THE TRIPS AGREEMENT AND ITS EFFECTS ON THE R&D SPENDING OF US-OWNED MULTINATIONAL COMPANIES IN DEVELOPING COUNTRIES

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ABSTRACT

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) has revolutionized the way international intellectual property rights are defined and enforced. The biggest changes have been for developing countries that were required to adopt stringent US style intellectual property protection in return for membership in the World Trade Organization and the increased access to international markets associated with WTO membership. Many critics of the TRIPS regime argue that the new intellectual property protections are unduly burdensome to developing countries and that their costs far outweigh their benefits. On the other hand, TRIPS proponents contend that a high global level of intellectual property protection benefits developing countries by encouraging innovation and technology transfer, as well as attracting foreign direct investment. In this thesis, I test whether the strict intellectual property protection regulations required by the TRIPS agreement benefit developing countries, specifically by attracting private US research and development funds. I used empirical data to examine the level of country-specific research and development (R&D) spending by foreign affiliates of US-owned multinational companies between 1989-2003 as a function of whether the country has adopted two of the major patent protection regulations required by TRIPS – patent protection for a duration of twenty years and patent protection for pharmaceuticals. Results from the regression analysis suggest that providing a patent protection duration of twenty years positively impacts the R&D spending while providing patent protection for pharmaceuticals does not impact it. As such, pharmaceutical patent protection should be enforced in a case-by-case manner, whereas twenty-year patent protection should be broadly undertaken.

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Chapter 1. Introduction

The global intellectual property system has recently undergone a substantial harmonization and expansion, largely through implementation of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). The TRIPS agreement was negotiated during the 1986-94 Uruguay Round as part of the World Trade Organization's (WTO) General Agreement on Trade and Tariffs. All WTO member countries are required to adhere to the TRIPS agreement, which requires domestic enforcement of stringent intellectual property rights, modeled largely on the US and European Union patent systems. The TRIPS agreement came into effect on January 1, 1995, but developing and least developed countries[1] were given additional time to make their domestic intellectual property systems TRIPS compliant. The deadline for developing countries to implement the TRIPS provisions was January 1, 2000, and least-developed countries are currently scheduled to implement the TRIPS provisions beginning July 1, 2013[2].

The TRIPS provisions have been controversial since their inception, and there is still considerable debate over whether the global harmonization of intellectual property rights (IPRs) is helpful or harmful to developing countries. Generally, three

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[1] The WTO does not define developing countries. Within the WTO framework, developing countries are those that self-identify as such. The WTO does formally recognize thirty-two member nations as least-developed countries based on their United Nations designation as such.

[2] Least developed countries have until 2016 to extend patent protection to pharmaceuticals.

arguments have been made about IPRs: (1) that increased IPRs will benefit developing countries by increasing domestic innovation, and encouraging foreign direct investment and technology transfer; (2) that increased IPRs will harm developing countries because they are net consumers of domestic products and/or they have imitation based technology sectors (Deardorff, 1992); and (3) that increased IPRs generate a variety of positive and negative effects that could either expand or limit economic development in developing countries depending on the particular circumstances of the implementation of IPRs in individual countries (Maskus, 2001). In the face of such controversy, it seems wise to take a closer look at specific issues surrounding the potential benefit or harm of IPRs. Therefore, careful consideration must be given to the details of the provisions that are implemented for the protection of IPRs when attempting to assess their usefulness to developing countries.

Several previous studies have examined the economic returns to increased protection of IPRs in developing countries. These studies have generally used an overall measure of the strength of a country's intellectual property protection based on the country's patent laws, because overall measures are widespread and data on patent protection is fairly easy to access. However, one major problem with these overall measures of patent protection is that they are not able to disaggregate the differing effects of particular patent protection provisions. For example, they may have a positive effect on innovation, and at the same time have a negative effect imitation-based domestic industries. If we start with the assumption that IPRs can generate a variety of effects, some good and some not-so good, then it is important to isolate the effects of individual provisions to determine which provisions are producing desirable outcomes and which ones are not. This is especially critical for analyzing the effectiveness of a global harmonization scheme like the TRIPS Agreement that requires developing countries to sign on to a package of provisions related to IPRs. That is why this study examines very specific intellectual property provisions that are contained within the bundle of regulations required by the TRIPS agreement.

In particular, I focus in this thesis on five particular patent provisions that are required by the TRIPS agreement. The first is the requirement that countries provide patent protection that lasts for twenty years from the date that the patent is issued. I chose this provision because many countries, including the United States, were required to change their domestic regulation to provide for the twenty-year patent term in order to comply with the TRIPS agreement. Because of this, I believe that the conversion to a twenty-year patent term is a good proxy for compliance with the TRIPS agreement. Secondly, I examined the TRIPS requirement that countries provide patent protection for pharmaceuticals. I chose this provision because it is one of the most controversial of the TRIPS provisions and one that developing countries in particular have fought against. As noted earlier, developing countries were given additional time to implement this provision and many least-developed nations have yet to implement it. Developing countries and critics of the TRIPS pharmaceutical patent provision have argued that it would have severe negative consequences on public health outcomes in these countries. Conversely, U.S. pharmaceutical companies and proponents of the provision have lobbied for it extensively and argue that it will help the populations in developing countries because pharmaceuticals will be more willing to invest in local R&D if they are assured that their products will not be counterfeited. Next, I examined the TRIPS provisions requiring patent protection for software, patent protection for manufacturing processes, and allowing countries to issue compulsory licenses for pharmaceuticals and other products. While these three provisions are as important as the first two, they did not lend themselves to easy quantification, and consequently they are not included in the regression model.

It is also important to carefully define the economic benefit that the IPRs are thought to affect. In this I focus on research and development (R&D) funding by U.S. owned corporations to developing countries through their foreign affiliates. Research and development activity is a key economic variable to examine because economists believe that investments in R&D stimulate long-term growth. In developing countries, there may be budgetary or other constraints on the resources available for domestic

R&D expenditures. Therefore R&D funding from outside sources assumes an even greater importance and national policies that would increase international R&D investments, such as stronger protection of IPRs, deserve careful consideration.

This thesis is divided into six chapters. In the next chapter, I discuss previous studies that have examined the relationship between IPRs and developing countries. I make note of how this thesis adds to the existing literature. Next, in Chapter 3, I outline the model that I use in my regression analysis and define the variables used in the model. Chapter 4 discusses the data used with the model, and Chapter 5 follows with a look at the results of the regression analysis. Finally, Chapter 6 concludes with a discussion of the policy implications of these results.

Chapter 2. Literature Review

The impact of the TRIPS patent regulations on developing countries was previously analyzed by McCalman (2001). In that study, McCalman attempted to quantify the impact of international patent harmonization as implied by the TRIPS agreement. He estimated a structural model for the value of patent rights held by 29 countries and examined how the value of those rights would change if all countries implemented the TRIPS patent provisions. McCalman found that patent harmonization generated large transfers of income between countries, with the United States benefiting at the expense of developing countries. McCalman also estimated that there would be a worldwide deadweight loss resulting from higher international standards of patent protection. However, one problem with McCalman's study is that it calculated the impact of the TRIPS patent provision by estimating the change in patent value based on data from 29 countries, only 6 of which were developing countries.[3] This study is an improvement on that estimation because it looks at a broader panel of countries, including many developing countries. This study also uses actual economic data to evaluate the impact of the TRIPS provisions rather than using estimated data.

[3] The countries examined in the McCalman study are: United States, Japan, Germany, United Kingdom, France, Australia, Korea, South Africa, Israel, Sweden, Switzerland, Canada, Brazil, Italy, Austria, Netherlands, Finland, Spain, Denmark, India, Norway, New Zealand, Mexico, Ireland, Belgium, Greece, Columbia, Portugal, Panama.

There have also been empirical studies that have examined the effect of increased protection of IPRs on developing countries, and these studies have had mixed results. Park and Ginarte (1997) found that stronger IPRs increase domestic R&D activities of developed countries, but did not increase the domestic R&D activities of developing countries. They theorized that in developing countries, a significant part of domestic R&D activity is imitation rather than innovation research. On the other hand, Chen and Puttitanum (2005) found that increasing IPRs encouraged domestic innovation and noted that there is a U-shaped relationship between IPRs and level of economic growth reflecting the trade-off between imitating foreign technologies and encouraging domestic innovation. While this thesis does not address the issue of domestic innovation examined by Chen and Puttitanum, it does extend the work done by Park and Ginarte by looking at foreign R&D investment in developing countries as a possible augmentation to the limited domestic R&D in those countries. Again, my thesis looks specifically at the patent protection initiated by the TRIPS agreement, rather than looking at stronger patent protection in broad terms. This approach is useful from a policy standpoint since the TRIPS agreement has set the framework within which future negotiations and policy refinement on international patent regulations will be conducted.

Finally, Bransetter et. al. (2005) used the data source that I use in this thesis and found that IPR reform generated an increase in technology transfer from US multinational companies to their foreign affiliates. Bransetter et. al. used the data from the Bureau of Economic Analysis to examine sixteen countries that had undergone an IPR reform between 1982-1999. Because their analysis does not consider post-2000 reforms, the authors do not consider the post-2000 changes implemented in accordance with the TRIPS agreement, whereas I do take this period into account. My analysis is also broader in the sense that it evaluates data from 49 countries in which US multinational companies reported R&D spending by their affiliates. Most importantly, Branstetter et. al. used an umbrella measure of IP strength. Thus, this master's thesis improves upon the existing literature by disaggregating the effects of particular IP provisions on US multinational company's R&D spending.

Chapter 3. Model

The empirical model I use in this thesis is based on previous research by Park and Ginarte (1997), Chen and Puttitanum (2005), and Branstetter et. al. (2005).   The hypothesis that I am testing is that by adopting the patent regulations required by the TRIPS agreement, countries will increase the amount of R&D investment from U.S. owned companies.

My conceptual model can be expressed as:

$$\mathbf{(R\&D)_{it} = \mathit{f}\,(WTO;\ GDPCAP;\ TRADE;\ EDU;\ EF;\ CORPTAX;\ IPR\_STRENGTH;\ TWENTY;\ PHARMA)_{it}}$$

where for each country (i) in year (t):

R&D – is the amount of money, in millions of U.S. dollars, that U.S. owned multinational companies spend on research and development in that country through its foreign affiliates.

WTO – indicates whether the country is a member of the World Trade Organization in a given year.

GDPCAP – is the country's per capita GDP in constant 2000 US dollars from the World Development Indicators.

TRADE – is the country's trade volume as a percentage of GDP used as a measure of trade openness from the World Development Indicators.

EDU– is the percent total enrollment among the school-age population at the secondary level from UNESCO.

EF – is a measure of the country's economic freedom from www.freetheworld.com.

IPR_STRENGTH – is a measure of the strength of the country's enforcement of patent regulations; taken from the intellectual property rights index created by Ginarte and Park (1997).

CORPTAX – is the country's corporate tax rate.

LOWINCOME – indicates whether I have designated a country as a low-income country. A low-income country is defined as having a 2003 GDP per capita of $3,000 U.S. dollars or less.

MIDINCOME – indicates whether I have designated a country as a middle-income country. A middle-income country is defined as having a 2003 GDP per capita of between $5,000 and $20,000 U.S. dollars.

HIGHINCOME – indicates whether I have designated a country as a high-income country. A high-income country is defined as having a 2003 GDP per capita of greater than $20,000 U.S. dollars or less.

TWENTY – indicates whether a country has adopted a patent duration of twenty years as required by the TRIPS agreement.

PHARMA – indicates whether a country has adopted patent protection for pharmaceuticals as required by the TRIPS agreement.

The control variables **WTO, GDPCAP, TRADE, COPRTAX, EDU** and **EF** have all been used in the previous literature. The variable **IPR_STRENGTH** created by Ginarte and Park is an important complement to my explanatory variables **TWENTY** and **PHARMA** for two reasons. First, my variables only measure whether a country has adopted the relevant patent provisions. They do not account for the more difficult measurement of whether the country has mechanisms in place to actively enforce the patent regulations. Since, the Ginarte and Park IPR index takes into the strength of patent enforcement in each country, it is my proxy for enforcement of the TRIPS regulations. Secondly, **IPR_STRENGTH** is my counterpoint for comparing whether the effect of very specific patent provisions on R&D funding is different from the effect of stronger IPR protection more generally.

Originally in planning this study, I wanted to include three additional intellectual property variables. Those variables were to have been:

COMP_LICENSE – would have indicated whether a country has exercised its right under TRIPS to issue compulsory license for pharmaceuticals or other products. I did not include this variable because I found that only country, Taiwan, has issued a compulsory license under TRIPS. Even with all of the attention Brazil has received regarding its opposition to recognizing pharmaceutical patents, its government has only threatened to issue compulsory licenses. Accordingly, there were not enough data points to include this indicator variable.

SOFTWARE – would have indicated whether a country issues patents for software. I did not include this variable because as I researched it, I found that it is really not clear when TRIPS requires patent protection and when copyright protection is sufficient for software. Since there is not a clear TRIPS requirement, I decided not to include it as a variable at this time.

PROCESS – would have indicated whether a country issues patents for manufacturing processes. During my research, I found that the more relevant question under TRIPS is whether a country has reversed the burden of proof requirement for process patent infringement cases. Time constraints prevented me from gathering the additional information necessary to include this as a variable. It presents an interesting avenue for future research.

Previous research and theory suggests that **WTO**, **GDPCAP**, **TRADE**, **EDU**, **EF** and **IPR_STRENGTH** are positively correlated with increased R&D expenditures, while **CORPTAX** is negatively correlated since lower corporate tax rates will induce more foreign investment. My contribution to the model is through the creation of the variables **TWENTY** and **PHARMA**. Before performing the analysis, I was unsure whether **TWENTY** and **PHARMA** would be correlated with **R&D** since previous empirical studies on whether stronger IPRs lead economic benefits for developing countries have had mixed results. The results from Branstetter et. al. (2005) would seem to suggest a positive correlation, but their results are based on a small data set. I did expect that any correlation I did find would be positive, since there is nothing in the existing literature that suggests increasing patent protection would lead to countries receiving less R&D investment.

Endogeneity does pose a possible modeling concern. Graff and Zilberman (1994) point out that questions of the endogeneity of intellectual property arise repeatedly in cross-country empirical analyses. It could be argued that those companies that find a country attractive for R&D investment will press that country's government into enacting more stringent protection for IPRs. There is no definitive solution to this problem, but in this case I believe that the short time-span of 15 years gives adequate protection against endogeneity: as I explain next. Lobbying for changes in patent policy is a long-term process as countries have a tendency to maintain lax intellectual property protection so long as they remain net importers of technology. Also, multinational companies seeking to introduce stricter intellectual property protections will meet resistance from entrenched domestic interests that want to continue to profit from free and open access to new technology. Those efforts presumably take decades. The same explanation works for the argument that R&D funding from multinational companies will affect a country's GDP. In the long-term yes, but not in a time span of 15 years.

Chapter 4. Data

Dependent Variable

Panel data for the dependent variable **R&D** comes from the US Department of Commerce, Bureau of Economic Analysis' (BEA) annual survey of U.S. Direct Investment Abroad: Operations of U.S. Parent Companies and Their Foreign Affiliates. The survey collects detailed data on the financial structure and operations of U.S. parent companies and their foreign affiliates. There are 61 countries for which information is collected regarding R&D spending between the years 1989- 2003. Of those 61 countries, I was able to use 49 of those countries in my regression analysis because there were 12 countries that I was not able to include simply due to insufficient information available about those countries for the control variables. Table 1 below shows the 61 countries represented in the BEA survey data along with a few key demographic features of each country. Asterisks are placed next to the twelve countries that were not included the regression analysis. The twelve countries not included are not systematically different from the 49 countries that were included. Tables 2 and 3 at the end of this chapter show descriptive statistics for all of the variables both with and without the 12 countries not included in the regression.

TABLE 1 – COUNTRIES INCLUDED IN SURVEY INFORMATION AND REGRESSION ANALYSIS

Country	Region	2003 GDP Per Capita
Argentina	Latin America	$6,957
Australia	Asia & Pacific	$21,688
Austria	Europe	$24,217
Bahamas*	Caribbean	$14,928
Barbados*	Caribbean	$9,256
Belgium	Europe	$22,544
Bermuda*	Caribbean	†
Brazil	Latin America	$3,536
Canada	North America	$24,222
Chile	Latin America	$5,196
China	Asia & Pacific	$983
Columbia	Latin America	$2,022
Costa Rica	Latin America	$4,413
Czech Republic	Europe	$5, 899
Denmark	Europe	$30,262
Dominican Republic	Caribbean	$2,436
Ecuador	Latin America	$1,368
Egypt	Middle East	$1,622
Finland	Europe	$24,225
France	Europe	$22,723
Germany	Europe	$22,868
Greece	Europe	$11,449
Guatemala*	Latin America	†
Honduras	Latin America	$933
Hong Kong	Asia & Pacific	$25,625
Hungary	Europe	$5,105
India	Asia & Pacific	$511
Indonesia	Asia & Pacific	$874
Ireland	Europe	$27,932
Israel	Middle East	$17,298
Italy	Europe	$19,090

Country	**Region**	**2003 GDP Per Capita**
Jamaica	Caribbean	$3,189
Japan	Asia & Pacific	$28,869
Luxembourg	Europe	$46,067
Malaysia	Asia & Pacific	$4,011
Mexico	Latin America	$5,803
Netherlands	Europe	$22,973
Netherlands Antilles*	Caribbean	†
New Zealand*	Asia & Pacific	$14,538
Nigeria	Africa	$357
Norway	Europe	$38,260
Panama	Latin America	$4,177
Peru	Latin America	$2131
Philippines*	Asia & Pacific	$1,035
Poland	Europe	$4,634
Portugal	Europe	$10,284
Russia	Europe	$2,138
Saudi Arabia*	Middle East	$9,066
Singapore*	Asia & Pacific	$22,238
South Africa	Africa	$3,171
South Korea	Asia & Pacific	$12,236
Spain	Europe	$14,691
Sweden	Europe	$27,998
Switzerland	Europe	$33,765
Taiwan*	Asia & Pacific	†
Thailand	Asia & Pacific	$2,276
Trinidad and Tobago*	Caribbean	$5,763
Turkey	Europe	$2,977
United Arab Emirates*	Middle East	†
United Kingdom	Europe	$25,742
Venezuela	Latin America	$3,968

* country not included in regression analysis; † data not available

As seen from Table 1 above, the characteristics of the countries in the survey data vary from developing to highly developed with the 2003 per capita GDP ranging from $357 to $46,067. One issue with the country selection is that there are no least-developed countries included in the data. The survey data only includes countries with foreign affiliates of U.S. owned companies. This leads to a possible selection bias against extremely weak and collapsed states. Accordingly, my results are applicable only to nations where foreign investment is already present. I do not attempt to extend my conclusions to countries that are trying to attract initial foreign investment in R&D.

Control Variables

The data on the countries' corporate tax rate, **CORPTAX**, comes from the BEA survey. I calculated each country's corporate tax rate from the survey's Income Statement of Affiliates, Country by Account. I divided the aggregate amount of income taxes paid by foreign affiliates in each country by the aggregate net income of foreign affiliates in each country. I calculated the aggregate net income by subtracting the affiliates' costs and expenses, excluding income tax, from the foreign affiliates' total income. As you can see in Tables 2 and 3, some countries had negative corporate income tax rates because the aggregate cost and expenses exceeded the aggregate total income.[4]

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[4] A negative tax rate is, in effect, a subsidy. The government gives corporations tax breaks that result in a positive return, rather than a tax liability.

The data for the variables **GDPCAP** and **TRADE** come from the World Development Indicators available online from the World Bank, and the data for the variable **EDU** is from UNESCO and is also available online. Data for the variable **WTO** comes from the official WTO membership list which also gives the effective date of membership. The variable **EF**, which measures economic freedom, comes from the organization Free the World, and the variable **IPR_STRENGTH** an intellectual property rights index created by Park and Ginarte (1997).

TRIPS Variables

I began constructing the variables **TWENTY** and **PHARMA** based on information from the WTO TRIPS Council's review of implementing legislation, available in a database on the WTO website. For each member country, the TRIPS Council provides a written report, updated with annexes as needed, that outlines the national legislation which that member country has enacted in order to comply with the TRIPS requirements and contains responses to questions and concerns that other member countries have regarding the national legislation. After reviewing all of the TRIPS Council's reports, I consulted primary and secondary international law sources such as official national government websites and United States Trade Representative reports to verify and supplement the information contained in the TRIPS Council's reports. At the end of this review, I was able to ascertain in what year, if at all, each country had enacted legislation providing for a twenty-year patent duration and providing patent protection for pharmaceuticals.

To generate the dummy variables, I gave each country that has enacted legislation for implementing the twenty-year and pharmaceutical patent provisions a value of one in the year the legislation was enacted and for each year thereafter. I assigned a value of zero for all previous years. Countries that have not finalized their implementing legislation, even if such legislation has been proposed, received a value of zero for all years. **TWENTY** and **PHARMA** were considered separately, so that it is possible for a country to receive values of one for one of the indicators and zero on the other for any given year.

Interaction Terms

I also wanted to examine whether the TRIPS variables had a differential effect on countries of different income levels. For this, I used four interaction terms: **TWENTY *MIDINCOME, TWENTY *HIGHINCOME, PHARMA *MIDINCOME,** and **PHARMA * HIGHINCOME.** These interaction terms compare the effect of **TWENTY** or **PHARMA** for middle and high-income countries relative to the base group of low-income countries. The data for the income level indicators comes from the World Development Indicators.

TABLE 2 – DESCRIPTIVE STATISTICS FOR ALL 61 BEA SURVEY COUNTRIES

Variable		Mean	Standard Deviation	Minimum	Maximum	Observations
ln (R&D)	overall	3.096	2.734	-1.386	8.321	N = 742
	between		2.687	-1.386	7.961	n = 60
	within		0.8236	-1.131	5.921	T-bar = 12.37
ln (GDPCAP)	overall	8.796	1.268	5.717	10.74	N = 803
	between		1.245	5.813	10.51	n = 59
	within		0.1243	8.190	9.929	T-bar = 13.61
EDU	overall	87.96	50.91	11.20	887.8	N = 633
	between		28.74	29.16	155.9	n =59
	within		42.24	-0.04233	819.9	T-bar = 10.73
EF	overall	6.579	1.091	2.900	9.100	N = 804
	between		0.9627	4.427	8.647	n = 57
	within		0.5239	4.019	8.053	T-bar = 14.11
WTO	overall	0.5527	0.4975	0	1	N = 854
	between		0.1874	0	1	n = 61
	within		0.4709	-0.04731	1.453	T-bar = 14.00
TRADE	overall	77.06	51.16	13.00	298.0	N = 773
	between		56.63	18.89	298.0	n = 56
	within		12.94	-48.40	138.6	T-bar = 13.80
CORPTAX	overall	0.2544	0.4095	-6.250	2.091	N = 829
	between		0.2885	-1.495	0.8628	n = 61
	within		0.3483	-6.319	2.022	T-bar = 13.59
IPR_STRENGTH	overall	3.016	0.9820	0.3300	4.860	N = 752
	between		0.8716	1.047	4.447	n = 54
	within		0.4537	1.850	4.360	T-bar = 13.93
TWENTY	overall	0.6849	0.4648	0	1	N = 841
	between		0.3334	0	1	n = 60
	within		0.3326	-0.2484	1.618	14.02
PHARMA	overall	0.7422	0.4377	0	1	N = 772
	between		0.3588	0	1	n = 56
	within		0.2567	-0.1911	1.542	T-bar = 13.79

TABLE 3 – DESCRIPTIVE STATISTICS FOR 49 INCLUDED COUNTRIES

Variable		Mean	Standard Deviation	Minimum	Maximum	Observations
ln (R&D)	overall	3.419	2.642	-1.386	8.321	N = 628
	between		2.503	-1.017	7.961	n = 49
	within		0.8559	-0.8085	6.244	T-bar = 12.82
ln (GDPCAP)	overall	8.759	1.304	5.717	10.74	N = 692
	between		1.283	5.813	10.51	n = 49
	within		0.1297	8.153	9.893	T-bar = 14.12
EDU	overall	89.14	53.93	11.20	887.8	N = 553
	between		29.88	29.16	155.9	n = 49
	within		45.11	1.142	821.1	T = 11.29
EF	overall	6.516	1.094	2.9	9.100	N = 694
	between		0.9651	4.427	8.647	n = 49
	within		0.5313	3.956	7.989	T-bar = 14.16
WTO	overall	0.5951	0.4912	0	1	N = 694
	between		0.1384	0	1	n = 49
	within		0.4823	-0.004899	1.195	T-bar = 14.16
TRADE	overall	75.79	52.58	13.00	295.0	N = 693
	between		51.07	18.87	271.8	n =49
	within		12.95	-49.68	137.3	T-bar = 14.14
CORPTAX	overall	0.2317	0.4362	-6.250	2.091	N = 684
	between		0.2961	-1.495	0.6396	n = 49
	within		0.3794	-6.312	2.029	T-bar = 13.96
IPR_STRENGTH	overall	3.063	0.9751	0.3300	4.860	N = 687
	between		0.8547	1.151	4.447	n =49
	within		0.4632	1.897	4.407	T-bar = 14.02
TWENTY	overall	0.7337	0.4423	0	1	N = 691
	between		0.3094	0	1	n = 49
	within		0.3218	-0.1996	1.667	T-bar = 14.102
PHARMA	overall	0.7815	0.4135	0	1	N = 691
	between		0.3279	0	1	n = 49
	within		0.2567	-0.1519	1.515	T-bar = 14.10

Chapter 5. Results

I conducted both random effects and fixed effect estimations on the panel data. Because I worked with cross-sectional time-series data, I used the xtserial command in Stata to test for autocorrelation. The results of that test suggested that correcting for autocorrelation was in order (with a p value of .2%). I also conducted a Hausman test, which suggested that the fixed effects model was preferred for the estimations that were not corrected for autocorrelation (with a p value of .3%). However, the Hausman test was inconclusive for the estimations that were corrected for autocorrelation. Because heteroskedasticity can be a problem in cross-country panel regressions in which there a wide span in the countries' GDP, I also conducted generalized least squares (GLS) and pooled ordinary least squares (OLS) with Newey-West standard errors, to correct for both autocorrelation and heteroskedasticity. In Tables 4-7, I report the coefficient results for all of these estimations. The preferred models are the random and fixed effects models with autocorrelation correction and the GLS estimates. Results from the models not corrected for autocorrelations and from the pooled OLS estimates are reported and discussed only for reference purposes.

Control Variables

In most of the estimations **GDPCAP** was strongly statistically significant and showed an elasticity of between 1.4 and 1.8. However, in the fixed effects estimations

TABLE 4 – RANDOM EFFECTS ESTIMATES

	Corrected for Autocorrelation			**Not Corrected for Autocorrelation**		
y = ln(RD)	Basic Model	20 year Interactions	Pharmaceutical Interactions	Basic Model	20 year Interactions	Pharmaceutica l Interactions
Natural log of GDP per capita	1.410*** (0.1772)	1.447*** (0.1853)	1.316*** (0.1847)	1.378*** (0.1810)	1.391*** (0.1878)	1.143*** (0.1861)
% total enrollment in secondary school	-0.000005 (0.0004)	-0.000005 (0.0005)	-0.00001 (0.0005)	-0.0007 (0.0006)	-0.0007 (0.0006)	-0.0007 (0.0006)
Economic Freedom	0.2097** (0.0838)	0.20808 (0.0844)	0.2131** (0.0844)	0.373*** (0.0757)	0.3439*** (0.0760)	0.3598*** (0.0748)
Membership in WTO	0.2563** (0.1186)	0.2652** (0.1197)	0.2700** (0.1194)	0.448*** (0.1019)	0.4474*** (0.1027)	0.4524*** (0.1010)
Corporate tax rate	-0.1096 (0.0874)	-0.1085 (0.0882)	-0.1137 (0.0888)	-0.1161 (0.1073)	-0.1238 (0.1076)	-0.1361 (0.1068)
% trade volume	-0.0006 (0.0030)	-0.0010 (0.0030)	-0.0015 (0.0029)	0.0027 (0.0027)	0.0026 (0.0027)	0.0020 (0.0026)
Park and Ginarte IPR Index	0.7722 (0.1174)	0.0736 (0.1178)	0.7580 (0.1177)	-0.0788 (0.1047)	-0.0877 (0.1056)	-0.0871 (0.1039)
20 year patent duration	0.4217*** (0.1426)	0.4497** (0.1802)	0.4687** (0.1500)	0.2671** (0.1250)	0.1316 (0.2097)	0.4054*** (0.1303)
Pharmaceutical patent protection	-0.0634 (0.1638)	-0.0787 (0.1678)	-0.2314 (0.2245)	-0.0551 (0.1394)	-0.0452 (0.1439)	0.5028 (0.2391)
TWENTY * mid income		0.0534 (0.2651)			0.2683 (0.2143)	
TWENTY * high income		-0.2109 (0.2972)			-0.0825 (0.2458)	
PHARMA * mid income			0.3197 (0.2998)			0.6731*** (0.2552)
PHARMA * high income			0.32056 (0.3323)			0.9743*** (0.2873)
R^2 within	0.4016	0.4028	0.4088	0.4268	0.4306	0.4402
R^2 between	0.5382	0.5367	0.5517	0.4943	0.4912	0.5184
R^2 overall	0.5299	0.5267	0.5425	0.7896	0.4857	0.5175
Number of obs.	492	492	492	492	492	492
Number of groups	49	49	29	49	49	49

*** p<.01, ** p<.05, * p<.1

TABLE 5 – FIXED EFFECTS ESTIMATES

	Corrected for Autocorrelation			Not Corrected for Autocorrelation		
y = ln(RD)	Basic Model	20 year Interactions	Pharmaceutical Interactions	Basic Model	20 year Interactions	Pharmaceutical Interactions
Natural log of GDP per capita	0.2510*** (0.0959)	0.2502*** (0.0970)	0.2287*** (0.0961)	1.763*** (0.3929)	1.746*** (0.3927)	1.696*** (0.3893)
% total enrollment in secondary school	-0.0001 (0.0004)	-0.0001 (0.0004)	-0.0001 (0.0004)	-0.0007 (0.0006)	-0.0007 (0.0006)	-0.0006 (0.0006)
Economic Freedom	0.0421 (0.0977)	0.0429 (0.0981)	0.0539 (0.0976)	0.3725*** (0.0757)	0.3707*** (0.0764)	0.3876*** (0.0750)
Membership in WTO	0.0797 (0.1325)	0.0788 (0.1342)	0.0792 (0.1322)	0.3026*** (0.1112)	0.3072*** (0.1134)	0.2789*** (0.1101)
Corporate tax rate	-0.1141 (0.0918)	-0.1154 (0.0923)	-0.1212 (0.0919)	-0.1155 (0.1063)	-0.1274 (0.1065)	-0.1361 (0.1051)
% trade volume	0.0088*** (0.0038)	0.0088*** (0.0038)	0.0082*** (0.0038)	0.0099*** (0.0033)	0.0100*** (0.0033)	0.0095*** (0.0033)
Park and Ginarte IPR Index	0.1854 (0.1327)	0.1807 (0.1337)	0.1863 (0.1322)	-0.1090 (0.1072)	-0.1221 (0.1083)	-0.1140 (0.1059)
20 year patent duration	0.4300*** (0.1542)	0.4114*** (0.1992)	0.5096*** (0.1586)	0.2898*** (0.1252)	0.1402 (0.2125)	0.4212*** (0.1294)
Pharmaceutical patent protection	-0.1475 (0.1798)	-0.1438 (0.1841)	-0.4568* (0.2401)	-0.0332 (0.1383)	-0.0203 (0.1428)	0.4839 (0.2418)
TWENTY * mid income		0.0641 (0.3085)			0.3039 (0.2161)	
TWENTY * high income		-0.14388 (0.3272)			-0.0899 (0.2517)	
PHARMA * mid income			0.5514 (0.3468)			0.7290*** (0.2630)
PHARMA * high income			0.7217* (0.3760)			0.9413*** (0.2911)
R^2 within	0.2686	0.2695	0.2809	0.4369	0.4408	0.4534
R^2 between	0.2416	0.2453	0.3670	0.4320	0.4270	0.4546
R^2 overall	0.2468	0.2502	0.3635	0.4386	0.4332	0.4637
Number of obs.	443	443	443	492	492	492
Number of groups	49	49	49	49	49	49

*** p<.01, ** p<.05, * p<.1

TABLE 6 – GENERALIZED LEAST SQUARES ESTIMATES

y=ln(R&D)	Basic Model	20 year Interactions	Pharmaceutical Interactions
Natural log of GDP per capita	1.756*** (0.0930)	1.397*** (0.1299)	1.267*** (0.1388)
% total enrollment in secondary school	0.0002 (0.0005)	0.0001 (0.0005)	0.00005 (0.0005)
Economic Freedom	0.2793*** (0.0669)	0.1131 (0.0812)	0.0995 (0.0805)
Membership in WTO	-0.1676* (0.0661)	0.0359 (0.1047)	0.0488 (0.1029)
% trade volume	-0.0058*** (0.0025)	-0.0070*** (0.0023)	-0.0073*** (0.0022)
Corporate tax rate	-0.1102 (0.0747)	-0.1200 (0.0742)	-0.1246* (0.0742)
Park and Ginarte IPR Index	0.1009 (0.0843)	0.2269*** (0.1004)	0.2401* (0.1004)
20 year patent duration	0.6116*** (0.1225)	0.3810*** (0.1671)	0.4726*** (0.1310)
Pharmaceutical patent protection	0.1451 (0.1630)	0.1705 (0.1620)	0.0306 (0.2027)
TWENTY * mid income		0.0746 (0.2271)	
TWENTY * high income		0.2500 (0.9508)	
PHARMA * mid income			0.0893 (0.2576)
PHARMA * high income			0.6913 (0.3216)
Number of obs.	492	492	492
Number of groups	49	49	49

*** p<.01, ** p<.05, * p<.1

TABLE 7 – POOLED OLS ESTIMATES WITH NEWEY-WEST STANDARD ERRORS

y=ln(R&D)	Basic Model	20 year Interactions	Pharmaceutical Interactions
Natural log of GDP per capita	1.177*** (0.1491)	0.8452*** (0.1733)	0.6712*** (0.1648)
% total enrollment in secondary school	-0.0005 (0.0007)	-0.0012* (0.0007)	-0.00158 (0.0008)
Economic Freedom	0.2451* (0.1365)	0.1008 (0.1461)	0.0234 (0.1427)
Membership in WTO	0.3593 (0.2298)	0.4832*** (0.2314)	0.5813*** (0.2180)
% trade volume	-0.0131*** (0.0025)	-0.0132*** (0.0026)	-0.0126*** (0.1457)
Corporate tax rate	0.0696 (0.1555)	-0.0017 (0.1513)	-0.0697 (0.1661)
Park and Ginarte IPR Index	0.1045 (0.1583)	0.1340 (0.1476)	-0.0361 (0.1457)
20 year patent duration	0.8377*** (0.2617)	1.806*** (0.3684)	0.9957*** (0.2255)
Pharmaceutical patent protection	0.5146* (0.3080)	0.8026*** (0.2979)	2.5916*** (0.4326)
TWENTY * mid income		0.5029 (0.3690)	
TWENTY * high income		1.5755*** (0.4353)	
PHARMA * mid income			0.8563** (0.3664)
PHARMA * high income			2.533*** (0.4678)
Number of obs.	492	492	492

*** p<.01, ** p<.05, * p<.1

that were corrected for autocorrelation, **GDPCAP** was less strongly significant and had an elasticity of 0.25, and in the pooled OLS with Newey-West standard errors, **GDPCAP** had an elasticity of between 0.7 and 1.2.

Economic freedom **(EF)** was most strongly statistically significant in the random effects estimation and was not statistically significant in the fixed effects estimations corrected for autocorrelation, OLS estimations with Newey-West standard errors, or the GLS models with income dummies or interaction terms. The coefficients for the models in which **EF** was statistically significant suggest that an increase of 1 point on the economic freedom index would increase R&D funding by between .20 and .40 percent. Likewise, **WTO** was most strongly statistically significant in the random effects estimations and was not statistically significant in the fixed effects estimations corrected for autocorrelation or the GLS models with income dummies or interaction terms. The coefficients for the models in which **WTO** was statistically significant suggest that being a member of the WTO versus not being a member of the WTO would increase R&D funding by between .45 and .60 percent, with the exception of the GLS estimation which predicts a 0.17 percent decrease in funding – a result that is inconsistent with our expectations and the results of other preferred models.

TRADE was statistically significant in three of the estimations – fixed effects, GLS, and OLS with Newey-West standard errors. Interestingly, the GLS estimations and the pooled OLS estimations with Newey-West standard errors show a negative impact of trade on R&D funding. However the fixed effects estimations and the random effects estimations corrected for autocorrelation show a positive impact of trade on R&D funding ,which is what is expected intuitively and from the previous literature.

CORPTAX was mildly statistically significant in only one specification of the GLS estimation. As expected, the coefficient has a negative sign in all estimations (with the exception of the basic model in the OLS estimation with Newey-West standard errors). The model in which **CORPTAX** was statistically significant predict that a one percentage point decrease in the corporate tax rate decreases R&D funding by 0.12%.

IPR_STRENGTH was statistically significant in only two specifications of the GLS estimation. For the random effects and fixed effects estimations, **IPR_STRENGTH** is negative in the models that are corrected for autocorrelation. In the models that were statistically significant, it is predicted that a one point increase in the Park and Ginarte IPR index would increase R&D funding by between .23 and .24 percent.

Finally in contrast to what economic theory would have predicted, **EDU** was negative in all estimations except the GLS where the coefficients were insignificant.

EDU was negative and statistically significant in the OLS with Newey-West standard errors estimations for the models with interaction terms. The negative sign would suggest that as enrollment in secondary education in a country increases, R&D spending in that country by U.S. owned companies decreases. Although the results are all insignificant a consistent negative sign deserves some attention as to why the **EDU** variable may be misrepresenting the effect of education on R&D spending. First, **EDU** is only informative of the school enrollment and offers no information on school quality. It may be the case that in developing countries there have been many successful initiatives what have increased secondary school attendance, yet these schools still lack the resources to produce well-trained graduates that would attract multinational business investment. Additionally, school enrollment figures may be over-inflated in some countries.

TRIPS Variables

TWENTY is positively correlated with R&D and strongly significant in all in estimations for all models that are corrected for autocorrelation. While **TWENTY** is positive in all models, the coefficient estimates vary widely. The statistically significant models predict that having a twenty-year patent duration can increase R&D funding by anywhere from .27 to 1.8 percent.

On the other hand, **PHARMA** is statistically insignificant in all estimations except the fixed effects model corrected for autocorrelation, with the pharmaceutical interaction terms and the OLS estimations with Newey-West standard errors. Additionally, the fixed effects and random effects estimations result in a negative coefficient, which is theoretically unexpected, but a plausible explanation is left for future work.

Interaction Terms

None of the **TWENTY** interaction terms are statistically significant, with the exception of the interaction between **TWENTY** and high income in the pooled OLS regressions with Newey-West standard errors. This single statistically significant coefficient would suggest that high-income countries that provide twenty-year patent protection receive a 1.6% increase in R&D funding above that which a low-income country would receive from providing twenty-year patent protection. However, the fact that most of the **TWENTY** interaction terms are not statistically significant suggests that there is no differential return to providing twenty-year patent protection based on country income level.

The **PHARMA** interaction terms were statistically significant in the random and fixed effects models not corrected for autocorrelation and in the pooled OLS model with Newey-West standard errors. The signs on these interaction terms were consistently positive in all of our models indicating that providing pharmaceutical patent protection provided a greater increase to R&D funding for middle and high income countries than the returns provided to low in come countries. The coefficient estimates for the statistically significant models range from a 0.7 to 0.8% greater increase in R&D funding for middle income countries and a 0.9 to 2.5% greater increase in R&D funding for high income countries.

Chapter 6. Conclusion

The positive and significant coefficients on the variable **TWENTY** seem to corroborate the arguments of TRIPS supporters that stronger protection of IPRs will help developing countries attract R&D and technology transfer from more advanced countries. Yet, the inconsistent and largely insignificant results of **PHARMA** would point the other way to corroborate TRIPS critics who argue that increased IPRs do not benefit developing countries. These results suggest that a case-by-case examination of all the provisions is necessary. The specific policy implications from this thesis are that twenty-year patent protection should be broadly undertaken, while the details of pharmaceutical patent protection need to be more carefully examined.

References

Branstetter, R. F., 2005. "Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence From U.S. Firm-Level Data." National Bureau of Economic Research Working Paper.

Chen, Y., Puttitanum, T., 2005. "Intellectual Property Rights and Innovation in Developing Countries." *Journal of Development Economics ,* Vol. 78, No. 2, pp. 474-493.

Deardorff, A., 1992. "Welfare Effects of Global Patent Protection." *Economica, New Series* Vol. 59, No. 233, 35-51.

Graff, G.D., Zilberman, D., 2004. "The Political Economy of Intellectual Property: Reexamining European Policy on GMOs." Presented at Seeds of Change: Intellectual Property Protection for Agricultural Biotechnology, University of Illinois, April 8-10.

Helfer, L. R., 2004. "Regime Shifting: The TRIPS Agreement and New Dynamics of International Intellectual Property Lawmaking." *Yale Journal of International Law* 29:1.

Maskus, K.E., 2001. "Intellectual Property Challenges for Developing Countries: An Economic Perspective." *University of Illinois Law Review* 2001, 457.

McCalman, P. 2001. "Reaping What You Sow: An Empirical Analysis of International Patent Harmonization." *Journal of International Economics* 55(1): 161-86.

Moschini, G., 2003. "Intellectual Property Rights and the World Trade Organization: Retrospect and Prospects." Iowa State University, Department of Economics, Staff General Research Papers, No. 10442.

Park, W.G., Ginarte, J.C., 1997. "Intellectual property rights and economic growth." *Contemporary Economic Policy* 15, 51-61.