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Do Intellectual Property Rights Encourage Innovative Activity?

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Abstract

The aim of this paper is to analyse the effect of intellectual property rights on innovative activity, and to determine whether strengthening protection through government intervention will be effective and beneficial. By applying a difference-in-differences analysis technique that has previously been unused in this area, we find further evidence to suggest that stronger intellectual property rights protection does improve the aggregate rate of innovation in a country, and that government intervention through the TRIPS agreement was a successful method of stimulating the effect.

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1. Introduction

Modern economic theory has increasingly emphasised the importance of technological development in endogenous growth models. The perceived benefits of advancing technology have led many to study the relationship between innovation and economic growth, mostly confirming these theoretical arguments. The determinants of innovation have therefore become very interesting, none more so than intellectual property rights protection (IPRP), one of the easier factors to manipulate. There is an ongoing debate as to whether stronger intellectual property rights protection encourages or hinders technological change. The main argument in favour of protection is that it enables and incentivises technological development by offering innovators a short-term monopoly to profit from. However concerns have recently emerged relating to the creation of costs and obstacles that could prevent further downstream developments and slow innovation. Despite the controversial nature, governments and international bodies have continued to pursue policies of increasing protection. The agreement on Trade-Related Intellectual Property Rights issues under the WTO is a major example of this, requiring all members to impose a minimum standard of IPRP.

The debate on IPRs exists in part because there is no cumulative empirical evidence to convince either way. By using a difference-in-differences technique, this paper analyses the effect of the most recent drive to increase IPRP, the TRIPS agreement. It adds to the thin and mixed literature by using a natural experiment analysis of the effect of protection on innovation intensity, and also acts as a policy effectiveness study, illustrating whether government intervention is successful. The results show that countries exposed to the TRIPS agreement saw an increase in innovation (proxied by R&D expenditures), implying the WTO policy had the intended effect. We therefore add another dimension to the argument that IPRP does have a strong positive effect on innovative activity.

2. Theoretical Framework and Review of Literature

A great deal of literature exists on the topic of innovation economics and the contributions of new technologies and processes to our economic and social welfare. Many papers have pointed theoretically and empirically towards a link between innovation and economic growth, supporting theories propounded by authors such as Schumpeter (1942) and Solow (1956). According to Grossman and Helpman (1991), innovation is a major determinant of a country's productivity growth, having an impact both through new developments, as well as the enhanced ability to exploit existing information (Cohen and Levinthal 1989). Mitchell (1999) goes as far as to say that over the last 50 years, advances in technology have been the single most important factor in creating economic growth in many economies. The existence of this link makes the determinants of innovation important for policymakers. A large amount of empirical analysis has been dedicated to understanding what drives innovation. Teitel (1994) and Grande and Peschke (1999) conclude that economic prosperity (per capita income) and population are the major determinants of R&D spending. Yang and Maskus (1999) find factor endowments and imitation costs significant. Furman, Porter and Stern (2002) and Varsakelis (2006) identify education quality as being an important explanatory variable.

This paper focuses primarily on the contribution of intellectual property rights, which have been highlighted in theoretical studies as being of prime importance alongside other institutions (Lundvall et al., 2002). It is a central assumption of capitalism that property rights enable and encourage the owner to develop the property and guide incentives to achieve a greater internalisation of externalities (Demsetz, 1967). It became apparent that these principles could be applied to intangibles, and Sherman and Bently (1999) point to the British Statute of Anne 1710 and the Statute of Monopolies 1623 as the origin of copyright and patent law respectively. The term intellectual property was not used until the nineteenth century, but since then many countries have developed systems of IPRP.

Kanwar and Evenson (2003) point to the fact that innovations are partially non-excludable and are a non-rival good, as the basis of the argument in favour of IPRP. Economic theory suggests that IPRs provide the prospect of protected reward that should encourage creative and technological advance. Through bestowing temporary monopoly power to an innovator, firms and individuals can be rationally incentivised to invest in and further develop new ideas, as they can expect remuneration for their costs and efforts. Carrying out research and development and bringing an invention to market is a long and expensive process with no guarantee of success. When success is achieved, if there are no IPRs, “free-riders” who did not incur any cost of investment can imitate the discovery and appropriate its value, reducing profit to the innovator. The concept lends itself to game theory. A particularly clear example is given in Ramanujam (2006):

Firm B

Firm A		Invest	Don’t invest
	Invest	(3, 3)	(0, 5)
	Don’t invest	(5, 0)	(1, 1)

Game 1

Firm B

Firm A		Invest	Don’t invest
	Invest	(10, 10)	(6, -2)
	Don’t invest	(-2, 6)	(1, 1)

Game 2

This is a simple prisoner’s dilemma game. In Game 1 there are no IPRs, and consequently if the players choose different strategies to each other, he who invests incurs cost that cancels out a reduced benefit, while his opponent does not invest and gets the development for free. The Nash equilibrium in Game 1 is such that neither firm will invest which is a sub-optimal outcome. Game 2 shows payoffs representing an environment where there is IPRP. Now investing has a bigger payoff as inventors are given some monopoly power, and failing to invest when the other firm invests results in a loss as the non-investing firm cannot imitate or compete. The Nash equilibrium here is for both firms to invest in R&D, which is Pareto optimal. Economies benefit further as innovations are openly disclosed in an IPRP system, rather than being protected through secrecy. It follows that increasing intellectual property rights protection should contribute a positive effect to the economy, a view supported by Edquist (1999) who emphasises the importance of IPRs in his ‘Innovation Policy’.

Many papers have empirically shown a link between IPRP and economic growth. Gould and Gruben (1996) find evidence to support the theory that IPRP is a significant determinant of growth, particularly in relatively open economies. Falvey, Foster and Greenaway (2004) find that in low and high-income countries there is a positive and significant relationship, but this is not the case for middle-income countries. Lai (1998) similarly establishes that wealthy countries see a positive effect, and for less well-off nations, it depends on whether imitation or multinationalisation is the main channel of international production transfer.

This paper however seeks to understand the relationship between IPRP and innovative activity. The effect of IPR on economic growth involves first, the effect of protection on innovation, and second, the effect of innovation on economic growth. Depending on the contribution of innovation to growth, the value of IPRP may be distorted when analysing it directly with respect to economic growth. It is therefore preferable to look at the effect of protection on innovative activity itself. Varsakelis (2001) tests whether national culture, patent protection, and the degree of openness of an economy are determinants of R&D intensity, concluding that countries with a strong patent protection framework invest more in R&D, and that national culture is correlated to R&D investment. However the model used isn't particularly well specified as it contains few explanatory variables, increasing the likelihood of omitted variable bias, and the paper uses cross-sectional regression analysis. Bebczuk (2002) also deals with the issue of R&D determinants, finding the protection of property rights to be crucial in fostering innovative activities, alongside other variables such as tertiary education and financial development. This paper is reasonably well specified, however works on less than one hundred observations and is a pooled OLS cross-sectional analysis. Panel data could potentially provide a stronger conclusion. Kanwar and Evenson (2003) do provide evidence using panel data over the period 1981 to 1995 to prove the significance of IPRs as incentives for spurring innovation. The regression contains many sensible explanatory variables, making the results more robust. However the regression only has two data points for each country and covers only 32 countries. The paper also fails to explore endogeneity, a major issue in all previous studies.

Most papers have found a positive relationship between IPRs and innovation, and while we expect to find this result, the effect remains contentious. Mansfield (1986), in his survey based analysis of the effect of protection, found that in the majority of industries, patents don’t play a large role in the decision to innovate. Lerner (2002) looked at the effect of policy changes that strengthen patents and found that in general this did not spur innovation. Some suggest that IP laws can actively discourage innovation. These theories contend that downstream investment can be discouraged as IPRs make it impossible or more costly to use upstream innovations in any future developments. Heller and Eisenberg (1998) promote the theory of an ‘anticommons’ effect, suggesting that particularly in scientific research, the proliferation of IPRs inhibits research, as rights held in previous discoveries constitute obstacles. Through analysis of scientific paper citation rates, Murray and Stern (2005) find empirical evidence to suggest a modest anticommons effect. There is also concern about the strategic use of an IPR system, with producers inclined to accumulate ‘sleeping patents’ in an effort to preserve market share (Gilbert and Newbery, 1982). Chin and Grossman (1988) suggest that IPRP can prevent the dissemination of available know-how, and they emphasise the importance of striking a balance between the need to reward purveyors of new information and the need to maximise the benefit of developments.

The theoretical and empirical discussion is therefore ambiguous as to whether IPRs are beneficial, and to what extent governments should develop their strength. Penrose (1951) stated that:

> “If national patent laws did not exist, it would be difficult to make a conclusive case for introducing them: but the fact that they do exist shifts the burden of proof and it is equally difficult to make a really conclusive case for abolishing them.”

This paper hopes to analyse specifically the effect of IPRP on R&D spending using a difference in differences technique. It aims to shed a new light on the issue and contribute to the existing literature, using a technique yet to be applied to the area, and also evaluating the effect of IPRs in a setting of international policy change, which is of major interest to governments across the world.

3. Empirical Methodology

3.1 Data and Independent Variable

The analysis in this paper is based on a dataset that has been compiled from numerous sources giving data across 121 countries over a ten-year period from 1998-2007 (see Appendix). This gives a total of 1210 observations, however due to missing data, when the full regression is implemented this comes down to 258, which is still substantially more than has been analysed in previous work.

To proceed with the estimation we must first clarify how we will measure innovation. The true benefits of new technologies are not seen until they are introduced into the market. Many innovations may exist and yet not be exploited commercially because they may not be economically viable. Therefore we should aim to explain the adoption or economic exploitation of new technologies rather than the generation of innovations *per se*. However in practice, this would be very difficult to measure. In this analysis, gross expenditure on research and development *(GERD)* will be used as a proxy for innovative activity, as has been the case in the majority of papers analysing innovation. While R&D spending does not necessarily result in the use of new technology, it is a closer proxy than measures of capital investment, and encompasses more activity than measures of patent applications. The data we use for R&D expenditure is measured as a percentage of GDP to give us an idea of intensity[1]. On average, across the sample, research and

[1] For analysis, in line with previous literature, we use the natural logarithm of R&D spending.

development spending comprises around 1.12% of a countries GDP, with a minimum of 0.006% and a maximum of 4.24%. There is a growth trend over the period, although most of this occurs towards the back end. When split into treatment and control group, there is a similar trend initially, but an obvious difference from the year 2002, with the treatment group catching up with the control group (see Appendix). This indicates that there may be some effect owing to the TRIPS agreement, which we assume to take effect for our control group from the beginning of 2002. The agreement was signed in 1995, and some countries were expected to meet the requirements by 1996. However these countries were those who would see little change in their intellectual property rights protection levels, as they were already at the level required and wouldn't offer any variation. This paper therefore analyses the effect on those countries that were asked to implement the changes by 2000. The assessment of whether they had achieved the standards was not published until the end of 2001, which is why we class 2002 as the first year after the treatment, as this is when people would have been made aware of the changes.[2]

We will therefore implement the difference in differences technique taking the year 2002 as the event time, enabling us to assess the impact of the TRIPS agreement on innovative activity. We take data on R&D spending from before and after 2002 on two groups, one who is exposed to the treatment, and one who is not, acting as a control. The treatment group in this analysis is all those countries required to implement the requirements of the TRIPS agreement by

[2] Information on TRIPS available at http://www.wto.org/english/tratop_E/trips_e/trips_e.htm

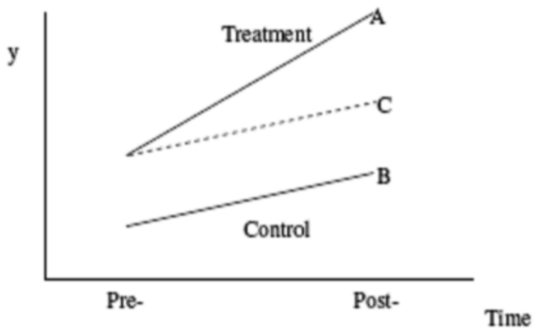
the year 2000, and the control group comprises a group of countries that did not sign up to the TRIPS agreement, and those who were required to implement the changes either in 1996, or not until 2016, and therefore are not affected by the agreement over the period studied.

While many papers that undertake a difference in differences regression use just two data points either side of the event, we will be using 4 years before and 6 years after the event. This is beneficial, as it will provide a more accurate indication of the effect of the treatment, reducing the possibility of some seasonal or cyclical effect affecting levels of R&D in the pre or post period. It also allows for the fact that any increase in R&D expenditure may not be immediate, as it will take companies time to implement new research programs. By taking the average R&D expenditure for both treatment and control groups in the periods before and after the event, we can calculate how the two groups change over the time period. The difference between these two figures is the difference in differences estimator.

Table 1			
	Pre	Post	**Difference**
Treatment	-0.98482	-0.76973	0.215091
obs	*98*	*138*	
Control	0.022754	-0.14495	-0.1676996
obs	*128*	*228*	
Difference	1.007579	0.624788	**0.3827906**

This figure estimates the impact of the TRIPS agreement, assuming R&D expenditure in the treatment group would have changed by the same amount as the control group had there been no TRIPS agreement. This is a relatively crude measure, and leaves many factors unaccounted for. Figure 1 illustrates what it shows.

Figure 1.



There is an initial difference between the treatment and control group, and both change over the event but by different amounts. By assuming that the base trend will be the same, we expect the treatment group would have ended up at point C without any treatment effect. The difference in differences estimator therefore gives us the difference between point A and C, showing the effect that the treatment has had on the trend of the treatment group.

The same outcome can be achieved by OLS regression:

$$GERD = \alpha + \beta_1 post + \beta_2 treat + \beta_3 treat * post$$

where *GERD* is the natural log of gross expenditure on research and development, *treat* is a dummy variable that takes a value of 1 if the observation is from the treatment group, *post* is a dummy variable that takes a value of 1 if the observation is in the year 2002 or after, and *treat*post* is an interactive dummy that says if the observation is from a country in the treatment group and in 2002 or later. The coefficient β_3 is therefore the difference in differences estimator. The benefit of using a regression is that it allows us to add explanatory variables to better control for time and cross-country variations. Given that we are taking a number of years either side of the event, we will replace the variable *after* with a set of year dummies.

Several control variables that have been suggested to influence R&D expenditure will also be included in the regression, which is now specified as:

$$GERD = \alpha + \beta_1 Y + \beta_2 treat + \beta_3 treat * post + \beta_4 C$$

where Y is a set of year dummies and *C* is a set of control variables.

3.2 Control Variables

While analysis of mean characteristics of the treatment and control groups does not suggest any problematic differences (see Appendix), to ensure comparability and improve the accuracy of the regression, Meyer (1995) suggests that we control for observable individual characteristics that could differ between the two groups and influence R&D expenditure. The control variables that will be used have been selected from related literature on the determinants of R&D expenditure. In accordance with the previous literature, natural logs of these will be used in the regression.

Several papers suggest using some measure of GDP. R&D has been found to be pro-cyclical, and determines the market size for future inventions, which forecasts any projects profitability (Bebczuk, 2002). There are several issues with using GDP itself, primarily reverse-causation and endogeneity. Kanwar and Evenson (2003) therefore suggest using two variables to capture this; gross domestic savings as a percentage of GDP, lagged one period, to capture the supply side effect (internal savings available for R&D investment), and the ratio of current GDP per capita to GDP per capita lagged one period to capture the demand-pull effect.[3] The regression will therefore contain these two variables *(S_{t-1})* and *(Demand)*.

Human capital has been identified as being central to R&D (Romer, 1990). It is an enabling factor, which is essential for innovative activity. While some studies use variables such as literacy rates, the most popular measure focuses more around tertiary education, as this is the level at which research and development predominantly takes place. As in Bebczuk (2002), tertiary school enrolment figures *(Tert)* will be used.

Political instability is an important factor influencing investment decisions. R&D can be a lengthy and costly process and is inherently risky. Instability greatly increases this risk, and could make it irrational to invest in certain projects, reducing levels of R&D. Kanwar and Evenson (2003) also point to the diversion of resources away from investment during instability. To capture this I have used a political stability index from the World Bank to construct a dummy variable *(Unstable)* for each country in each year, that takes a value of 1 if a country scored 0 or below (and were therefore considered unstable) and a value of 0 if they scored above zero.

The financial development of the country also needs to be taken into consideration. R&D requires large amounts of funding, with returns often unavailable until long into the future. Due to the risky nature of such investment, most financing occurs internally, which should be captured by our

[3] The variable measuring demand has many of the problems related to GDP itself, and is likely to have a lesser effect than savings, however it will be included in the initial regression to ascertain if there is anything to be drawn from it as Kanwar and Evenson suggest.

savings variable. However Bebczuk (2002) suggests that some R&D will be financed externally, and the availability of credit along the way can also be very useful to help facilitate problems. A measure of domestic credit available to the private sector as a percentage of GDP *(Cred)* will therefore be included to encompass this, and act as a measure for general financial development. Kanwar and Evenson (2003) add that real lending rates could be used to measure the cost of borrowing money, and also reflect the opportunity cost of internal funds *(Lendr)*.[4]

Economic openness has also been included in most previous studies, under the premise that with increased competition from abroad, firms are forced to invest relatively more in R&D, and cross-border technology flows may result in knowledge spillovers that have a positive impact on R&D. Some however find the opposite effect. Bebczuk (2002) attributes this to the fact that as a country becomes more open, it can reduce its R&D spending in areas where it has a comparative disadvantage, as it can still benefit from the innovation in these areas from other countries. To examine this, trade relative to GDP *(Open)* will be included.

The above discussion gives the final estimation model:

$$\begin{aligned} GERD &= \alpha + \beta_1 Y + \beta_2 Treat + \beta_3 Treat * Post + \beta_4 S_{t-1} + \beta_5 Demand \\ &+ \beta_6 Tert + \beta_7 Unstable + \beta_8 Cred + \beta_9 Lendr + \beta_{10} Open \end{aligned}$$

[4] While this will be experimentally included, I imagine that credit to the private sector will prove a better explanatory variable, and the two will likely explain much the similar effect.

3.3 Estimation Issues

The difference in differences technique has several advantages over cross sectional or panel-data analysis. When using a natural experiment, Meyer (1995) suggests that the variation in the explanatory variable can plausibly be considered exogenous. This helps to solve one of the key issues with previous studies that have been criticised for not considering endogeneity. However there may still be endogeneity issues involved the laws of interventions themselves (Bertrand et al., 2004). For example in this study, the decision to participate in the TRIPS agreement may be in some way influenced by levels of R&D spending. However the agreement was imposed on all members of the WTO, so there was no individual decision from each nation as to whether they would introduce the changes. Linking the effect of R&D spending to WTO membership is much more tenuous, giving more plausibility to the concept of this being an exogenous shock to intellectual property rights.

One of the major criticisms of the difference in differences technique comes from Bertrand et al. (2004). They point to how many papers using the technique focus on many years of data and serially correlated outcomes, which will underestimate standard errors and cause researchers to attribute significance where there is none. To account for this we will cluster the standard errors by country, which groups the standard errors across each nation, rather than for each observation. Initial regressions not using clustered standard errors gave very similar results, and clustering in our case didn't have much impact on values or significance. Bertrand's criticism implies that we may have found some move towards insignificance, which does not occur, adding strength to the robustness of the results.

Selecting an appropriate control group is one of the most important parts of the difference-in-differences regression. In our case, we were somewhat limited in choosing a control group, and there are some differences by definition between the treatment and the control. Our control group contains the wealthiest and poorest countries, while the treatment group contains mostly developing countries. There is some possibility of selection bias. However the study of pre-existing trends before the event gives some plausibility to the use of the control group, as the two tend to move in parallel, and we deal with this as best we can by controlling for many of the observable differences in the regression.

4. Results and Discussion

Table 2 shows the results of the regression analysis. Column (1) contains the basic difference-in-differences regression, which provides the same result as comparing the means from both groups before and after, and calculating the difference, as previously done in Table 1. The small difference in the two estimators occurs as in the regression we have included a set of year dummies. Comparing the means is equivalent to having just one time dummy variable that takes a value one if in the post period, making it slightly less accurate. In the OLS regression, the difference-in-differences estimator is the coefficient on the variable *treat*post.* The positive and highly significant value indicates that those countries in the treatment group, who were forced to improve their intellectual property rights to meet a minimum standard, saw a larger increase in their R&D expenditure over the period compared to those in the control group. While this is the result we were expecting to find, without adding any controls variables to the regression we cannot be sure that the estimated difference is caused entirely by participation in the TRIPS agreement.

Column (2) shows the full regression model, including the control variables that have been suggested in previous literature. The majority of the control variables exhibit the suggested sign and show significance in agreement with the research. Savings, tertiary education and credit available to the private sector all have a positive and significant effect on R&D expenditure. We find economic openness to have a significant and negative effect on R&D, which goes against more traditional theories but agrees with Bebczuk (2002) as explained above. The demand variable is very insignificant in this model, confirming our expectations that much of its effect would be better explained by lagged savings. The real lending rate of interest is also insignificant, which is not surprising due to its correlation with credit, which we assumed would be a better explanatory variable. By including the set of control variables, we can explain more of the variation in R&D expenditure and refine the effect attributed to the difference in differences estimator. It remains positive and significant.

Table 2: Dependent Variable: *GERD* (Gross Expenditure on Research and Development)

Variable	(1)		(2)		(3)		(4)	
y1999	0.098	(1.43)	(dropped)		(dropped)		(dropped)	
y2000	0.052	(0.61)	0.159	(1.20)	0.164	(1.21)	0.165	(1.23)
y2001	-0.042	(-0.44)	(dropped)		(dropped)		(dropped)	
y2002	-0.330	(-2.19)	-0.000	(-0.00)	-0.021	(-0.13)	-0.010	(-0.06)
y2003	-0.220	(-1.37)	0.041	(0.25)	-0.009	(-0.05)	0.025	(0.15)
y2004	-0.158	(-0.97)	0.046	(0.27)	-0.006	(-0.03)	0.025	(0.14)
y2005	-0.265	(-1.54)	0.012	(0.07)	-0.156	(-0.08)	0.007	(0.04)
y2006	0.046	(0.35)	0.077	(0.48)	0.120	(0.64)	0.141	(0.77)
y2007	0.13	(0.89)	0.001	(0.00)	0.051	(0.21)	0.086	(0.38)
Treat	-1.01***	(-4.20)	-1.022***	(-4.82)	-1.016***	(-5.30)	-1.009***	(-5.12)
treat*post (DiD)	**0.409*****	**(2.73)**	**0.301***	**(1.69)**	**0.356****	**(2.15)**	**0.338****	**(2.13)**
S_{t-1}			0.563**	(2.13)	0.579**	(2.40)	0.586**	(2.47)
Demand			-0.042	(-0.11)	0.169	(0.42)		
Tert			0.271***	(3.23)	0.257***	(3.38)	0.258***	(3.42)
Unstable			-0.475***	(-3.24)	-0.429***	(-3.07)	-0.428***	(-3.06)
Cred			0.331***	(2.75)	0.322***	(3.18)	0.317***	(3.24)
Lendr			-0.055	(-0.36)				
Open			-0.567***	(-3.97)	-0.552***	(-4.11)	-0.551***	(-4.10)
Constant	-0.002	(-0.01)	-1.373	(-1.26)	-1.527**	(-2.07)	-1.541**	(-2.12)
F-test stat	4.00		15.36		14.48		13.25	
R-squared	0.1308		0.6878		0.6578		0.6578	
Observations	592		258		320		320	

All variables in natural logs, t-statistic in parenthesis
* = Significant at the 10% level
** = Significant at the 5% level
*** = Significant at the 1& level

The main concern with the results is that due to missing data, there is insufficient observations in the years 1999 and 2000, resulting in the time dummy effects being dropped. While there are enough to carry out the regression, this could result in inaccuracies as we have less data available in the pre-treatment period. However until fuller data exists, this problem cannot be solved unless control variables are removed, which would reduce the explanatory power of the model.

Columns (3) and (4) show the results if we remove the questionable and insignificant control variables *Lendr* and *Demand*. There are only small changes in the coefficients, including the difference-in-differences estimator. The final specification in column (4) implies that countries in the treatment group, who made changes to their intellectual property rights protection according to the TRIPS agreement, saw a 33.8 % increase in research and development intensity relative to those in the control group when compared before and after 2002. This adds further support to the literature that suggests increased intellectual property rights protection has a positive impact on research and development expenditure at the aggregate level. It appears that if there is any negative impact of IPRs on innovative activity caused by an anti-commons effect or the restricted access to new developments, it is dramatically outweighed by the positive impact of developing better incentive structures for research programs. In line with previous findings, when studied at the aggregate level, intellectual property rights protection appears to be an important determinant of innovative activity. From taking the difference-in-differences perspective, we have proved this using another technique, and can emphasise causality with more confidence than those using cross-sectional and panel data approaches.

From a policy effectiveness point of view, our study also assesses the effectiveness of the TRIPS agreement as a global initiative to try and stimulate technological development. The results illustrate that the TRIPS policy was successful in directly stimulating growth in research and development spending, which can be taken as a proxy for innovative activity. This adds another dimension of strength to the policy implications arising from this study. While the results prove that a country can expect to experience an increase in research and development spending if it strengthens its intellectual property rights protection, they also prove that government intervention is successful in generating such a change.

5. Concluding Remarks

The result of our difference-in-differences analysis shows that the TRIPS agreement had a strong positive effect on research and development spending, which we take to indicate an increase in the rate of innovative activity. This paper adds to the empirical literature that is building to verify the hypotheses that at the aggregate level, stronger intellectual property rights have a positive effect on innovation. By illustrating the success of the TRIPS agreement, the policy implications that can be drawn from this analysis are strengthened and imply that governments should seek to improve the strength and effective implementation of IPRP. This will contribute to increasing levels of innovation, which has been extensively proven in theory and empirics to contribute to economic growth and improved social welfare.

This analysis by no means completes the intellectual study of such an important and broad topic. Using aggregate data gives a good understanding of the total effect of such policy change on a country, however it is a somewhat blunt view. Further work could be undertaken to understand the effects at the industry level, giving perhaps further insight into where the advantages and disadvantages of such policies lie. This may give a better indication of the appropriateness of strong intellectual property rights for individual countries.

A further extension could involve analysing the effect of the TRIPS agreement with more focus on the development level of the countries. Several papers suggest that countries at different stages of development will be affected by intellectual property rights protection in different ways, so it would be interesting to see how the introduction of minimum standards has affected each group. Work could consider how the international balance of innovation changes, whether there is any shift the location of R&D activity and whether the efficiency of global innovation has been improved.

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7. Appendix

Data Sources

Variable[5]	Name	Source
Gross expenditure on research and development as a % of GDP	*GERD*	Unesco Statistical Yearbooks
Dummy variable with value 1 if required to incorporate minimum standards of intellectual property rights by 2000	*Treat*	WTO website – http://www.wto.org/
Lagged Savings as a % of GDP	*St-1*	Constructed from World Bank WDI Database (2008)
Measure of demand – $\frac{GDP_t}{GDP_{t-1}}$	*Demand*	Constructed from World Bank WDI Database (2008)
Enrolment in tertiary education	*Tert*	Constructed from World Bank Edstats Database (2008)
Dummy variable with value one if the observation was politically unstable.	*Unstable*	World Bank Aggregate Governance Indicators Database (2009)
Credit available to the private sector as a % of GDP	*Cred*	World Bank WDI Database (2008)
Real lending rate	*Lendr*	World Bank WDI Database (2008)
Trade value as a % of GDP	*Open*	World Bank WDI Database (2008)

[5] Variables all in natural logs, other than dummy variables.

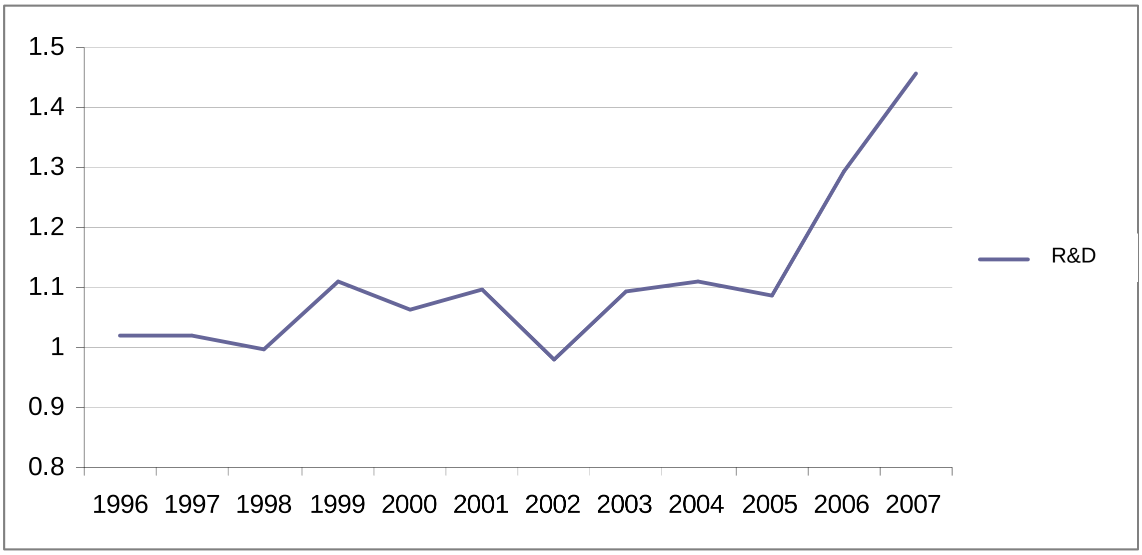
Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
GERD	592	1.118835	1.024426	0.0061351	4.772824
Demand	1160	1.070176	0.1307232	0.3380204	2.132347
St-1	1008	19.12716	10.14872	-40.22571	56.90038
Cred	1137	53.95307	51.69609	0.6827951	319.7201
Tert	798	31.26004	25.11861	0.2913504	94.87337
Open	1119	84.37182	55.79602	15.865	456.6461
Lendr	955	18.35401	30.53511	1.664833	578.9583
Unstable	960	0.5364583	0.4989289	0	1

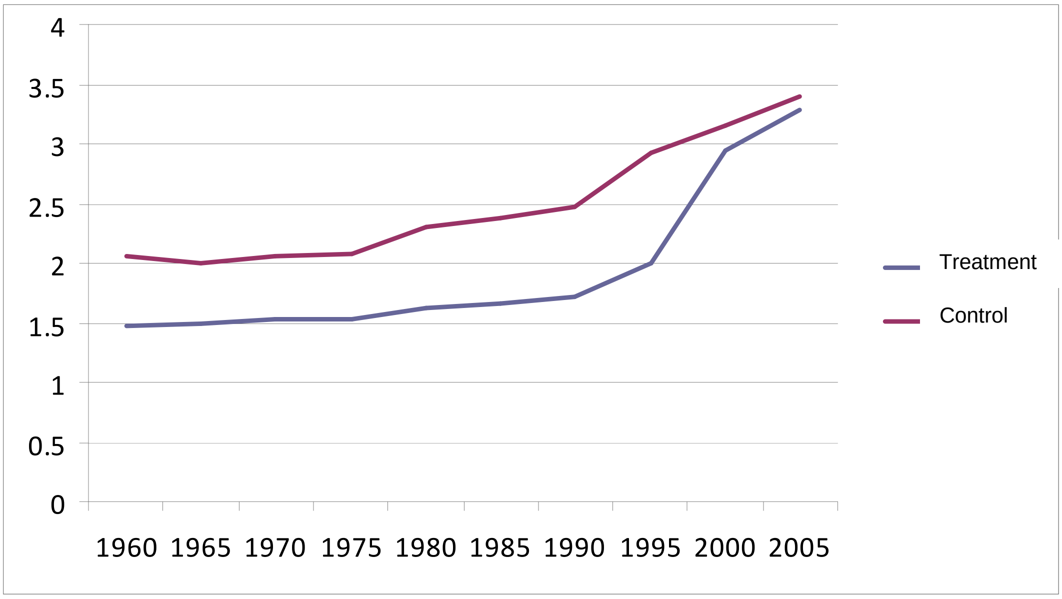
Correlation Matrix

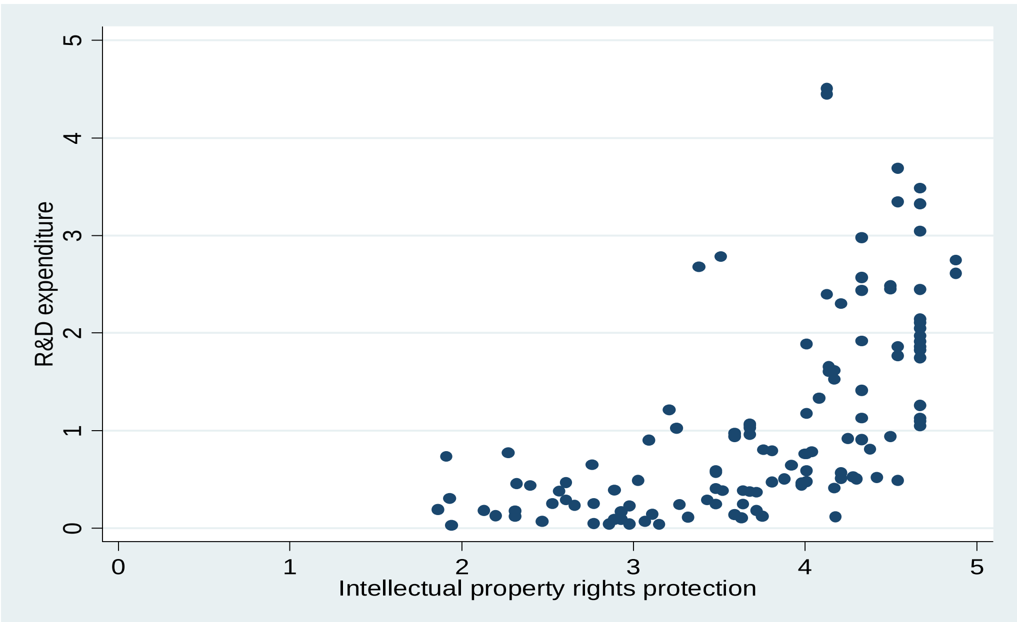
	Demand	***St-1***	***Lendr***	***Open***	***Tert***	***Cred***
Demand	1.0000					
St-1	0.0882	1.0000				
Lendr	-0.1489	-0.3886	1.0000			
Open	0.1165	0.1099	-0.0910	1.0000		
Tert	0.1037	0.2256	-0.4174	0.0894	1.0000	
Cred	-0.0564	0.2561	-0.4309	0.0166	0.5556	1.0000

Trend in R&D Spending



Trend in intellectual property rights[6]





[6] Figures taken from Ginarte and Park (2005)

Countries included in study

Control		Treatment	
Algeria	Malawi	Argentina	Papua New Guinea
Angola	Mali	Botswana	Paraguay
Australia	Mauritania	Brazil	Peru
Austria	Mozambique	Cameroon	Phillipines
Bangladesh	Nepal	Chile	Poland
Belgium	Netherlands	China	Singapore
Benin	New Zealand	Columbia	Sri Lanka
Bolivia	Niger	Congo	Swaziland
Bulgaria	Norway	Costa Rica	Thailand
Burkina Faso	Panama	Cyprus	Trinidad and Tobago
Burma	Portugal	Dominican Republic	Tunisia
Burundi	Romania	Egypt	Turkey
Canada	Russian Federation	El Salvador	Uruguay
Central African Republic	Rwanda	Fiji	Venezuela
Chad	Saudi Arabia	Gabon	Zimbabwe
Czech Republic	Senegal	Ghana	
Denmark	Sierra Leone	Grenada	
Ecuador	Slovak Republic	Guatemala	
Ethiopia	Somalia	Guyana	
Finland	South Africa	Honduras	
France	Spain	Hong Kong	
Germany	Sudan	India	
Greece	Sweden	Indonesia	
Haiti	Switzerland	Isreal	
Hungary	Syria	Ivory Coast	
Iceland	Taiwan	Jamaica	
Iran	Tanzania	Kenya	
Iraq	Togo	Korea	
Ireland	Uganda	Malaysia	
Italy	Ukraine	Malta	
Japan	United Kingdom	Mauritius	
Jordan	United States	Mexico	
Liberia	Viet Nam	Morocco	
Lithuania	Zambia	Nicaragua	
Luxembourg		Nigeria	
Madagascar		Pakistan	

Split by Control and Treatment Groups

treat	Freq.	Percent	Cum.
0	700	57.85	57.85
1	510	42.15	100
Total	1,210	100	

	Treatment group					Control Group				
Variable	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
gerd	236	0.762122	0.991909	0.034903	4.772824	356	1.355307	0.977313	0.006135	4.238408
demand	498	1.061512	0.140033	0.33802	2.132347	662	1.076693	0.122964	0.637229	1.65962
save	391	21.06443	10.29379	-6.77287	56.90038	617	17.89948	9.868861	-40.2257	54.44001
cred	494	47.73006	43.37302	0.682795	256.3967	643	58.73405	56.84699	1.615531	319.7201
tert	310	22.54754	15.93383	1.296651	67.13381	488	36.79463	28.15082	0.29135	94.87337
open	474	92.3698	66.62416	15.865	456.6461	645	78.49424	45.41745	18.96889	405.1142
lendr	438	22.02614	42.37558	5	578.9583	517	15.243	13.48817	1.664833	103.1602
unstable	408	0.585784	0.493191	0	1	552	0.5	0.500454	0	1

R&D by Treatment and Control Group