The Effects of the TRIPS Agreement on International Protection of Intellectual Property Rights†

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Abstract
We investigate the effectiveness of the TRIPS Agreement in triggering changes to countries' intellectual property rights (IPR) protection regimes in an empirical panel model that utilises a range of aggregation strategies. The effects of the TRIPS Agreement on IPR protection vary across levels of development and geography. Developed countries, where IPR protection regimes closely resembled TRIPS Agreement obligations before implementation, were not significantly affected. Developing countries significantly responded to the TRIPS Agreement by tightening IPR protection regimes. The empirical evidence suggests that the TRIPS Agreement has been successful in coercing WTO member countries to strengthen domestic protection of IPR.

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Introduction

The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) was made part of the World Trade Organisation's (WTO's) set of agreements in the Uruguay Round (UR) negotiations to provide a coercive framework in which WTO member countries could extraterritorially enforce the Intellectual Property Rights (IPR) of domestic firms. Member countries were obliged to undertake legislative reform to establish laws and regulations that meet with international standards, as described in the TRIPS Agreement. If innovating firms from member countries are dissatisfied with the level of IPR protection afforded to their innovations, then disputes between the innovating firm's host country and the offending country are handled through the WTO's Dispute Settlement Understanding (DSU). The DSU allows for cross-agreement retaliation, which means that a country that is found in violation of its TRIPS Agreement obligations can be subjected to retaliatory trade sanctions under another WTO agreement; usually the General Agreement on Tariffs and Trade (GATT).

The introduction of the TRIPS Agreement into the WTO marked a significant departure for multilateral trade agreements; the focus of a major agreement was a non-trade issue for the first time. The requirements that are spelled out in the TRIPS Agreement confer obligations on how member countries must protect IPR within their domestic boundaries, while other WTO agreements aim to provide a predictable regulatory environment for international trade and to reduce barriers and trade-distorting policies in member countries. Developing WTO member countries, under pressure from developed countries, agreed to the inclusion of the TRIPS Agreement in return for promised better access to developed-country markets for manufactured and agricultural products.[1] Developed countries viewed intellectual property as important components of their future

[1] Whether developing countries received the level of access they were promised is debatable, due to dirty tariffication and the erection of regulatory and other non-tariff barriers (Hoekman and Martin, 2001).

industrial strategies, and were dissatisfied with the level of IPR protection in the markets of many of their trading partners. This "capture" of the WTO by developed-countries' innovating firms has been controversial; Bhagwati (2004) characterises this phenomenon as the transition of the WTO from a promoter of international trade to a "royalty collection agency".

The TRIPS Agreement also diverges from other WTO agreements by introducing rules that cannot be shown to be welfare increasing at the global level. The GATT and Agreement on Agriculture can be shown to have global welfare-enhancing effects within the confines of neoclassical trade theory through *gains from trade*. Deardorff (1990), however, shows that the marginal cost of protection (measured as the growth of deadweight loss that results from monopoly pricing) is constant, or increases, as geographic coverage expands and the marginal benefit of IPR protection decreases as geographical coverage expands. There must, therefore, exist an optimal geographic coverage of IPR protection, beyond which global welfare declines. The fallout of this argument is that certain countries should be exempt from TRIPS Agreement obligations if the objective of such an agreement is to maximise global welfare. The TRIPS Agreement does not strive for such an optimum; rather the TRIPS Agreement calls for the harmonisation of IPR regulations across all WTO member countries.[2]

This article investigates whether the TRIPS Agreement has been successful in achieving its primary objective; stronger legislative protection of IPR in WTO-member countries. We undertake an empirical investigation into the effects of the TRIPS Agreement

[2] The TRIPS Council granted implementation delays to developing WTO member countries, and least-developed member countries are not subject to the agreement until 2013 (WTO, 2005, Undated). These exceptions are not exemptions in the interest of global welfare (in the spirit of Deardorff), but rather implementation delays in recognition of some countries' practical inabilities to protect IPR to TRIPS Agreement standards.

on a numerical index of IPR strength. If the TRIPS Agreement can be shown to have had positive and significant effects on the strength of IPR across a panel of countries, then this research will provide evidence that the TRIPS Agreement has been, at least somewhat, successful in its primary objective. If a significant relationship cannot be identified, then the effectiveness of the TRIPS Agreement is uncertain.

This paper is unique for a few key reasons. We utilise a distinctive dataset that includes observations on a time-series/cross-section panel of countries whose obligations under the TRIPS Agreement have varied over time, including: a) countries that were bound by the TRIPS Agreement since its inception, 2) countries that were bound at later dates through either later accession into the WTO or through TRIPS Council extensions, and 3) countries that are not yet bound by TRIPS Agreement rules. These diverse observations generate substantial variation in our independent variable of interest (TRIPS Agreement implementation).

We analyse the empirical results over a range of aggregation strategies. The TRIPS Agreement, if fully implemented on all WTO member countries, would have had a very wide range of effects on different countries. The Agreement's requirements closely resemble IPR mechanisms that already existed in developed countries; those countries whose IPR legal infrastructures differed the most from these developed countries were required to make the most significant changes. We analyse how the TRIPS Agreement affected IPR in countries at different stages of development and by geography.[3]

[3] The potential positive implications of the TRIPS Agreement (*e.g.*, increased rates of innovation as a result of the transfer of rents to innovating firms and faster technology transfer from innovating to adopting countries) and the potential negative implications of the TRIPS Agreement (*e.g.*, deadweight losses associated with monopoly pricing, restricted access to pharmaceuticals and modern-variety seeds in developing countries, large public expenditures required for compliance, and efforts by other non-trade related lobby groups to capture new WTO negotiations after observing the TRIPS Agreement precedent) are not discussed in this article.

This paper is organised as follows. The second section provides an overview of international IPR agreements, introduces the important elements of the TRIPS Agreement and discusses the Agreement's implementation schedules. The third section discusses the determinants of IPR protection, including a survey of relevant literature. The fourth section presents the empirical model and data and discusses the estimation strategy. Section five discusses the empirical results and the paper closes with concluding remarks and observations.

The TRIPS Agreement

There is a long history of international treaties designed to coordinate protection of IPR across international borders.[4] The Paris Convention for the Protection of Intellectual Property and the Berne Convention for the Protection of Literary and Artistic Works, both established in the 1880s, were the primary instruments of trans-border IPR protection until the formation of the WTO. The Paris Convention established minimum standards for the protection of industrial property (patents) and called for national treatment of patents among signatory countries. The Berne Convention established protection standards for art and written works, and called for national treatment and a most-favoured nation obligation.

The United Nations' World Intellectual Property Organisation (WIPO) was created in 1967 as the administrative body for multilateral IPR treaties. The WIPO provides technical support to developing countries in the establishment of IPR laws and shares information with the WTO. The WIPO is a UN agency, and has no mechanism for enforcing IPR or the treaties (Paris and Berne) that it administers.

[4] This paper presents only a very brief overview of Intellectual Property (IP) protection agreements, other than the TRIPS Agreement. See Trebilcock and Howse (2005) for a more thorough treatment of international IP agreements.

The TRIPS Agreement became part of the WTO in the UR negotiations. The United States (US) pushed hard to bring the coercive means of the WTO's DSU to bear on what US negotiators perceived to be weak protection of US firms' IPR within its trading partners. The US already maintained the Trade Remedy Law (Section 337 of the US Tariff Act), which allowed for the withdrawal of tariff concessions under the Generalised System of Preferences for countries who were deemed to have insufficient IPR protection systems. However Section 337 only allowed for action against imports into the US that were of suspect origin, and therefore did not protect the IPR of US firms in foreign markets. The TRIPS Agreement was designed to protect these IPR regardless of source or destination market by making the TRIPS Agreement part of the WTO's *single undertaking*. All member countries[5] were required to either accept all WTO agreements as a package, or accept none.

The TRIPS Agreement is comprised of seven parts; the three most relevant to this research are described here. Part I calls for national treatment of all WTO-member firms in the protection of IPR and for most-favoured nation status to firms from all member countries. Part I also calls for member countries to abide by the articles of the Paris Convention and discusses overlap with the Berne Convention, the Rome Convention and the Treaty on Intellectual Property in Respect of Integrated Circuits.

Part II of the TRIPS Agreement defines the minimum standards of IPR protection that member countries must implement to be compliant with the Agreement. Copyrights are to be protected in alignment with the Berne Convention, and for a minimum of 50 years. Patents shall receive 20 years of protection, and though plants, animals and biological processes are exempt, patents must provide protection to plant varieties.[6] Compulsory

[5] See note 2, above.
[6] Countries may also provide "effective *sui generis*" protection to plant varieties, though it is unclear what constitutes sufficiently "effective" *sui generis* protection (Lesser, 2000).

licensing of patented products is allowed under specified conditions in which patent protection may generate high social or economic costs.

Part III outlines the rules of enforcement for IPR protection in member countries. Judicial authorities must have the authority to issue injunctions in cases of IPR infringement, and have the authority to award damages to be paid by the infringer to the rights holder. It is worth noting that the payment of damages is unlikely to occur in cases of IPR infringement. If member countries do not comply with their WTO agreement obligations (for example, by not awarding damages to a rights holder), then the DSU allows for cross-agreement retaliation. The host country of an infringing firm may be directed to either pay compensation or face retaliatory trade sanctions under the GATT. Host countries of infringing firms rarely have incentives to opt for compensation; Yampoin and Kerr (1998) show that the incentives to pay compensation in lieu of accepting retaliation decline as the size of the pirate industry increases and the costs of enforcement rise.

The TRIPS Agreement came into effect with the formation of the WTO in 1995. Developing and least-developed member countries were granted initial implementation delays, and have been granted further delays over the past several years (see note 2). The TRIPS Agreement has also been the subject of consultations at the Doha Development Agenda (DDA) negotiations, though primarily on issues of implementation, not substance. There are two primary points of IP negotiation in the DDA. The first is the extension of protection for products that are defined by geographic indicators, beyond existing UR protection for wines and spirits. The second issue revolves around the use of genetic resources and traditional knowledge in commercialised technology (primarily agricultural products and pharmaceuticals). A proposal by a group of developing countries would require patent applications to disclose the country of origin of genetic materials and

traditional knowledge that are used in novel products (WTO, 2008) and the Plant Genetic Resources Treaty calls for a *sui generis* system that would authorise payments from commercialising firms to populations indigenous to the source of the genetic material. This strategy is an attempt by developing countries to forestall incidents of "biopiracy", in which firms obtain legal rights over traditional and indigenous products and remedies. If a DDA deal is completed, then the TRIPS Agreement will remain largely unchanged from its current structure with only minor implementation amendments.

It is important to note that the nature of the WTO's DSU does not automatically result in the imposition of penalties on member countries that do not fulfil their Agreement obligations. Retaliatory measures are only authorised if a complainant country wins a case through the initial, and usually appellate, body of the WTO. It is therefore important to view the TRIPS Agreement not only as a means of structuring punitive measures against those members that violate their obligations, but also as a tool that can be brandished to make coercive threats against member countries in efforts to change behaviour without instigating formal WTO panels. The jurisprudence under the TRIPS Agreement provides some guidance on how WTO panels will interpret international disputes over protection of IPR, but there have been relatively few TRIPS Agreement disputes (relative to the number of disputes arising from other WTO agreements, such as the Agreement on Agriculture or the Agreement on Antidumping).[7]

One of the primary avenues through which the TRIPS Agreement can affect the international protection of IPR is member countries use of the Agreement as a threat. Negotiated settlements between countries often precede, and sometimes prevent, formal WTO cases. These negotiations between complainant and defendant countries may be

[7] See Trebilcock and Howse (2005) for a history of TRIPS Agreement jurisprudence.

flavoured by the existence of the TRIPS Agreement. Both parties know that the TRIPS Agreement allows for punitive retaliatory measures against an offending member country, and defendant countries have to weigh the potential costs of trade retaliation in their decisions on IPR protection reform. Trebilcock and Howse (2005) discuss one important such case in which lawyers representing US and EU pharmaceutical firms pressured the South African government to repeal legislation that allowed parallel importation[8] of HIV/AIDS medication from lower-price countries. Though the TRIPS Agreement allows for parallel importation of medications under specific circumstances, the significant uncertainty surrounding a potential WTO dispute panel's interpretation of the Agreement allowed pharmaceutical-industry negotiators to use the threat of TRIPS Agreement retaliation to influence South African legislators.[9] The implementation of a levy on genetically-modified soybean seeds in Brazil is another example in which a negotiated agreement may have averted a formal WTO case. A large share of Brazil's herbicide-tolerant soybean crop is grown from farmer-saved seeds, for which no royalties are paid to innovating firms. The Brazilian National Association of Seed Producers agreed to the application of a levy on soybean seeds, some of the proceeds of which are directed to the IP-owning firms (The Western Producer, 2005). Farmers can either pay a levy on certified seeds at the point of purchase and receive a certificate of authenticity, or can deliver their crops to points of sale (usually elevators) and be charged the levy if they cannot produce a certificate of authenticity. These cases speak to the potential for the TRIPS Agreement to act as a credible threat in disputes over IPR protection.

[8] Parallel importation is the importation of a product from a country (outside the home country of the IP-owning firm) without the explicit permission of the IP-owning firm. An example would be South Africa importing patented HIV medication from another African country in which the IP-owner agreed to sell the medication at a price that is lower than in the home (usually US or EU) market.

[9] Pharmaceutical firms eventually backed away from this case in response to pressure from civil-society groups such as Médecins Sans Frontiéres and Oxfam (Trebilcock and Howse, 2005).

Determinants of IPR Protection

This paper estimates the effectiveness of the TRIPS Agreement in strengthening IPR protection across a range of countries. To conduct such an investigation, it is necessary to develop an empirical model that measures the relative importance of a range of influences on IPR protection, and then isolate the effects of the TRIPS Agreement. There have been several attempts to estimate the effects of economic, social and political factors on the strength of IPR protection across countries. Important considerations across this thread of research include measures of national income or development, educational attainment, research and development (R&D) intensity, the sophistication/effectiveness of legal and governance infrastructures, and membership in international agreements.

Ginarte and Park (G&P) (1997) develop a patent strength index for a large cross-section of countries that is comprised of five categories; 1) coverage of a range of products, 2) membership in international treaties, 3) protection for innovators against the loss of patent rights, 4) the presence of legal enforcement mechanisms and 5) duration of patent. A theoretical welfare maximisation model is tested using their constructed patent strength index in a cross-section empirical model that estimates the effects of a range of independent variables on the dependent index variable. One of G&P's (1997) key findings is a positive and significant relationship between income and patent strength. However this relationship is rendered insignificant in a more comprehensive specification that controls for trade openness, research and development spending, market and political freedoms and educational attainment. G&P (1997) argue that it is not development itself that is important in determining patent strength, but the *determinants* of development. G&P (1997) also find a threshold below which R&D expenditures are not significant determinants of patent

strength; R&D expenditures are only significant for relatively wealthy countries with large R&D to GDP ratios. Marron and Steel (2000) estimate the effects of a range of economic and cultural variables on software piracy rates in a panel model. They find that economic institutions (proxied by an index of perceived investor risk) and cultural traditions (*i.e.*, individualistic vs. collectivistic) are important determinants of software piracy rates. Marron and Steel (2000, p. 172) suggest that "efforts to reform intellectual property rights around the world must be sensitive to differences in cultural traditions and economic institutions, as well as economic development." The TRIPS Agreement takes the opposite approach; harmonisation of IPR standards across all member countries regardless of cultural and economic differences.[10]

Lerner (2002) examines the protection of IPR in 60 countries over a 150-year period and finds evidence that supports three explanations for international variation in IPR: 1) stage of development (positive relationship), 2) degree of authoritarian rule (positive relationship) and 3) colonial history and legal family (strong protection in countries with French and German legal traditions). Shadlen *et al*. (2005) introduce international political considerations into a model that explains international variation in IPR. They suggest that the domestic factors that have been used to explain international variation in IPR in other studies have not varied enough in recent years to explain the fall in software piracy rates, and look to international factors such as the WTO and bilateral investment treaties with the US as external influences on IPR. Shadlen *et al*. (2005) find that external and international pressures are significant determinants of IPR, but that government effectiveness is insignificant.

[10] Selective implementation delays for developing countries aside.

Model and Data

We develop an empirical model that controls for the important determinants of IPR to isolate the effects of the TRIPS Agreement on international variation in IPR protection. The model's components and our *ex ante* expectations of their signs follows.

We use a modified version of G&P (1997) and Park's (2008) patent strength index as the dependent variable to measure IPR protection across countries. This index provides a long time series across a large cross section of countries that vary in their obligations under the WTO. This variation allows us to pick up the effects of TRIPS Agreement implementation in our empirical results. We modify the updated index from Park (2008), which includes TRIPS Agreement accession in its calculation. We subtract 0.04 (the TRIPS Agreement contribution to the Park index) to avoid endogeneity where required because we include TRIPS Agreement accession as an independent variable in our model.

The use of a modified version of G&P (1997) and Park's (2008) index differentiates our study from those that use software piracy as a measure of IPR protection. As Marron and Steel (2000) point out, these models infer underlying national policies from estimated piracy rates. Park's (2008) index more explicitly captures national policies by directly measuring laws and regulations. This study also analyses the effects of the TRIPS Agreement on what Shadlen *et al.* (2005) refer to as *inputs* into IPR protection (laws, regulations, etc.), rather than *outputs* of IPR protection (piracy rates). Figure 1 presents a summary representation of the dependent variable. Endpoints of each line segment represent the maximum and minimum values of the index in each sample year. The variation of IPR protection across countries narrowed over the sample period, and the means (represented by the ♦ symbol) increased over time.

We use a binary variable to capture individual countries' TRIPS Agreement obligations. A country is assigned one if it is subject to the TRIPS Agreement and zero if it is not. The sample includes a wide range of developed and developing countries as well as WTO-member and non-member countries; the countries in our sample are presented in Table A1 of the appendix. The sample includes observations every five years from 1990 to 2005, and covers a fifteen-year period over which the TRIPS Agreement was not in existence through the implementation period of several WTO member countries. There are also countries in the sample that are not WTO member countries, and others that have not yet had to implement the reforms called for by the TRIPS Agreement. These factors generate substantial variation in the TRIPS Agreement binary variable. The estimated parameters on this variable should be positive and significant if the TRIPS Agreement has been successful in strengthening IPR protection in WTO member countries.

The extent of a country's compliance with the TRIPS Agreement will have direct bearing on the numerical score of our dependent variable. For example, a country that bestows 20-year patents receives a contribution of one point towards its IPR score (G&P, 1997); this corresponds directly to the TRIPS Agreement's requirement of 20-year patents. However the index also measures several characteristics of a country's IPR protection system that do not correspond directly to the TRIPS Agreement (for example, the availability of a range of enforcement mechanisms). Our analysis investigates the effectiveness of the TRIPS Agreement as a coercive tool in affecting the overall IPR environment in a range of countries, as quantified by the index.

We include real GDP per capita as a measure of each country's stage of development. Several studies have found that higher-income countries exhibit stronger IPR, though this result has been shown to be less significant when other economic variables that

are associated with development are included in regressions (G&P, 1997). The estimated parameter on the income variable is expected to be positive and significant, however the level of significance may fall as other independent variables are included in the regression. The GDP per capita data are from the International Monetary Fund (IMF) World Economic Outlook database.

Innovations and discoveries are the products of R&D, and domestic firms will generate internal pressure for IPR protection when these firms conduct productive R&D. We use the United Nations Development Programme's (UNDP) Human Development Report measure of researchers and technicians in R&D per million people to control for this effect on the level of IPR protection. More researchers should generate more internal pressure to protect indigenous R&D, and this estimated coefficient is expected to be positive. This measure provides wider coverage (more countries and more years) than alternative R&D variables, including R&D spending per capita.[11] It should be noted that these data are reported in the Human Development Reports in five-year blocks (for example, number of researchers from 1996-2000), where the most recent number available is reported. We use the figure that is closest to our pooled sample observations.[12,13]

High rates of education are expected to correlate positively with patent protection because IPR are often associated with the products of intellectual capital. This relationship was empirically established by G&P (1997), however Marron and Steel (2000) found that education was insignificant in determining software piracy rates. Our model uses combined

[11] For example, the OECD measure of R&D spending is available only for OECD (plus a few other large) countries. Our sample includes several non-OECD countries, and we believe that the benefits of including these countries in our dataset are substantial. The UN measure of R&D spending also omits several countries in our dataset.

[12] A few countries in the sample were missing data for this variable in 1990. We interpolated the missing observations using that country's growth rate of ratio of tertiary students in science and engineering to backcast from 1995 values.

[13] See the results section, below, for a discussion of endogeneity issues that may arise with the use of R&D in explaining IPR protection.

first-, second- and third-level enrolment rates from the UNDP's Human Development Report to estimate the effects of education on IPR protection. We expect education to be positively related to IPR protection.[14]

The passing of patent laws and the enforcement of regulations is dependent on a government's ability to effectively implement legislation. We utilise the legal structure and security of property rights index from the Economic Freedom of the World report (Gwartney *et al.,* 2008) to capture countries' capacities to legislate and regulate patent laws. This index comprises responses to survey questions regarding countries' protection of property rights, impartial courts and an accounting for strength of law and order. This index provides a measure of governments' perceived ability to implement and enforce regulations and laws, especially with respect to property rights. We expect this index to be positively correlated with IPR protection.

We also consider a country's propensity to trade internationally in estimating its level of IPR protection. Countries that are relatively dependent on exports may produce more products that embody IP, and therefore have stronger incentives to protect IPR. G&P (1997) suggest that relatively open countries may also have incentives to protect patents in efforts to establish reputations for respecting international agreements. The empirical model includes countries' ratio of imports to GDP and of exports to GDP. Imports and exports are from the United Nations Comtrade database and GDP data are from the IMF World Economic Outlook database. We also control for the implementation of the TRIPS Agreement over time by including a linear trend in the model, beginning with 1 in 1990. Table 1 provides summary statistics of the dataset.

[14] Note that education (and to some extent income) variables are "enabling" variables in technology adoption models, in that these variables indicate how capable an economy is of adopting a new technology. We view the effects of education as more direct in the context of this model. Education generates products that embody IPR, thereby generating direct pressure for stronger IPR.

The estimating equation is

(1) $$IPR_{it} = \alpha_0 + \alpha_1 TRIPS_{it} + \alpha_2 GDPC_{it} + \alpha_3 RD_{it} + \alpha_4 EDUC_{it} + \alpha_5 GOV_{it} + \alpha_6 IMP_{it} + \alpha_7 EXP_{it} + \alpha_8 TREND_t + \varepsilon_{it}.$$

All variables are as defined above, with subscript *i* indicating country *i*, subscript *t* indicating time period *t*, and ε_{it} and is the stochastic error term.

Non-spherical error terms resulting from heteroskedasticity, autocorrelation and contemporaneous correlation across panel sets are anticipated in the dataset. Heteroskedasticity can occur because the patent strength indices of, for example, small developing countries may be more volatile than the indices of larger developed countries. This is especially true for developing countries that were expected to make significant changes to their IPR regimes to be compliant with the TRIPS Agreement. Autocorrelation within panels is anticipated given the evolving patterns of patent strength indices. Contemporaneous correlation across panels may also exist in the dataset because adjacent/regional countries' time-specific shocks could generate contemporaneously correlated error terms.

The number of panels in our dataset is larger than the number of time periods. Consequently, feasible generalized least square (FGLS) estimation cannot account for contemporaneously correlated panel sets. We therefore address contemporaneous correlation by applying a variant of FGLS; the panel-corrected standard error (PCSE). This approach controls for heteroskedasticity, AR(1) autocorrelation with a common parameter across panels or with panel-specific parameters, and for contemporaneous correlation across panels (Beck and Katz, 1995, 1996).

There is also the potential for endogeneity issues in a model that explains IPR protection with R&D intensity (see Rapp and Rozek [1990] for a discussion of the relationship between IPR protection and R&D activities). The structure of our R&D variable is likely to render any endogeneity issues insignificant, however. The UN Human Development Reports provide R&D data in five-year blocs; for example, the value used for 2000 is the most recent observation from the 1996-2000 period. These data are not updated every year, and most of our observed values appear more than once over the reported five-year period. This implies that many of our R&D observations are lagged, thereby diminishing concerns of endogeneity between IPR protection and R&D intensity.

Results and Discussion

The effects of the TRIPS Agreement on developed and developing countries are expected to differ because many of the TRIPS Agreement's disciplines call for harmonisation of IPR protection to levels that already exist in many developed countries; this suggests that the TRIPS binary variable will be larger/more significant for developing than for developed countries. Table 2 presents empirical results for the model when TRIPS Agreement effects are disaggregated by level of development.[15] The second column (Model 1) of Table 2 supports the hypothesis that TRIPS Agreement effects differ across levels of development. The estimated coefficient on the TRIPS binary variable is positive and highly significant for developing countries. Accession into the TRIPS Agreement has played an important role in the implementation of IPR reforms in developing countries. The estimated coefficient for developed countries is positive, but not significant. This is not surprising, since many TRIPS Agreement obligations are consistent with IPR regulations and institutions that were already

[15] We follow the IMF's classification of developing and developed countries.

in place in developed countries. Accession into the TRIPS Agreement did not play a significant role in IPR protection in high-income developed countries.

Estimated coefficients for education, governance and R&D intensity all conform to theoretical expectations (positive) and are all significant. These factors can play important roles in generating domestic IP, and have had significant effects on the protection of IPR. The effects of trade openness are not significant. These results suggest that, once controlling for other major determinants of IPR, a country's propensity to trade does not affect its regulatory protection of IPR.

The estimated effects of income on IPR protection depend on model specification. Education, governance and R&D are highly correlated with, and theoretical determinants of, income. The inclusion of all of these variables in the regression renders the income coefficient insignificant. Column 3 (Model 2) of Table 2 presents the model estimated with income, but without education, governance and R&D variables. Income is significant in this model, and all other estimated parameters are quantitatively and qualitatively similar to model 1. The difference between models 1 and 2 suggests that the *determinants* of income, not necessarily income itself, are important in establishing the strength of IPR enforcement. This result is also found by G&P (1997), and the similarity of our results lends support to their finding.

Columns 4 and 5 of Table 2 present the estimation results when allowing for panel-specific autocorrelation effects. The estimated coefficients are quantitatively and qualitatively similar to the estimates from models 1 and 2. Estimated parameters have the expected signs, and are significant (with the exceptions of trade openness measures). The empirical results are robust to this alternative specification.

Table 3 presents the estimation results for the model when TRIPS Agreement effects are disaggregated by geography. Disaggregating by development level (Table 2) lumps countries as diverse as Argentina and Hungary together with Bangladesh and Benin. It may be unrealistic to expect that the effects of the TRIPS Agreement are common across this grouping; Argentina and Hungary are both subject to the TRIPS Agreement disciplines while Bangladesh and Benin are not. Also, many countries in South America and Eastern Europe have relatively high incomes and education levels (both Argentina and Hungary are above the sample means while Bangladesh and Benin are below the sample means) and are establishing burgeoning technology industries. Another important reason for separating the effects by geography is that the TRIPS Agreement, as part of the WTO set of agreements, is subject to the DSU. Countries that do not fulfil their obligations may be subject to punitive barriers on their exports to other WTO member countries. As such, the effectiveness of the TRIPS Agreement in determining the level of IPR across regions can provide some information on the effectiveness of the TRIPS Agreement as a coercive threat. Countries that have a lot to lose from trade retaliation may respond differently than those with little to lose.

The empirical results in table 3 closely conform with expectations. The effects of the TRIPS Agreement on IPR protection in Europe are positive, but not significant. This result is expected because many European countries maintained IPR protection regimes that were near or at TRIPS Agreement levels before 1995. Note that this aggregation includes all European countries, not just member countries of the European Union. Relatively low-income European countries such as Bulgaria, Hungary and Romania are included in this group and can explain why the estimated effect of the TRIPS Agreement is larger for Europe than the estimated effect for developed countries from Table 2 (though both effects are

statistically insignificant). The results for North America, consisting of Canada and the US, are also insignificant.

The estimated effects of the TRIPS Agreement on countries in Central and South America are large and highly significant. Changes in deterministic microeconomic (education, R&D, governance) and macroeconomic (GDP) variables have had positive and significant effects on IPR protection, and the presence of the TRIPS Agreement has significantly increased these countries' commitments to IPR protection. Because the empirical model controls for the important domestic factors in determining IPR protection, the results suggest that countries in Central and South America take seriously the threat of cross-agreement trade retaliation. This result is consistent with the high degree of trade dependence that many Central and South American countries have on the US (the chief proponent of the TRIPS Agreement).[16] These countries have a lot to lose if retaliatory sanctions are imposed on their exports to the US. These countries also had to make significant adjustments to their domestic IPR systems in order to be compliant with the TRIPS Agreement, unlike most countries in North American and Europe. The results for North Africa and the Middle East are similar to those of Central and South America in both significance and magnitude.

No Sub-Saharan African countries are bound by TRIPS until 2013, with the exception of South Africa. The estimated coefficient for Sub-Saharan Africa is positive, but is insignificant; this suggests that the TRIPS Agreement has not significantly affected IPR protection in South Africa. South Africa is relatively dependent on exports to developed countries, but this does not seem to have resulted in the TRIPS Agreement having a significant effect on protection of IPR. It is possible that South Africa's geographic and

[16] For example, the shares of Mexico and Brazil's total exports destined for the US were 70.1% and 24.6% in 1990, and 59.6% and 19% in 2005, respectively.

political positioning (neighbouring countries that have weak IPR protection and are not bound by the TRIPS Agreement) have offset any coercive effects that the WTO Agreements might have on other (non Sub-Saharan) countries.

The effect of the TRIPS Agreement on countries in Oceania is not significant. This result is anticipated because this aggregation includes only Australia and New Zealand - countries where IPR protection was relatively strong prior to the implementation of the TRIPS Agreement. The TRIPS Agreement binary variable has had positive and significant effects of IPR protection in Asian countries. The rationale for this result is similar to the results for Central and South America; several Asian countries are heavily dependent on access to consumer markets in Europe and the US[17], and take seriously the threat of trade retaliation.

Columns 4 and 5 of Table 3 present parameter estimates when allowing for panel-specific autoregressive effects. These results are quantitatively and qualitatively similar to the baseline results in columns 2 and 3, and suggest that the estimated results are robust to this alternative specification.

Conclusions

The TRIPS Agreement is a core component of the WTO's set of agreements, and is likely to be a fixture of future international trade agreements despite the controversy surrounding its implementation. All WTO member countries are required to comply with the Agreement's requirements (with the exception of countries that are not bound until 2013), or risk retaliatory trade sanctions. The TRIPS Agreement does not discriminate between members despite the absence of a theoretical rationale for the establishment of a single

[17] The share of China's exports destined for the US grew from 8.4% in 1990 to 21.4% in 2005. India's share of exports destined to the US grew from 14.5% in 1990 to 16.8% in 2005.

harmonised set of IPR protection mechanisms across countries. All countries (regardless of IPR protection starting point or development level) have to comply with harmonised standards to fulfil their obligations.

We develop an empirical model using a broad panel dataset to evaluate the effectiveness of the TRIPS Agreement in tightening IPR protection across a range of countries. There are three important observations that can be made of the empirical estimates. First, domestic factors are important determinants of IPR protection, as measured by our modified version of G&P's (1997) index. This result is consistent with the findings of other authors on similar topics who have found that income, education, governance and domestic R&D activity generate stronger IPR protection.

Second, the TRIPS Agreement has had significant effects on IPR protection over its implementation period, but the significance of these effects depends on countries' development levels. We find that disaggregating the panel of countries by level of development yields different results for developed and developing countries, even when controlling for per capita income. The TRIPS Agreement has had significant effects on IPR protection in developing countries, but has not measurably affected developed countries' level of IPR protection. This result is consistent with the setting of TRIPS Agreements standards to conform closely to IPR protection regimes that were already in place in many developed countries. Developed countries did not have to markedly alter their regimes to be compliant with the TRIPS Agreement.

We also find that the effects of the TRIPS Agreement vary across regions. The TRIPS Agreement has had positive and significant effects on IPR protection in Central and South America, in Asia and in North Africa and the Middle East. The TRIPS Agreement has not

significantly affected protection of IPR in Sub-Saharan Africa, however the only Sub-Saharan African country in our sample that is bound by the TRIPS Agreement is South Africa.

Countries that are relatively dependent on exports to countries that pushed for the TRIPS Agreement's inclusion in the WTO (*i.e.*, developed countries) may take the threat of retaliatory trade sanctions seriously because they have much to lose in the form of lost exports. This provides evidence that the TRIPS Agreement has been successful as a coercive threat in international trade relations. An interesting extension of this research would be to investigate the reasons that some developing countries/regions have responded to the TRIPS Agreement more significantly than others. We anecdotally observe that regions with high export dependence on developed countries have made significant changes to their IPR protection system. A comprehensive investigation of this issue would require the development of a bilateral trade flows empirical framework and database.

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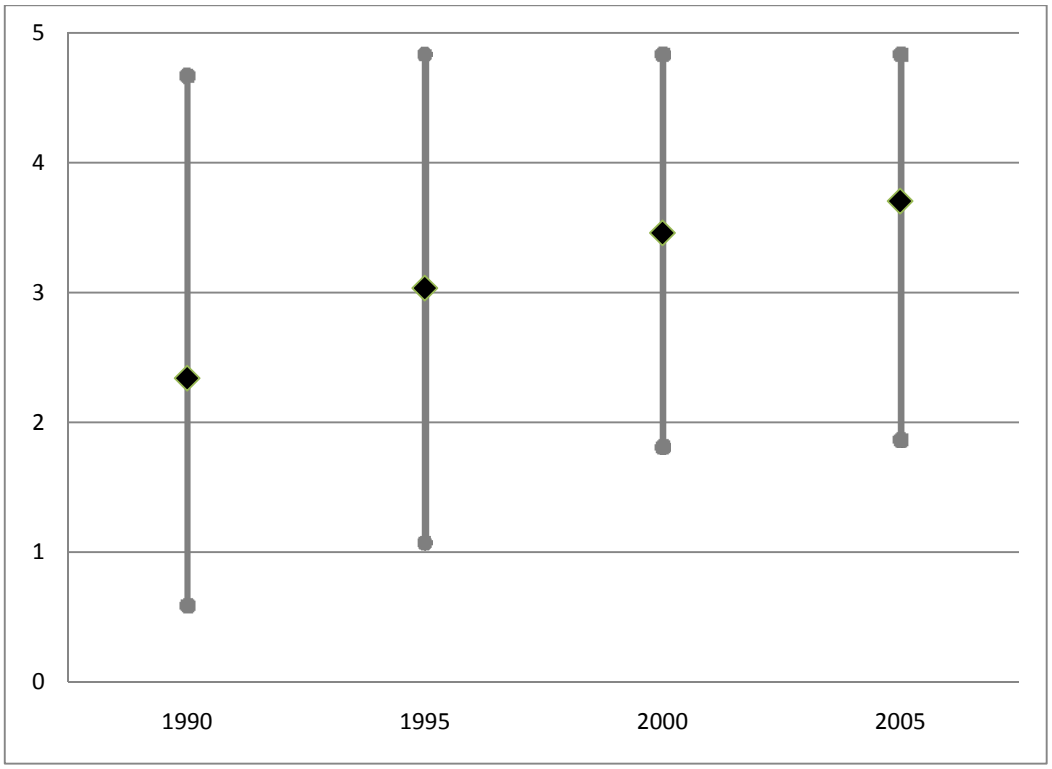
Figure 1. IPR Protection Indices



Notes: Values are based on G&P (2007) and Park (2008), with modifications for TRIPS Agreement accession.

The mean for each period is represented by the ♦ symbol.

Table 1. Summary Statistics

Variables	Mean	Standard Deviation	Minimum	Maximum
Patent strength index (Park, 2008)	3.13	1.11	0.59	4.84
Researchers and technicians in R&D per million of population	1630.61	1914.51	2	10000
Combined first-, second-, and third-level enrolment ratios	72.46	19.55	23	114
Governance index	6.24	1.99	1.95	9.63
TRIPS binary variable	0.51	0.51	0	1
GDP per capita (US dollars)	11108.44	13219.13	98.03	65509.21
Openness to import (imports to GDP ratio)	0.27	0.17	0.03	0.89
Propensity to export (exports to GDP ratio)	0.24	0.18	0.01	1.09

Notes: The GDP per capita and researchers and technicians variables are scaled down by a factor of 1000 in the regression analysis to generate more readable parameter estimates.

Table 2. Panel-Corrected Standard Error (PCSE) Estimates (Effects of the TRIPS Agreement on IPR Strength of Developed and Developing Countries)

	Common (AR1)		Panel Specific (AR1)	
	Coefficients (z-Value)	Coefficients (z-Value)	Coefficients (z-Value)	Coefficients (z-Value)
	Model 1	Model 2	Model 1	Model 2
TRIPS (Developing Countries)	0.558[a] (0.214)	0.647[a] (0.215)	0.640[a] (0.192)	0.673[a] (0.212)
TRIPS (Developed Countries)	0.149 (0.269)	0.215 (0.329)	0.158 (0.244)	0.179 (0.241)
GDPC	0.009 (0.013)	0.029[b] (0.012)	0.016 (0.012)	0.036[a] (0.013)
Education	0.017[a] (0.003)		0.015[a] (0.005)	
Governance	0.019[c] (0.010)		0.022[b] (0.011)	
R&D	0.128[a] (0.033)		0.139[a] (0.020)	
Openness to Import	0.235 (0.341)	0.254 (0.357)	0.328 (0.243)	0.409 (0.270)
Propensity to Export	0.175 (0.331)	0.252 (0.391)	0.209 (0.211)	0.290 (0.236)
Trend	0.042[a] (0.012)	0.046[a] (0.012)	0.039[a] (0.010)	0.047[a] (0.012)
Observations	236	236	236	236
R^2	0.963	0.960	0.973	0.977
rho	0.273	0.275	*	*

Notes: The dependent variable is patent strength. Parameters are estimated by the Prais-Winsten estimator. The common AR(1) parameter is denoted by *rho*. The z-values are constructed from standard errors that are corrected for heteroskedasticity and contemporaneous correlation of error terms across panels. Superscripts "a", "b" and "c" denote significance at the 1%, 5%, and 10% levels, respectively.

Table 3. Panel-Corrected Standard Error (PCSE) Estimates (Effects of the TRIPS Agreement on IPR Strength of Different Geographic Regions)

	Common (AR1)		Panel Specific (AR1)	
	Coefficients (z-Value)	Coefficients (z-Value)	Coefficients (z-Value)	Coefficients (z-Value)
	Model 1	Model 2	Model 1	Model 2
TRIPS (Europe)	0.205	0.232	0.287	0.277
	(0.201)	(0.224)	(0.208)	(0.198)
TRIPS (North America)	0.203	0.141	0.309	0.157
	(0.236)	(0.239)	(0.236)	(0.233)
TRIPS (Central and South America)	0.924[a]	1.048[a]	0.977[a]	1.065[a]
	(0.312)	(0.336)	(0.249)	(0.256)
TRIPS (North Africa and the Middle East)	0.629[b]	0.789[a]	0.538[a]	0.717[a]
	(0.247)	(0.257)	(0.193)	(0.191)
TRIPS (Sub-Saharan Africa)	0.144	0.191	-0.035	0.093
	(0.283)	(0.304)	(0.312)	(0.307)
TRIPS (Oceania)	0.173	0.244	0.209	0.254
	(0.342)	(0.281)	(0.284)	(0.269)
TRIPS (Asia)	0.362[a]	0.435[b]	0.305[b]	0.372[b]
	(0.124)	(0.171)	(0.135)	(0.168)
GDPC	0.005	0.023[b]	0.014	0.029[b]
	(0.011)	(0.011)	(0.012)	(0.012)
Education	0.018[a]		0.012[b]	
	(0.005)		(0.005)	
Governance	0.018[c]		0.025[b]	
	(0.010)		(0.012)	
R&D	0.113[a]		0.141[a]	
	(0.035)		(0.025)	
Openness to Import	0.280	0.263	0.387	0.421
	(0.348)	(0.362)	(0.234)	(0.283)
Propensity to Export	0.189	0.283	0.222	0.311
	(0.341)	(0.384)	(0.204)	(0.224)
Trend	0.043[a]	0.044[a]	0.037[a]	0.045[a]
	(0.011)	(0.012)	(0.011)	(0.013)
Observations	236	236	236	236
R^2	0.966	0.962	0.977	0.975
rho	0.285	0.279	*	*

Notes: The dependent variable is patent strength. Parameters are estimated by the Prais-Winsten estimator. The common AR(1) parameter is denoted by *rho*. The z-values are constructed from standard errors that are corrected for heteroskedasticity and contemporaneous correlation of error terms across panels. Superscripts "a", "b" and "c" denote significance at the 1%, 5%, and 10% levels, respectively.

Appendix

Table A1. List of countries in sample

Argentina	Germany	Philippines
Australia	Greece	Poland
Austria	Hungary	Portugal
Bangladesh	Iceland	Romania
Belgium	India	Rwanda
Benin	Iran	Senegal
Bolivia	Ireland	South Africa
Brazil	Italy	Spain
Bulgaria	Japan	Sri Lanka
Burundi	Jordan	Sweden
Canada	Korea, Republic of	Thailand
Central African Republic	Madagascar	Togo
China	Malaysia	Tunisia
Cyprus	Mauritius	Uganda
Denmark	Mexico	United Kingdom
Ecuador	Netherlands	United States
Egypt	New Zealand	Uruguay
El Salvador	Norway	Venezuela
Finland	Pakistan	Viet Nam
France	Peru	