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Enforcing Intellectual Property Rights: Estimating the Optimal Level of Enforcing Patent Protection

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> *"Just as energy is the basis of life, and ideas the source of innovation, so is innovation the vital spark of all human change, improvement and progress."*
> *-Theodore Levitt*

As international integration of economies increases, intellectual property rights (IPRs) become increasingly important to developing economic prosperity. The importance of IPRs has been clearly addressed in many recent articles but there remains a question as to whether or not countries truly enforce the IPRs to which they claim.

Intellectual property rights give innovators, both individuals and firms, the right to control and derive benefits from writing (copyright), inventions (patents), processes (trade secrets) and identifiers (trademarks) (definition provided by American Friends Service Committee). IPRs are important to growth of an economy because they allow for an increase in incentives for parties to pursue new forms of innovation. IPRs are important because they have the ability to affect the stock of intellectual knowledge in a country. However, IPRs are dependent on the ability and/or willingness of a country to enforce them. It is possible that the benefits of enforcing IPRs do not always outweigh the costs. Consequently, a country may change its enforcement level in order to implement its specific policy.

A country's stance on IPR enforcement depends on its level of development and will represent its cost-benefit analysis behind the act of enforcing. In other words, a country may decide that the costs of enforcement actually hinder the country's economic well-being, enforcing less would then increase their economic gains. For example, in a developing country the total cost of education would be affected by the cost of education commodities and IPRs would directly affect these costs. If the country has weak IPRs than the cost of education would decrease because of an increase in pirated software (e.g. word processor) and copying of copyrighted material (e.g. textbooks).

The goal of my research is to develop a model that estimates the level of IPR enforcement that countries have during different development stages. It will develop a new measure for enforcement that attempts to capture the *actual* level of enforcement, where as in the past mainly *statutory enforcement* has been observed.

I am going to attempt to observe and distinguish the point at which the benefits of increasing *true enforcement* outweigh the costs. It has been previously stated that higher levels of IPR protection are not necessarily 'better,' the level of protection in a country is "one which balances the dynamic benefits and costs of protection"(Ginarte and Park 1997). Thus the level of *true enforcement* in a particular country should not have a linear relationship with a country's level of GDP per capita (GDPPC). My claim is that a country's level of *true enforcement* changes based on its current stage of development and its level of GDPPC growth.

The remainder of this paper is organized as follows: Part I recognizes previous studies that were most useful to writing and motivating this paper. Part II exhausts the theory behind the importance of IPRs, IPR enforcement and the theoretical costs and benefits of IPRs. Part II continues with addressing why a country has an optimal level of *true enforcement* based on a cost-benefit analysis. A model that aims to capture the cost benefit analysis is then suggested. Following the discussion of the model, Part III reviews the definition and nature of the data. Part IV describes the methodology behind creating a new measure, *true enforcement*, which discriminates between statutory enforcement and *actual* enforcement. After creating *true enforcement*, a basic model is developed and discussed. Part V presents the results and analyzes the data of the regressed model(s). Part VI revisits the advantages of having a more accurate measure of actual enforcement levels and addresses the application of the measure by innovators in order to develop a better product strategy.

I. Literature Review

While previous work forms the expectations about IPRs and their enforcement, none have attempted to develop a way of capturing *true enforcement.* I will discuss each source in order of its importance to the paper.

Ginarte and Park (G&P, 1997) developed an index that gauges the level of intellectual patent protection during 1960-1990 for 110 countries. The significance of their index is that it is a more continuous measure than that of the previous available index created by Rapp and Rozek(1990). Rapp and Rozek originally created a dichotomous index based on whether or not a country was involved in certain forms of protection, they also addressed the costs and benefits of IPR protection within developing countries.

The Ginarte and Park index took this a step further by creating components to five major categories; coverage, membership, loss of protection, enforcement and duration, each of which were partitioned into different sections. This study finds that developed countries tend to provide more intellectual patent protection. It also suggests that the findings support the fact that R&D levels should increase in order to act as an incentive to increase patent protection levels.[1]

In Maskus' (2000) book, *Intellectual Property Rights in the Global Economy*, he discusses the pros and cons of methods currently used to quantify IPRs. The three methods observed are: a qualitative approach (using membership and National Trade Estimate Reports of the U.S. Trade Representatives), indices that analyze IPR legal structure components (Rapp and Rozek 1990, Ginarte and Park 1997), and the survey/perception approach which reviews multinational enterprise(MNE) managers (Sherwood 1997 World Economic Forum). Maskus concludes that protecting IP has increased globally along with adopted treaties, and enforcement tends to lag behind legislative changes.

Chiang (2004) discusses the importance of IPR enforcement to develop better trade relations. He approaches the situation based on U.S International Trade Commission (USITC) complaints, which are based on cross-boarder violations. This study places emphasis on the costs and benefits of taking a case to court. More importantly, this study uses corruption measures to proxy a country's level of efficient enforcement and it attempts to explain the

existence of court cases. Chiang finds the "evidence shows that corruption indicators do not explain the existence of a case but do influence the number of cases filed"(Chiang 2004).

It is important to note that most of the countries used in this study are developed and would therefore have lower levels of corruption. In several regressions Chiang uses both the corruption and Ginarte and Park index to explain the number of court case filings by U.S. firms. Chiang uses the G&P index as a whole to proxy patent protection, it is not broken down in order to observe just enforcement. Chiang finds that investigations of violations are more frequent in countries that have intense import competition. Furthermore, Chiang finds that "greater technology access to U.S. patents by respondent firms increases violation filings, especially in countries where corruption levels are higher"(Chiang 2004).

All of these sources have motivated this paper towards developing a new measure for IPR enforcement. While some may have mentioned the downfall of their index and/or measurements, none have adjusted their data observations to represent a measurement of enforcement that is closer to portraying actual levels of enforcement within an economy. It is extremely important to develop a measurement that is more affective at capturing real enforcement levels because in most countries the perception of enforcement is never the same as the actual level. Estimating the actual level of enforcement during a specific time will aid in developing a more robust model that represents an economy's IPR regime.

The ability to estimate actual levels of IPR enforcement will empower innovators' choice of IPR pursuit. If a country has not reached a point where they believe enforcing IPRs is beneficial to their economic well being than it would be more efficient for an innovator to pursue a different avenue of developing their innovative good. With a more accurate measurement of enforcement an innovator will be able to make more informed decisions (e.g. develop a more successful marketing/pricing scheme for their good). [2]

II. Theory

This section will first discuss the importance of IPRs on economic health, the costs and benefits of increasing IPRs and the motivation to enforce them. This section then lays out a mathematical approach to how a country chooses an optimal level of IPR enforcement.

Economic Growth

Sustainable positive economic growth is an everlasting concern for countries. It is a common belief among economists that the driving source of GDP growth is technological change (A). Whether technological change is created endogenously or exogenously, its ability to increase productivity, number of jobs, income, and reduce costs of production is quite obvious (see appendix A for graphical explanation). It has been stated that IPRs affect economic growth indirectly through the accumulation of factors such as R&D and are associated with growth because of increasing investment levels (Ginarte and Park 1997, Romer 1989). This paper assumes we are going to assume that a country can affect its level of technological change by augmenting their IPRs.

Romer(1989) considers human capital to be the main determinant of technological change. Human capital is made up of several components, primarily, level of education and research and development. Intellectual property rights have a strong ability to affect technological innovation because they create an incentive for individuals and firms to take part in research and development. This paper assumes that regardless whether or not IPRs are available in a given country the innovator will actually respond to the level at which the available IPRs are enforced. A country's stock of technological knowledge is therefore rooted in its devotion to creating incentives to pursue more research and development. Without enforced intellectual property rights (IPRs) countries lack an efficient system that allows them to propel domestic innovation, increase their level of incentives to develop new and improved materials, and reach their full growth potential.

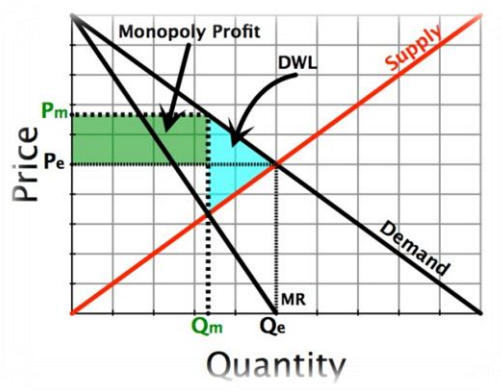
Regardless of a country's growth and development level it is interesting to note that several of these countries do in fact have laws that enable protection of IPRs; however, high levels of IPR violation, domestic and nondomestic, still occur. The discrepancy seems to be within a country's choice to enforce at a particular level and its perceived enforcement. While this decision is based on the costs and benefits of enforcing IPRs, ultimately, low levels of enforcement reduce the ability of a country to grow in the long run.

The Costs

While evidence supports that IPRs are strongly associated with economic growth, some countries seem to forego enforcing IPRs because the costs associated with increasing enforcement outweigh the benefits.

When IPRs are strengthened, the amount of market access for firms that are not innovative enough is reduced this cost decreases the amount of available options to consumers. Those firms that can afford to pay for IPRs, in this case patents, will be granted protection for their new product/process. This product/process, because of its innovative nature, is desired more than other products in the market. Therefore increasing legal protection for innovative goods motivates the innovator to develop goods that do not have a perfect substitute available. Enforced legal protection enables them to capitalize on monopolistic gains from an increase in market power and thus encourages them to develop more innovative goods (increase in producer surplus $P^e \rightarrow P^m$, new monopolistic price= P^m).

(2.1)



The innovator will be able to charge monopolistic price for the product. If an innovator charges a monopolistic price, a market inefficiency will result (DWL, costs to consumers). The innovator chooses to raise their revenue to a level that covers the cost of invention, production and produces a sufficient shield to the risk of producing their good in a market prone to forgery. By charging a monopolistic price for their goods, companies are creating higher monetary costs for consumers. Consumers in a country that have a lack of IPR enforcement fear rising prices that come along with increased enforcement. This increase in costs is why some consumers prefer illegal copies that come at a cheaper price.

Strengthening IPRs also raises the cost of acquiring new technology, an effect that is referred to as the *rent transfer effect(*LaCroix, Sumner J., and D.E. Konan.). The *rent transfer effect* is when costs are incurred because learning by imitation is no longer an option and therefore there is a decline in R&D that deals with imitation, such as reverse engineering. Now local imitators of foreign goods find they are required to pay royalties to foreign companies that own the IPRs, driving the price of goods up because the local firms need to maintain a healthy business. The *rent transfer effect* shifts profits to the innovators that were once copied, in most cases these are nondomestic firms.

Another big cost and concern when a country chooses to strengthen its IPR enforcement is known as the *innovation effect(*LaCroix, Sumner J., and D.E. Konan.). The innovation effect is specific to countries that had once relied on imitating others in order to create their products, as a country transitions to strengthening enforcement it is possible that their levels of R&D will decrease. This increase in enforcement is expected to decrease R&D in industries that had previously been using a lot of reverse engineering. These firms are caught up in a transitional stage from being imitators to becoming innovators. This increase in enforcement also affects the amount of human capital available for R&D sections because consumers now have to pay more for legitimate versions of textbooks, and for education. A large fear that the *innovation effect* creates is that education levels will decrease, and thus cause a delay in local innovation and a transfer of jobs to more educated foreigners. The *innovation effect* differs from the *rent transfer effect* because it decreases education and R&D levels within a country, where the *rent transfer effect* relates specifically to paying royalties to original product innovators.

The final, more concrete costs to increasing IPR enforcement deal with training and creating more IPR experts. As IPR enforcement increases, there is a need of more capable law infrastructure, including more technical, judicial, legal and administrative personnel that have the corresponding law degree and/or certification. This cost will later be referred to as 'G' in the cost-benefit optimization section.

Most of the discussed costs (except law infrastructure) combine to form an economy's aggregate price for increasing IPR enforcement.

The Benefits

Having looked at the costs, we now explore how strengthening enforcement can be beneficial to an economy. Innovation, creativity and quality of products all ultimately improve along with increasing enforcement and positively affect levels of 'A.' R&D sectors have increased incentives to be innovative because their rights will actually be enforced. Domestic innovators will have the opportunity to bring more protected creative products to the markets and thus have an increased ability to develop a brand-name reputation.

As innovators begin to develop more ideas and get them patented, the importance of owning a trademark increases. Trademarks represent the reputation of a firm for its quality and support, if a trademark didn't have protection then the firm's reputation would lack protection against being ruined by misrepresentation from an infringer. Those companies that once imitated other's processes and products will now have to think for themselves, this will increase concerns about remaining in business and consequently create a greater concentration on local innovation. This encourages more domestic inventive and artistic activity.

Possibly the biggest benefits that come from increasing enforcement involves a significant increase in foreign direct investment and international trade relations. With stronger IPR enforcement foreign firms will be less reluctant to locate their firms domestically. This will create more technological "spillovers" to domestic markets adding to domestic stock of knowledge and R&D.

Increased levels of foreign direct investment will create more economic growth as new foreign firms create more jobs for local workers. It is safe to assume this even if one allows for the possibility that the presence of such foreign firms will cause displacement of a small number of local businesses. Increasing enforcement will make foreign countries less concerned about technology being stolen. Therefore firms that had once withheld from trading or bringing over current technology (technology is, on average, 5 years delayed), will now bring more up-to-date technology into the domestic country. The transfer of technology allows domestic firms to increase their quality of goods sold to local vendors because of this spillover (LaCroix, Sumner J., and D.E. Konan.).

All of the discussed benefits make-up a portion of the aggregate level of output a country receives from increasing IPR enforcement.

Cost-Benefit Optimization

(2.2) $$W(\Theta) = V(p(\Theta, X_P), Y(\Theta, X_Y)) - G(\Theta)$$

A country is expected to choose its level of enforcement based on its level of welfare. It is assumed that all countries want to maximize their level of social welfare. Although, Ginarte and Park use this social welfare function to calculate the optimal level of intellectual patent protection, it is still applicable when focusing on enforcement. A simplified version of Ginarte and Park's social welfare function will be used.

The previously discussed aggregate output[3] (Y) and aggregate price[4] (P) are the driving forces that determine the optimal level of IPR enforcement. When the level of enforcement increases (Θ), it affects the aggregate level of output($Y = v(\Theta, Xy)$) and the aggregate price($P = p(\Theta, Xp)$). As mentioned earlier, when enforcement increases aggregate prices increase but they increase at a diminishing rate as enforcement begins to enable more monopolistic prices $(\partial P / \partial \Theta) > 0, (\partial^2 P / \partial \Theta^2) < 0)$.

Aggregate output is affected in two different ways as enforcement increases. Enforcement has the ability to increase output by allowing more people to become owners of innovative goods and thus increasing the market share and production $(\partial Y / \partial \Theta) > 0)$. However, the monopolistic price levels that increasing enforcement creates also affect output and thus output can have a negative effect on welfare $((\partial Y / \partial \Theta) < 0)$. Ginarte and Park(1997) suggest that at low levels of output an increase in market share and production would overpower change in output because of reduced monopolistic production, whereas at higher levels of output the opposite would be observed. The effect of output on welfare is therefore expected to increase welfare at a diminishing rate and eventually begin to decrease welfare at an exponential rate $((\partial^2 Y / \partial \Theta^2) < 0)$.

Increasing enforcement in some cases requires more development of the law structure(G) within an economy. The infrastructure costs show a direct relationship with increasing enforcement, a country needs to make adjustments to their infrastructure as they increase their level of enforcement $((\partial G / \partial \Theta) > 0)$. While it is possible that infrastructure costs begin to diminish this would be supporting the belief that there is a level of infrastructure that will be able to deal with any amount of cases and/or IPR issues that arise. This paper therefore assumes that there are not diminishing returns to G $((\partial^2 G / \partial \Theta^2) > 0)$ even though the cost of G can become relatively small to a country's level of GDPPC.

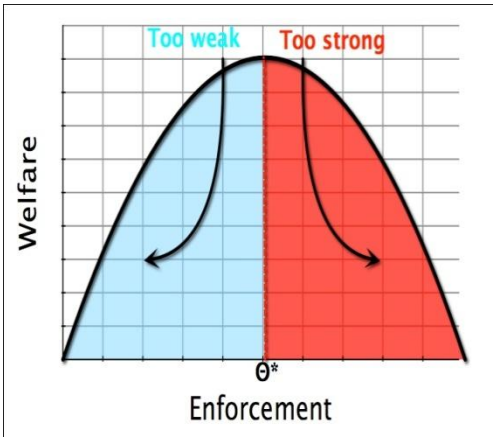
Given the above relationships that increasing enforcement has with price, output and infrastructure cost, we can observe the final social welfare maximization equation:

(2.3)

$$\frac{\partial W}{\partial \Theta^*} = \underbrace{\left[\left(\frac{\partial V}{\partial P}\frac{\partial P}{\partial \Theta^*}\right)}_{A} + \underbrace{\left(\frac{\partial V}{\partial Y}\frac{\partial Y}{\partial \Theta^*}\right)\right]}_{B} + \underbrace{\left[\frac{\partial G}{\partial \Theta^*}\right]}_{C} = 0$$

In order to maximize welfare, the sum of A and B must be equal to the effect of Θ on G (C). Maximization is obtained when a country chooses their optimal level of enforcement (Θ^*).

(2.4)



This cost-benefit optimization visualization is also known in environmental economics as the "environmental Kuznet's curve"(Maskus 2000). The belief behind the environmental version of Kuznet's curve is that in a developing industry there is less concern about increasing pollution byproducts than there is about increasing GDPPC. As soon as the pollution begins to become unbearable interests begin to become more socially focused. Like the environmental Kuznet's curve developing countries are expected to have a decreased concern about enforcing IPRs until they reach a certain point at which they must increase their enforcement to generate more GDPPC.

III. Data

All data observations are by 5-year increments (1995,2000,2005) and represent the ten-year time period of 1995-2005.

GDP

GDP per capita is used to measure a country's level of development taking into account their population. GDP per capita is provided by the World Bank's *World Development Indicators* database. This measure gauges the available wealth to each individual in a nation. All countries' GDPPC is observed in constant U.S. dollars for the year 2000. GDPPC is expected to have a logarithmic relationship with enforcement levels. The natural log of GDP per capita is squared because a country's level of GDP is expected to influence enforcement differently for different levels of GDPPC. For example, low-income countries may enforce more than middle-income countries depending on each country's specific cost-benefit analysis.

GDP per capita growth rates are also observed so that countries with the same income level can be compared based on their rate of growth. A country labeled as a high-income country is not expected to act the same as another high-income country if they have non-identical growth rates. A country's growth is observed for each 5-year and 10-year period.

Intellectual Patent Protection (IPP)- Statutory Enforcement

Statutory enforcement data is taken from Ginarte and Park's index of Patent Protection, which is an attempt "to provide an indicator of the strength of patent protection, not the quality of patent systems" (Park 2008). If a country has 'perfect' enforcement they are granted a score of 1. Otherwise, each enforcement score below 1 is based on how many available ways laws the country offers to enforce patents. *Statutory enforcement* is made up of three different components: Preliminary injunctions, contributory infringement pleadings, and burden-of-proof reversals. Preliminary injunction is defined as "pre-trial actions that require individuals to cease an alleged infringement." The availability of a preliminary injunction allows the court to protect the patentee from infringement until the court has made a final decision. Contributory infringement aids the patentee in stopping indirect aid to infringers from third-party participants. Third-party participants are defined as individuals/firms who take "actions that have not in themselves infringe a patent right but cause or otherwise result in infringement by others." Burden-of-proof reversals relate to the manner in which the infringer should defend his case. Instead of the prosecutor being required to prove the infringer guilty, the putative infringer must prove that they have not violated another's existing patent. If a country has one of the above measures they were awarded 1/3 of the possible perfect score of one (having all three would be a 'perfect' enforcement score).

As Ginarte and Park have mentioned this measure of enforcement can only determine the statutory level of enforcement. Thus, it is possible that this enforcement measure overestimates *true enforcement*. They make several suggestions to deal with this overestimation, such as: observing the execution of laws by court case activity, attitude of judges and enforcement officials, number/level of damages awarded, and number and nature of complaints. While it is possible that some of these complaints may be about corruption, at best they only observe corruption within the law structure. The possibility of corruption before entering statutory enforcement is never observed. This paper tries to capture *true enforcement* by combining the corruption perception index and Ginarte and Park's *statutory enforcement* measure.

Corruption Perceptions Index

The Corruption Perceptions Index is provided by Transparency International, "the global coalition against corruption."[5] The CPI grants countries a score between ten and one, with ten being not-corrupt and one being the most corrupt. Each score represents non-residential (both near and far from the vicinity of the country being scored), and residential opinions (individuals can be from national or multi-national firms). While the total score created by the combination of all sources represents consistent ethical and cultural standards, each response from the different types of sources is highly correlated with its perception score.

The index is created by combining survey results collected by qualified country analyst groups and businesspeople. The number of sources for these surveys varies during each year and the number of survey respondents varies for each source. For example, the CPI 2005 uses 16 sources, 10 of which are analyst groups and the remaining 6 businesspeople. See Appendix B for a more detailed explanation about each source and its unique surveys. It is important to note that the CPI makes sure that each source has compatible methodologies in order to make the

results comparable. Also, each source has been given a strict outline regarding Transparency International's acceptance criteria for the CPI.

The CPI combines surveys and observations from more than just one year for each given index-year. In other words, although the CPI may be observing the year 2005, it is possible that some of the CPI sources provided observations from previous years. When more than one year is observed by a source, he/she assesses whether or not the current year in question should be adjusted when compared to the previous years. This enables the CPI to create a corruption measure for each year that has less of an abrupt change from year to year. However, this hinders the CPI's ability to be compared on a year-to-year basis because previous year observations may be used in year currently being observed.

Healthcare

The healthcare data is provided by the World Healthcare Organization Statistical Information System (WHOSIS). The Statistical Information System is a database of 193 World Health Organization countries and is composed of 70 different healthcare indicators. The indicator used in this paper is *Per capita total expenditure on health* (PPP int. $), which is calculated into constant 2000 $.

Education

The education data is provided by the United Nations Educational, Scientific and Cultural Organization Institute for Statistics (UNESCO-UIS). The Institute for Statistics includes data from three different sources: UNESCO, Global Education Digest and Millennium Development Goals. The statistic measure used from UNESCO-UIS is *Public expenditure on education as a percent of GDP*, which is calculated into a constant 2000 $ per capita measure.

IV. Methodology

This section lays out the objective and procedure behind creating the measure *true enforcement*, which aims to capture a country's actual level of patent enforcement. It then presents the basic model and its variables' functional forms.

The Enforcement measure presented by G&P's index is based on discrete observations that measure the existence of specific laws and law structure within a country. This measure is not capable of capturing whether or not a patent right is ultimately enforced. G&P's measure of Enforcement (Enf) does not have a say in the efficiency of enforcement. It instead represents the means and availability of laws to aid those in need of patent protection. Measuring corruption allows us to capture and proxy how efficient enforcement is (Chiang 2004) within a country. Although a country may have many available ways of dealing with court cases, this only makes the act of prosecuting easier. It is obvious that lower levels of statutory *enforcement* could act as a deterrent to prosecuting an infringer, however, bad corruption within a country can easily deter innovators from even considering prosecuting. It is therefore be possible that a country with a perfect level of enforcement (Enf=1), meaning that they offer all available ways of protection within the court system, to never even use their legal system because of bad corruption levels.

True enforcement (*Enft*), is a measurement which attempts to convey the innovators trust in the enforcement system. As stressed by G&P (1997), this paper assumes that *Enforcement* has, in some cases, over-estimated a country's ability to actually enforce its IPRs. *True enforcement* integrates statutory enforcement with the corruptions perception index in order to develop a continuous measure that expresses a less-overestimated value for each country.

(4.1) $$EnfT = Enf - ((\delta - CPI)\lambda) + (\lambda(\delta - 1))$$

The construction of *true enforcement* places a weight(λ) on corruption in order to place a penalty on over-estimated Enforcement levels. The penalty is represented by $(\delta - CPI)\lambda$, where δ is defined as the value of CPI that each country is compared to. It is noted that delta's(δ) largest possible value is 10, representing a country that is considered to not be corrupt. The countries are then considered by how far their level of corruption is from the best expected value by taking the difference of their actual level of corruption (CPI) from δ. Corruption is not expected to have a constant linear effect on enforcement and/or an innovators perception of enforcement. It is possible that corruption levels have a nonlinear effect on enforcement. For example, corruption may not actually affect how an innovator feels about the enforcement system unless it is below a specific threshold (e.g. CPI=5). Multiplying the difference by λ emphasizes how much a country's deviation from δ should actually affect its level of Enforcement to represent a *true level of enforcement*. Even though corruption levels have an effect on an innovator's enforcement system perception levels, the weight (λ) is used to determine just how much corruption plays a role in their overall perception. It is therefore possible for a country with a lower level of statutory enforcement than another to have a higher level of true enforcement than that country, if the value of λ is large enough.[6]

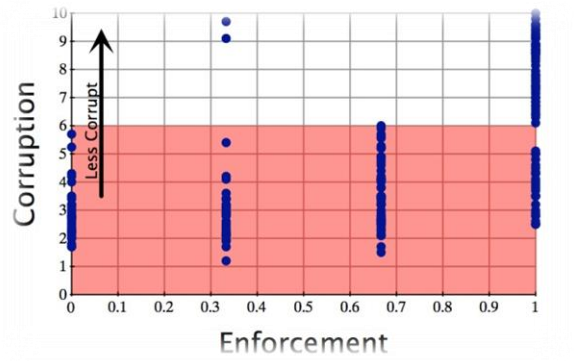
Furthermore, the calculation does not allow for *EnfT* to be less than zero and a country with the value of zero is therefore considered to have no capability of enforcing patents. By establishing that *EnfT*= 0 represents no enforcement at all, the effect of corruption must be scaled in order to make this the minimum threshold. Bounding the value of *EnfT* to be greater than or equal to zero is done by scaling the penalty by adding $\lambda(\delta - 1)$.

This study first treats all countries of different development levels as equals by penalizing them at a constant rate (δ=10, λ=1/27). This assumption creates a simplified calculation of *true enforcement*. The weighted value of the penalty first assumes that it is impossible for a country to pass below another country with a lower level of statutory enforcement. For example, a country with Enf=1 cannot be penalized to the point at which they would be granted a lesser value of EnfT than the least corrupt country within Enf=2/3, in order for this to be held true λ must be equal to 1/27.

When observing statutory enforcement values with corruption levels, there seems to be a clear cut off for corruption levels (see graph below). Besides the two outliers for Enf=1/3, every country with a value of Enf less than 1 never receives a corruption score of more than 6. The correlation between corruption and statutory enforcement is equal to .619. This correlation of corruption and statutory enforcement is expected because of simultaneity issues between the two measures with respect to a country's level of development. However, it is very odd that there is a clear distinction between statutory enforcement and corruption scores(red vs. white area, fig

4.2). This observation could possibly be supporting the fact that the CPI is biased.[7] Delta (δ) is therefore observed at different values to try and deal with this suspicious trend in CPI observations.

(4.2)



This simple story acts as a stepping-stone to embracing the theory and belief that corruption levels within a country can actually act as a strong deterrent to using the available law structure. The weight of the penalty is therefore increased (λ=0, 1/27, 29/200[8], 2/9, 1/3, 1) in order to allow for corruption values within a country to have a stronger effect on *true enforcement*.[9] See Appendix A for correlation statistics for these weights.

The Model

The basic model presented by this paper is:

(4.3) $$EnfT = \beta_0 + \beta_1 \ln GDPPC + \beta_2 (\ln GDPPC)^2 + \beta_3 \ln HEA + \beta_4 \ln EDU + u$$

GDPPC is logged because it is expected to have a nonlinear relationship with *true enforcement.* As previously mentioned, countries of different development stages are not expected to increase enforcement at the same rate. The natural logarithm log of GDPPC is then squared because there is a nonlinear relationship within the natural logarithm of GDPPC and *EnfT*, not dealing with this nonlinearity would violate assumptions of OLS.[10] Both the lnGDPPC and $(\ln GDPPC)^2$ were regressed against the dependent variable and will be discussed in the results section.[11]

The expenditure variables, education (lnEDU) and healthcare (lnHEA) were logged because they are expected have a nonlinear relationship with *EnfT* because of the trade off of the cost and benefits to increasing enforcement. For example, if enforcement increases in an undeveloped country that is accustomed to copying books, then the amount of education expenditure could decreases because of less people being able to afford school. It is also possible that education expenditure could increase because people would in fact start to purchase legitimate copies. This idea was previously discussed when defining the *innovation effect* and it is also applicable to healthcare expenditure.[12]

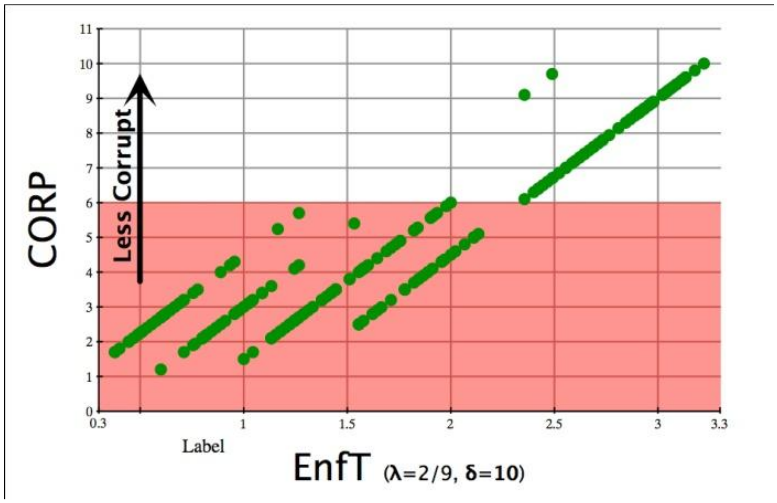
V. Data Analysis

This section discusses the implications behind the results produced after observing *true enforcement* with $\lambda = 2/9$ and $\delta = 10$. After discussing the values for λ and δ, the paper will review the basic statistics for a country's expenditure levels, and development/growth. It will next discuss an econometric analysis of the model's parameter estimates and t-statistics and the possible econometric problems that occurred.

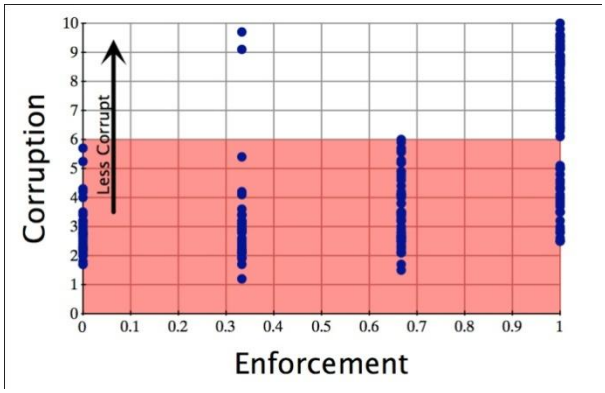
True enforcement was calculated and observed for many different combinations of λ and δ. For simplicity of explanation it makes the most sense for lambda to have an equal penalty for all countries. Simply put, regardless of how much *statutory enforcement* a country has, corruption levels should still have a pretty similar effect on patent protection systems. Delta must remain as the max value of the CPI(10) because lambda is nondiscriminatory, if delta were to change it would be possible for a country's *EnfT* observation to appreciate in value. Following the theory this would not make sense because a country's value of enforcement has not been underestimated by *statutory enforcement*, it has been overestimated. Furthermore, although the CPI may seem to be biased in its measure, the way in which it is constructed is defined to be very unbiased.

The value for lambda is $\lambda = 2/9$ for several reasons. Since corruption has the ability to deter *statutory enforcement* corruption should be weighted enough that its penalty has enough power to actually decrease *statutory enforcement*.[13] With $\lambda = 2/9$ a change in *statutory enforcement* by one law(or a 1/3 unit increase) has the same effect on *true enforcement* as a change in the CPI score by two units. If $\lambda = 1$, then a single unit increase/decrease in CPI would have the same effect as adding an additional three laws(a change of *statutory enforcement* from 0 to 1), this is clearly unrealistic. With these parameters, *statutory enforcement* is penalized and scaled to look like the following continuous measure of *true enforcement:*

(5.1) *True Enforcement*



(5.2) *Statutory Enforcement*



Basis Statistics

When observing the basic statistics of growth and development's levels affect *EnfT* there are several important trends that can be identified. Just as G&P (1997) found when observing the average levels of their IPP index for countries of different growth and development levels, there does not seem to be a pattern among growth rates and its effect on *EnfT*. However, higher income countries are found to have higher levels of *EnfT*. Also, when G&P observed the value for their index for low-income countries, they found that fast growing countries had the highest level of patent protection.

These results show that the low-income high growth countries to in fact have the highest average of enforcement levels (.937) Another really interesting result is that low-income low growth(.894) countries have a higher average of enforcement than low-income medium growth(.609) countries do. This could be because of a country's need to trigger a form of innovation by offering some form of patent protection. One more thing that is interesting about these results is the jump between a middle-income and a High-income country's average. This leads to support the theory that there is a non-linear relationship between GDDPC and *EnfT*.

Looking at the results for each expenditure variable, healthcare and education, there are some inferences that can be made based on the basic statistics. It is important to note that although the variables are observed in the model are in terms of expenditure rates, these tables observe the expenditure as a percentage of GDP. This is done in order to stress how each income level treats these two variables. Healthcare expenditure as a percentage of GDP is of specific interest because of jump it takes from middle-income to high-income countries.

Table 1: True Enforcement- Income and Growth level statistics

Level	Mean	St Dev	Max Effect	# of Observations
Low Income Low growth	0.894	0.263	1.44	19
Low Income Medium growth	0.609	0.216	0.977	12
Low Income High growth	0.937	0.322	1.644	19
Middle Income Low growth	1.35	0.472	2.11	20
Middle Income Medium growth	1.408	0.412	2.0	22
Middle Income High growth	1.484	0.346	2.0	20
High Income Low growth	2.42	0.664	3.13	28
High Income Medium growth	2.389	0.532	3.12	33
High Income High growth	2.469	0.698	3.22	30

This could be happening for a couple reasons; it is rational to believe that the increase in price of patent protected related healthcare products (e.g. drugs) is much greater than that of the increase in price of education products. Theoretically speaking healthcare goods are expected to be more elastic than educational goods. In other words, people would rather live to be more than thirty-years old than be smart for fifteen of those thirty years. Consider a country that is transitioning into a high-income level where the mean of *true enforcement* ranges from 2.389 to 2.469 (see previous table), and is leaving a middle-income level where the mean of *true enforcement* ranges from 1.35 to 1.484,[14] as the transition occurs and *EnfT* levels increase a country will adjust its expenditure rates based on how elastic the goods are. It makes sense that there is a larger increase in healthcare expenditure (% of GDP) than there is in education expenditure (% of GDP) because health is more elastic to a human being and healthcare goods that were once infringed are more expensive than education and education goods.

Table 2 & 3: Healthcare Expenditure and Education Expenditure per capita as a percent of GDP

Level	Mean	St Dev	# of Observations
Low Income	0.024	0.015	50
Middle Income	0.034	0.017	63
High Income	0.06	0.02	95

Level	Mean	St Dev	# of Observations
Low Income	0.035	0.011	39
Middle Income	0.041	0.015	54
High Income	0.052	0.013	91

Econometric Analysis

The estimated basic model's, for $\lambda = 2/9$ and $\delta = 10$, parameter estimates were found to be:

(5.3)

$$EnfT = 2.473 - .671 \ln GDPPC + .053(\ln GDPPC)^2 + .059 \ln HEA + .167 \ln EDU + u$$

(.779) (.201) (.012) (.06) (.096)
(3.17)** (-3.33)** (4.42)** (.98) (1.73)*

Adj R^2=.77
F-Value= 154.79

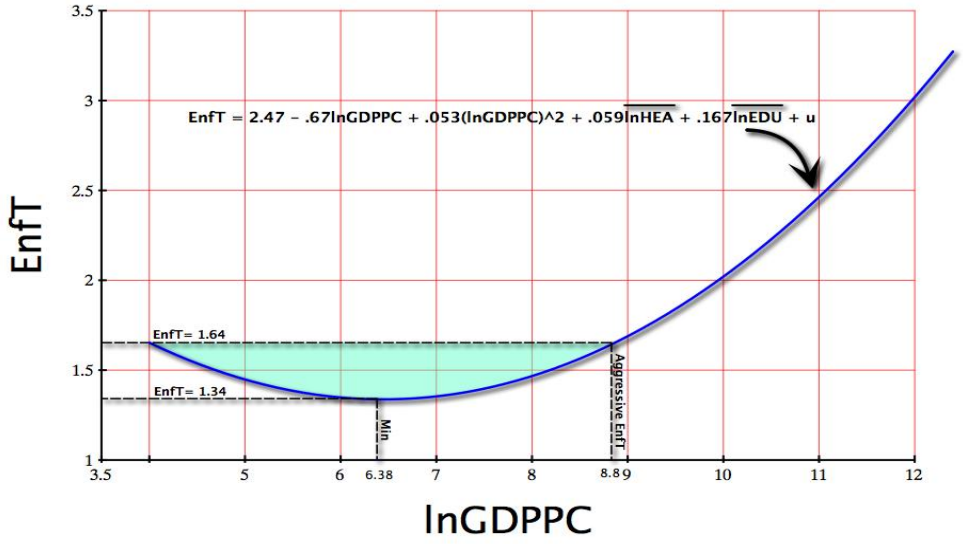
The basic model as a whole is significant and is capable of explaining 77 percent of the variation within a country's *true enforcement* level. These results suggest that as income levels increase *EnfT* levels decrease for low–income countries. When income levels begin to increase to much greater levels than those experienced by low-income countries *EnfT* levels increase quite rapidly. This basic model was also observed without taking the natural log of GDPPC or squaring the natural log. However, the results showed a flip in the parameter estimates' signs, a decrease in the Adj-R^2 value and in the t-stats.

The model suggests that a country does in fact change its enforcement of patents in a nonlinear way, with low-income a country will weaken its *EnfT* levels as its income begins to rise. The graph below represents continuous observations of the possible optimal levels of enforcement a country would choose for a given level of GDPPC.

At a certain point (See below graph, "Aggressive *EnfT"*) a country realizes that its level of enforcement needs to increased more drastically in order increase social welfare. Countries that they need to take a more aggressive stance on enforcing patents in order to create more innovation driven growth. Similar to Maskus' (2000) findings using G&P's index, which was specific to intellectual patent protection (not enforcement), this paper finds that the estimated

curve's minimum value of *EnfT* occurs at lnGDDPC = 6.38 ($590) (Maskus found min= lnGDPPC 6.26). However, Maskus found that after lnGDPPC=7.92 a country begins to increase its patent protection more than they have in the past where this paper's results show that point to be lnGDDPC=8.8, or $6,634 per capita ("Aggressive *EnfT")*.

(5.4)



Econometric Shortcomings

The basic model has several shortcomings that in some cases could be strengthened. Some of the problems the model runs into really cannot be dealt with that easily for several reasons.

None of the reported variances of inflation results are below 5, which suggests that there is a good amount of multicollinearity within the model. This multicollinearity is not surprising because all of the independent variables are heavily affected by a country's level of GDPPC. For example, expenditure levels are much more inclined to increase when a country has more income to spend. However, since multicollinearity makes t-stats smaller, the only variable it may have affected is healthcare. Multicollinearity's effect is not a concern in this the model.

The model may be miss-specified because of omitted variables. The addition of new variables could be argued in several ways, other authors (Ginarte and Park, Maskus) have factored into account levels of trade, market openness, cultural differences(Das and DeLoach 2001), political stability, secondary and tertiary education retrieval rates and level of R&D. Several of these measures and their theoretical effects on *EnfT* could have fit quite nicely into the paper. For example, a measurement concerning the number of international treaties a country belonged to was considered. It is unclear if treaty membership would increase *EnfT*, because of increased demands for enforcement from foreign innovators, or if it would act as an artificial driver for overestimated *statutory enforcement* levels.[15] It is possible that the model is also dealing with two types of simultaneity because it may be missing some of these explanatory

variables. Ginarte and Park (1997) concluded that their findings support the fact that R&D levels should increase in order to act as an incentive to increase patent protection levels. Research and development could influence not only the dependent variable but could also be influencing the education expenditure variable. This may be affecting the model in such a way that education in reality is not significant because R&D levels have not been controlled for.

The second type of simultaneity that omission of variables can also cause was previously discussed in the theory section of this paper. It is possible that countries first increase enforcement to triggering innovation and generate growth or it is also possible that country's growth triggers an increase in enforcement. The latter of the two would be more plausible if the cost to increasing infrastructure (G) is too high for a specific country(Ginarte and Park 1997). Re-specifying the model by adding new explanatory variables was unfortunately beyond the scope of this paper.

Autocorrelation seems to be the main econometric problem with the model. Autocorrelation typically creates heteroscedasticity, which can be tested for using White's general test. The resulting chi^2 value shows that heteroscedasticity is present, with the model's chi^2 value equal to 21.11, compared to a critical chi^2 value of 23.685 (α=.05). This heteroscedasticity will create inefficient coefficient estimates and makes t-statistics wrong because of bias estimates caused by non-constant error term residuals that mislead the variance estimations. Furthermore, the consequences of having autocorrelation in the model creates smaller standard errors and in turn produces artificial t-statistics and biased coefficient estimations.

One remedy for solving autocorrelation issues with panel data, the 'first-differencing' model, was observed as a first attempt to deal with autocorrelation and heteroscedasticity. The results did manage to greatly decrease all variance of inflation measures to below 3 but none of the T- statistics were significant and the Adj-R^2 was practically nonexistent. These poor results suggest that the first-differencing approach has in fact over-differenced the model and has replaced positive autocorrelation with negative autocorrelation. The first-differencing method would have required copious amounts of observations to be dropped from the regression and would have left only twenty-nine out of a hundred and ten countries to be observed. The distribution of those twenty-nine countries' income-level groups, each having three observations (year 1995, 2000, 2005) with eighty-seven total observations, is biased towards explaining only high-income level countries. The biased results, 72.41% of the total observations are represented by high-income countries (Fig 5.5), are expected because of the basic assumption that high-income countries are more apt to record data within their economy.

Table 4: First-differencing's income level distribution

Low-Income	Middle-Income	High-Income
3/87, 3.44%	21/87, 24.13%	63/87, 72.41%

The best way that this paper dealt with autocorrelation was by using the more simple 'fixed-effects' method, controlling for the year observations with dummy variables. When the dummy years are added the following results are created:

(5.6)

$$EnfT = 2.517 - .684\ln GDPPC + .052(\ln GDPPC)^2 + .08\ln HEA + .15\ln EDU + d00 + d05$$

(.784) (.2) (.011) (.062) (.097) (.082) (.081)

(3.21)** (-3.41) ** (4.40)** (1.35) (1.60) (1.31) (-.18)

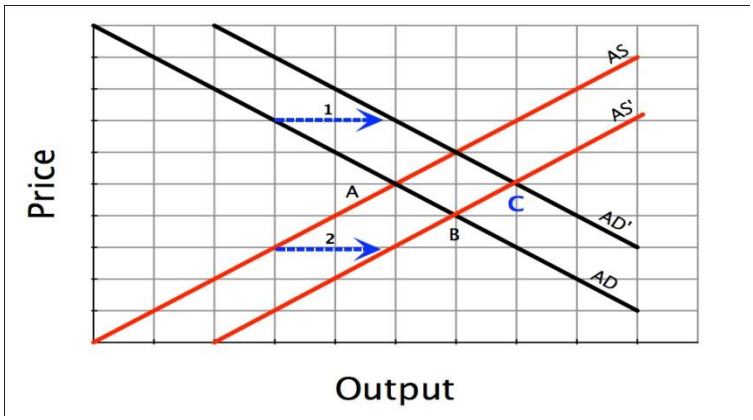
Controlling for the year observations by including dummy variables has affected the model by making lnEDU insignificant. The fact that lnEDU is insignificant is not a concern, especially because EDU is most probably apart of the miss-specification problem previously mentioned. Overall, even after attempting to control for autocorrelation with the fixed effects model, the paper's main results remain in tact. The model still effectively estimates the level of IPR enforcement that countries have during different development stages. It suggests that a country's IPR enforcement regime acts in a nonlinear manner, represented by the balance of their costs and benefits behind enforcing(fig 5.4).

VI. Conclusion

It is obvious that intellectual property rights are very important to the growth of an economy, a vast amount of economic literature that focuses on IPRs clearly supports this. However, the existing literature does not focus enough on the gap between actual and perceived levels of enforcement. The smaller this gap is the more ability an innovator will have to understand an economy's IPR regime. Acknowledging and abating this perception-reality disparity is very important to developing more reliable information for innovators. This investigation has contributed to the literature by creating a new, interesting, and more accurate proxy for actual levels of IPR enforcement using corruption levels to adjust for the imbalance between perceptions and reality.

True enforcement is a more accurate measurement for enforcement levels and it aims to bring a, this more accurate measurement enables people to make better policy decisions. Having a more accurate estimate of actual enforcement levels will empower innovators, making their choices more successful and efficient. If a country has not reached a point where they believe enforcing IPRs is beneficial to their economic well being than it would be more efficient for an innovator to pursue a different avenue of developing their innovative good. With a more accurate measurement of enforcement an innovator has a greater ability to make the most informed decision. This will lead to developing a more successful marketing/pricing scheme for their good. A measurement such as *true enforcement* increases the ability of an intellectual property right system to develop and motivate innovators to bring stimulation to an economy.

VII. Appendix A



Increase in technological innovation:

-Reduction in production costs: AS shift AS →AS', equilibrium pt. B

-Increase in jobs and income: AD shift AD → AD', equilibrium pt. C

Equilibrium 'C' is a higher level of productivity and output with a relatively low price increase (if any at all)

Correlation matrix: Corruption, ENF, and GDPPC parameter signs

λ	Enf	Corp	lnGDPPC (sign/sig)	$(\text{lnGDPPC})^2$ (sign/sig)
0	1.00	0.619	+/n	-/n
1/27	0.983	0.744	+/n	+/n
29/200	0.899	0.899	-/y	+/y
2/9	0.836	0.948	-/y	+/y
3/9	0.802	0.965	-/y	+/y
1	0.697	0.995	-/y	+/y
20000	0.619	1	-/y	+/y

VIII. Appendix B – Corruption Perceptions Index Analyst groups for the year 2005: All information is provided by *Transparency International.*

Annex: Sources for the TI Corruption Perceptions Index (CPI) 2005

Number	**1**	**2**	**3**	**4**
Abbreviation	CU	EIU	FH	II
Source	Columbia University, The Center for International Earth Science Information Network	Economist Intelligence Unit	Freedom House	Information International
Name	State Capacity Survey	Country Risk Service and Country Forecast	Nations in Transit	Survey of Middle Eastern Businesspeople
Year	2003	2005	2005	2003
Internet	http://www.ciesin.org/	www.eiu.com	http://www.freedomhouse.org/research/nattransit.htm	www.information-international.com
Who was surveyed?	US-resident country experts (policy analysts, academics and journalists)	Expert staff assessment	Assessment by US, regional, and in-country experts	Senior businesspeople from Bahrain, Lebanon and UAE
Subject asked	Severity of corruption within the state	The misuse of public office for private (or political party) gain	Extent of corruption as practiced in governments, as perceived by the public and as reported in the media, as well as the implementation of anticorruption initiatives	How common are bribes, how costly are they for doing business and how frequently are public contracts awarded to friends and relatives in neighbouring countries
Number of replies	224	Not applicable	Not applicable	382 assessments from 165 respondents
Coverage	95 countries	156 countries	29 countries/territories	31 countries
Number	**5**	**6**	**7**	**8**
Abbreviation	IMD			MIG
Source	International Institute for Management Development, Lausanne, Switzerland			Merchant International Group
Name	World Competitiveness Yearbook			Grey Area Dynamics
Year	2003	2004	2005	2005
Internet	www.imd.ch			www.merchantinternational.com
Who was surveyed?	Executives in top and middle management; domestic and international companies			Expert staff and network of local correspondents
Subject asked	Bribery and corruption in the economy			Corruption, ranging from bribery of government ministers to inducements payable to the "humblest clerk"
Number of replies	> 4,000	4166	Roughly 4000	Not applicable
Coverage	51 countries			155 countries
Number	**9**	**10**	**11**	**12**
Abbreviation	PERC			UNECA
Source	Political & Economic Risk Consultancy			United Nations Economic Commission for Africa
Name	Asian Intelligence Newsletter			Africa Governance Report
Year	2003	2004	2005	2005
Internet	www.asiarisk.com/			http://www.uneca.org/agr/
Who was surveyed?	Expatriate business executives			National expert survey (between 70 and 120 in each country)
Subject asked	How bad do you consider the problem of corruption to be in the country in which you are working as well as in your home country?			"Corruption Control". This includes aspects related to corruption in the legislature, judiciary, and at the executive level, as well as in tax collection. Aspects of access to justice and government services are also involved
Number of replies	More than 1,000	More than 1,000	More than 1,000	Roughly 2800
Coverage	14 countries		12 countries	28 countries
Number	**13**	**14**	**15**	**16**
Abbreviation	WEF			WMRC
Source	World Economic Forum			World Markets Research Centre
Name	Global Competitiveness Report			Risk Ratings
Year	2003/04	2004/05	2005/06	2005
Internet	www.weforum.org			www.wmrc.com
Who was surveyed?	Senior business leaders; domestic and international companies			Expert staff assessment
Subject asked	Undocumented extra payments or bribes connected with various government functions			The likelihood of encountering corrupt officials, ranging from petty bureaucratic corruption to grand political corruption
Number of replies	7,741	8,700	10,993	Not applicable
Coverage	102 countries	104 countries	117 countries	186 countries

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Notes

[1] Ginarte and Park (2008) – updated index, adding more countries to 122 and increasing their collection period from 1990-2005.

[2] If actual enforcement levels are low and perceived enforcement levels are high, it would not make sense for an innovator to implement a monopolistic pricing scheme because consumers would just switch to the infringed version. Another example of the perception-reality gap having a negative impact on an innovator: if perceptions are high an innovator may believe that they can litigate because of available laws, upon realization of the gap the innovator would find out that they cannot litigate efficiently because actual enforcement is much lower. If the innovator had a more accurate measurement to refer to they would be able to sell more goods by not charging monopolistic prices. The innovator would be able to avoid wasting money on prosecuting infringers within an inefficient enforcement system, losing sales to infringers, and in some cases not waste time, money and effort on patent applications.

[3] Stimulation of innovation, increase in 'A,' increased quality and variety of goods, increased trade relations and FDI

[4] Increased prices, less available goods, fixed and variable infrastructure costs

[5] http://www.transparency.org/

[6] For example, if country A has a Enf=1 and CPI=3, while country B has an Enf=.66 and a CPI=6 and (δ=10, λ=2/9), Country A would be penalized enough for its *EnfT* value to be less than Country B's. Please refer the fig. 5.1 and 5.2 in the data analysis section, notice that a lot *EnfT* values for some countries become less than other countries (Country A < Country B) who have a smaller Enf value as seen by comparing the green data points to the blue data points.

[7] Although Transparency International's construction of the Corruption Perception Index aims not to be biased and through its nature has done a great job at collecting CPI values, there seems to be a divergence in how countries with less statutory Enforcement levels are treated from those with an Enf value of 1.

[8] When λ= .145 (29/200) Corruption and Enf are equally correlated with *True Enforcement* (.89984).

[9] As λ approaches ∞, Enforcement's influence on *EnfT* decreases, while the belief that corruption can completely negate the purpose of statutory Enforcement is quite understandable, it does not make sense for the value of λ to allow for this negation. Even though corruption levels discourage innovators, innovators are still affected by the available means to enforcing their rights and prosecuting infringers. The penalty is never weighted more than 1, where this weight represents a single unit increase in CPI as the same effect as an increase of Enf from 0$\rightarrow$1 on *EnfT*.

[10] Seen in Maskus 2000

[11] GDPPC (not logged) and GDPPC(not logged)^2 were also observed.

[12] The effect that increasing *EnfT* has on these two expenditure variables is dependent on the elasticity of the goods within each variable (e.g. books, and vaccines)

[13] Recall that when λ=29/200 corruption and Enf are equally correlated. Thus λ should be increased in order to give corruption more power in explaining *True Enforcement*.

[14] Recall the max and min for *True Enforcement*: 3.22 and .433

[15] Countries could possible join international treaties that required a specific level of *Statutory Enforcement*, that does not mean that the system would actually be used.