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Measuring Intellectual Property 'Strength' and Effects: An Assessment of Patent Scoring Systems and Causality

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MEASURING INTELLECTUAL PROPERTY 'STRENGTH' AND EFFECTS: AN ASSESSMENT OF PATENT SCORING SYSTEMS AND CAUSALITY

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ABSTRACT

Intellectual property rights legislation, and particularly patent law, is roundly supported as well as condemned across the globe. The adoption of the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement in the 1990s both expanded the scope of minimal protection as well as the controversy. One factor contributing to the strength and disparity of those opinions is the limited

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evidence of its actual economic effects. A central and unresolved issue is the question if stronger patent systems enhance national economic growth, or if growing countries necessarily evolve the institutions associated with stronger patent rights. In short, which way does the causality flow? Underlying the approach to resolving that issue are measures of the relative 'strength' of patent systems across countries, called patent 'scores' or 'indexes.' This paper contributes to an understanding of both these dimensions, beginning with an examination of the ten available patent indexes. Emphasis of the analysis is on developing countries where the controversies are sharpest and the range of protection greatest.

The available indexes are closely correlated, often statistically inseparable. The number of available indexes can be reduced with little loss of information. The assessment of patent indexes does enable the identification of the three distinct components of those indexes, joining/compliance with international conventions, strengthening the national patent office, and enhancing enforcement. By analyzing countries at different stages of economic development, it is apparent that they follow a similar progression in enhancing patent law.

Countries which expedite the process tend to grow fastest, indicating that strengthened patent systems lead and not lag growth. Major enhancements are not realized until after improvements in governance efficiency, a substantial component of which is curbing corruption. TRIPS mandates enforcement processes but not outcomes, giving member states considerable discretion. The pivot point comes at median middle income countries. Data envelopment analysis is used to measure comparative effectiveness of generating national income through patenting. Low income countries can enhance patent efficiency by two to eleven percent compared to the most efficient. A number can make relatively low cost enhancements through the adoption/implementation of international intellectual property agreements. In addition, adoption of these steps signals the intent to protect innovation investments. Middle income countries, more efficient as a group, have a large potential scope of improvement, up to fifty percent, but mostly by the difficult task of enhancing governing efficiency/reducing corruption. It is hoped the results of this analysis will provide additional incentives to undertake that process.

I. INTRODUCTION

Developing scoring systems, also referred to as indexes, for measuring the 'strength' of national patent systems has become a bit of a cottage industry in recent years. From initial efforts in 1990 there are at present ten systems publicly available, including an effort of my own. Note should be made that the focus here is on patent indexes exclusively, and not on more general Intellectual Property Rights (IPR) indexes which also include components on copyright and trademarks. In the first Section of this article I examine and compare the systems, finding that most current ones are statistically nearly identical, including those based on interview data or on secondary sources. That means at minimum that there is much redundancy in the multiplication of efforts to generate patent strength indexes and many can be abandoned with little loss of information.

All of these patent indexes – or just one index if my suggestion is ultimately followed – have uses, several in fact. They can be used to track across time changes in a country's patent protection. Clearly, the World Intellectual Property Organization, which supports the enhancement of IPR systems worldwide, and the World Trade Organization, which in the last completed trade agreement incorporated IPR as a trade dimension,[1] are interested in tracking the progression of IP systems in multiple countries.[2] More broadly, public officials as well as those who champion the needs of developing countries in particular are keenly interested to know what the effect of strengthening patents has on national economics and living standards. There, opinions vary widely, some claiming even the least developed countries benefit[3] while others take the opposite view, that, "[i]f you want to have one tool for imperialistic control, it's patent law under the WTO agreement."[4] At present, there is no clear, persuasive answer to this important issue. Complicating the matter, the costs of strengthened patent rights are readily calculated, say as the price of a patented pharmaceutical when enhanced rights no longer allow the sale of generics. Benefits though are more ephemeral – increases in employment in R&D, high tech manufacturing or enhanced access to importing efficient technologies. It is difficult to measure these benefits conclusively when the counterfactual is not clear.

Economists have used IP indexes in an effort to quantify the benefits of enhanced IPRs by examining the relationship between say foreign direct investment (FDI) and a national patent score.[5] Typically the relationship is strongly positive, but critics rightly question the direction of causality. Is it enhanced IPRs which lead to rising FDI, or does the group of countries which attract FDI have in place the institutions which also raise the index scores? Here the critics have a legitimate point; the correlation between per capita national gross domestic product (GDP) and patent scores is in the range of 0.88, statistically indistinguishable at the five percent level.[6]

In the second Section of this analysis I examine the direction of the causal relationship. Emphasis is on developing countries because as a group they have the most divergent index scores and debate the merits of IPR most strenuously. My results indicate that enhanced patent systems lead to stronger economic performance, and not vice versa. Indeed there is even evidence of a progression of steps taken by countries as they move from lower low income to higher middle

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[1] Agreement on Trade-Related Aspects of Intellectual Property Rights, Marrakesh Agreement Establishing the World Trade Organization annex 1C, Apr. 15, 1994, 1869 U.N.T.S. 299, 33 I.L.M. 1197, *available at* http://www.wto.org/english/docs_e/legal_e/legal_e.htm [hereinafter TRIPS].

[2] *See infra* notes 58-59 and accompanying text (describing the reporting process for TRIPS compliance).

[3] *See* World Intellectual Property Office, Economic Development and Patents, http://www.wipo.int/patent-law/en/developments/economic.html (last visited Nov. 1, 2010) ("Many countries, in particular least developed countries, have only begun to address the challenges of setting up an appropriate patent system in place to reap economic and social benefits.").

[4] *See* Nic Paget-Clarke, *Interview with Vandana Shiva: The Role of Patents in the Rise of Globalization*, MOTION MAG., Aug. 27, 2003, *available at* http://www.inmotionmagazine.com/global/vshiva4_int.html#Anchor-The-34478.

[5] *See infra* Section III.A.

[6] *See infra* Section III.A.

income. That progression begins with joining/complying with the relevant international organizations, and progressing to enhancing the efficiency of delivery of government services, or reducing corruption, to put the matter more bluntly. By following these measures countries can be seen as signaling their intention to stimulate inventive activity. Within this general progression there is a wide range of effectiveness with which individual countries achieve those steps, as is revealed by an application of data envelopment analysis. The national benefits from successful execution are substantial, above thirty percent in a few cases, but so is the complexity.

II. PATENT INDEXES

As of the time of writing, there are ten available patent indexes of two distinct types. One form is based on a review of national patent legislation only, which is to say does not include an assessment of implementation/litigation matters while the second form does, either by incorporating factors representing litigation or through surveys of individuals with a direct knowledge of the actual operation of patent systems in each country included. The number of indexed countries is quite large, well over 100 for most systems, meaning that values are available for a range of developing countries for which the patent strength issue is most contentious. However, not every system includes exactly the same mix of countries so comparisons among the systems, while indicative, are not definitive.

In this section, the available patent index systems are described and critiqued according to their method of composition and compared statistically. Included is an index of my own design first presented in 2002 and updated here.

A. Review of Available Patent Indexes

The currently available indexes are as follows:
Based on IP law:
Rapp and Rozek (1990)
Ginarte and Park (1997) with updates to 2005
Park and Wagh (2001) updated annually to 2006

Incorporating implementation/enforcement factors:
Mansfield (1995)
Sherwood (1997a) and (1997b)
Taylor Wessing Global Intellectual Property Index 2009
World Economic Forum Global Competitiveness Index 2009
Property Rights Alliance International Property Rights Index 2010
Economic Freedom of the World: 2009 Annual Report
Lesser (2002)

Rapp and Rozek[7] (R&R) based their five point ranking system, the first

[7] *See* Richard T. Rapp & Richard P. Rozek, *Benefits and Costs of Intellectual Property Protection in Developing Countries* n.11 (Nat'l Econ. Research Assocs., Inc., Working Paper No. 3, 1990)

effort to establish an international patent index, on the minimum standards set by the U.S. Chamber of Commerce. That is, most attention is given to laws "in force against infringement but not on their enforcement or implementation."[8] Their approach is based on that described in *Gadbaw and Richards*.[9] In total, 160 countries are ranked.[10]

Ginarte and Park[11] (G&P), in a broadening of the Rapp and Rozek index,[12] use a score based on the sum of five national components:

- extent of coverage (pharmaceuticals, food, etc.),
- membership in international agreements,
- loss of protection (compulsory license provisions, etc.),
- enforcement mechanisms (provisions for injunctions, pleadings, etc.), and
- duration of protection (standard = twenty years).

A sensitivity test was done on the effects of a range of weights in the ranking of countries under the system. As the results are quite insensitive to the weights tested, an un-weighted sum is used. The absence of consideration of enforcement is justified by noting, "the main concern about [developing countries] is the absence of laws [on infringement]."[13] This index appears to be the most frequently used in other studies and by 2005 includes ranks for 122 countries.[14]

Park and Wagh (2001)[15] and (2002)[16] (P&W) in the spirit of Ginarte and Park[17] calculate index values in five-year increments from 1970-2000 and annually through 2006.[18] Their system is based on five categories, (1) coverage (patentable subject matter), (2) duration of protection, (3) enforcement mechanisms, (4) membership in international patent treaties, and (5) limitations like compulsory licenses on patent rights. Each category has a maximum value of one so the index can range from zero to five while sub-categories contain from one (duration of protection) to seven components (patentable subject matter). Hence, the patentability of pharmaceuticals adds 1/7 to a national index while membership in the Paris Convention adds 1/3. There is no discussion of the derivation of the

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[hereinafter R&R].

[8] *Id.*

[9] *See* R.M. GADBAW & T. J. RICHARDS, INTELLECTUAL PROPERTY RIGHTS: GLOBAL CONSENSUS, GLOBAL CONFLICT? 11, 52-55 (London: Westview Press 1998).

[10] *See* R&R, *supra* note 7, at tbl.A-1.

[11] *See* Juan C. Ginarte & Walter G. Park, *Determinants of Patent Rights: A Cross-National Study*, 26 RES. POL'Y, 283, 301 (1997) (original report contains five year incremental values 1960-90 with updates to 2005) [hereinafter G&P].

[12] *See* R&R, s*upra* note 7.

[13] *See* G&P, s*upra* note 11, at 289.

[14] PROP. RIGHTS ALLIANCE, INTERNATIONAL PROPERTY RIGHTS INDEX 2010 REPORT 139 (2010), *available at* http://www.internationalpropertyrightsindex.org/ [hereinafter IPRI].

[15] W.G. Park & S. Wagh, *Intellectual Property and Patent Regimes, in* ECONOMIC FREEDOM OF THE WORLD: ANNUAL REPORT 2001 ch. 4 (J. Gwartney & R. Lawson eds., 2001), http://www.cato.org/pubs/efw/efw2001/efw01-ch4.pdf [hereinafter P&W].

[16] *Id.* at ch. 2.

[17] *See* G&P, *supra* note 11.

[18] *See* P&W, *supra* note 15, at ch. 2 (data available at http://www.freetheworld.com/datasets_efw .html).

weights nor if, for example, the patentability of foods should be valued at less than half of the significance of the existence of preliminary injunctions. In all, sixty three countries are ranked in 2000,[19] 140 in 2006 when the supporting organization, Economic Freedom of the World,[20] broadened its category on property rights from being specifically IP rights to real and financial property.

Mansfield (1995)[21] (M) surveyed 180 executives and patent attorneys in the U.S., Japan and Germany. Focus was on the chemical and drugs, machinery, and electrical equipment industries believed to be particularly sensitive to intellectual property protection. Respondents were asked for fourteen more technologically advanced developing countries to indicate when IP protection was 'too weak' to permit transfer of sensitive technologies to (a) invest in joint ventures, (b) wholly owned subsidiaries and (c) licensing key technologies. In general, protection levels were considered more adequate for machinery than chemicals and drugs.

Sherwood (1997a)[22] (S) also utilized a judgment-based ranking, relying on his own assessment of the conditions in eighteen developing countries, most in Latin America. Each country was ranked on a 100-point scale for nine components including enforceability (twenty-five points), administration (ten points), and patents (seventeen points). The scales were thoroughly researched with interviews in each country. A verbal justification is given for deducting points in each component, but the overall allocation of points to each component is not discussed. Thus, there seems to be a major arbitrary component to the system despite the care which went into its construction. Using a similar procedure, *Sherwood* (1997b)[23] scaled the TRIPS requirements. They received a score of fifty-five, identical with the value given to South Korea, the highest granted of the eighteen countries. In contrast, the IPR aspects of NAFTA (North American Free Trade Agreement) are ranked at a sixty-eight.

Taylor Wessing Global Intellectual Property Index 2009 (TW '09).[24] Unlike the other indexes reviewed here this is a private firm effort available without charge but registration is required. Initiated in 2008, the current version ranks just twenty-four countries developed, emerging and larger developing countries. Due to the restricted number of countries included in this index, it is of limited use in the current analysis. Moreover, the overall index is a compilation of scores for trademark, patent and copyright protection; here the focus is solely on the patent index.

The index is based on a combination of two distinct components, referred to

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[19] *Id*. at tbl.2.

[20] CATO INST., ECONOMIC FREEDOM OF THE WORLD (2010), *available at* http://www.cato.org/pubs/efw.

[21] E. Mansfield, *Intellectual Property Protection, Direct Investment and Technology Transfer: Germany, Japan and the United States* (World Bank Int'l Fin. Group, Discussion Paper No. 19, 1995) [hereinafter Mansfield].

[22] R.M. Sherwood, *Intellectual Property Systems and Investment Stimulation: The Rating of Systems in Eighteen Developing Countries*, 37 IDEA 261, 262-371 (1997) [hereinafter Sherwood].

[23] R.M. Sherwood, *The TRIPS Agreement: Implications for Developing Countries*, 37 IDEA 491, 492-545 (1997).

[24] Taylor Wessing, Taylor Wessing Global Intellectual Property Index, 2009 Methodology, http://www.taylorwessing.com/ipindex/methodology.php (last visited Nov. 11, 2010) [hereinafter Taylor Wessing].

as 'jurisdictional assessments' and 'instrumental factors.' The former is a fifty-three item questionnaire completed by 495 respondents consisting of CEOs and lawyers. The core of the questionnaire consists of a 1 – 10 (high) ranking of elements of national IP, for patents the elements being (1) obtaining and maintaining, (2) exploiting, (3) enforcing/cost-effectiveness, and (4) attacking (Appendix A). The selection of the respondents is not described beyond a request on the questionnaire (question fifty-one) for respondents to forward to "business contacts and associates who may be interested in helping us with this survey."[25] For their part, the instrumental factors[26] are a group of forty-nine existing indexes and data. Examples include the 'Ease of Doing Business',[27] the 'Human Development Index,[28] and Legal Enforcement of Contracts.[29] Many of these components are used/reported elsewhere in this current analysis of patent indexes.

Coalescing a series of components into a single score requires, of course, some process. In the case of the Taylor Wessing Index, the process is called a 'factor assessment model' using support vector machine mathematics (SVM). "For each of the 16 areas covered by the questionnaire the predictions made by the SVM are combined with the actual assessments to create a matrix of how each respondent assessed or was predicted to have assessed each of the twenty-four jurisdictions."[30] No additional details are given on how the SVM is applied, nor which statistical package is utilized making it not possible to assess the methodology further.

The *World Economic Forum Global Competitiveness Index 2009* (WEF/IPR '09) provides annually an assessment of the competitiveness of 133 countries.[31] The full index incorporates both hard data and a survey of the international business community, utilizing twelve so-called 'pillars of competitiveness.' Of relevance here is not the full index, but a result from the opinion survey on intellectual property protection, indicator 1.02 from the 1st pillar, Institutions. The question asks, "[h]ow would you rate intellectual property protection, including anti-counterfeiting measures, in your country?"[32] In total, 12,614 surveys were retained after editing for an average of ninety five responses per country with actual response numbers ranging from 373 (China) down to thirty one (Libya, Timor-Leste).[33] There is no discussion of the respondent process nor the changes in respondents over time. Both on-line and hard copy survey collection processes are used with answers scored on a one to seven (high) scale. For purposes here, it is important to recall that the survey value applies to **all** IPR and not just patents,

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[25] *Id.* at question 51.

[26] *Id.* at app.C.

[27] Doing Business, Economy Rankings, http://www.doingbusiness.org/rankings (last visited Nov. 16, 2010).

[28] U.N. DEV. PROGRAMME, THE HUMAN DEVELOPMENT INDEX (HDI) (2010), http://hdr.undp.org/en/statistics/hdi/.

[29] FRASER INST., ECONOMIC FREEDOM OF THE WORLD 2009 ANNUAL REPORT (2009) *available at* http://www.freetheworld.com/release_2009.html [hereinafter ECONOMIC FREEDOM ANNUAL REPORT].

[30] Taylor Wessing, *supra* note 24.

[31] WORLD ECON. FORUM, THE GLOBAL COMPETITIVENESS REPORT 2009-2010, http://www.weforum.org/pdf/GCR09/GCR20092010fullreport.pdf [hereinafter GLOBAL COMPETITIVENESS REPORT].

[32] *Id.* § 1.02.

[33] *Id.* at 49 tbl.1.

or as used here is it a composite index like the others being based as it is on a single question.

Property Rights Alliance International Property Rights Index 2010 (IPRI '10)[34] operates from the premise that property rights play an important role in prosperity. The index is based on three core components, the legal and political environment, physical property rights, and intellectual property rights with the last of direct relevance here. The IPR component itself is composed of three variables, the Global Competitiveness Index question on IP protection, the Ginarte-Park Index of Patent Rights, and a measure of copyright piracy.[35] The first components are assessed separately above and while the International Property Rights Index brings nothing truly novel to this assessment of patent indexes it does present an alternative approach to the others.

The Economic Freedom of the World: 2009 Annual Report (EFW)[36] used to incorporate an element on intellectual property. However, beginning in 2007, that component has been replaced by one related to the protection of property rights broadly, including for financial assets,[37] with that data drawn from the World Economic Forum Global Competitiveness Report.[38] As a result, the Economic Freedom of the World is not of direct relevance to this analysis.

B. Constructing an IPR Score

1. Components of an IPR Score

Lesser[39] in constructing a new scoring system to reflect patent protection in the post-TRIPS era noted prior scores typically have in common the following components:

- protectable subject matter
- convention membership
- enforcement
- administration
- duration of protection

Harmonization under TRIPS simplifies some inputs into the index. For example, TRIPS[40] sets the duration of patent protection at twenty years from first application so that an indication of TRIPS compliance by a country captures the duration factor as well as serving as a proxy for protectable subject matter. However, as countries have the option of protecting plants with patents or an 'effective *sui generis* system,' or both,[41] it is important to identify the choice made.

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[34] *See* IPRI, *supra* note 14.

[35] *Id.* at chs. III-IV.

[36] ECONOMIC FREEDOM ANNUAL REPORT, s*upra* note 29.

[37] *Id.* at 194.

[38] GLOBAL COMPETITIVENESS REPORT, s*upra* note 31.

[39] W. Lesser, *The Effects of Intellectual Property Rights on Foreign Direct Investments and Imports into Developing Countries in the Post-TRIPS Era*, 5 INTELL. PROP. STRATEGY TODAY 1, 2-16 (2002).

[40] TRIPS, *supra* note 1, at art. 33.

[41] *Id.* at art. 27.3(b).

Most countries are opting for Plant Breeders' Rights rather than patents for plants for which membership in UPOV, the international convention, is a strong indicator if not actually required. India for example has a Protection of Plant Varieties and Farmers' Rights Act of 2001[42] but is not a member of UPOV.

Additional and more current information on enforcement issues was needed so a practitioners survey was developed. The survey was sent to patent attorneys and licensing executives of biotechnology firms in the U.S. and Europe following an extensive period of instrument development and in-person interviews. Public sector licensing officers were contacted as well. In total, seventeen surveys and interviews were distributed with a response rate of fifty-nine percent. Biotechnology firms (pharmaceutical and agricultural) are an appropriate response group because the importance of IPR protection to that sector means a high level of awareness of technology transfer issues. The survey results emphasized how important a factor the enforceability of IP statutes is in a country. Slowness of a national court system, poor standing of a foreign plaintiff, lack of technical competence, or inability to enforce a judgment once made were all reasons to downgrade the effectiveness of a national system.

Repeating the initial list, the duration of protection can be dropped as a component while cost of protection can be added, as follows:

- protectable subject matter
- convention membership
- enforcement
- administration
- cost of protection

Ways of quantifying each of these components using public sources were described as:

Protectable subject matter: As noted, TRIPS mandates a minimum scope of subject matter for patent protection so that satisfaction of the TRIPS requirements is an indication of the allowable subject matter. Countries must certify their compliance with WTO in the IP/N/1/[3 letter country code]/P publication series. Those which have certified compliance are noted with a 1; a 0 is used otherwise. Under TRIPS,[43] countries are obliged to implement the provisions within prescribed time periods based on their level of development. For developed countries, the period was one year following the date of entry into force of the WTO Agreement, and for developing countries five years, and up to ten for products not previously protected. The least developed countries are allowed ten years or up to January 2006 with additional extensions considered on request. For pharmaceuticals products, the Doha Declaration[44] extended the deadline until January 2016.

The only subject area where compliance is not fully indicative is for plants,

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[42] The Protection of Plant Varieties and Farmers' Rights Act, 2000, No. 53, Acts of Parliament, 2001, http://www.grain.org/brl_files/india-pvp-2001-en.pdf.

[43] TRIPS, *supra* note 1, at arts. 65-66.

[44] World Trade Organization, Ministerial Declaration on the TRIPS Agreement and Public Health of 14 November 2001, ¶ 7, WT/MIN(01)/DEC/2 (2001).

where countries under Article 27.3(b) TRIPS[45] have the option of using patents and/or Plant Breeders Rights (PBR). Membership in UPOV (a 1, 0 otherwise) is taken as an indication of the selection of the PBR option.[46]

Convention membership: In addition to membership in UPOV, signatories to the Patent Cooperation Treaty (PCT)[47] are also noted (1 = member, 0 = not member). Participation in the PCT serves several functions for inventors, largely by reducing direct and indirect costs of application. Membership in the Paris Convention[48] is no longer a meaningful distinction for most countries are now members and compliance with 1967 Convention Articles 1-12 and 19 is mandated by TRIPS.[49]

Cost of protection: While an important issue for firms, no data set of costs existed while only a few countries made posted fees readily available through a website or other system. Thus, it was not possible to include a measure of costliness in the scoring system.

Administration: Patent office administration incorporates a range of critical factors from efficiency and transparency to adequacy of funding and training of examiners. Of these, the technical competence of examiners, when substantive examination is undertaken, is perhaps most significant. Such competency should be observable *directly* by examining the educational background and experience of employees, and *indirectly* by the number of granted patents which are overturned by the courts. For the former, few patent offices provide information on the backgrounds of their employees. With regards to court challenges, as one survey respondent noted, cases brought reflect not a random sample of issued patents but rather those cases which are both ambiguous and potentially involving significant sums. As a result, differences across countries can reflect a number of factors in addition to the actions of a patent office. Then, there is the issue of the transparency of a national court system which can affect the outcome and the absence of a database on cases brought and their resolutions, so that approach is not viable. Ginarte and Park[50] identified related reasons for abandoning an attempt to use a measure of complaints against a patent system.

As an expedient, the decision was made to distinguish between those patent offices which maintained a detailed web page, and those which did not (1 = web page exists, 0 = does not exist). The presence of the web page is then taken to reflect an office which is better supported and more interconnected.

Enforcement: Enforcement takes particular relevance due to the emphasis placed on it by the survey respondents. Yet again there is no generally available ranking of national legal systems, assessments of the competence of justices, and the like. There, the choice was made to use the Transparency International

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[45] TRIPS, s*upra* note 1.

[46] International Convention for the Protection of New Varieties of Plants, 1961 (membership list available at http://www.upov.int/export/sites/upov/en/about/members/pdf/pub423.pdf).

[47] World Intellectual Property Organization Patent Cooperation Treaty, June 19, 1970, *available at* http://www.wipo.int/treaties/en/ShowResults.jsp?lang=en&treaty_id=6 [hereafter PCT].

[48] Paris Convention for the Protection of Industrial Property, Mar. 20, 1883.

[49] *See* TRIPS, *supra* note 1, at art. 2.

[50] G&P, *supra* note 11, at 290.

"Corruption Perceptions Index" (CPI) for 1998. The annual index then ranked ninety-nine countries on a zero (highly corrupt) to ten (highly clean) scale. Each country score is an average of three to fourteen individual surveys of the *perception*s of corruption as seen by business people as well as "country/risk/expert analysts."[51] All such indexes have the limitation that they reflect perceptions only, but as Kaufmann, Kraay and Zoido-Lobatón[52] note, the subject is "inherently subjective" yet "perceptions of the quality of governance may often be as important as objective differences in institutions across countries."

Limitations nonetheless remain for, as Kaufmann, Kraay and Zoido-Lobatón[53] emphasize, there is substantial unexplained error in any estimates, to the point that that individual country CPI rankings are not statistically differentiable. Second is the matter of interest - here largely the competency and integrity of the IP court system – and what is measured, aggregate perceptions of corruption in private-private and private-public interactions. This distinction can be seen in reference to the U.S. which has a 1998 CPI value of 7.5, eighteenth on the list.[54] Whatever the integrity of other kinds of interactions may be, the U.S. is widely regarded as having a highly effective IP court system, particularly after 1982 when patent appeal cases were consolidated in a new Court of Appeals for the Federal Circuit.[55] Nonetheless, the CPI does represent a systematic effort to quantify aspects of the application of law in a diverse group of countries.

2. Constructing a Scoring System

Of the eighty-five countries included in the 1998 CPI,[56] forty-four are developing countries, which constitute the sample used. The sample is not a random one, but does represent a diverse geographical and economic range of countries.

A key step is identifying a proper weighting scheme for aggregating the values into a single index figure. For his purposes, Lesser[57] sought a more systematic approach, in particular the use of *factor analysis*. In this case, a three-factor model with a verimax rotation provided results explaining a total of seventy-seven percent of the variance of the variables.

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[51] TRANSPARENCY INT'L, CORRUPTION PERCEPTIONS INDEX 2010: LONG METHODOLOGICAL BRIEF (2010), *available at* http://www.transparency.org/policyresearch/surveysindices/cpi/2010/indetail#4.

[52] *See e.g.*, D. Kaufmann, A. Kraay & P. Zoido-Lobatón, *Governance Matters* 2 (World Bank Policy Research, Working Paper No. 2196, 1999), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=188568.

[53] D. Kaufmann, A. Kraay & P. Zoido-Lobatón, *Aggregating Governance Indicators* (World Bank Policy Research, Working Paper No. 2195, 1999), http://info.worldbank.org/governance/wgi/pdf/govind.pdf.

[54] *See* CORRUPTION PERCEPTIONS INDEX 1998, *infra* note 56.

[55] *See* P.W. GRUBB, PATENTS FOR CHEMICALS, PHARMACEUTICALS AND BIOTECHNOLOGY ch. 2 (Clarendon Press 4th ed. 1999).

[56] *See* TRANSPARENCY INT'L, CORRUPTION PERCEPTIONS INDEX 1998, *available at* http://www.transparency.org/policyresearch/surveysindices/cpi/previous_cpi/1998.

[57] Lesser, *supra* note 39.

3. Updating and Expanding the Scoring System

Several factors have changed since the initial work in 2002. For one, establishing a website has become far simpler so that the mere existence of a patent office site signifies little. As an alternative, the ability to search a national patent database online is used.[58] The sites can then be searched for the existence of online search capacity (scored 1, 0 otherwise). It should be emphasized that the issue is not *any* option to search a patent data file that is provided on a central and regional basis by the World Intellectual Property Organization among other groups,[59] but rather, the capacity of a national office to offer that function.

The concept of implementing TRIPS requirements has not changed since the 2002 analysis – TRIPS[60] Article 63.2 requires countries to notify the World Trade Organization when laws and regulations pertaining to meeting TRIPS commitments have been adopted – but the presentation of data have migrated.[61]

TRIPS notifications also apply to notification on enforcement, but the form of those notifications is considered inadequate to assess the level of enforceability at the national level. The CPI for 2009, now available for 180 countries, remains a strong possibility with the strengths and weaknesses as described above.[62] However in the interim period, several other possible measures of enforceability have become available. These include World Bank data on the cost of doing business in countries,[63] and particularly the cost of contract enforcement. There are clear if imperfect connections between the enforceability of contracts and enforcing patent rights. Specifically, the data report the number of days required, number of steps in the process and the cost measured as a percent of the claims. The World Economic Forum[64] has a related question (1.05) on judicial independence, "[t]o what extent is the judiciary in your country independent from influences of members of government, citizens, or firms?" A third measure of corruption is the World Bank Institute variable, Control of Corruption, defined as "perceptions of the extent to which public power is exercised for private gain" including both corruption, both small and grand, and the 'capture' of the state by the elite and private interests.[65] However the correlation with the CPI, r = .98, is

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[58] World Intellectual Property Organization, External Databases, http://www.wipo.int/patentscope/en/dbsearch/national_databases.html (last visited March 31, 2011) (for a list of international patent office websites); *see also* World Intellectual Property Organization, Patentscope: International and National Patent Collections Search, http://www.wipo.int/patentscope/search/en/search.jsf (last visited March 31, 2011) (for access to national and international patent office searches).

[59] *Id.* International searches are available at http://www.wipo.int/patentscope/en/; while multiple national and regional patent files can be searched from a central point at http://www.wipo.int/patentscope/search/en/search.jsf.

[60] TRIPS, *supra* note 1, at art. 63.2.

[61] TRIPS implementation notices are available at http://www.wto.org/english/tratop_e/trips_e/intel8_e.htm.

[62] Kaufmann, Kraay & Zoido-Lobatón, *supra* notes 52-53; CORRUPTION PERCEPTIONS INDEX 1998, *supra* note 56; TRANSPARENCY INT'L, CORRUPTION PERCEPTIONS INDEX 2009, http://www.transparency.org/policyresearch/surveysindices/cpi/2009/cpi2009table.

[63] Doing Business, Enforcing Contracts, http://www.doingbusiness.org/ExploreTopics/EnforcingContracts/ (last visited Nov. 12, 2010).

[64] GLOBAL COMPETITIVENESS REPORT, *supra* note 31, § 1.05.

[65] World Bank, Control of Corruption, http://info.worldbank.org/governance/wgi/pdf/cc.pdf.

so high as, again, to provide no additional information over using the CPI.[66]

Used in composing a score, the World Bank data however led to odd results. This is perhaps a result of the range of the data; while the cost of enforcing contracts in many countries was in the twenty-five to thirty-three percent range, several came in a well over 100%. The World Economic Forum data[67] on judicial independence has a simple correlation of .85 with the Corruption Perception Index,[68] and using the nonparametric rank sum test, the two series are not independent at the ninety-five percent confidence level.[69] Thus, since the judicial independence data bring little new information and in order to retain consistency with the 2002 index, the decision was made to continue use of the Corruption Perception Index.

Applying factor analysis to generate weights for a four component model indicated that the PCT component was redundant in the sense that it added little to the explained variance (up twenty percentage points and giving a weighting of nearly one (.997)).[70] This means that for the 142 PCT members – accounting for nearly all countries in the current data set – the index is increased by one point (.997). Dropping it leaves three components with, in this case, a three-factor model with an equamax rotation.[71] This provides results which could be described in terms of the expected underlying relationships as follows:

Factor 1 (35%): Scope, weighing most heavily on UPOV and TRIPS compliance

Factor 2 (28%): Enforcement, weighing most heavily on the CPI

Factor 3 (27%): Institution, patent office efficiency/ sophistication

The factor weights, which explain a total of ninety percent of the variance of the variables, are shown in Table 1.

Table 1: Computed Factor Weightings of the Three Component Index Model

	Scope	Enforcement	PO Efficiency	Communality
CPI '09	.214	.949	.201	.986
UPOV	.895	.169	.198	.868
TRIPs	.720	.366	.306	.745
PO Eff.	.220	.201	.953	.996
% Variance	35	28	27	90

The aggregate factor values (communality) are used to weigh the individual index components in generating the IP score; that is, the computed communality value from Table 1 is for each country analyzed multiplied by the data value for that country. The weights have the intuitive appeal that the near-greatest weight is

[66] World Bank, Worldwide Governance Indicators, http://info.worldbank.org/governance/wgi/index.asp (last visited Nov. 12, 2010).

[67] GLOBAL COMPETITIVENESS REPORT, *supra* note 31.

[68] CORRUPTION PERCEPTION INDEX 1998, *supra* note 56.

[69] Results not shown for brevity; the rank sum test described at http://www.stat.auckland.ac.nz/~wild/ChanceEnc/Ch10.wilcoxon.pdf.

[70] Results of four component factor model suppressed for brevity.

[71] Factors were computed using Minitab Version 15 for Windows.

placed on the CPI, a proxy for the enforceability of IPR, which the survey respondents indicated as the most significant aspect of the effectiveness of patents at the national level.[72] As significant is patent office efficiency/sophistication. Compared to the 2002 index, this component has become more significant, but since the variable used to measure it has changed no direct comparison can be made.[73]

The three factors can, alternatively, be viewed as differing approaches to strengthening patent systems. Countries may (1) join/implement international agreements (TRIPS, UPOV), (2) enhance the operation of their patent offices, or (3) improve enforcement by reducing corruption.[74] The strongest rights of course are achievable only by being well established in all three dimensions. But not all countries presently have strong systems and hence have alternative paths available for strengthening them. For example, they may in a matter of degrees focus first directly on patent systems by say fully implementing TRIPS, or they may first tackle enforcement/corruption and then shift attention to the patent system in particular. Which approaches are pursued and the consequences are explored further in Section III.[75]

The resulting index values, referred to here as the 'Cortez Patent Index,' are presented in Table 2 for 148 countries in 2009. The country selection was determined largely by data availability, but some countries in non-equilibrium states (like Afghanistan) were dropped, as were very small and fledgling states like Vanuatu.

[72] *See supra* Section II.B.1.

[73] Lesser, *supra* note 39.

[74] *See infra* Sections III.B-C.

[75] *See infra* Section III.

Table 2: Computed Patent score – the Cortez Patent Index, Selected Countries, 2009

Country	Score	El Salvador	3.3524
Albania	4.7682	Ethiopia	2.6622
Algeria	2.7608	Estonia	9.1166
Angola	1.8734	Finland	11.3844
Argentina	5.4684	France	10.3984
Armenia	4.4032	Gabon	2.8594
Australia	11.1872	Gambia	2.8594
Austria	9.4024	Georgia	4.9106
Azerbaijan	3.1358	Germany	10.497
Bahrain	5.7736	Ghana	4.5904
Bangladesh	2.3664	Greece	5.4878
Belarus	3.2344	Guatemala	3.3524
Belgium	9.6096	Guinea	1.7748
Bhutan	4.93	Guyana	2.5636
Bolivia	4.2752	Haiti	1.7748
Bosnia	2.958	Honduras	3.21
Botswana	6.2666	Hong Kong	8.0852
Brazil	5.2612	Hungary	7.6376
Burkina Faso	3.5496	Iceland	10.1912
Brunei	5.423	India	4.0974
Bulgaria	5.3598	Indonesia	4.5018
Burundi	1.7748	Iran	1.7748
Cambodia	1.972	Iraq	1.479
Cameroon	2.1692	Ireland	9.629
Canada	11.1872	Israel	8.6236
CAR	1.972	Italy	6.8488
Chad	1.5776	Jamaica	2.958
Chile	9.2152	Japan	10.2012
China	6.1586	Jordan	6.543
Colombia	6.2572	Kazakhstan	2.6622
Congo DR	1.8734	Kenya	3.7822
Costa Rica	6.8388	Korea (S)	7.164
Cote d'Ivoire	2.0706	Kuwait	4.0426
Croatia	5.8528	Kyrgyzstan	3.4864
Cyprus	7.2526	Laos	1.972
Czech Rep	6.4444	Latvia	6.05
Denmark	11.7788	Lebanon	2.465
DR	3.826	Liberia	3.0566
Ecuador	3.7822	Lithuania	7.4404
Egypt	2.7608	Luxembourg	8.8302
Country	Score	Malaysia	5.182

Namibia	4.437	Sierra Leone	2.1692
Madagascar	2.958	Singapore	11.6802
Mali	2.7608	Slovakia	7.046
Mauritania	2.465	Slovenia	8.3716
Mauritius	5.3244	SA	7.2432
Malawi	3.2538	Sri Lanka	3.0566
Mexico	4.8668	Spain	8.6236
Mongolia	3.4072	Sudan	1.479
Morocco	5.8628	Suriname	3.6482
Mozambique	2.465	Syria	3.5596
Namibia	4.437	Swaziland	4.2946
Nepal	2.2678	Sweden	11.6802
Netherlands	11.3844	Switzerland	11.483
NZ	11.8774	Taiwan	7.2626
Nicaragua	5.074	Tajikistan	1.972
Niger	2.8594	Tanzania	2.5636
Nigeria	3.21	Thailand	4.0974
Norway	10.1912	Togo	2.7608
Oman	7.036	Tonga	2.958
Pakistan	4.1074	T&T	5.1626
Panama	5.2164	Tunisia	5.8528
Papua New Guinea	2.0706	Turkey	6.9474
Paraguay	3.6836	Uganda	2.465
Peru	5.3892	UAE	6.409
Philippines	4.1074	Ukraine	3.7822
Poland	7.539	UK	10.2012
Portugal	8.3278	USA	10.004
Moldova	4.1218	Uruguay	8.2192
Qatar	7.647	Uzbekistan	3.6388
Romania	6.3558	Venezuela	3.6144
Russia	4.0332	Vietnam	4.2752
Rwanda	3.2538	Yemen	2.0706
Saudi Arabia	4.2398	Zambia	2.958
Senegal	2.958	Zimbabwe	2.9142
Serbia	4.447		

C. Correlations

The first step in evaluating the available patent indexes is to consider the correlations among them. Correlations, even high correlations, are not in themselves indicators of significance overlap among the scores. Rather, that relationship can be assessed further by examining the significance of the relationship using a rank sum test or other statistical tests.

Considering first the correlations among the several indexes when first

developed, which is to say in the 1990s, the relationship between the Mansfield[76] and Sherwood[77] scales is fairly strong (r = .663).[78] On the other hand, the relationship is weaker between Sherwood's and the two legislation-based systems (r = .144 and .060) for R&R[79] and G&P[80] respectively.[81] Given the related base of those latter two indexes, it is surprising they are not very closely correlated (r = .235).[82] The correlations for the most recent index values are reported in Table 3.[83] In all cases it is important to recognize that the countries with reported scores are not the same for all indexes so the computed correlations reflect some sample-difference effects.[84] Since the years differ slightly across the indexes there is possibly also a year effect reflected in the results.

Table 3: Correlations Among the Major IP Indexes, Mid-2000s[85]

	Cortez '09	WEF/IPR	G&P '05	IPRI '10	P&W '06
Cortez '09	1				
WEF/IPR '09	.84	1			
G&P '05	.80	.63	1		
IPRI '10	.87	.93	.70	1	
P&W '06	.80	.90	.61	.91	1

Considering these correlations individually, it can be noted that the relationship between the G&P[86] and P&W[87] indexes has strengthened since the 1990s, from r = .235 to .61.[88] Very likely this change reflects the standardization of patent legislation following the large scale implementation of the TRIPS[89] legislation as these are both legislation-based indexes. The strongest correlation, r = .93, is between WEF/IPR[90] and IPRI,[91] which is not surprising as those indexes apply to all IP while the remaining three are patent-specific.[92] The next-strongest

[76] Mansfield, *supra* note 21.
[77] Sherwood, *supra* note 22.
[78] Computed.
[79] R&R, *supra* note 7.
[80] G&P, *supra* note 11.
[81] Computed.
[82] Computed.
[83] Computed.
[84] *See* discussion *supra* Section II.A.
[85] Computed; data sources as identified in left-most column.
[86] G&P, *supra* note 11.
[87] P&W, *supra* note 15.
[88] Computed.
[89] TRIPS, *supra* note 1.
[90] GLOBAL COMPETITIVENESS REPORT, *supra* note 31.
[91] IPRI, *supra* note 14.
[92] *See* discussion *supra* Section II.A.

correlation, r = .91, between P&W[93] and IPRI is a little surprising as IPRI uses the G&P[94] index in its composition, not P&W,[95] but then both are text-based indexes and so share clear similarities.[96] The third highest correlation value, r = .90, is between WEF/IPR and P&W.[97] There is no new information there. Rather, it is a reflection of the transitivity rule: since IPRI and WEF/IPR are strongly correlated and the same applies to IPRI and P&W, then it follows that WEF/IPR and P&W must be strongly correlated as well.

Wakasugi and Ito[98] attempted to resolve the relative merits of legislation based and those incorporating aspects of enforcement by comparing the Park and Wagh[99] index with one based on the 2007 responses of 5,500 Japanese firms with overseas affiliates regarding IPR enforcement in forty-five countries.[100] Using the survey they were able to collect actual data on the investments and royalty payments from affiliates in those forty-five countries.[101] They found an r = .70 correlation between the two indexes, notable if not quite as strong as some in Table 3 above, but noted that for seventeen countries the two diverged by more than ten percent.[102] Using GLS regression analysis they report the signs and statistical significance of the explanatory variables were nearly the same whether the P&W or survey index was used, but that the elasticity of royalty payments when using the survey index was .96, notably higher than the .36 when the P&W index was used.[103] That is, the index which incorporated enforcement considerations reflected more accurately the actual overseas investments in affiliates than did the legislation-based index. That result is not really surprising.

What is perhaps most notable in Table 3 is the strong correlations of the four other indexes with the Cortez Index.[104] As an indication of the strength of these correlations, the ranking of countries under the Cortez and IPRI[105] indexes is not significantly different at the ninety-five percent level using the rank sum test.[106] The existence of an overriding commonality in these indexes is suggested. That is, as is noted below,[107] countries at different levels of development have multiple routes available for enhancing their patent index values. They can join/satisfy international organizations, enhance the operation of the patent office, or improve

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[93] P&W, *supra* note 15.

[94] G&P, *supra* note 11.

[95] P&W, *supra* note 15; *see also supra* Section II.A.

[96] *See* discussion *supra* Section II.A.

[97] GLOBAL COMPETITIVENESS REPORT, *supra* note 31; P&W, *supra* note 15.

[98] Advanced Practice Education Associates Conference ("APEA"), Ryuhei Wakasugi & Banri Ito, *Protection of Intellectual Property and International Technology Transfer: Empirical Evidence* (July 25-26, 2007), http://www.apeaweb.org/confer/hk07/papers/wakasugi-ito.pdf.

[99] P&W, *supra* note 15.

[100] APEA, *supra* note 98.

[101] *Id.*

[102] *Id.*

[103] *Id.*

[104] *See supra* tbl.2.

[105] *See* IPRI, *supra* note 14.

[106] Computed; *see supra* note 69 and accompanying text (describing the rank sum test).

[107] *See infra* Section III.D.

enforcement.[108] The evidence, that alternative patent index systems which use distinct means to quantify those components result in such closely aligned results, suggests the existence of a dominant underlying component of the indexes, as is revealed again through transitivity. If A and B are both closely correlated with C, then A and B also must be strongly correlated. In Section III an attempt is made to identify just what aspect of the index constitutes this 'C.'[109]

Pursuing the possibility of a dominant underlying dimension further, correlations are indeed generally found to be very strong. For example, r = .89 between WEF/IPR[110] and the EFW[111] measure of judicial independence, while r = .90 between CPI[112] and WEF/IPR (which by transitivity means CPI is also highly correlated with judicial independence, r = .85 to be exact). Cases where correlations are not strong are between the CPI[113] and World Bank measures of the cost of doing business,[114] namely the cost and time for contract enforcement. Those correlations are, respectively, r = -0.36 and -0.22. The negative signs are understandable as for example as contract enforcement becomes more costly as a proportion of the settlement amount the implication is enforcement is more cumbersome. The low correlation values perhaps further reflects the wide diversity in the "Cost of Doing Business" figures.[115]

D. Conclusions Regarding Patent Indexes

The above assessment indicates there are far closer parallels among the available indexes than there are differences among them. In general, there are both conceptual reasons and some empirical evidence to prefer the indexes which measure aspects of enforcement over the purely legislation based ones, although the distinctions appear more important when analyzing individual countries than the overall conclusions. More generally though the closeness of the several indexes suggests that at the current level of sophistication of index construction any one will serve about as well as another, particularly when evaluating trends rather than individual country results. Practical matters must also be considered, namely that WEF/IPR[116] and IPRI[117] are being supplied annually while the others at present are not.[118] Hence the suggestion in the introduction above[119] that a

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[108] *See supra* Section II.B.

[109] *See infra* Section III.

[110] GLOBAL COMPETITIVENESS REPORT, *supra* note 31.

[111] *See* ECONOMIC FREEDOM ANNUAL REPORT, *supra* note 29.

[112] *See* TRANSPARENCY INT'L, CORRUPTION PERCEPTIONS INDEX 2009, *supra* note 62.

[113] *Id*.

[114] WORLD BANK, DOING BUSINESS 2010: COMPARING REGULATION IN 183 ECONOMIES (World Bank, International Finance Corporation, and Palgrave MacMillan 2009), http://www.doingbusiness.org/documents/fullreport/2010/DB10-full-report.pdf.

[115] *See supra* Section II.B.

[116] *See* GLOBAL COMPETITIVENESS REPORT, *supra* note 31.

[117] *See* IPRI, *supra* note 14.

[118] It would of course be possible for any research to create the Cortez Patent Index for any year for which data is available. The text here lays out the construction process in detail. Researchers must decide whether to utilize the weights presented here or recalculate the weights every year. This is a common issue with computing indexes. *See* WILLIAM G. TOMEK & KENNETH L. ROBINSON,

single patent strength index will serve most purposes. We now turn to the more complex question of the causality between indexes and economic growth. As a key element, the observation that countries at different levels of development have alternative approaches to strengthening their index score is utilized.

III. PATENT INDEXES AND ECONOMIC GROWTH

A. Causality

As among the components of patent indexes, strong correlations abound between the indexes and measurements of GDP, R&D and technology licensing per capita. Using PPP (Purchasing Power Parody)[120] per capita as an alternative measure of GDP, which adjusts for national purchasing power and hence better reflects national standards of living, the correlations are between r = 0.75 and 0.84. As noted though, correlations do not demonstrate causality, or directions of causality. For example, Rapp and Rozek observe, "[p]harmaceutical R&D is conducted in those countries where intellectual property is protected."[121] Pharmaceutical R&D is often analyzed because the sector is a heavy investor in R&D and, due to the relative ease of copying compounds once discovered, depends more than most industries on strong patent protection. However, as we have seen, countries with strong patent systems also tend to be wealthier with larger markets so the observation that pharma R&D is associated with stronger patent rights does not help in identifying the direction of causality; whether, strong IPR leading to R&D, or R&D contributing to strengthened IPR through institutional enhancements associated with wealthier nations.[122]

Ginarte and Park conclude that the level of IP protection is driven not by the level of economic development (such as is measurable as GDP/capita) but rather by the determinants of economic development – R&D expenditures, market freedom and openness.[123] Concerning R&D in particular, they detect evidence of distinct sub-groups and divide the sample into those with above and below median levels of R&D per capita investment. The results indicate R&D is important for the richer group but not for the poorer, indicating why stronger patent rights might not be of interest/value to the poorer sub-set. Particularly, they suggest the underlying factor is the size of R&D; some critical minimum size (likely nationally

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AGRICULTURAL PRODUCT PRICES 190-92 (Cornell U. Press, 3d ed. 1990).

[119] *See supra* Section I.

[120] WORLD BANK, GROSS NATIONAL INCOME PER CAPITA 2009: ATLAS METHOD AND PPP (2009), http://siteresources.worldbank.org/DATASTATISTICS/Resources/GNIPC.pdf.

[121] R&R, *supra* note 7, at 19.

[122] More recent evidence from India though does suggest that causality runs from strong patent rights to R&D investments. *See* Biswajit Dhar & K.M. Gopakumay, *Effect of Product Patents on the Indian Pharmaceutical Industry*, at 53-56, http://wtocentre.iift.ac.in/Papers/3.pdf. India did not allow product patents for pharmaceutical products from 1970 to 1995, leading to limited domestic R&D directed to the discovery of new compounds. *Id.* However from 1995 to 2004, domestic pharma R&D increased more than six fold to almost US $340 million, with domestic non-generic producers investing most heavily. *Id.* Interestingly, multinational firms operating in India raised domestic R&D very little post-1995. *Id.*

[123] *See* G&P, *supra* note 11, at 297.

determined) may be needed to justify the expense of a strong patent system. Of course, a counter argument can be made that R&D investments increase once the government/institutional factors are in place to protect those investments, that is, that R&D is a lagging not leading indicator of economic development. Alternatively, Ginarte and Park find openness of an economy is statistically important for poorer nations but not for the richer group, if only because richer nations are generally fully open.[124]

Here I evaluated exceptions to a direct relationship between a patent score and PPP/capita by ranking both and examining those countries where one rank was notably higher or lower than the other. In practice I took the squared difference between the rankings of the Cortez Index and PPP/capita and found eighteen countries for which the PPP/capita greatly exceeded the rankings of the Cortez Index value. Of those eighteen, fifteen are leading natural resource exporters, particularly oil.[125] This relationship makes perfect sense; resource-endowed countries do not need to stimulate innovation to prosper and so do not invest in complex IPR systems. Only three countries in this group (Bosnia, Egypt and Lebanon) are not major natural resource exporters.

Conversely, there are but six countries for which the Cortez Index value far exceeds their PPP/capita rank, Ghana, Jordan, Kenya, Liberia, Morocco, and Nicaragua.[126] This group requires further evaluation.[127] Re-computing the correlations with the fifteen natural resource-dependent countries excluded does little to change the figures. The correlation between the Cortez Index[128] and PPP/capita is then r = 0.88 while between PPP/capita and CPI[129] r = 0.90, and r = 0.95 between the Index and CPI. Exploring further, the correlation between the CPI and the WEF measure of judicial independence[130] is r = 0.76. It is of no great surprise that removing fifteen countries from a list of 148 does not change the underlying relationships. But these correlations do emphasize the apparent existence of fundamental determinant relationships among this data.[131] As was discussed above,[132] countries have available three distinct approaches to strengthening patent systems: enhancing enforcement by reducing corruption, joining/complying with international conventions, and, finally, enhancing patent office operations. Due to the particularly strong correlations existing between several measures of corruption and the available patent indexes, as a working hypothesis corruption/enforceability of IP rights is identified as the fundamental causal factor among the several indexes. That is, the level of corruption/governing efficiency is hypothesized to be the principal determinant of countries stronger

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[124] *Id.* at 298.

[125] The fifteen countries are: Algeria, Angola, Azerbaijan, Bahrain, Belarus (a re-exporter of oil from Russia), Brunei, DR Congo, Gabon, Jamaica, Kazakhstan, Kuwait, Russia, Saudi Arabia, Trinidad and Tobago, and Venezuela. *Id.*

[126] Computed; for brevity analysis not shown.

[127] *See infra* Section III.C.

[128] *See supra* tbl.2.

[129] *See* TRANSPARENCY INT'L, CORRUPTION PERCEPTIONS INDEX 2010, *supra* note 51.

[130] GLOBAL COMPETITIVENESS REPORT, *supra* note 31.

[131] *See infra* Section III.C.

[132] *See supra* Section II.B.

patent index scores, and subsequently moving to higher income levels. Alternative explanations are explored further below,[133] but as will be seen, the mechanism chosen by countries to enhance patent rights is central here to identifying the direction of causality. First though, we examine in more depth the effects of corruption on patent systems and enforcement.

B. Role of Enforcement and Corruption

Students of the economics of corruption typically use the term to refer to the misuse of government office, the paying of government representatives **not** to do their jobs (in contrast to expediting a process, as with tips).[134] Corruption at high levels affecting policy is particularly problematic. Perhaps though for some cases the term 'corruption' is too strong a one. Corruption is difficult to define and identify in practice, has legal implications, and a moralistic dimension. Indeed, under some systems, corruption is seen as permitting governments to function, and not as an evil.[135] The particular term used though is not important; what is is the consequences. The inept, non-systematic delivery of public services, including allocations based not on stated criteria and merit, has the same effect of creating uncertainty, and uncertainty is anathema to the long term investments required for much innovation. Ineffective governance can be attributable to inexperience, lack of technical and organizational skills, or conflict with traditional approaches, in addition to corruption in the legal sense. Thus for those uncomfortable with the broad use of the concept of government corruption, particularly when specific evidence is limited, the term 'ineffective governance' can be used interchangeably.

The broad characteristics of inefficiency and uncertainty are not different across many corrupt/ineffectively governed countries, many of which are poor, for just those reasons. The World Bank's 2005 World Development Report, *A Better Investment Climate for Everyone*, makes the point, repeatedly, that, "secure property rights and good governance are central to economic growth. . .".[136] And, "the more secure the rights, the faster the growth."[137] In those instances the reference and examples are to real property while TRIPS provides some specific connection between the real and intellectual property.

To that end, it is instructive to consider how the TRIPS agreement treats enforcement. Clearly, the framers understood the significance and, unlike prior IP agreements, TRIPS[138] contains detailed provisions relating to the enforcement of those rights. However, the drafters "recognized that differences in the legal means to enforce IPRs were enormous among countries, and that such differences could

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[133] *See supra* Section II.C.

[134] *See, e.g.*, Pranab Bardhan, *Corruption and Development: A Review of Issues*, 35 J. ECON. LIT. 1320, 1346 (1997).

[135] Dexter Filkins, *Inside Corrupt-istan*, N.Y. TIMES, Sept. 5, 2010, at 6 ("while public graft is pernicious, there is no point in trying to abolish it – and that trying to do so could destroy the very government the West has helped to build").

[136] WORLD BANK, 2005 WORLD DEVELOPMENT REPORT, A BETTER INVESTMENT CLIMATE FOR EVERYONE 2 (2005), http://siteresources.worldbank.org/INTWDR2005/Resources/complete_report.pdf.

[137] *Id.* at 79.

[138] *See* TRIPS, *supra* note 1, at pt. III.

not be reasonably eliminated." Thus the provisions "rather than prescribing how to ensure enforcement, determine what the outcomes of the adopted measures should be."[139] TRIPS Article 41.1 reads in part (emphasis added), "[m]embers shall ensure that enforcement *procedures* as specified in this Part are available under their law so as to permit *effective* action against any act of infringement of intellectual property rights covered by this Agreement. . ."

Several points can be made regarding this article. The focus is clearly on the availability of procedures to remedy enforcement limitations, and not on the application of those procedures in individual cases. It is as always difficult to define and measure when action has indeed been 'effective,' and moreover the issue at hand is infringement which itself is defined in national law. Among the TRIPS mandated procedures are:

Article 41.2: "Procedures concerning the enforcement of intellectual property rights shall be fair and equitable. They shall not be unnecessarily complicated or costly, or entail unreasonable time-limits or unwarranted delays." And

Article 41.4 (in part): "Parties to a proceeding shall have an opportunity for review by a judicial authority of final administrative decisions . . ."

But "[m]embers shall be free to determine the appropriate method of implementing the provisions of this Agreement within their own legal system." (Article 1.1 in part). And (Article 41.5):

> It is understood that this part does not create any obligation to put in place a judicial system for the enforcement of intellectual property rights distinct from that for the enforcement of law in general, nor does it affect the capacity of Members to enforce their law in general. Nothing in this part creates any obligation with respect to the distribution of resources as between enforcement of intellectual property rights and the enforcement of law in general.[140]

From this overview it is evident the framers of the TRIPS agreement consider enforcement provisions to be critical, central, to an effective IPR system, but mandating specific legal systems is not feasible for a multi-state agreement. But, limiting requirements to certain minimal procedures leaves great discretion in implementation to national authorities. In short, the effectiveness of enforcement under TRIPS can be expected to vary considerable among nations. Unsurprisingly, not all countries will find the resulting levels of enforcement adequate.[141] Some will ascribe the inadequacies to governing inefficiencies, to inexperience and inadequate expertise, or to corruption. For those countries which do choose to enhance enforcement, a costly and complex undertaking, why do they differ from the others? What motivates them?

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[139] CARLOS M. CORREA, TRADE RELATED ASPECTS OF INTELLECTUAL PROPERTY RIGHTS: A COMMENTARY ON THE TRIPS AGREEMENT 409 (2007) (interpreting the TRIPS articles relating to enforcement).

[140] *See also* TRIPS, *supra* note 1, at arts. 42-45.

[141] *See, e.g.*, OFFICE OF THE UNITED STATES TRADE REPRESENTATIVE, SPECIAL 301 REPORT (2010), http://www.ustr.gov/webfm_send/1906 (identifying particular intellectual property violation concerns regarding specific countries).

C. National Incentives to Curb Corruption

Since countries have few detailed enforcement mandates under TRIPS, it is relevant to ask what leads some countries to establish high standards, which are both complex to implement and costly. We turn next to incentives for nations to make those changes, considered within the broader context of curbing overall corruption/enhancing governance. As an underlying consideration, it is assumed that corruption reduction is a complex and often wrenching process which can affect political alignments as power bases change. The complexity of the process can be seen in the World Bank Institute's report on Ghana's National Anti-Corruption Strategy.[142]

The report, prepared at government request in the context of a return to constitutional rule, was a response to "growing official and civil society recognition of the dangers of corruption, and the need to curb it."[143] Identified obstacles to reducing corruption included: weak political will, mixed signals from the Executive Branch, weak institutions, an inadequate adherence to the rule of law, entrenched patronage, weak private sector, weak civil society, and pervasive cynicism. To this list can be added government 'capture' by elites. The incentive in this instance for the Ghanaian government to tackle corruption was a return to constitutional rule, but others exist, including:

- Public outcry over an environmental catastrophe followed by a weak government response. Examples include the Russian wild fires during the 2010 summer.[144]
- The rise of an educated middle class with the expectation of greater control. India with its new technologies and industries is an example. Among other changes, the larger middle class affects the power base of the established elites.
- Direct financial incentives, such as access to foreign aid if reform stipulations are met. An example is the US Millennium Challenge.[145]
- The rise of enlightened leadership or other forms of serendipity. Enlightened leaders from inside and outside government ranks have included Nelson Mandela, Gandhi, and Gorbachev.[146]

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[142] WORLD BANK, REPORT ON GHANA'S NATIONAL ANTI-CORRUPTION STRATEGY, http://siteresources.worldbank.org/INTWBIGOVANTCOR/Resources/A1-durban-ghana.pdf.

[143] *Id.*

[144] L. Shevtsova & D.J. Kramer, *In the Russian Wildfires, Will Putin get Burned*, WASH. POST, Aug. 15, 2010, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2010/08/13/AR2010081302642.html) ("The poor response to the fires will further widen the chasm separating the nation's authorities from society. Even before Russia began burning, 82 percent of citizens surveyed by the state-run VTsIOM polling agency said state officials do not respect the law.").

[145] Millennium Challenge Act of 2003, 108th Cong. (Council on Foreign Relations, 1st Sess. 2003) *available at* http://www.cfr.org/poverty/millennium-challenge-act-2003/p16232.

[146] More serendipitous changes include events following the death of Guinean dictator Lansana Conte' in 2008. *See Guinea's First Free Election Praised for Transparency*, CNN WORLD, July 28, 2010, http://articles.cnn.com/2010-06-28/world/guinea.elections_1_carter-center-election-period-president-lansana-conte?_s=PM:WORLD (Capt. Moussa Dadis Camara seized power but was seriously wounded in an assassination attempt the following year, and while he survived under overseas care, he has promised not to return. That led the way to democratic elections in June 2010 with a runoff

The intent here is to select one of the above and document through national examples how the incentive led to reductions in corruption and rises in the strength of patent protection, followed by enhanced growth rates. This path serves as an example of how countries responses to incentives effectively enhanced IP enforcement and thereby accelerated growth. The incentive evaluated here is the financial one, in particular the US Millennium Challenge Act. The Challenge Corporation was created in 2004 as a government-funded but independent foreign aid corporation which invests in countries committed to good governance, economic freedom, and investment in their citizens. Accepted countries must score above the median relative to their income level peers in the 'ruling justly' and 'economic freedom' criteria, and above the median on the 'control of corruption category'.[147] Indicators are sourced from third parties – the control of corruption data from the World Bank Institute[148] – and it is both possible and precedented to be de-certified if the criteria fall below the established standards.

The countries selected for the initial analysis are those six identified above[149] as having a Cortex Index rank substantially exceeding their PPP per capita rank: Ghana, Jordan, Kenya, Liberia, Morocco, and Nicaragua. Although identified purely empirically, this is a standout set of nations. The World Bank[150] identified among a handful of countries making particular progress in reforms Ghana and Morocco (international software sales) and Ghana and Nicaragua (enhancements in real property rights). Moreover, Ghana, Morocco and Nicaragua are three of 20 presently with MCA funding (Nicaragua's was terminated in 2009), and Jordan and Kenya represent two of eighteen with Threshold Programs; a program with Liberia is under preparation. Kenya's program is specifically focused on reductions in corruption in public procurement. Clearly, these are reform-minded countries.

As regards economic growth, data in Table 4 indicates these countries typically grew faster at or before program eligibility; a showing of advances with the MCA goals is required prior to eligibility. Of course no analysis of a small number cases like this is likely to be absolutely in agreement. In some cases the divergence from the expected enhancements in growth can be explained by exogenous factors, such as the upheavals occurring in Kenya in early 2008 following a contested election. Other cases like Nicaragua are not consistent with expectations at all, but then Nicaragua lost its eligibility in 2009 exactly for not meeting the MCA goals. In general though countries which made a commitment to enhance governance, and through that process increased their patent index scores, have grown faster than others in the region, the preferred base of comparison.

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scheduled for later in the year.).

[147] *See* Millennium Challenge Act, *supra* note 145, § 606-07.

[148] *See supra* Section II.B.

[149] *See supra* Section III.A.

[150] 2005 WORLD DEVELOPMENT REPORT, *supra* note 136.

Table 4: Relative Real GDP Growth Rates for Six Countries with Strong Patent Index Scores

Country	'95-2000	'04	'05	'06	'07	'08
Ghana						
Global	+	-	+	+	-	++
Regional	-	++	++	+	+	++
Jordan						
Global	+	++	++	++	++	++
Regional	-	++	++	++	++	++
Kenya						
Global	—	—	+	+	++	—*
Regional	—	++	++	+	++	—*
Liberia						
Global	++	—	-	++	++	++
Regional	++	—	+	++	++	++
Morocco						
Global	—	-	—	++	—	++
Regional	—	-	—	++	+	—
Nicaragua						
Global	++	-	-	—	—	—
Regional	+	+	—	—	—	—

Key: + <1% higher; ++ >1% higher; - <1% lower; —>1% lower

Shaded numbers indicate when Millennium Challenge Account program eligibility began

* year of political ferment

Data: World Bank data available at http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

D. Hypothesis and Analysis

The five case countries discussed above are sufficient only to establish that countries, given an incentive, can work to improve governance/reduce corruption which in turn strengthens patent rights and economic growth. There are alternative approaches to the same end, namely joining international IP agreements and strengthening the patent office.[151] Both approaches increase the patent score. It is then an empirical question which is the more effective approach to increasing national incomes or growth. Of course by answering that question we are effectively also determining whether stronger IP rights lead to - cause - economic growth, or if economic growth also raises IP rights, or reverse causality.

Of the two approaches identified, the one involving joining international conventions and/or strengthening the patent office is clearly the direct one focused specifically on patent rights. If countries which use that approach are more economically successful then it can reasonable be concluded enhanced IP leads to higher incomes and growth. That is, there is no strong argument that growth *per se* leads countries to invest in their patent offices so when countries do, and grow, it

[151] *See supra* Section II.B.

can reasonably be concluded that the improvement caused the economic growth. Conversely, if enhanced governance/reduced corruption leads to the growth, that is an indirect way to enhance patent rights through improved enforcement while simultaneously strengthening other government sectors. Thus, growth led by enhancing the governance process is the causal factor, and strengthened patent systems is one indirect factor in that growth; governance leads to growth and to an improved patent system. Enhanced governance is both the more complex and encompassing reform so it can be expected that countries which implement that approach are more successful, rapidly growing/ higher income ones.

To test these hypothesizes factor analysis is again used employing three factors and equamax rotation.[152] Countries are classified as low, middle (combining lower and upper middle) and high per capita income according to the World Bank method.[153] Income categories are divided into above and below the median level and compared. Results for the low income group are shown in Table 5, and in Table 6 for the middle income nations.

Table 5: Factor Weightings for Low Income Countries, Above Median Income

	Factor 1	Factor 2	Factor 3	Communality
CPI '09	.138	-.938	-.211	.994
UPOV	.859	-.032	-.369	.875
TRIPs	.764	-.505	-.061	.843
PO Eff.	.203	-.198	-.945	.973
% Variance	.575	.178	.156	.909

The only factor with any explanatory power in Table 5 is factor 1, which applies to international agreement membership/compliance. The negative signs in factors 2 and 3 can be interpreted as 'not,' as not CPI and not PO efficiency. Thus the more economically successful (above median) of the lowest income countries are members of the international agreements related to IP and have satisfied their TRIPS obligations, but have not advanced on either corruption reduction or strengthening patent office practices. A factor analysis model could not even be applied to the sub-median income grouping of these low income countries, which is to say the poorest of the poor. The reason is lack of variability; that category as a group is not even members of the international IP agreements, or satisfied their obligations under those agreements. They indeed have advanced in no way on strengthening patent rights.

[152] *See also supra* Section II.B.

[153] World Bank, How We Classify Countries, http://data.worldbank.org/about/country-classifications (last visited Nov. 15, 2010).

Table 6A: Factor Weightings for Median Income Countries, Above Median Income

	Factor 1	Factor 2	Factor 3	Communality
CPI '09	.919	.084	.092	.859
UPOV	.164	.966	.132	.977
TRIPs	.748	.370	.222	.745
PO Eff.	.130	.129	.981	.997
% Var	.362	.273	.260	.894

Table 6B: Factor Weightings for Median Income Countries, Below Median Income

	Factor 1	Factor 2	Factor 3	Communality
CPI '09	.062	-.038	-.992	.989
UPOV	.879	-.032	-.175	.804
TRIPs	.800	.322	.068	.749
POEff.	.106	.978	.038	.969
% Var	.357	.266	.255	.878

The higher income of the median group (Table 6A) have, compared to the below median group, addressed corruption/enhanced governance more effectively and complied with their TRIPS obligations. Secondly, they joined UPOV and enhanced patent office functioning. In contrast, the below median income group (Table 6B) joined/complied with the international conventions and secondly invested in patent office practices, but have not made advances in reducing corruption. That is, the lower of the median income countries is closest to the upper group of the low income cohort, but also invest in their patent office practices.

E. Conclusion on the Direction of Causality

Within these four groupings of countries by income levels there is a clear progression of steps related to enhancing patent protection. The lowest have done nothing, the next steps being joining/satisfying the relevant international agreements, and strengthening the patent offices. Finally, corruption/governing efficiency is addressed. This sequence is not surprising, for working within the international agreements involves the least commitment, while enhancing governance is a complex and far reaching undertaking. This relationship between commitment and scope would be widely recognized by investors so that by undertaking each, countries are signaling varying levels of intent to foster innovation incentives. More significantly, the sequence identified here supports the explanation that countries specifically target strengthened IPRs as an economic growth mechanism and, indeed, income growth follows. That is, stronger IPRs contribute to growth, and are not a consequence of that growth.

Of particular relevance in that conclusion is the stage at which national patent offices are enhanced. Unlike joining the WTO/TRIPS, which provides enhanced trade access, there are no benefits to a strengthened patent office beyond the direct benefits of what those patents provide. Thus the decision to invest is made on its own merits, and does contribute to growth. The final component assessed here, corruption reduction, has the broadest reach and is most closely connected with national income levels. However, corruption reduction generally follows advances in democracy except in those cases when there is a particular motivation.[154] Thus countries seem able to raise incomes to some degree by focusing directly on strengthening IPR systems, but beyond some level corruption reduction becomes paramount, and corruption reduction follows economic growth. The income level at which that tipping point occurs? The evidence presented here suggests median middle income countries.

IV. INDIVIDUAL STATE ANALYSIS

The preceding section provides some general direction for nations interested to enhance income through a strengthened patent system by identifying the usually most promising directions for enhancements. Yet more country-specific indications of the relative standings of countries as regards the components of their systems would be of assist to any reform plans. In this section that analysis is reported using Data Envelopment Analysis (DEA).

A. Data Envelopment Analysis

DEA is related to a class of linear programming-based measures of production efficiency. DEA however is a non-parametric estimator which removes the necessity to specify a (potentially erroneous) relationship between inputs and outputs and hence is particularly well suited to the application to the patent issues examined here. As a simple, conceptual example of DEA, Beasley[155] examines four bank branch operations for their relative efficiency. Each branch has one input, staff number, and two outputs, number of personal and business transactions completed. Applying DEA, two branches are found to have an efficiency ranking of 100 with the other two estimated at forty-three percent and thirty-six percent. These are known as technical efficiencies, the technical success of the branches in translating staff numbers into completed bank transactions. DEA analysis can also be used to compute allocation efficiencies, the degree to which technical efficiencies align with input costs. Computing allocation efficiencies however requires data on costs – staff costs in the bank analysis example. In our patent analysis we have no cost data on say reducing corruption/enhancing governance efficiency and so our application is limited to technical efficiencies.

Returning to the bank branch example, Beasley[156] makes the important

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[154] *See also supra* Section II.C.

[155] J.E. Beasley, Operations Research Notes, http://people.brunel.ac.uk/~mastjjb/jeb/or/dea.html (last visited Nov. 15, 2010).

[156] *Id.*

observation that the branch with a thirty-six percent technical efficiency allocation *should not* be taken to indicate that branch is nearly one third as efficient as the branches with a 100 efficiency ranking. Rather these *relative* efficiency rankings indicate that if the poorer-performing branches adopted the same practices as those ranked higher they would be able to enhance their own performance. Stated more generally, Tauer, Fried and Fry[157] note that the entities ranked as 100s are on the technical efficiency frontier. The frontier is calculated based on the data used in each analysis; different data will lead to a different calculated frontier. As such the frontier represents the best feasible practice, not some abstract representation. This is both a strength and weakness of the technique; efficiency is evaluated relative to a particular set of peers. Additionally, the analysis assumes that the practices available to one entity are available to all peers as well, and that the production process is similar for all entities analyzed.

The analysis here uses freeware, specifically R[158] and FEAR[159], an R package. These programs are not for the faint-of-heart. As a non-parametric method, standard goodness-of-fit techniques do not apply. Simar and Wilson[160] have however identified a bootstrapping technique which re-samples the data-generation process and, by comparing to the original estimate, mimics the distribution of the original estimator. This bootstrapping technique is available in FEAR and is used to estimate the confidence intervals of the estimated efficiency scores.

B. Analysis and Results

Applying DEA to the patent data requires specifying both inputs and outputs. Inputs are, as have been presented previously, the four components of the Cortez Patent Index, CPI, UPOV membership, satisfying of the TRIPS requirements, and patent office efficiency.[161] Outputs of interest include, as discussed previously, both PPP/capita[162] and GDP growth rates.[163] Both are used here. The FEAR software further requires specifying whether the production frontier represents variable, non-increasing, or constant returns to scale. Variable returns to scale was selected as the most flexible option. But re-running the analysis using both constant and non-increasing returns indicates that while the numerical values did change, the relative positioning was largely unaltered.

The analysis is run separately for low and middle (combining lower and

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[157] Loren W. Tauer, Harold O. Fried, & William E. Fry, *Measuring Efficiencies of Academic Departments within a College*, 15 EDUC. ECON. 473, 489 (2007).

[158] R-Project, The R Project for Statistical Computing, http://www.r-project.org/, (last visited Nov. 16, 2010).

[159] Clemson University Faculty, Biography of Professor Paul W. Wilson, http://www.clemson.edu/economics/faculty/wilson/ (last visited Nov. 16, 2010).

[160] Leopold Simar & Paul W. Wilson, *Sensitivity Analysis of Efficiency Scores: How to Bootstrap in Nonparametric Frontier Models*, 44 MGMT. SCI. 49, 61 (1998).

[161] *See supra* Section II.B.

[162] GROSS NATIONAL INCOME PER CAPITA 2009, *supra* note 120.

[163] World Bank, GDP Growth, http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG (last visited Nov. 18, 2010) (listing the average GDP growth for low income countries from 2004-2009 and for middle income countries for 2005-2009). *See also supra* Sections III.A,C.

upper) income countries as the low income countries may not have all the options available to the medium level, a key assumption of DEA. The results are reported in Tables 7 and 8 for the low and medium groups respectively, with their respective bootstrap confidence intervals[164] presented in Appendix Tables A and B.

There are clearly many factors which contribute to a country's income and growth levels, including such factors as resources, location, population size and growth rate, educational levels, infrastructure, etc. Indeed, very little is explainable solely by the level of CPI, UPOV membership, TRIPS status and efficiency of the patent office, which is to say by the components of the Cortez Index. This point is apparent from a simple reading of Tables 7 and 8. Few would anticipate countries like Chad and Pakistan to be at or near the efficiency frontier. Rather the results should be read in the reverse: due to their growth and income levels, those countries define the frontier. It is instructive to examine the differences in the DEA results for four inputs (col. 2), one input (CPI, col. 3), and three inputs (UPOV, TRIPS, PO, col. 5). These differences are reported respectively in columns 4 and 6. Notable first is that few low income countries, indeed but five of thirty-one, would benefit from joining UPOV, satisfying TRIPS obligations and/or enhancing the national patent office. For those that would, benefits would be modest – on the order of three to four percent (.02/.64) compared to what more efficient peer countries have achieved. This result is consistent with the finding in Section III.D that the below-median group of the low income countries has done little to enhance the standing of their patent systems so as not to register on the sample-determined DEA frontier. In short, with few examples of membership, the DEA approach provides little direction for this low income group of countries. For those which do register though, as noted above, the benefit is in the three to four percent range, which is notable.

All analyzed countries do have a CPI number, and there the analysis indicates an improvement of up to ten percent (Mauritania, Nepal, Guinea) possible by emulating the practices of other countries with similar CPI scores. Interestingly, two of the countries identified for a Cortex Index ranking higher than their PPP/capita rank, Ghana and Kenya, can improve their performance by four to five percent by following the practices of peer countries.[165] Their governments appear to have identified a need but have as yet not benefited fully from addressing it.

Considering the middle income countries (Table 8) the country level analysis supports the general conclusions above.[166] That is, the below-median group typically enhanced their patent systems by first joining/complying with the relevant international organizations and improving the patent office, while the above median ones went on to deal with corruption/governing efficiency. What though is revealed by the analysis in Table 8 is the degree of efficiency among countries in following these general steps. Considering column 6 which reports the difference in efficiency when considering UPOV/TRIPS/PO only, most

[164] Based on 2,000 iterations.

[165] *See supra* Section III.C.

[166] *See supra* Section III.D.

countries show no difference in efficiency, indicating they are utilizing these aspects at the efficiency frontier. A number of countries though are well below the frontier – up to twenty-one percent for Ecuador (.14/.65) and seventeen percent for both Paraguay and Ukraine. The very large value for Sudan is a puzzle which possibly can be explained by its failing state with government institutions one of many victims.

Far more common and pernicious is the relative inefficiency with which numerous countries manage corruption/delivering government services. A number of countries are thirty percent or more off the efficiency frontier, which, it is important to recall, is defined by actual accomplishments of peer middle income countries and not by some hypothetical standard. Among that group are Armenia, Bhutan, Egypt, Guatemala, Guyana, Honduras, and India. The appearance of both Egypt and India on the list should not be surprising as both have a regrettable reputation for corruption and governmental ineptitude.

Table 7: Data Envelopment Analysis, Low Income Countries, 2 Outputs, 1, 3 and 4 Inputs

(1) Country	(2) 4 Inputs	(3) 1 Input/CPI	(4) Diff 3-2	(5) Input: UPOV/TRIPS/PO	(6) Diff 5-2
Bangladesh	0.72	0.68	-.04	0.72	0
Burundi	0.36	0.36	0	0.34	-.02
Cambodia	1.00	1.00	0	1.00	0
CAR	0.31	0.29	-.02	0.31	0
Chad	1.00	1.00	0	0.92	-.04
Congo DR	1.00	1.00	0	1.00	0
Cote d'Ivoire	0.55	0.55	0	0.55	0
Ethiopia	1.00	1.00	0	1.00	0
Gambia	0.65	0.63	-.02	0.65	0
Ghana	0.69	0.66	-.03	0.69	0
Guinea	0.38	0.34	-.04	0.37	.-01
Kenya	0.64	0.61	-.03	0.62	-.02
Liberia	0.55	0.55	0	0.55	0
Madagascar	0.55	0.54	-.01	0.55	0
Mali	0.51	0.48	-.03	0.51	0
Mauritania	0.80	0.72	-.08	0.80	0
Malawi	0.62	0.62	0	0.62	0
Mozambique	0.70	0.70	0	0.70	0
Nepal	0.50	0.46	-.04	0.50	0
Niger	0.46	0.46	0	0.46	0
Pakistan	0.93	0.93	0	0.93	0
Senegal	0.66	0.62	-.04	0.66	0
Sierra Leone	0.62	0.62	0	0.61	-.01
Tajikistan	0.89	0.85	-.04	0.89	0

Tanzania	0.70	0.70	0	0.70	0
Togo	0.31	0.27	-.04	0.31	0
Uganda	0.79	0.79	0	0.79	0
Uzbekistan	1.00	1.00	0	1.00	0
Vietnam	1.00	0.96	-.04	1.00	0
Yemen	0.79	0.79	0	0.79	0
Zambia	0.63	0.61	-.02	0.63	0

Table 8: Data Envelopment Analysis, Middle Income Countries, 2 Outputs, 1, 3 and 4 Inputs

DATA ENVELOPE RESULTS

(1) Country	(2) 4 Inputs	(3) 1 Input/CPI	(4) Diff 3-2	(5) 2 Input: UPOV/TRIPS/PO	(6) Diff 5-2
Albania	0.59	0.51	-.08	0.54	-.05
Algeria	0.63	0.44	-.19	0.63	0
Angola	1.00	1.00	0	1.00	0
Argentina	0.86	0.86	0	0.86	0
Armenia	0.77	0.53	-.23	0.77	0
Azerbaijan	1.00	1.00	0	1.00	0
Belarus	1.00	0.79	-.21	1.00	0
Bhutan	0.72	0.49	-.23	0.72	0
Bolivia	0.36	0.32	-.04	0.33	-.03
Bosnia	0.77	0.54	-.23	0.77	0
Botswana	0.94	0.69	-.25	0.94	0
Brazil	0.68	0.57	-.11	0.62	-.04
Bulgaria	0.81	0.71	-.10	0.77	-.04
Cameroon	0.26	0.19	-.07	0.26	0
Chile	0.73	0.73	0	0.73	0
China	0.57	0.57	0	0.57	0
Colombia	0.52	0.52	0	0.52	0
Costa Rica	0.70	0.64	-.10	0.70	0
DR	0.69	0.57	-.12	0.69	0
Ecuador	0.65	0.48	-.18	0.51	-.14
Egypt	0.60	0.41	-.19	0.60	0
El Salvador	0.54	0.37	-.17	0.54	0
Gabon	0.94	0.68	-.26	0.94	0
Georgia	0.45	0.42	-.03	0.45	0
Guatemala	0.47	0.32	-.15	0.47	0
Guyana	0.30	0.21	-.09	0.30	0
Honduras	0.44	0.31	-.13	0.44	0
India	0.52	0.35	-.17	0.52	0
Indonesia	0.45	0.33	-.12	0.45	0

Iran	1.00	1.00	0	0.96	-.04
Jamaica	0.55	0.40	-.15	0.55	0
Jordan	0.48	0.46	-.02	0.48	0
Kazakhstan	0.9	0.66	-.33	0.96	0
Latvia	1.00	0.92	-.08	1.00	0
Lebanon	1.00	0.72	-.28	1.00	0
Lithuania	0.92	0.92	0	0.92	0
Malaysia	1.00	0.74	-.26	1.00	0
Mauritius	1.00	0.72	-.28	1.00	0
Mexico	0.97	0.77	-.22	0.85	-.08
Mongolia	0.53	0.36	-.17	0.53	0
Morocco	0.32	0.32	0	0.32	0
Nicaragua	0.20	0.20	0	0.20	0
Nigeria	0.35	0.25	-.10	0.35	0
Panama	0.79	0.79	0	0.79	0
Papua New Guinea	0.32	0.26	-.06	0.33	.01
Paraguay	0.40	0.36	-.04	0.33	-.07
Peru	0.76	0.57	-.19	0.76	0
Philippines	0.41	0.30	-.11	0.41	0
Poland	1.00	1.00	0	1.00	0
Romania	0.82	0.82	0	0.82	0
Russia	1.00	1.00	0	1.00	0
Serbia	0.91	0.64	-.27	0.91	0
So Africa	0.57	0.57	0	0.57	0
Sri Lanka	0.55	0.37	-.18	0.55	0
Sudan	1.00	1.00	0	0.50	-.50
Suriname	0.60	0.42	-.18	0.60	0
Syria	0.47	0.32	-.15	0.47	0
Swaziland	0.38	0.27	-.11	0.37	-.01
Thailand	0.62	0.45	-.17	0.61	-.01
Tunisia	0.51	0.48	-.03	0.51	0
Turkey	0.74	0.74	0	0.74	0
Ukraine	0.52	0.41	-.11	0.43	-.09
Uruguay	0.81	0.75	-.06	0.81	0
Venezuela	1.00	1.00	0	1.00	0

In India's case just consider the debacle over preparing for the Commonwealth Games.[167] Numerous other countries while not as deficient as

[167] Jim Yardley, *As Global Games Begin, India Hopes for Chance to Save National Pride*, N.Y. TIMES, Oct. 3, 2010, at 6 ("The answer, to many of those involved with the [Commonwealth] games, is that India's political culture, if prized for its commitment to democracy, often seems unable to transcend its own dysfunction.").

those named above nonetheless have much potential to enhance national economic standards by improving the efficiency of governmental operations, which in many cases requires reducing corruption. That more countries have not advanced in this area further attests to the complexity and lack of compelling incentives to do so.

V. CONCLUSIONS

While the pathway from the introduction here to the conclusions is tortured, the conclusions themselves are straightforward. Patent indexes are largely interchangeable, although those which capture implementation/enforcement aspects are to be preferred over those which reflect legislation only. Some savings could be made by reducing the current overlapping of available indexes. As regards the larger and thornier question of the direction of causality between the strength of a patent system and an economy, the evidence identified here indicates it is from enhancing the patent system to economic growth. Indeed, there are two apparent stages, the simpler being joining/complying with the relevant international conventions and the more complex involving enabling enforcement, which entails the general improvement in the delivery of government services, typically incorporating the reduction of corruption. In general, lower income countries begin with institutions and later address corruption, clearly the more encompassing undertaking. Investors recognize these distinctions and can interpret the undertaking of each step as signaling different degrees of intentions to foster innovations. Yet while this is the general pattern, there are major differences in the efficiency of execution of these general goals across individual countries. The task is not an easy one, but the benefits are clear, and substantial. Most regrettable, they appear to fall short in all too many cases. Just perhaps, highlighting the benefits and way forward as is done here will help, a little.

APPENDIX

Appendix Table A: Bootstrap Confidence Interval Estimates, Low Income Countries, 4 Inputs/2 Outputs*

Obs.	DEA	Corrected	Bias	Var.	Confidence	Interval
1	0.7228	0.6544	0.06839	0.0016	0.6100	-0.7141
2	0.3608	0.2610	0.09971	0.0049	0.2522	-0.3536
3	1.0000	0.7949	0.20509	0.0104	0.7648	-0.9772
4	0.3084	0.2563	0.05204	0.0009	0.2401	-0.3026
5	1.0000	0.3280	0.67195	0.3598	0.5902	-0.9796
6	1.0000	0.6334	0.36653	0.0450	0.6906	-0.9812
7	0.5517	0.4381	0.11359	0.0070	0.4075	-0.5485
8	1.0000	0.8377	0.16220	0.0061	0.7967	-0.9759
9	0.6502	0.5972	0.05293	0.0009	0.5585	-0.6425
10	0.6943	0.6441	0.05013	0.0010	0.5976	-0.6880
11	0.3857	0.2600	0.12569	0.0066	0.2673	-0.3786
12	0.6433	0.5513	0.09191	0.0021	0.5177	-0.6286
13	0.5490	0.4706	0.07834	0.0018	0.4406	-0.5422
14	0.5552	0.5016	0.05359	0.0008	0.4715	-0.5488
15	0.5158	0.4731	0.04262	0.0007	0.4374	-0.5104
16	0.7969	0.7060	0.09082	0.0029	0.6527	-0.7844
17	0.6257	0.5619	0.06376	0.0016	0.5176	-0.6202
18	0.7040	0.6133	0.09060	0.0025	0.5716	-0.6876
19	0.5022	0.4444	0.05775	0.0011	0.4130	-0.4933
20	0.4562	0.4083	0.04784	0.0008	0.3785	-0.4503
21	0.9353	0.7689	0.16635	0.0102	0.7186	-0.9257
22	0.6586	0.5632	0.09536	0.0035	0.5211	-0.6499
23	0.6248	0.5283	0.09649	0.0029	0.4946	-0.6109
24	0.8896	0.7409	0.14864	0.0069	0.6974	-0.8692
25	0.7038	0.6318	0.07194	0.0013	0.5957	-0.6950
26	0.3069	0.2700	0.03689	0.0005	0.2491	-0.3021
27	0.7860	0.6952	0.09077	0.0024	0.6499	-0.7712
28	1.0000	0.6013	0.39866	0.0619	0.6702	-0.9819
29	1.0000	0.8242	0.17577	0.0063	0.7901	-0.9802
30	0.7931	0.6145	0.17855	0.0137	0.5846	-0.7872
31	0.6284	0.5795	0.04882	0.0009	0.5387	-0.6224

*Based on 2,000 iterations

Appendix Table B: Bootstrap Confidence Interval Estimates, Middle Income Countries, 4 Inputs/2 Outputs*

Obs.	DEA	Corrected	Bias	Var.	Confidence	Interval
1	0.5954	0.5185	0.0768	0.00149	0.48989	-0.58113
2	0.6354	0.5251	0.1102	0.00493	0.48618	-0.62772
3	1.00	0.4226	0.5773	0.16849	0.62303	-0.97813
4	0.8565	0.6806	0.1758	0.00830	0.66620	-0.84230
5	0.7678	0.6580	0.1097	0.00579	0.59878	-0.75400
6	1.00	0.4609	0.5390	0.13410	0.63541	-0.97760
7	1.00	0.7437	0.2562	0.01923	0.73685	-0.98470
8	0.7204	0.5874	0.1329	0.01010	0.53662	-0.71210
9	0.3604	0.2964	0.0639	0.00104	0.28479	-0.35213
10	0.7708	0.6836	0.0871	0.00300	0.62908	-0.75812
11	0.9407	0.8223	0.1183	0.00655	0.75077	-0.92923
12	0.6815	0.5855	0.0959	0.00277	0.55203	-0.66842
13	0.8119	0.6931	0.1187	0.00408	0.65576	-0.79571
14	0.2607	0.2007	0.0599	0.00163	0.18862	-0.25499
15	0.7282	0.6431	0.0850	0.00325	0.59228	-0.72232
16	0.5722	0.4673	0.1048	0.00478	0.43792	-0.56440
17	0.5227	0.4637	0.0589	0.00119	0.43289	-0.5166
18	0.6964	0.5882	0.1081	0.00385	0.55359	-0.68517
19	0.688	0.5602	0.1277	0.00463	0.53570	-0.67576
20	0.6539	0.5315	0.1223	0.00697	0.49150	-0.64006
21	0.601	0.5282	0.0727	0.00240	0.48187	-0.59305
22	0.5408	0.4788	0.0619	0.00157	0.44216	-0.53323
23	0.9459	0.7768	0.1690	0.01298	0.71890	-0.93821
24	0.4543	0.3308	0.1234	0.00674	0.32433	-0.44659
25	0.4691	0.4233	0.0457	0.00103	0.38497	-0.46383
26	0.2987	0.2589	0.0397	0.00061	0.23805	-0.29344
27	0.4455	0.3862	0.0592	0.00156	0.35333	-0.43905
28	0.5195	0.4320	0.0874	0.00457	0.38962	-0.51406
29	0.4554	0.4061	0.0492	0.00076	0.37999	-0.45069
30	1.00	0.2928	0.7071	0.33187	0.59955	-0.97855
31	0.5523	0.4597	0.0925	0.00428	0.42306	-0.54903
32	0.4799	0.3816	0.0982	0.00325	0.36608	-0.47168
33	0.9571	0.8363	0.1207	0.00558	0.76773	-0.94052
34	1.00	0.8022	0.1977	0.00973	0.77664	-0.98250
35	1.00	0.7224	0.2775	0.02533	0.72053	-0.98293
36	0.922	0.8152	0.1067	0.00482	0.75144	-0.91251
37	1.00	0.8400	0.1599	0.00617	0.79406	-0.97732
38	1.00	0.8432	0.1567	0.01069	0.77860	-0.98732
39	0.971	0.8483	0.1226	0.00436	0.79640	-0.95216
40	0.5325	0.4317	0.1007	0.00561	0.39380	-0.52524

41	0.3196	0.2754	0.0441	0.00059	0.25908	-0.31415
42	0.203	0.1491	0.0538	0.00094	0.14926	-0.19863
43	0.3511	0.2672	0.0838	0.00341	0.25198	-0.34539
44	0.7872	0.5653	0.2218	0.01484	0.57738	-0.77351
45	0.3265	0.2300	0.0964	0.00542	0.22283	-0.32009
46	0.4003	0.2971	0.1031	0.00336	0.29340	-0.39390
47	0.7651	0.6830	0.0820	0.00128	0.65197	-0.75312
48	0.4107	0.3502	0.0604	0.00108	0.32679	-0.40214
49	1.00	0.8778	0.1221	0.00641	0.80904	-0.99190
50	0.8223	0.7086	0.1136	0.00397	0.66646	-0.81040
51	1.00	0.4589	0.5410	0.12406	0.63978	-0.97852
52	0.9151	0.8052	0.1098	0.00495	0.74264	-0.90630
53	0.5684	0.5071	0.0612	0.00164	0.46691	-0.5621
54	0.5481	0.4732	0.0748	0.00297	0.42872	-0.54185
55	1.00	0.2250	0.7749	0.53596	0.57711	-0.97504
56	0.6048	0.5474	0.0573	0.00147	0.50258	-0.59805
57	0.4697	0.4133	0.0563	0.00131	0.37957	-0.46365
58	0.3803	0.3382	0.0420	0.00052	0.31692	-0.37438
59	0.623	0.5514	0.0715	0.00157	0.51462	-0.61124
60	0.5125	0.4277	0.0847	0.00177	0.40895	-0.50311
61	0.7455	0.6416	0.1038	0.00350	0.60021	-0.73682
62	0.5231	0.4250	0.0980	0.00399	0.39765	-0.51376
63	0.8135	0.6898	0.1236	0.00588	0.64352	-0.80097
64	1.00	0.5614	0.4385	0.10305	0.64008	-0.97223