged patents, R&D spending, and a productivity term. The latter equation was augmented by a dummy variable indicating which countries had a utility model law in place, which enabled investigating whether the existence of such laws spurred patenting; that is, whether protecting utility models encouraged patentable invention. The authors demonstrated that the existence of a utility model regime was due primarily to each country's colonial origins rather than current economic factors that would generate sample selection bias, so that inclusion of the binary

[6] This is an example of the approach pioneered by Rajan and Zingales (1998) in their study of financial markets and growth. It is now widely used in international studies of innovation, contract enforcement, and related elements.

variable would not suffer from endogeneity problems. This careful relation between theory and estimation marks the study by Kim et al. (2012) as particularly credible.

Using their preferred estimation approach, the authors found evidence for the idea that different forms of patent rights are "appropriate" for varying development levels. First, the strength of patent rights (the GP index) had a positive and significant effect on patenting, but only for developed high-income (HI) countries. It had no evident effect on USPTO patent applications from lower-income and middle-income economies. Second, the coefficient for the existence of a utility model law increased future USPTO patent applications, but only in middle-income and lower-income economies. The effect in HI countries was negative but insignificant. In brief, protection of utility models can be an important determinant of the flow of internationally patentable inventions, a novel finding in the literature.

The next question is whether patenting activity raised the per-capita economic growth. Again, Kim et al. (2012) found that the propensity to patent in the USPTO positively affected per-capita growth, but only for HI countries. There was no effect in low-income and middle-income nations. The authors argued that this result reflected the relatively high costs of technology inputs in these countries from increased patenting, which offsets any growth benefit from stronger protection. In contrast, the existence of utility model laws had a positive and significant relationship with economic growth rates in these locations. Thus, policies protecting incremental innovations seem to correlate positively with economic growth in lagging economies. While many observers have argued for this form of tailoring IP policies to suit development needs, this study was the first credible demonstration of the empirical effects on invention and, perhaps, on growth rates.

II. *Innovation*

If stronger patent rights correlate with economic growth, presumably it is because they encourage innovation and technology diffusion. It remains difficult to find such causal links empirically, for reasons discussed above. Again, however, it is useful to review selected recent studies to elicit certain conclusions that seem robust.[7]

Branstetter et al. (2006) analyzed the responses of affiliates of US multinational enterprises (MNEs) to major reforms of patent laws in sixteen countries, most of them developing or emerging, between 1982 and 1999. Their event analysis considered 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 showed no impact on domestic applications. However, the reforms had a

[7] For a review of earlier econometric studies, see Maskus (2012). There is also important evidence, albeit inconclusive and context-specific, from careful studies of historical innovation episodes, as discussed in Moser (2013).

significant and positive impact on foreign patent applications, both in the short and long run, raising non-resident filings in the average nation by more than 50 percent. These findings reinforced the conventional wisdom, analyzed further in Lerner (2009), that multinational firms are more responsive to increases in patent rights in developing countries than are domestic firms. This point is unsurprising, particularly when one considers that the greatest short-term beneficiaries of domestic patent strengthening are likely to be global firms seeking to deploy their technologies locally.

In an important contribution, Qian (2007) analyzed twenty-six countries that, between 1978 and 2002, implemented laws establishing patent protection for pharmaceutical products; the study examined how that move influenced innovation in the industry. Her primary innovation measure was citation-weighted drug patent applications registered in the USPTO, and the analysis compared matched country pairs that differed in whether they adopted reforms. Various national and industry control variables were included in the regressions. Qian found no significant direct impacts of legal changes on US drug patent applications, even up to ten years later. However, there were important interaction effects: countries with higher educational attainment and per-capita income as well as greater measured market freedom significantly increased such applications post-IP reforms. Qian's results suggest that the innovation impact of IPRs depends heavily on complementary socioeconomic factors. Low-income economies with limited educational attainment and technical skills as well as restricted markets are less likely to motivate more internationally protectable inventions simply by improving their IP regimes. This result is likely relevant to other patent-sensitive sectors as well, but to my knowledge, this question has not yet been studied.

Kyle and McGahan (2012) studied global pharmaceutical innovation in the periods just before and after TRIPS was negotiated. That this new regime would expand innovation incentives, especially in treatments for diseases endemic to poor countries, was a key promise by TRIPS advocates. The authors exploited the fact that TRIPS compliance occurred at different times and across countries with different relative disease burdens. This diversity enabled them to study how global disease-specific R&D investments (measured as Phase I clinical trials) were changed after TRIPS, controlling for the global market in each medicine. They distinguished global diseases (experienced in most countries) from neglected diseases (also experienced in most countries, but of greatest interest in poor regions). In this difference-in-difference (DID) setup, the authors found increases in clinical trials for drugs aimed at both types of disease after TRIPS compliance, but significantly more for drugs aimed at global diseases. They next broke down these impacts into country groups classified by income levels. Here they found no indications of an increase in clinical trials for drugs aimed at neglected diseases after TRIPS compliance was achieved within developing countries. Rather, there were significant increases in R&D spending on illnesses with a large presence in HI countries. Such findings

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reinforce the fact that pharmaceutical companies are profit-seeking entities and that stronger global patent regimes are unlikely to induce more private spending on drugs that offer limited market potential.[8]

Two final papers are of interest, in that they demonstrate the reliance of innovation effects of IPRs on other factors. Aghion et al. (2015) investigated whether the innovation responses of firms to competition-raising product market reforms in the European Union varied according to the strength of national patent rights. They presented a model in which competition enhancements are complementary to patent strength in driving innovation, particularly in industries that are patent-intensive. The product market reform they analyzed was the formulation in 1992 of the Single Market Program, which worked over several years to remove regulatory barriers to trade across the European Union. This initiative resulted in considerable increases in product market integration and competition in the years before national patent laws became harmonized. The authors studied innovation responses in two groups of countries, those with stronger patent rights and those with weaker rights, in the period 1987 to 2003.

At first blush, the idea of complementarity in patents and product competition seems odd. Patents limit static competition in order to generate temporary monopoly rents, leading – in theory – to faster and deeper dynamic competition. Product competition, in contrast, should reduce market rents statically, potentially diminishing innovation incentives. However, the model of similar firms showed that a company could escape the competition through successful innovation, an incentive enhanced by patent protection. Aghion et al. (2015) were the first researchers to identify that complementarity empirically. They regressed measures of innovation (such as R&D over value added, and patents granted at the USPTO) on a product–reform variable, which was zero before 1992 and between zero and one post-1992, with the value depending on how much each industry was expected to be affected by reforms. This variable was interacted with a dummy variable over the two country groups, indicating strong and weak patents. Also included were control variables and country-year and industry-year fixed effects.

Their data included a panel of two-digit manufacturing industries, characterized as more or less patent-reliant on the basis of US data. In this DID setup, the findings showed that product market reforms did not directly raise R&D intensities, but the interaction of such reforms with patent rights was significant and positive in industries with high or medium patent relevance and located in countries with strong patent rights. However, in countries with weaker patent rights, there were no R&D

[8] See also Bhattacharya et al. (2020), who found significant increases in pharmaceutical R&D among Indian firms after implementation of the 2002 Patent Amendments Act, which implemented TRIPS standards. There was little indication of a shift in investment resources toward neglected diseases.

impacts in either patent-relevant or other industries. These results also held true when the dependent variable was USPTO patent grants.

The paper has empirical weaknesses, particularly concerning its measures of patent strength and its limited disaggregation of industries. But it does suggest that incentives to invest in innovation are spurred by product market competition in countries with strong patent regimes. One lesson is that as developing nations strengthen their IP regimes in the hope of encouraging technological activity, they should also consider relaxing their barriers to domestic competition.

A final point to recognize is that the scope of patent rights may have differential impacts on R&D, depending on the availability and structure of financial resources to fund R&D. Maskus et al. (2019) set out a straightforward theoretical model in which costly R&D must be financed through external channels. Further, the outcome of R&D is uncertain, and investments are therefore vulnerable to shirking in a principal–agent relationship. Hence, firms could – for example – borrow in the domestic bond market, which is an arm's-length relationship and involves little or no monitoring by creditors (the principals) of research managers at the inventor firms (the agents). Such investments are liable to carry a risk premium and to be relatively costly. Alternatively, R&D investments could be financed through bank loans and issuing equity, both of which offer greater scope for the lenders or investors to oversee the innovator's efforts. A third possibility is that domestic innovators could arrange financing through inward foreign direct investment (FDI), becoming affiliated with international firms as a source of funding. The authors argued that patent protection can offset some of the R&D disincentives arising from limited financial development, for several reasons. Primarily, poorly developed financial systems are inefficient at allocating resources to promising investment projects with uncertain returns, particularly where intangible assets (e.g., the potential for future profits garnered through patents) cannot be collateralized. Put briefly, patents permit potential innovators to reveal more details about the nature of their R&D programs to lenders. All this suggests that the responsiveness of R&D to IP protection should be stronger in countries with limited financial development in general and with deficient equity and bank-lending markets in particular.

These questions were studied using panel data on R&D intensity in twenty-two industries across twenty OECD countries from 1990 to 2009. To implement their DID approach, Maskus et al. (2019) noted that two industry characteristics could be used to identify the interrelationships between financial development and IPRs. First, industries differ considerably in the intensity with which they register patents. Second, they vary in their dependence on external sources of finance as opposed to internal sources (retained earnings). Controlling for these two elements, the authors hypothesized that industries with higher patent intensity should be more responsive to patent protection, as in the conventional wisdom. In addition, this sensitivity should be higher in countries with limited lending and ownership markets (bank financing and equity). In contrast, the elasticity of R&D to patent strength should be

higher in countries with highly developed bond markets, where enforceable patents effectively reduce the monitoring costs.

These hypotheses were clearly born out in the econometric model, in which private business enterprise R&D intensity, by industry, was regressed on multiple variables: country-level measures of financial development; patent enforcement (the product of GP and the Fraser Index); interaction terms between the variables of interest; industry patent intensity; external financial dependence; asset tangibility; and country, industry, and year fixed effects. The results showed that the patent index itself had little effect on R&D shares. However, there was a significant and positive coefficient for the interaction between patent intensity and IP protection in countries with below-median private credit and below-median stock market capitalization (both relative to GDP). In contrast, this interaction was significant and positive for countries with above-median private bond market size. Interestingly, the same interaction was highly significant and positive for all countries when financial development was measured as the stock of inward FDI.

The authors interpreted these results to mean that patent protection effectively substitutes for inadequate direct monitoring possibilities (that is, where bank lending and stock markets are weak) and expands the access of inventors to bond financing in relatively developed economies. Most powerfully, increased availability of foreign finance through FDI works together with patents to increase local R&D incentives, at least within these OECD economies. This last result is important for it sheds light on the common finding that FDI reacts positively to patent reforms among middle-income and emerging economies.[9]

III. *Summary*

Before proceeding, it is worth taking stock of the messages the recent research seems to be offering. In my view these conclusions remain tentative and in need of further validation but do offer food for thought.

First, economic growth may be positively influenced by a strong patent scope, but this conclusion must be heavily qualified. Aggregate national-level growth regressions remain highly suspect for their inability to establish causality. In particular, the mechanisms for such a relationship remain understudied. Moreover, such growth impacts seem conditional in that they may exist for upper-income emerging countries and developed countries with threshold levels of education, market competition, adequate governance, and other factors. To date, there is virtually no evidence of a growth effect – positive or negative – from IP protection in poor developing economies.

Second, studies done with industry- or enterprise-level data are considerably more informative than those aggregate data. It remains technically challenging to find

[9] See Maskus (2012) for a review.

such data, especially for the enterprise level, and to devise appropriate hypotheses and testing techniques. However, the findings of various DID approaches support the view that R&D and patenting within high-technology goods are sensitive to domestic patent rights at the microeconomic level – again when attention is limited to HI and emerging countries.

Third, types of knowledge protection, such as patents versus utility models, may matter differentially for innovation as economic development proceeds, at least beyond certain thresholds. There is empirical merit in thinking of such devices as "appropriate" or "inappropriate" IP protection.

Fourth, the ability of strong patent rights to encourage innovative activity depends on other economic factors, such as product market competition and financial development. There is a long list of such factors, including simple trade liberalization, that could alter this elasticity, which itself would vary across industries and countries. This possibility calls for more research that combines micro data with measurable policy and economic variables through models that identify such interactions. This remains a large research agenda.

Fifth, readers who pay attention to the details of this review will have seen that little of the extant research, even in recent papers, directly asks whether innovation incentives have changed in the post-TRIPS era. There are hints that they might have, again heavily conditioned by additional factors. But additional research aimed at this question is sorely needed.

Finally, there are other important research questions that have yet to be asked. I will mention just two of many. We have yet to introduce meaningfully other elements of IP protection – such as copyrights, trademarks, and trade secrets – into consistent innovation analysis. This task will necessarily be more difficult, both for reasons of limited data and conceptual ambiguities, but it should be undertaken. And economists have not yet studied systematically what has happened to competition processes in emerging and developing countries after the implementation of patent reforms. Do domestic firms leave the market, and to what extent? Are they more likely to become acquired by foreign enterprises, particularly in high-technology sectors? On what other factors do such decisions depend?

C. NEW RESEARCH IN IP PROTECTION AND INTERNATIONAL TRADE

It is fair to say that international trade economists have devoted considerable effort to understanding how IP reforms in the post-TRIPS era may be influencing international trade, FDI, and licensing, all forms of both purposeful technology transfer and learning spillovers. In some ways this focus is natural, because, for all the difficulty in isolating the innovation effects of patents, it is straightforward to argue that IPRs should encourage technology transactions across borders. After all, patents encourage innovation only indirectly by safeguarding the rights of rights holders to use, sell, and license their technologies and new products. Thus, incentive or

disincentive effects of IP reforms should be most easily detectable in international technology flows. It also helps that trade data are easily available, highly detailed, and consistently organized across countries. Finally, increases in trade and investment may, in many circumstances, be interpreted as a major form of innovation.

The role of IPRs in international trade, FDI, and licensing is the subject of many empirical studies, dating back to Maskus and Penubarti (1995). Doing justice to that literature would take up far too much space in this chapter and there are numerous published reviews available.[10] In this section, I wish to highlight important new results that extend international trade research in novel directions and expand our framework for thinking about global IP. For completeness, however, I briefly summarize what might be called a consensus position among trade specialists from earlier research, including a major reference or two for each result. In much simplified form, that consensus would involve the following claims, among others.

First, significant patent reforms, including those associated with TRIPS, increase flows of high-technology exports and FDI to emerging countries that possess an existing base of human capital and some R&D capacity (Ivus, 2010). Second, these increases include positive investments in new technological activities by local affiliates of MNEs in high-technology sectors, including R&D, licensing, new product development, exports, and employment. There is also evidence of positive spillover effects for local firms (Branstetter et al., 2011). Third, MNEs are a source of considerable knowledge spillovers for upstream suppliers, and the extent of those spillovers is positively affected by IP protection (Javorcik, 2004). Fourth, international licensing responds positively to both affiliated and unaffiliated local firms, but particularly the latter (Yang and Maskus, 2001; Nagaoka, 2009). Finally, these impacts generally do not carry through to the poor developing countries. I turn next to seven important new areas of research linking IP protection to trade in crucial ways.

I. *TRIPS, PTAs, and IP Reforms Increase High-Technology Exports in High-Income and Middle-Income Countries*

It is intuitive that the strong IP standards imposed by TRIPS would increase high-technology exports from advanced economies to emerging and developing countries. Less expected is the robust finding in recent papers that the standards also are pro-export in emerging nations with at least moderate technological capacity. This was first noted by Delgado et al. (2013), who estimated the determinants of both imports and exports across countries in a DID framework. Specifically, they regressed sectoral imports or exports across countries on a dummy variable for the years following TRIPS compliance, along with interactions of that variable with indicators for high-IP goods and three-way interactions (also involving dummies) for

[10] See Park (2008), Maskus (2012), and the update in Maskus (2019).

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HI countries and for developing countries. Traded goods in manufacturing were allocated to either IP-sensitive sectors (the treatment group) or sectors that are not sensitive to IP use (the control group) for 158 countries over the period 1993–2009. The definition of high-IP goods varied across specifications, including high-IP clusters such as biopharmaceutical products, medical devices, and information-communication technologies.

The initial regressions showed that in the years after TRIPS implementation, there were large increases in high-IP exports, and this finding held true for both HI countries and developing countries (DCs). Moreover, the coefficients grew in magnitude as the years elapsed, suggesting both a significant and a time-distributed effect. Total imports of high-IP goods were also sensitive to TRIPS, but with lower coefficients. Interestingly, exports of nearly all the high-IP clusters were highly elastic to TRIPS in both the HI and DC groups. The DC imports remained relatively insensitive to this breakdown, although there were significant effects on imports from innovative countries in chemicals and information technologies. In brief, the findings suggest that TRIPS is strongly expanding the export of high-technology goods (relative to low-technology goods) from both HI and DC markets.

Maskus and Ridley (2020) extended this analysis to the trade impacts of PTAs that embody elevated TRIPS-Plus standards at the request of either the United States or the EU – the major *demandeurs* of highly protective IP standards. The researchers labeled such accords "IP-related trade agreements" (IPAs), and these have proliferated greatly in the last twenty years. Their econometric specification departed from that in Delgado et al. (2013) by, first, including both IPAs and TRIPS in the interactions; and second, setting up the control group as low-IP goods in countries that do not join an IPA, and the treatment group as high-IP goods in countries that do. Moreover, they estimated a version of the gravity trade model using highly detailed bilateral trade statistics, accounting for IPA membership of both exporters and importers. Trade flows to the major partner country were excluded in order to avoid that source of endogeneity in agreement formation. Country groups were broken down into low-income (LI), lower-middle income, upper-middle income, and HI. There were 187 countries included over the period 1995–2014, covering much of the post-TRIPS era.

Among many results in the paper, two are most novel. First, both TRIPS and IPAs have significant impacts on bilateral trade, but often these effects are more pronounced for IPAs. Both policy interventions significantly raise exports of most high-IP clusters from all country groups except LI. The effects on bilateral imports are generally insignificant, except in biopharmaceuticals and medical devices, where imports are stimulated by IPAs that involve developing and emerging countries. Second, there is a marked "comparative advantage" effect, in that IPAs tend to reduce exports of low-IP goods and raise exports of high-IP goods – at least relative to the control group of other countries.

These studies are interesting in shedding light on how trade patterns may evolve in the wake of major international IP agreements. However, they leave unanswered some fundamental questions that require considerably more research. For example, what are the channels through which trade agreements may (relatively) expand exports of high-IP products? The results in Maskus and Ridley (2020) suggest that IPAs may encourage multinational firms to increase production and exports from local affiliates, but that is only a surmise. How do local firms become competent exporters within such agreements? Does this happen because they acquire and adapt new technologies and products of higher quality? Is the export expansion the result of greater entry into exports by firms that had not been exporting?

Such questions occupy the authors of two other studies that I highlight here. Maskus and Yang (2018) estimated models, based on trade theory, of how exports of patent-intensive goods respond to national effective patent rights rather than membership in TRIPS or IPAs. The authors used trade data concorded to the standard industrial classification across 102 countries in five-year increments over the period 1995–2010, along with several industry characteristics interacted with country factor endowments and policy measures. The results showed that exports of patent-intensive goods were significantly higher in countries with stronger domestic patent rights, with some evidence of higher coefficients over time. Interestingly, the export effects in developing and emerging countries were also positive, although significantly lower than those for developed nations. In their final specification, they included additional interactions with three variables commonly thought to embody technology transfer: the inward stock of non-resident applications by technology class, within-firm imports of intermediate inputs from the United States (aggregated to industries), and industry employment in affiliates of US MNEs. All three variables increased the elasticity of exports with respect to patent rights in patent-intensive sectors. This finding suggests that all the examined variables were sources of technology transfer and quality upgrading.

The second study was by Lai et al. (2020). Their question was whether stronger IP enforcement would encourage innovation and export growth among Chinese firms during the period just after China joined the WTO. They developed a theoretical model of heterogeneous firms, in which the dividing lines separating firms that are productive enough to export, import new capital goods, and invest in new products depended both on tariff cuts and IPRs. IP protection was measured as the ratio of judicial cases in each province in which the IP owner, as plaintiff, prevailed. These figures for the early 2000s and 2006 were compiled from legal reporting sources and combined with firm-level data on exports, capital and intermediate-goods imports, and new product development. The findings supported the theory: more productive firms export and invest in capital and new products.

The model predicted that stronger IPRs would encourage more of all three activities – exports, capital importation, and new goods – among highly productive firms, while forcing less productive Chinese firms out of the market. Moreover, most

of the positive impacts should occur at the "extensive margin," meaning new entry into those activities by firms that were not previously active in those areas. Careful estimation found results supporting these hypotheses, although there were also positive effects along the intensive margins. In brief, the combined effect of trade liberalization and patent enforcement tended to push surviving Chinese firms into higher-productivity activities and to both export and innovate more. These findings point to induced innovation as a primary channel for export growth at the micro level.[11]

II. *IP Protection Correlates with Export Quality and Sophistication*

I noted earlier the evidence that exports of high-technology and high-IP goods to emerging economies rise significantly after IP reforms. This broad insight has been refined with more detailed trade figures and firm-level data to understand the sources of these increases. Is there a simple intensive margin effect, where existing exporters simply sell more to the same markets? Is it an extensive margin effect, where firms enter exporting and may export to new markets? Or is it the result of higher export quality, which finds more international markets and permits higher export-price markups? All of these scenarios are possible, and all contribute, as noted by Lai et al. (2020) in their paper on China.

Three recent papers have studied the characteristics of high-IP exports that increase in the wake of IP reforms. Ivus (2015) studied detailed product-level US exports to foreign destinations from 1990 to 2000. She estimated how such exports reacted to changes in patent laws abroad, measured by the GP index, which was instrumented to control for policy endogeneity. Her identifying factor was that countries that were not former colonies of European powers were required by TRIPS to strengthen their patent rights significantly more than those that were. Her statistical analysis found a significantly higher entry of new varieties of products into emerging markets with relatively stronger expansion of patent rights in the 1990s. Nearly all of this relative increase in trade came through the introduction of new products, implying that extensive margin effects dominated export growth. Put in simpler terms, developing economies with relatively greater expansion of patent rights in this period gained access to significantly more new product varieties, implying a gain from trade through enhanced choice.

Lin and Lincoln (2017) took this analysis further by analyzing confidential export data of US firms to different locations, matching those figures to firm-level data on US patents owned and industry characteristics from the Census of Manufactures. Using 1997 data, they found that just 9 percent of US manufacturing firms owned at least one patent at the USPTO. However, these firms were quite large and

[11] There is an emerging literature on productivity growth and exports induced by tariff cuts, exemplified by Bustos (2011), Aghion et al. (2017), and Bloom et al. (2015).

accounted for 89 percent of US manufacturing exports, demonstrating the joint concentration of size, innovation, and exporting. They estimated a simple DID model to see if firms owning patents were more likely to export to countries with stronger patent rights, measured by the GP index, than to other countries. They included several other interactions between firm characteristics and the GP index, plus additional controls and fixed effects, in the 1997 cross-section. The authors discovered that a substantial rise in a foreign country's GP index would raise the probability by 2.9 percent that a firm owning a US patent would begin exporting to that country; this increase was statistically significant. Similar results were found for patent-owning firms with relatively high average wages and skills in their employment mix. The authors extended this analysis by tracking how US enterprises chose to serve six emerging markets that engaged in substantial IP reforms, as identified in Branstetter et al. (2011). Using matched pairs analysis, with the treatment firms being those that owned a US patent, Lin and Lincoln (2017) found significantly larger increases in exports by the treatment firms, compared to other firms, to five of six reforming economies. These findings suggest that at least part of the reason for the positive export response of high-technology goods to patent reforms is that patent-owning firms choose to enter new markets. In turn, the reforming economies benefit from access to newer technologies and new products.

A third paper, by Sweet and Maggio (2015), studied the characteristics of manufactured exports from developing economies with differing levels of IPRs. The authors equated innovation with the sophistication of exports, measured by an index of product complexity at the national level. This index (ECI) measured the diversity of exports across industry classes, in comparison with a global or development-consistent standard across countries. It was computed from detailed trade data. The authors regressed ECI on the GP index, a vector of national controls, and country and year fixed effects every five years between 1965 and 2005. They found robust evidence that patent protection was positively correlated with export sophistication. In this context, emerging economies may benefit from higher export earnings after patent reforms. Again, however, this result pertained only to countries above a threshold level of initial GDP per capita. This finding supports a common theme: simply adopting stronger patent in poor countries is unlikely to generate many innovation or export benefits – as reviewed in this chapter.

III. *High-Technology Exports from Developing Countries May Be Impeded by IP Rights in Rich Countries*

Shin et al. (2016) studied an important question: is the composition of exports from developing countries (the Global South) affected by IP protection in developed economies (the Global North)? They noted that developed economies – such as the United States and the EU – have laws in place protecting their IP-owning firms from infringing imports through bans or anti-dumping actions. Thus, the possibility exists

that higher IP protection in the North could diminish imports from the South through such actions.

The authors constructed a measure of each country's level of technology (LT), defined as either the total number of foreign patents or US patents its residents own. They estimated a basic gravity model of the determinants of bilateral exports, augmented by the importer's IP protection, the exporter's LT, an interaction between those variables, and various fixed effects. IP protection was measured by the annual survey of global technology managers by the World Economic Forum.

The primary results reported by Shin et al. (2016) were intriguing. First, the importer's IP level positively affected bilateral exports, consistent with prior findings. However, the interaction term was significant and negative, suggesting that in countries with high levels of IP protection, an increase in the exporter's LT level would be met with marginal reductions in trade. When the estimation was broken into income groups, this result existed for South to North exports, but not the reverse flows. In summary, as the exports of emerging countries expanded in technological intensity, those countries found it increasingly difficult to penetrate Northern markets.

This analysis can be criticized for its use of qualitative survey data and inadequate attempts to deal with endogeneity and measurement. However, it does point to the possibility that importer patent rights and exporter technology trade may not go hand in hand. Rather, there may be other impediments to trade that assert themselves to diminish this form of competition at the margin.

IV. *IP Protection Shrinks Effective Distance within Production Networks*

In an insightful analysis, Keller and Yeaple (2013) studied the behavior of MNEs to illuminate the spatial barriers to transferring knowledge from headquarters to affiliates. Firms can transfer technical information either via exports of intermediate inputs (embodied knowledge) or through direct communication (disembodied). Physical distance raises costs and reduces the amount of both forms of trade. It may seem counterintuitive that costs of communication rise with distance, but there are mistakes in transmitting knowledge directly, and the severity increases with remoteness. This is one explanation for the continued prominence of within-firm business travel by engineers and skilled managers. The authors modeled these processes and, under reasonable assumptions, showed that the costs of shipping inputs fell relative to communication costs the farther away was the affiliate. As a result, the technological content of intra-firm exports among US multinationals increased significantly as the distance increased, because firms chose to ship their high-technology inputs rather than relying on disembodied means of diffusion. The prediction was born out in this empirical work with confidential US data on the operations of such enterprises.

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One interesting finding that the authors did not discuss is that this substitution proposition was considerably attenuated by the strength of patent rights. Other things being equal, countries with stronger IP protection received a smaller share of embodied technology and a larger share of information transmission, raising relative affiliate sales. From this result it seems that stronger IPRs reduce the severity of the consequences of miscommunication, making firms more willing to share their technological information in disembodied form. At this point, the inference remains speculative but intriguing and further research is needed to understand why this might be.

In a complementary analysis, Piermartini and Rubinova (2018) found evidence of an important technology spillover within production networks or global value chains (GVCs). They hypothesized that new ideas flow to a country as a function of how closely that country is linked to other countries in which knowledge is generated. Their econometric model regressed patents registered through the Patent Cooperation Treaty (PCT), disaggregated into industries, among residents of one country, on several variables: domestic R&D spending, the weighted average of foreign R&D spending, national control variables, and country and industry fixed effects. The novelty is that the bilateral weights depend on various measures of networked trade linkages through vertical supply chains. These weights were computed from the World Input–Output Database, which links countries through these flows of intermediate inputs and outputs.

The authors found significant and positive spillover coefficients from weighted foreign R&D to domestic patent applications. In their main specification, they computed that a one-standard-deviation increase in GVC linkages raised PCT patenting by 5 percent, which held for both developed and emerging countries. Thus, countries that have firms linked closely to GVCs have higher innovation profiles. It is also noteworthy that the regressions showed a significant and positive effect of domestic patent protection on patenting.

V. *The Specifics of Patent Protection Matter for Trade Flows*

A final novel and important paper is Palangkarya et al. (2017). These economists, reviewing the literature on patent rights and trade, wondered what specific features of patent regimes affect microeconomic trade flows. Rather than using a national patent-law index such as the GP measure, they studied patent examination records in many countries and developed two measures of the difficulty of achieving patent protection in various destination jurisdictions. These measures included (i) bias at examination offices against foreign applicants who propose to export if they receive protection and (ii) the existence of patents owned by others that might block imports even if new patents are granted. These measures were included as "trade costs" in a gravity trade model of bilateral imports at the detailed industry level, estimated from 1976 to 1999 across 189 exporters to several locations where examination records and extant patents could be accessed. The authors distinguished industries as being high-

tech, medium-technology, or low-technology, and they hypothesized higher impacts in the first two groups.

Their regressions found significant and negative coefficients for both examiner bias and the likelihood of patent blockage on bilateral trade. This was true for all types of goods, but the coefficients were considerably larger for high-technology and medium-technology goods than for low-technology. From this evidence, it appears that specific elements of patent policy have strong effects on bilateral trade. Exporters of high-technology and medium-technology goods are particularly concerned about encountering lawsuits from blocking-patent owners if they export to countries where that action is a threat. Examination bias against foreign inventors similarly deters exports, suggesting that firms are aware of this problem. Their study was, to my knowledge, the first to combine trade data with patenting processes to achieve a microeconomic explanation for the correlation between exports and patent standards. It should stimulate an extended literature going forward.

VI. *Patent Rights and Global Innovation Networks*

One of the most significant, yet so far understudied, global trends in information diffusion is the growth of international networks across which R&D investments are made, whether to achieve local innovation or to collaborate on global technology solutions by specializing R&D resources. These global innovation networks (GINs) arose in good part within multinational enterprises seeking to maximize their innovation profits, but today they may involve collaboration across private firms, universities, public research laboratories, and charitable foundations (Maskus and Saggi, 2013). In these contexts, GINs may be uniquely poised to address critical public-goods issues requiring extensive international cooperation and skill specialization, ranging from vaccines to environmentally sensitive technologies.

Of greatest interest for this chapter are the roles played by MNEs in this globalization of research efforts. The traditional conception is that such firms have engaged in so-called headquarter services, most prominently R&D and marketing, the fruits of which could be spread at low cost among producing facilities in different countries. This insight cast MNEs as the core of the knowledge-capital model of FDI (Markusen, 2002). In brief, such firms concentrated R&D in their home location but transferred their knowledge-based advantages to reduce costs or introduce new products in foreign markets. The resulting FDI could either be horizontal, designed to sell similar products in local markets, or vertical, seeking lower factor costs, such as low-wage labor. Over time, as the costs of transferring technologies fell due to better information and communication technologies and the gains to producing abroad rose due to tariff cuts, this process evolved into extensive offshoring through complex production networks (Baldwin, 2016).

The emergence of R&D networks within MNEs was perhaps natural in this context (Branstetter et al., 2018). Early investments in R&D-based affiliates focused

on developing capacity for local adaptations of international technologies, complementing horizontal FDI. While this process transferred considerable knowledge abroad, it was not aimed at building deep local research capacities, although to some degree such capabilities emerged endogenously.

More recently, however, many MNEs have built major R&D centers in large emerging markets, primarily China and India, for more complex reasons, four of which stand out. First, these countries are producing large volumes of skilled workers with sufficient research and engineering proficiency to sustain large facilities with global inventive potential. Moreover, the governments have invested in complementary research infrastructures, including technologically advanced universities and public research facilities. Second, increasingly restrictive limitations on bringing technical workers to the United States and other technology hubs have encouraged firms to seek and employ talented inventors and scientists in the home locations of those employees.

Third, the process of invention itself is now so complex, with knowledge combined across multiple scientific and engineering disciplines, that the specialization of tasks within international R&D networks is considerably more efficient for firms than is using generalists situated within concentrated innovation centers in a headquarter location. Finally, the increasing application of modular software to technical problems has made it easier to split research tasks among specialized locations, raising the productivity of R&D (Branstetter et al., 2019). Indeed, the abundance of software engineers in China, India, and Israel explains why these countries have become major sources of global innovation mediated through MNEs, as indicated by the rapid growth of co-invention measured by international patent statistics listing multiple inventors across facilities within such firms.

I am unaware of formal econometric studies that establish a clear role for IP protection in encouraging R&D networks, a question that deserves careful analysis. After all, China is the source of considerable irritation among Western policymakers regarding its selective enforcement of the IPRs of foreign investors. In contrast, Israel has strong IP protection, and India is noted for its copyright strength. Making firm conclusions about these linkages is, again, problematic. However, given the evidence reviewed earlier regarding a positive association between patent laws and the FDI of high-technology MNEs, it seems likely that IP is a contributing factor in decisions about where to locate R&D facilities and how MNEs try to safeguard the outcomes of local R&D programs.

D. CONCLUDING REMARKS

In this chapter, I have reviewed recent statistical studies of the roles that the global IP system seems to play in encouraging innovation and shaping international trade and investment flows. This complex literature may fairly be summarized as follows. First, it remains challenging to demonstrate rigorously that the strength of IP protection, itself difficult to

measure, is a strong causal determinant of innovation. However, recent work points in that direction, with the important caveat that any such impacts depend on threshold levels of economic development, human capital availability, and market demands in a country. They depend as well on the surrounding economic framework, including competition, product regulation, financial development, and other factors. At the most basic level, IPRs do not have detectable influences on innovation or creativity in poor countries. Their incentive effects are the preserve of emerging and higher income countries.

Second, IPRs correlate positively with high-technology trade regarding both imports into developing and emerging countries and exports from those countries. In my view, there is sufficient evidence to claim that these effects are causal in important ways. Policy reforms associated with both TRIPS and membership in IP-related PTAs favor the growth of high-IP exports compared to other products and countries. Such reforms also encourage trade growth at the extensive margins, generating greater variety gains in importing countries that implement them. At the same time, IPRs can deter trade in important ways, a factor that is only beginning to be understood through careful statistical analysis. Finally, IP protection facilitates technology transfer through FDI and production networks, with recent evidence suggesting these dynamics complement the development of R&D sharing across borders. These various results support an earlier claim of mine that the global IP system improves the "plumbing" of the global architecture for formal technology transfer (Maskus, 2012).

While interesting, such findings are not yet definitive and require further study. And there are many additional questions that should be analyzed as data become available. For example, what are the precise mechanisms through which these IP policies may create high-technology exports and new products aimed at additional markets? At present, that question remains largely a black box. Opening the box will require combining microeconometric data of firms across countries, linking their trade and investment flows with measures of technological inputs and outputs. A large research agenda remains.

REFERENCES

Aghion, Philippe, Peter Howitt, and Susanne Prantl. 2015. Patent Rights, Product Market Reforms, and Innovation. *Journal of Economic Growth* 20, 223–262.

Aghion, Philippe, Antonin Bergeaud, Matthieu Lequien, and Marc Melitz. 2017. The Impact of Exports on Innovation: Theory and Evidence. Manuscript.

Baldwin, Richard. 2016. *The Great Convergence: Information Technology and the New Globalization*. Cambridge, MA: Harvard University Press.

Bhattacharya, Sourav, Pavel Chakraborty, and Chirantan Chatterjee. 2020. Intellectual Property Regimes and Wage Inequality. Manuscript.

Bloom, Nicholas, Mirko Draca, and John Van Reenen. 2015. Trade-Induced Technical Change? The Impact of Chinese Imports on Innovation, IT, and Productivity. *Review of Economic Studies* 83, 87–117.

Branstetter, Lee, Ray Fisman, C. Fritz Foley, and Kamal Saggi. 2011. Does Intellectual Property Rights Reform Spur Industrial Development? *Journal of International Economics* 83, 27–36.

Branstetter, Lee, Britta Glennon, and J. Bradford Jensen. 2018. Knowledge Transfer Abroad: The Role of US Inventors within Global R&D Networks. NBER working paper 24453.
2019. The IT Revolution and the Globalization of R&D. In Josh Lerner and Scott Stern, editors, *Innovation Policy and the Economy*. National Bureau of Economic Research. 19, 1–37.
Bustos, Paula. 2011. Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms. *American Economic Review* 101, 301–340.
Deere, Carolyn. 2008. *The Implementation Game: the TRIPS Agreement and the Global Politics of Intellectual Property Reform in Developing Countries*. Oxford: Oxford University Press.
Delgado, Mercedes, Margaret Kyle, and Anita M. McGahan. 2013. Intellectual Property Rights and the Geography of Trade. *Journal of Industrial Economics* 61, 733–762.
Falvey, Rod, Neil Foster, and David Greenaway. 2006. Intellectual Property Rights and Economic Growth. *Review of Development Economics* 10, 700–719.
Ginarte, Juan Carlos and Walter G. Park. 1997. Determinants of Patent Rights: A Cross-National Study. *Research Policy* 26, 283–301.
Gold, Richard E., Erica Shadeed, and Jean-Frederic Morin. 2019. Does Intellectual Property Lead to Growth? Insights from a Novel Dataset. *Regulation and Governance* 13, 107–124.
Hu, Albert G. Z. and I. P. L. Png. 2013. Patent Rights and Economic Growth: Evidence from Cross-Country Panels of Manufacturing Industries. Oxford Economic Papers, 675–698.
Ivus, Olena. 2010. Do Stronger Patent Rights Raise High-Tech Exports to the Developing World? *Journal of International Economics* 81, 38–47.
2015. Does Stronger Patent Protection Increase Export Variety? Evidence from US Product-Level Data. *Journal of International Business Studies* 46, 724–731.
Javorcik, Beata Smarzynska. 2004. Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages. *American Economic Review* 94, 604–627.
Keller, Wolfgang and Stephen Ross Yeaple. 2013. The Gravity of Knowledge. *American Economic Review* 103, 1414–1444.
Kim, Yee Kyoung, Keun Lee, Walter G. Park, and Kineung Choo. 2012. Appropriate Intellectual Property Protection and Economic Growth in Countries at Different Levels of Economic Development. *Research Policy* 41, 358–375.
Kyle, Margaret K. and Anita M. McGahan. 2012. Investments in Pharmaceuticals before and after TRIPS, *Review of Economics and Statistics* 94, 1157–1172.
Lai, Huiwen, Keith E. Maskus, and Lei Yang. 2020. Patent Reform, Exports and Productivity of Heterogeneous Firms in Developing Countries: Evidence from China. *European Economic Review* 123, third article, 23 pages.
Lerner, Josh. 2009. The Empirical Impact of Intellectual Property Rights on Innovation: Puzzles and Clues. *American Economic Review* 99, 343–348.
Lin, Jenny and William Lincoln. 2017. Pirate's Treasure. *Journal of International Economics* 109, 235–245.
Markusen, James R. 2002. *Multinational Firms and the Theory of International Trade*. Cambridge, MA: MIT Press.
Maskus, Keith E. 2012. *Private Rights and Public Problems: Global Intellectual Property Rights in the 21st Century*. Washington DC: Peterson Institute for International Economics.
2019. Economic Development and Intellectual Property Rights: Key Analytical Results from Economics. In Ben Depoorter and Peter Menell, editors, *The Economics of Intellectual Property Law: Volume 1 Theory*. London: Edward Elgar, 656–676.
Maskus, Keith E., Sahar Milani, and Rebecca Neumann. 2019. The Impact of Patent Protection and Financial Development on Industrial R&D. *Research Policy* 48, 355–370.

Maskus, Keith E. and Mohan Penubarti. 1995. How Trade-Related are Intellectual Property Rights? *Journal of International Economics* 39, 227–248.
Maskus, Keith E. and William Ridley. 2020. Intellectual-Property-Related Preferential Trade Agreements and the Composition of Trade. Manuscript.
Maskus, Keith E. and Kamal Saggi. 2013. Global Innovation Networks and Their Implications for the Multilateral Trading System. Geneva: International Center for Trade and Sustainable Development. Paper for the E-15 Initiative.
Maskus, Keith E. and Lei Yang. 2018. Domestic Patent Rights, Access to Technologies and the Structure of Exports. *Canadian Journal of Economics* 51, 483–509.
Moser, Petra. 2013. Patents and Innovation: Evidence from Economic History. *Journal of Economic Perspectives* 27, 23–44.
Nagaoka, Sadao, 2009. Does Stronger Patent Protection Facilitate International Technology Transfer? Some Evidence from Licensing Contracts of Japanese Firms. *Journal of Technology Transfer* 34, 128–144.
Odagiri, Hiroyuki, Akira Goto, Asushi Sunami, and Richard R. Nelson, editors. 2010. *Intellectual Property Rights, Development, and Catch-Up*. Oxford: Oxford University Press.
Palangkarya, Alfons, Paul H. Jensen, and Elizabeth Webster. The Effect of Patents on Trade. *Journal of International Economics* 105, 1–9.
Park, Walter G. 2008. Intellectual Property Rights and International Innovation. In Keith E. Maskus, editor, *Intellectual Property, Growth and Trade*. Amsterdam: Elsevier.
Piermartini, Roberta and Stela Rubinova. 2018. How Much Do Global Value Chains Boost Innovation? World Trade Organization, working paper.
Qian, Yi. 2007. Do National Patent Laws Stimulate Domestic Innovation in a Global Patenting Environment? A Cross-Country Analysis of Pharmaceutical Protection 1978–2002. *Review of Economics and Statistics* 89, 436–453.
Rajan, Raghuram and Luigi Zingales. 1998. Financial Dependence and Growth. *American Economic Review* 88, 559–586.
Shin, Wonkyu, Keun Lee, and Walter G. Park. 2016. When an Importer's Protection of IPR Interacts with an Exporter's Level of Technology: Comparing the Impacts on the Exports of North and South. *The World Economy* 39, 772–802.
Sweet, Cassandra M. and Dalibor S. E. Maggio. 2015. Do Stronger Intellectual Property Rights Increase Innovation? *World Development* 66, 665–667.
United Nations Conference on Trade and Development (UNCTAD). 2005. *Resource Book on TRIPS and Development: An Authoritative and Practical Guide to the TRIPS Agreement*. Geneva: United Nations.
World Intellectual Property Organization (WIPO). 2004. *WIPO Intellectual Property Handbook: Policy, Law and Use*. Geneva: WIPO.
World Intellectual Property Organization. 2019. *Global Innovation Index 2019*. Geneva: WIPO.
Yang, Guifang and Keith E. Maskus. 2001. Intellectual Property Rights and Licensing: An Econometric Investigation. *Review of World Economics* 137, 58–79.