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Intellectual Property Protection in Plant Varieties. A New Worldwide Index (1961-2011)

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Intellectual Property Protection in Plant Varieties. A New Worldwide Index (1961-2011)

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Abstract

In this paper, we construct a new index that measures the strength of intellectual property (IP) protection for plant varieties for 69 countries over the period 1961-2011. We examine the statistical properties of the index and we compare it with other measures of IP protection. We conclude that the indicator provides a reasonable proxy for assessing the relative strength of IP protection in plants across countries. Finally, we study the main determinants of the evolution of the index over time and we find that variables such as GDP per capita, types of political and institutional environment, levels of urbanization and schooling affect the level of IP protection for plant varieties. The TRIPS Agreement appears as an exogenous factor driving the process towards stronger levels of IP protection for all countries.

Keywords: Intellectual Property Rights; Plant Breeders' Rights; UPOV Convention; International Comparison

JEL Codes: O10, O34, 050, Q19

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1 Introduction

The progressive adoption of tighter intellectual property rights (IPRs) regimes after the ratification of the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) in 1994 has triggered the interest of economists and other social scientists on the possible effects of such policy shift on innovation and economic development. In particular, the TRIPS Agreement demands higher protection in domains, which previously, in many countries, were not subject to IP protection. This is the case of genetic resources including plant varieties. Notwithstanding the recent surge of interest in IPRs, most research in this field has been actually focusing on patents, while other types of protection, like plant breeders' rights (PBRs), have been relatively neglected.

The traditional economic rationale in support of patents and related forms of IPRs is a straightforward market failure argument based on the assumption that new knowledge is akin to a (quasi) public good. More specifically, in this view, new knowledge is conceived to be non-rival and hardly excludable and, therefore, once discovered, susceptible of easy imitation. In such conditions, the standard theory predicts that a competitive market configuration would be inevitably characterized by a systematic underinvestment in the generation of new technological knowledge. By attributing to innovators temporary exclusion rights on their inventions, the patent system enhances their prospects of appropriating a stream of economic returns sufficient to recover their investments in inventive activities, and thereby provides a solution to the market failure problem (Arrow, 1962).

Following this line of reasoning, one should expect to find a positive relationship between IPRs and innovation performance. However, recent studies have shown that the effect of IPRs on innovation is, by and large, technology and sector specific (Dosi et al., 2006; Boldrin and Levine, 2010) and that, in several circumstances, IPRs may not exert the positive and significant impact on R&D and inventive activities postulated by the theory, especially in developing countries (Helpman, 1993; Léger, 2007). In the specific case of plant varieties and genetic resources, the relation between IPRs and innovation remains a matter of debate. For example, in a recent study, Olmstead and Rhode (2008) have documented the dramatic rate of progress in plant breeding attained in the US during the nineteenth century, well before the introduction of any system of formal IPRs. In addition, the question is further complicated by other issues such as the moral aspects related with establishing property rights on life forms or on genetic resources without providing adequate compensation to the countries that host the biodiversity from which these have been generated (Kloppenburg, 2004). Furthermore, even if the economic and social consequences of granting increasingly strong IPRs for plant varieties have not been comprehensively appraised, many LDC countries are facing a growing pressure towards stronger IP protection systems that derives from trade agreements (Van Wijk and Jaffé, 1998).[1]

[1]The TRIPS Agreement was negotiated at the end of the Uruguay Round of the General Agreement on

In this paper, we examine the system of IPRs used to protect plant varieties and we try to measure its relative "strength" across countries, as has been done by other authors for patent systems (Ginarte and Park, 1997; Lerner, 2002). In order to do this, we construct a new index of the strength of IPRs for plant varieties at country level. Our hope is that this new indicator may become a new useful tool for assessing the effects of different IP systems over innovation, growth, technology transfer and productivity in agriculture. In this sense, we should regard it as a complementary measure of other IP measures such as the patent index of Ginarte and Park (1997)[2], frequently used as an indicator of the strength of IP protection for innovation in manufacturing and industrial activities. In addition, the construction of this new indicator for a cross-section of countries may contribute to the economic analysis of IPRs in two main ways. Firstly, it may shed light on the factors that have shaped the historical evolution of different IPRs systems. Secondly, it can contribute to provide a synthetic characterization of the institutional context of different countries for comparative studies of innovation policies in the agricultural sector in both developed and developing countries.

The index was constructed by means of a detailed study of the evolution of the legislation regulating the protection of plant varieties and related rights in each country. Our approach has been thoroughly comparative from the outset, and we have tried to identify the key-features of IP in plant varieties that are more likely to determine different levels of protection across countries. After the construction of our synthetic indicator, we have checked its "robustness" and plausibility by means of factor analysis and by looking at its correlation with other measures of IP protection. We have also examined the historical evolution of the index for countries of different income levels, development stage and geographical position.

Overall, we find that the level of protection has been increasing continuously throughout the period reflecting a broader trend towards the tightening of IP protection worldwide. Developed countries (DCs) have been offering IP protection for plant varieties for long time while less developed countries (LDCs) have adopted PBRs or patents for plants mainly after the signing of the TRIPS. Moreover, countries recently adopting IP systems are entering in the agreement with already high levels of protection.

In addition, we have carried out an exploratory econometric exercise in order to establish which factors could be plausible determinants of the IP index. Our results show that the level of IP protection for plant varieties is indeed correlated with variables such as GDP per capita, political and institutional system, schooling, openness to trade, and the relevance of agriculture for the economy. Interestingly enough, the patterns of correlation we have identified are not linear and they depend on the level of development of the country. Our analysis has also found a potential effect for exogenous factors, not related with the countries' specific characteristics, such as the signing of the TRIPS that are driving the

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Tariffs and Trade (GATT) in 1994 and became effective in 1996.

[2]Revisions and updates of the index of Ginarte and Park (1997) can be found in Park (2001); Park and Wagh (2002); and Park (2008).

process towards stronger IP systems.

The rest of the paper is organized as follows. In the next section, we discuss the motivation for constructing the index and we present in detail how the index of IP protection for plant varieties was constructed, as well as the data used and the sources. Section 3 examines the trends of evolution of the index across countries. Section 4 contains our econometric investigation of the possible determinants of the index. Section 5 concludes.

2 Measuring IP Protection for Plant Varieties

Current IP protection systems for plant varieties are the outcome of a complex process of historical development that has taken place at different paces in different legislations (Dutfield, 2011; Blakeney, 2005). Broadly speaking, there are two main forms of IP protection for plant varieties: patents and plant breeders' rights. Both of them grant a temporally limited exclusive control over the propagating material and the harvested material of a new plant variety. However, PBRs is a form of IP protection especially designed to protect plant varieties and, as such, it considers explicitly some of their specific attributes. In particular, plant varieties are characterized by an initial high cost of development but a low cost of reproduction. Innovation in plant varieties is cumulative and access to "protected" material is needed for attaining further improvements. Furthermore, some plant varieties are characterized by "self-reproduction" in the sense that the access to the plant material is enough for permitting its easy replication. Finally, in several cases, it is not always obvious what type of plant varieties can be genuinely regarded as inventions.

Analogously to patents, PBRs provide an exclusive right of marketing, reproduction, licensing, selling and distributing the variety preventing other parties from doing so without permission. However, for PBRs, the specific requirements to be satisfied for claiming protection are different from patents. In order to be a suitable matter for a PBR, a plant variety must be new, distinct, uniform and stable.[3] Recognizing some special attributes of plant varieties, PBRs may prescribe some exceptions or limitations to the rights of the holders that are typically not contemplated for patents. The most important are i) breeders' exception which allows breeders to use protected plant varieties for conducting research leading to a new variety; ii) farmers' exception which allow farmers (buyers) to self-reproduce seeds from plant varieties they have bought in order to use them in their own farms. Further details regarding these two exception clauses will be discussed in Section 2.1.

For long time, in most countries, new plant varieties were not regarded as a patentable subject matter. Accordingly, the United States Plant Patent Act of 1930, which introduced the patentability of asexually reproduced plants, is frequently considered as a major historical turning point in the evolution of the legislation (Moser and Rhode, 2011). Several countries refused to follow the American example preferring instead to work at

[3] In the case of patents, an invention must meet the following requirements: novelty; non-obviousness (involving a significant inventive step); and usefulness or susceptibility of industrial application.

the development of new “ad hoc” forms of protection for plant varieties. In 1961, the International Convention for the Protection of New Varieties of Plants (UPOV) was drafted to provide and promote an international and relatively harmonized system of IP protection especially designed for plant varieties with common basic guidelines for its members. Since then, most countries have adopted *sui generis* systems such as PBRs for the protection of plant varieties. More recently, some countries, like the United States and Australia, have introduced double protection as well (PBR and patent for the same plant variety, even sexually reproduced).

In a long-run perspective, it is possible to find examples of countries that have been very keen in offering IPRs for plant varieties alongside countries that were extremely reluctant to introduce them. However, the TRIPS Agreement determined a progressive tightening and a global diffusion of IPRs systems for plant varieties. Its article 27.3(b) establishes that members of the World Trade Organization (WTO) may exclude from patentability plants and animals other than micro-organisms, but they must provide protection for plant varieties, either by patents or by an effective sui generis system or by any combination thereof. As shown in figure 1, the UPOV Convention consisted of a relatively small group of countries until the early 1990s, but since then its membership has considerably expanded.

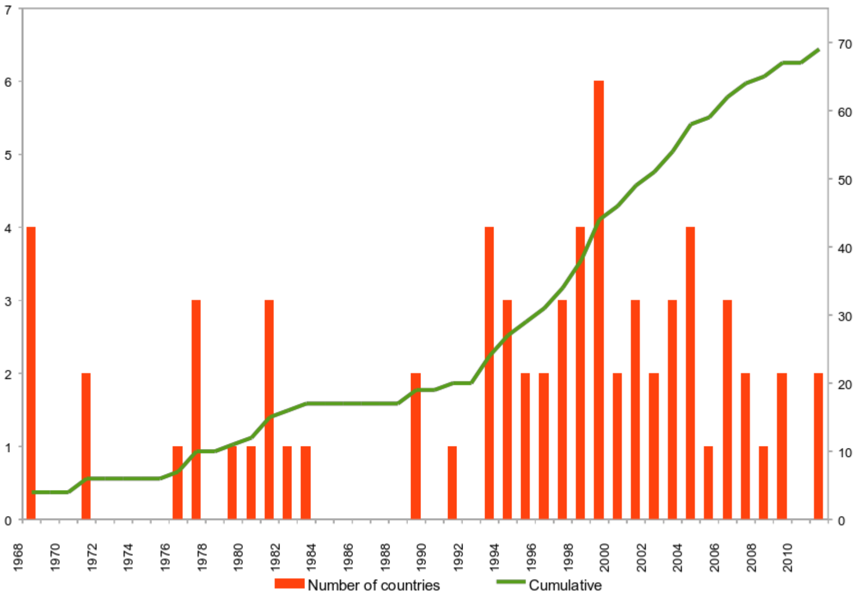

Figure 1: Number of Countries Becoming Members of UPOV by Year

Figure 2 shows this historical development from a geographical point of view. Before the ratification of the TRIPS Agreement, UPOV members were mostly Western European countries and “Western offshoots” such as the United States, Australia, Canada and South Africa. After the ratification of the TRIPS Agreement in 1994, LDCs in Latin America, Africa, Asia as well as former socialist economies of Eastern Europe are joining the Convention.

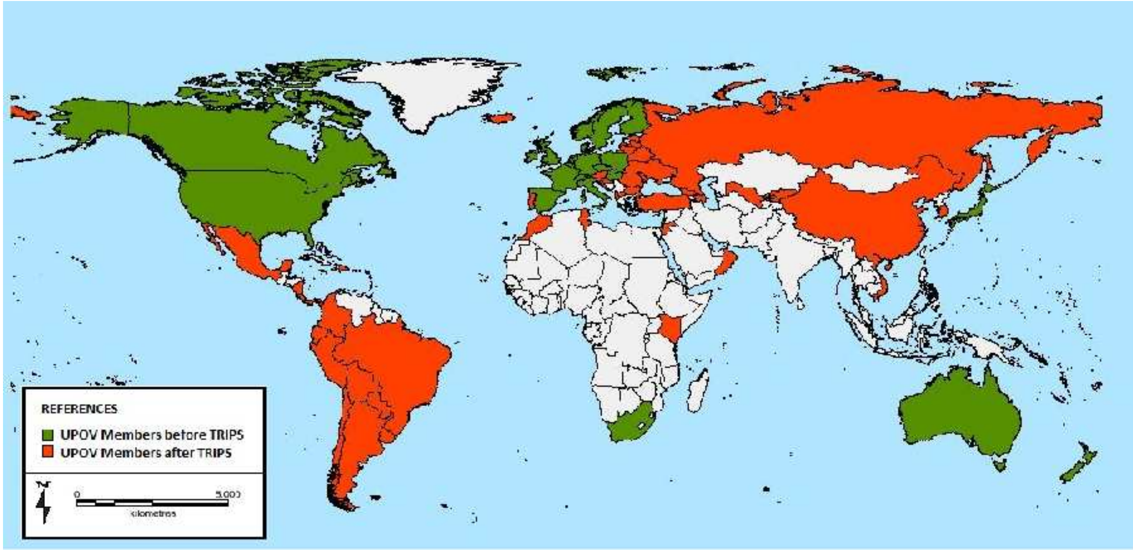

Figure 2: Members of UPOV Convention before and after TRIPS Agreement

This heterogeneity in the evolution of the patterns of legislation on the protection of plant varieties suggests that the construction of a synthetic indicator of the strength of IPR for plants, may contribute to enhance our understanding of the relationship between IPRs and innovation. Of course, the construction of a synthetic index of worldwide IP protection for plant may come at the price of neglecting some specific historical circumstances or some country-specific institutional detail, but, on the other hand, it has the advantage of providing us with a comparative comprehensive view of the main trends of IP protection in this domain.

2.1 The Construction of the Index

The index is based on a comparative historical perspective and it measures the level of IP protection available for plant varieties in different countries over the period 1961-2011. We have constructed the index for 69 countries, which were members of the UPOV Convention in 2011.[4] The index consists of five components that, considered together, determine the overall strength of IP system for plant varieties prevailing in each country. The five components of the index are: i) ratification of UPOV Conventions; ii) length of UPOV membership; iii) exceptions; iv) protection length; and, finally, v) coverage of patentability. Our approach is similar to the method used by Ginarte and Park (1997) for measuring the strength of patent protection.

The countries included in our sample rely on a rather similar basic legal framework regulating plant variety protection, which follows the general guidelines established by

[4]It is worth noting that there is a set of countries that provide protection for plants but are not UPOV members (for instance, India), which were not included in our database. Besides, some countries considered in our index used to offer some kind of IP protection before becoming members of UPOV (as Argentina or Australia).

UPOV. We constructed the index considering the elements that, within this common framework, tend to vary more from country to country and over time. This may lead to lose sight of some institutional specificities but it has the advantage of generating a comparable general measure of IP protection. The components of the index are set out in table 1.

Table 1: Index Components

	Component	Score Range	Normalized Score
1	Ratification of UPOV Conventions	0-3	[0,1]
	1961	0-1	
	1978	0-1	
	1991	0-1	
2	Length of Membership	0-51	[0,1]
	At most 51 years	0-51	
3	Exceptions	0-3	[0,1]
	No compulsory license	0-1	
	No farmer's exception	0-1	
	Essentially derived variety	0-1	
4	Duration	0-35	[0,1]
	At most 35 years	0-35	
5	Patentability	0-4	[0,1]
	Pharmaceuticals	0-1	
	Microorganisms	0-1	
	Food	0-1	
	Plants and animals	0-1	
	Index	0-96	[0,5]

Ratification of UPOV Conventions

This component considers whether a country has adhered to the subsequent revisions of the UPOV Convention: the "1961/1972 Act" which is the International Convention for the Protection of New Varieties of Plants of December 2, 1961, as amended by the Additional Act of November 10, 1972; the "1978 Act", which refers to the Act of October 23, 1978, of the Convention; and the "1991 Act", which is the Act of March 19, 1991, of the Convention.[5] A country adhering to the three Conventions or Acts receives a total score of 3 (1 for each Convention). The first countries entering the UPOV signed the 1961/1972 Convention and later, most of them, ratified all the subsequent revisions. However, a country that enters the UPOV Convention after the second or third revision, can decide

[5]The first UPOV Convention was adopted in 1961 and amended in 1972. The amendments modified, among other issues, the majority rules required for the decisions of the Council; the funding structure of the Convention; the contribution classes of the member States; the signature, the ratification and accession; the entry into force; and the reservations. Thus, unlike the following revisions (1978 and 1991) the 1972 amendment did not modify the type of IP rights proposed by the 1961 Convention.

which specific version of the Convention to sign. For example, Argentina became member of the UPOV in 1995 when the 1991 Act was already available, but it adhered to the 1978 Convention. However, since 1998, new members are not allowed to enter the UPOV 1978 Convention and they may only join the 1991 Act. Accordingly, in the construction of the index, we have assumed that a country signing the last Convention, by default, has also adhered to the previous ones. For instance, Bulgaria became member of UPOV in 1998 and adhered to the 1991 Act, which gives a score of 1 for each revision of the Convention, with a total score of 3.

Length of Membership

The length of membership is the duration (measured straightforwardly with the number of years) for which each country has been a member of the UPOV. The intuition is that countries with a longer length of membership were willing to protect plant varieties through PBRs before other countries. In particular, countries that became UPOV members before the TRIPS are more likely to have adopted IP protection independently and for internal motivations. On the contrary, since the TRIPS, becoming members of UPOV was, at least to a degree, imposed by external factors.

The first UPOV Convention was signed by a group of European countries, which wanted to protect plant varieties but found that patent systems were not appropriate mainly because of the self-reproduction characteristic of plants. Thus, the Convention had the objective of creating a *sui generis* system. Only five European countries became members of UPOV in 1961 and three more in the following year. However, the Convention of 1961 did not entered into force until 1968, because it established that at least three ratifications of countries with adequate IP systems were needed. It took seven years for the founding countries to adapt their plant variety protection systems following the guidelines of the Convention (Heitz, 1987; Dutfield, 2011). Afterwards, countries becoming members adopted the revised Act of 1961/1972. More recently, the UPOV Convention was signed mainly by developing countries that seek to implement the provisions of the TRIPS Agreement.

Exceptions

This component takes into account whether a country contemplate in its legislation three fundamental exceptions or limitations to PBRs: compulsory licenses, farmers' exception and breeders' exception.

The first exception is compulsory licenses, which most countries implement. It implies that an individual or the government may ask for a compulsory license in specific circumstances which mainly arise when the variety has not been used for a given period since the date of filling or grant of the right; or when the variety has not been used to a degree sufficient to satisfy the national needs; or when a national emergency is declared.

The second exception is the so-called farmers' privilege or farmers' exception, which states that farmers have the right to use the product of harvests, obtained using the new variety, for the purpose of reproduction in their farms, without paying new royalties to the breeders. In some cases, this exception also considers that farmers have the right to sell the product of their harvest to be sown in other lands. This exception was compulsory in the first two Acts of the UPOV and became optional in the 1991 Act. Some countries have been limiting this exception and others forbid the application of this clause to genetically modified seeds. The practice of saving seeds has almost disappeared in some countries, like in the United Sates, while in others it is still widespread. The construction of this component of our index is based on the evidence of legal documents (more specifically, we assume that there is no farmers' exception when it is explicitly stated that this is not recognized in the country or when its application requires a compensation for the breeder).

These two first exceptions have obviously a negative effect on the strength of IP protection, since when a country contemplate them, the holder is facing some limitations to the exertion of his/her IPR. Accordingly, in the construction of the component, for each of these two exception clauses, we assign a score of 1 to countries when their legislation does not uphold them.

Finally, the third exception is the so-called breeders' exception, which states that the right does not extend to the use of a variety undertaken for experimental purposes by other breeders. It implies that a breeder can use any protected plant variety, without authorization of its owner, to conduct research that may lead to the creation of a new plant variety, as long as the initial variety is not used repeatedly. This exemption seeks to protect innovations without preventing improvements and obtaining of new creations. The breeders' exception is compulsory in all the Conventions. However, the 1991 Act introduced the concept of essentially derived variety, which limits the breeders' exception. According to the Act, an essentially derived variety is one that is clearly distinguishable from the initial one but retains its essential characteristics. When this limitation is introduced, a breeder willing to obtain a variety considered essentially derived needs the authorization of the owner of the initial variety via a contract or license, paying a right for its experimental use. Thus, all countries contemplate the breeders' exception, but not all of them adopted the "essentially derived" doctrine. Accordingly, for this component we assign a score of 1 whenever a country's legislation has included this limitation.

Protection Length

This component considers the duration of the right. The legislation on plant varieties protection, sometimes, differentiates between plant varieties, and trees and vines, with the former receiving a shorter term of protection. For the construction of this component of the index, when a country applies this discrimination, we have decided to consider the longer protection. The 1961/1972 and 1978 Convention suggested a minimum protection period of 15 years for plant varieties and 18 years for vines and trees. Any country may adopt, however, a longer period of protection (UPOV, 1961, 1978). Meanwhile, the last

UPOV Convention states that duration of PBRs should be for a fixed period no shorter than 20 years for plant varieties and 25 years for vines and trees (UPOV, 1991).

Patent Scope

In this component, the strength of protection is measured by the possibility of granting patents in four specific areas related with plant breeding. These fields are: i) food, which obviously uses as inputs products from agriculture; ii) plant and animals, which countries may consider or not as patentable subject matter when they can be used to make more than a specific variety or when the technical feasibility of the invention is not confined to a particular plant variety;[6] iii) micro-organisms, which are closely related with the development of biotechnology and its application to plant breeding; and iv) pharmaceutical products, since the industry may also rely on biodiversity and genetic resources. Many countries used to regard some or all of these items as not patentable subject matter, considering them contrary to public order, morality, health or national interest or security. The TRIPS Agreement made compulsory to declare patentable micro-organisms, non-biological and microbiological processes for the production of plant varieties, and to provide some kind of IP protection for plant varieties. For each of these areas we assign a score of 1 when they were declared as patentable or not unpatentable in patent laws.

2.2 *Sources and Construction of the Index*

The information for the construction of the index was retrieved by examining the legislation of each country, which was available on-line. All websites were accessed between July and December 2012. In addition, we have interviewed experts of different countries in order to check or obtain missing information.

For data regarding the ratification of the UPOV Conventions as well as the length of membership, the source of information are the official Convention notifications documents, which include the different ratifications made by each country. These documents are available at the UPOV website: upov.int/upovlex/en/notifications.jsp. Information regarding early signatory countries can be found in Heitz (1987).

The information concerning the duration of protection and exceptions was taken from national legislation that is available at: WIPO Intellectual Property Laws and Treaties Database: www.wipo.int/wipolex/en/; UPOV Lex: www.upov.int/upovlex/en/; Farmers' Rights Database: www.farmersrights.org/database; and The World Law Guide: www.lexadin.nl/wlg/. For some countries, data regarding exceptions was extracted from the "Questionnaire on Exceptions and Limitations to Patents Rights", conducted by WIPO and available at: www.wipo.int/scp/en/exceptions/.

Finally, for the identification of the scope of patentability, the main information was generously provided to us by Walter Park, who has shared the data used in the construction

[6]For some countries, such as the United States since the 1930s with the Plant Patent Act, and for others, such as Australia, recently, this includes also the consideration of a particular plant variety as patentable subject matter.

of the patent index of Ginarte and Park (1997) and Park (2008). For the most recent period and for the countries that were missing in the original data, we have used the following sources: Lerner (2002), WIPO (2009), and official national documents from the WIPO Intellectual Property Laws and Treaties Database: www.wipo.int/wipolex/en/ and The World Law Guide: www.lexadin.nl/wlg/.

The value of each of the five components was transformed in a new indicator ranging between 0 and 1.[7] This was done using the formula:

$$X_{it} = \frac{x_{it} - \min(x_i)}{\max(x_i) - \min(x_i)}, \tag{1}$$

where x is the original score of each component $i = 1, ..., 5$ of the index for each year $t = 1969, ..., 2011$ and X is the value rescaled in the interval [0,1]. Afterwards, the rescaled values of the components were added and, as a result, the value of the index for a given country and a given year ranges between 0 and 5 with higher scores indicating a stronger system of protection for plant varieties.

Our index is constructed by making the simple sum of the different components and, therefore, implicitly assigning to each of them an equal weight. A factor analysis of the five components demonstrates that, in this case, this is a suitable approach. We have used a principal component factor estimation as this extraction method allows combining different components, which are expected to be highly correlated, into a single factor. The principal components method assumes that all the variability in a component should be used in the analysis, which is useful for our case. Table 2 presents the results. The Kaiser criterion suggested that only one factor, with eigenvalue greater than 1, should be retained and this factor explains 67.52% of the total variance.[8]

Table 2: Factor Analysis of the Index Components
(Factor Loadings and Unique Variances)

Variable	Factor Loading	Uniqueness
Ratification of UPOV Conventions	0.9034	0.184
Length of Membership	0.7452	0.4447
Exceptions	0.7321	0.4641
Duration of Right	0.9056	0.1799
Patentability	0.8052	0.35168

As expected, all the loadings on the factor are high, meaning that they are all relevant in defining the factor's dimensionality. The degree of uniqueness is low for Length of Membership and Exceptions, and it is very low for the other factor loadings, which implies that they are all relevant in the factor model and that there are not many unexplained

[7] This methodology is similar to the one adopted until 2011 by the United Nations Development Programme (UNDP) to construct the Human Development Index. See: Anand and Sen (1994).

[8] In addition, other estimation methods, as principal factor and iterated principal factors, generated factors with very similar loadings and explained even higher total variance.

factors affecting the relationships among them. In fact, as presented in Table 3, all index components are highly correlated and significant.

Table 3: Spearman's Rank Correlation Matrix of Index Components

Indicator	1	2	3	4	5
Ratification of UPOV Conventions	1				
Length of Membership	0.867***	1			
Exceptions	0.616***	0.432***	1		
Duration of Right	0.792***	0.747***	0.684***	1	
Patentability	0.660***	0.642***	0.458***	0.664***	1

Note: All coefficients are significant at the 1% probability level (***).

In addition, we have conducted a factor analysis using in the factor procedure polychoric correlations without normalizing their values, as this method was proved to be a better approach when dealing with discrete data (Kolenikov and Angeles, 2004). The extraction method was principal components factors and, again, only one factor was retained with eigenvalue greater than one. Like in the previous case, factors loadings are high and uniqueness is low for all components. Then, using these factor loadings, we computed a new weighted index that has the advantage of no requiring normalization of the values.

Table 4 shows that the indexes constructed using the simple sum of the components, and those constructed using the factor analysis for determining the weights are all highly correlated. The original unweighted index has a Spearman's rank correlation coefficient of 0.9915 with the first new weighted index constructed using factor analysis, and a Spearman's rank correlation coefficient of 0.9907 with the weighted index built with the polychoric correlations. These high correlations imply that the absolute values of the index slightly change but the ranking remains unchanged when using the two alternative weighted indexes. Therefore, for the sake of simplicity, in the rest of the paper, we shall use the unweighted index constructed by the simple addition of the normalized values of the five components.

Table 4: Spearman's Rank Correlation Matrix of the Different Indexes Constructed

Index	1	2	3
Unweighted Index	1		
Weighted Index using Factor Analysis	0.9915	1	
Weighted Index using Polychoric Correlations	0.9907	0.9973	1

It is also instructive to compare the index with alternative measures of IP protection. As we have already mentioned, the new IP index for plant varieties should be seen as a tool that complements other indicators. Overall, one should expect to find a significant and positive correlation with these other measures. Table 5 contains the Spearman's rank correlation coefficients of our plant variety protection index and these other indicators: i) patent protection index of Ginarte and Park (1997) and Park (2008); ii) an Intellectual Property Rights Index[9], which is part of the iii) Global Competitiveness Index[10] developed by the World Economic Forum (www.weforum.org); iv) an indicator of Intellectual Property Rights[11] protection, which is part of the v) International Property Right Index[12] developed by Property Rights Alliance (www.propertyrightsalliance.org/).

Table 5: Spearman's Correlation between IP Plant Varieties Index and other IPRs Measures

Indicator and Source	Correlation with Plant Variety Protection Index
Patent Index (1961-2005) (Ginarte and Park, 1997; Park, 2008)	0.8505***
Intellectual Property Protection (2006-2011) (The World Economic Forum)	0.4129***
Global Competitiveness Index (2006-2011) (The World Economic Forum)	0.4812***
Intellectual Property Rights (2007-2011) (Property Rights Alliance)	0.5097***
International Property Right Index (2007-2011) (Property Rights Alliance)	0.4410***

Note: All coefficients are significant at the 1% probability level (***).

Table 5 shows that the plant variety index is positively and highly correlated with the patent protection index of (Ginarte and Park, 1997) and (Park, 2008). The correlation is also positive and significant, but lower, with other indicators that are wider in their coverage since they also consider other types of IPRs and also property rights in other domains.

3 The Worldwide Evolution of IP Protection in Plant Varieties

In the appendix, we provide the detailed scores of the index of IP protection for plant varieties by decades for each country in our sample. In this section, we examine the worldwide evolution of IP protection in plant varieties as portrayed in our index. Table 6 contains summary statistics.

The summary statistics show that the mean of the index has been increasing over

[9]This index is constructed on the basis of surveys asking how would the interviewed rate intellectual property protection, including anti-counterfeiting measures, in her country [1 = very weak; 7 = very strong].

[10]Competitiveness is defined in this index as the set of institutions, policies, and factors that determine the level of productivity of a country and its' growth potential (Sala-I-Martin et al., 2009).

[11]It considers Protection of Intellectual Property Rights; Patent Protection; and Copyright Piracy; and Trademark Protection.

[12]This index has the following dimensions: Legal and Political Environment; Physical Property Rights; Intellectual Property Rights.

Table 6: Summary Statistics of the Index by Decades

Period	% Obs = 0	% Obs > 0	Mean without zeros	Mean	Sd	Min	Max	Skew
1961-1970	44.5	55.5	0.5	0.28	0.37	0	2.24	2.29
1971-1980	37.3	62.7	0.84	0.53	0.67	0	2.44	1.34
1981-1990	32.4	67.6	1.33	0.9	1.02	0	3.45	0.81
1991-2000	8.6	91.4	1.81	1.65	1.1	0	4.31	0.17
2001-2011	0.0	100.0	2.87	2.87	0.81	0.5	4.52	-0.85
1961-2011	21.6	78.4	1.79	1.4	1.29	0	4.52	0.46

time, even when not considering the years in which countries have a value of zero, which means that there is no IP protection available at that time. Meanwhile, the distribution has shifted from a positively skewed towards a negatively skewed one in the last decade considered, meaning that most countries have currently an index score that is above the mean. These two tendencies reflect the fact that countries, already providing protection in the past, have been tightening their systems, while countries entering UPOV and adopting IP protection systems in recent years are undertaking already strong protection levels. The shift from a positively skewed distribution of the index scores towards a negatively skewed distribution can be graphically observed in the histograms depicted in figure 3.

If we examine the evolution of the index taking into account the income or the development level of a country we find that different groups of countries have been increasing the strength of IP protection offered for plant varieties at different paces (Table 7).[13] The initial gap between high income countries and the others has been narrowing (especially since as middle and low income countries have been tightening their IP protection systems). A similar pattern is clear from the analysis of the index evolution according to the development level.

Table 7: Evolution of the IPRs Index for Plant Varieties
by Income and Development Level

Country	1961-1970	1971-1980	1981-1990	1991-2000	2001-2011
High Income (32)	0.43	0.82	1.42	2.25	3.19
Middle Income (24)	0.11	0.19	0.28	1.13	2.57
Low Income (12)	0.14	0.20	0.28	1.08	2.57
Developed Countries (31)	0.44	0.84	1.42	2.29	3.30
Developing Countries (38)	0.15	0.25	0.37	1.14	2.51

It is also interesting to examine the evolution of the index from a geographical point of

[13]The income level classification is taken from the World Development Indicators (databank.worldbank.org). High income are both OECD and non-OECD High Income economies; middle income are Upper Middle Income; and low income includes both Lower Middle Income and Low Income. The development level is taken from United Nations (2012), which considers developed economies, economies in transition and developing countries. For our analytical purposes and considering our sample of countries, the last two classifications were aggregated.

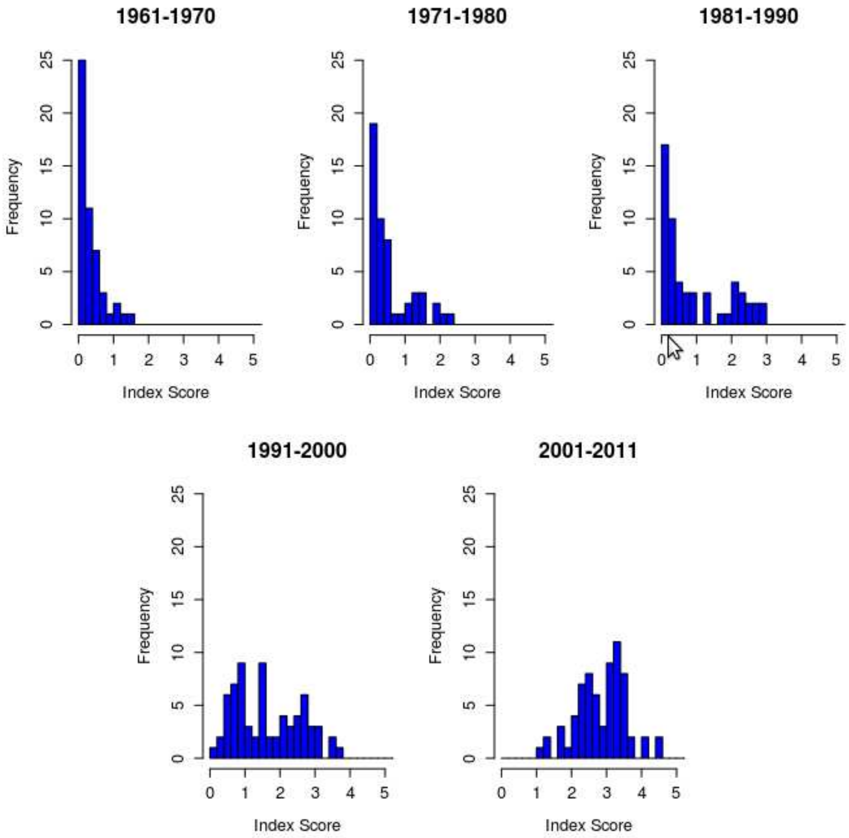

Figure 3: Distribution of the Index of IP Protection for Plant Varieties

view (Table 8). In this case, we observe that, in line with the evidence we found before, Western Europe, East and Central Europe, Oceania and North America are the world regions with higher income levels and stronger IP systems for plant varieties. As to the remaining regions, the evidence is mixed, with some of them starting with relatively high protection levels and others with lower ones but all of them increasing the mean of the index score over time.

We should note that the countries that belonged to the former Union of Soviet Socialist Republics or were part of Yugoslavia are included in our sample since the 1990s when they became independent States as shown by Table A of the Appendix. The reason for their exclusion in the previous period is that these countries did not have IP protection laws or, when they did have them, there were based on different and non-comparable institutional arrangements. For instance, the IP system prevailing in the Soviet Union was comprised of two main parts: the granting of inventor certificates for domestic inventors, and a patent system that was only formally similar to the ones of Western countries (Blair, 1973).[14] The case of China is similar as since the 1950s there was a dual system that considered

[14] A major distinction between the inventor's certificate and the patent is that the former was assigned to the State, while the patent was owned by the inventor or the party to whom he assigned it, as in Western countries.

Table 8: Evolution of the IPR Index for Plant Varieties by World Region

Country	1961-1970	1971-1980	1981-1990	1991-2000	2001-2011
Asia	0.38	0.45	0.72	1.24	2.62
East and Central Europe	0.10	0.20	0.39	1.37	3.03
Latin America and the Caribbean	0.12	0.15	0.16	1.07	2.26
Middle East and North Africa	0.19	0.42	0.63	1.17	2.53
North America	0.53	0.79	1.61	2.59	3.03
Oceania	0.38	0.50	1.51	2.70	3.12
Sub Saharan Africa	0.50	0.97	1.70	2.14	2.80
Western Europe	0.45	0.98	1.70	2.61	3.38

the granting of inventor's certificates and exclusive patent rights. However, the actual significance of these systems was marginal and it was only at the beginning of the 1980s that systems of IPRs protection similar to those prevailing in Western countries were gradually put in place (Ganea et al., 2009).

Figure 4 shows the evolution of the average value of the index alongside the index for a group of selected countries.

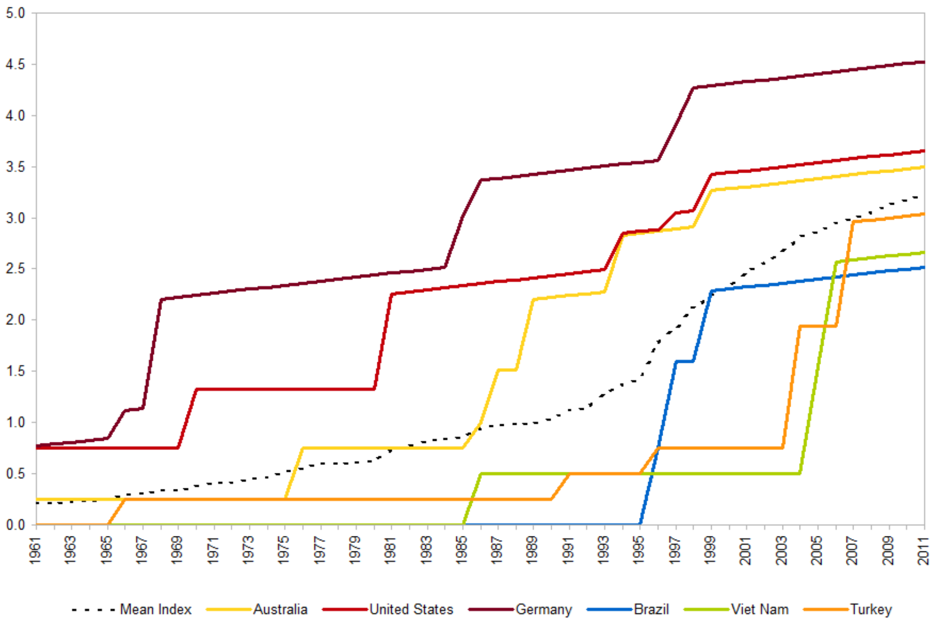

Figure 4: Evolution of the IP Index for Plant Varieties.
Selected Countries and Mean of IP Protection for all Countries

Our analysis of the historical evolution of the index suggests that all countries have been progressively tightening their IP systems for plant varieties over time. However, most LDCs adopted IP protection and became members of UPOV after the ratification of the

TRIPS, adopting quickly high levels of protection, which is reflected in high index scores for the last decade both for low and middle income countries as well as for developing economies. This finding is indeed consistent with the broader tightening of IPRs regimes in other domains.

4 The Determinants of IP Protection for Plant Varieties

In this section, we carry out some econometric exercises that examine the correlation of our index with some country characteristics in a multivariate setting. The variables we consider aim to capture specific country characteristics that may affect the decision of having a stronger or weaker IP system for plant varieties: development level; institutional and political factors; importance of agriculture; openness; and ratification of international agreements on IPRs. Table 9 summarizes the sources and independent variables used in the estimated models.

Table 9: Co-variates used in the Econometric Exercise

Aspect	Variable	Source
Economic Development	- GDP per capita (1990 International Geary-Khamis dollars)	Maddison Project
	- Average Years of Total Schooling of Population over 15 Years Old	Barro and Lee (2010)
	- Urban Population (1000) / Rural Population (1000)	FAOSTAT
Political regime	- Polity2	Marshall et al. (2010)
Institutional Framework	- Economic Freedom	The Heritage Foundation
Economic Relevance of Agriculture	- Net per capita Agricultural Production Index	FAOSTAT
	- Agricultural Export Value Index (2004-2006 = 100) (%)	FAOSTAT
Openness	- Openness at 2005 constant prices (%)	Heston et al. (2012)
International Agreement on IPRs	- Dummy for TRIPS Agreement	WIPO

Note: The dependent variable is the Index of the strength of IP protection for plant varieties.

As indicators of the level of economic development attained by a country we use GDP per capita (in log), estimated by the Maddison Project (www.ggdc.net/maddison/maddison-project/index.htm), the proportion of urban population over rural population, provided by FAOSTAT (faostast.fao.org) and the average years of schooling for population over 15 years old from Barro and Lee (2010). More developed countries usually have higher levels of urbanization and, consequently, the proportion is expected to increase with the level of development. In fact, as can be observed in Table 10, the correlation matrix shows that this variable is positively correlated with the GDP per capita. As long as schooling regards, the selected indicator measures education attainment in population over 15 years which is usually a good measure when dealing with both developed and developing countries.

Another relevant country characteristic that may determine the level of IP protection for plant varieties is obviously the role of agriculture in the total economy. To examine this effect we consider two variables developed by FAOSTAT (faostast.fao.org): i) the agricultural export value index, which represent the change in the current values of export FOB (free on board) expressed in US dollars, and ii) the net per capita production index of agricultural products, which shows the relative level of the aggregate volume of agricultural production for each year in comparison with the base period 1999-2001, divided by the index of population.

For characterizing the institutional and political environment of each country we use two variables: i) the index of political system developed by Marshall et al. (2010) for the Polity IV Project, which provides annual information on regime authority characteristics and level of democracy; and ii) the Index of Economic Freedom developed by The Heritage Foundation (www.heritage.org), which measures the following features of the institutional environment: business freedom; trade freedom; fiscal freedom; government spending; monetary freedom; investment freedom, financial freedom; property rights; freedom from corruption; and labor freedom. The correlation matrix of Table 10 shows that these two variables are positively correlated with the GDP per capita and they are not correlated among them as they capture different dimensions of the political and institutional framework.

Table 10: Correlation Matrix for Variables used in the Econometric Exercise

Independent Variables	1	2	3	4	5	6	7	8	9
1. GDP per cap.	1								
2. Urban Pop. / Rural Pop.	0.45	1							
3. Schooling of Pop. over 15	0.70	0.49	1						
4. Agric. Exp. Value Index	0.17	0.14	0.40	1					
5. Net (pc) Agric. Prod. Ind.	0.04	-0.14	-0.07	0.00	1				
6. Index of Political System	0.59	0.34	0.62	0.16	-0.10	1			
7. Economic Freedom	0.62	0.21	0.58	0.36	0.131	0.44	1		
8. Openness to Trade	0.07	-0.21	0.06	0.31	0.55	-0.13	0.30	1	
9. Ratification of TRIPS	0.14	0.16	0.36	0.63	-0.07	0.2129	0.39	0.25	1

Additionally, we use openness to trade at constant prices of 2005 in percentage from the Penn World Table 7.1 (pwt.sas.upenn.edu) available at Heston et al. (2012). This indicator is the total trade of a country (exports plus imports) divided by its real GDP in constant prices. Openness is included in the estimations because the literature usually argues that more openness facilitates technology transfer and promotes innovation. Then, it may be expected that a more open economy would have a stronger IPR index as a way of protecting its innovations. Finally, we introduce a dummy variable for the ratification of the TRIPS Agreement, expecting that this would capture the effect of this Agreement over the strength of IP systems.

Since we are dealing with a group of heterogeneous countries in terms of income and development levels, simple correlations may actually conceal more complex relations among the variables. Then, the models were estimated for the complete panel data set and two subsamples of 31 DCs and 38 LDCs to capture possible divergent patterns.

The first model was estimated using pooled OLS with robust standard errors (Table 11). For the full sample, all the estimators included were found significant at the 1% level and positively associated with the index of IP protection of plant variety, except for openness to trade, which resulted negatively correlated. The estimation of the two sub-samples according to development level uncovered important differences. The most striking result is that some variables present different signs for the two subsamples while being significant for both. This is the case of GDP per capita, schooling, political system, economic freedom and openness to trade. In some cases, the change in the sign is not relevant as the coefficients are close to zero. However, in the case of GDP per capita and economic freedom the differences are high. While for DCs, both variables have a positive impact in the level of IP protection, the impact is diametrically opposite in LDCs, especially for the GDP per capita. The final difference is that openness to trade does not influence the level of IP protection in LDCs and do not seem to matter much in DCs neither. Finally, the dummy introduced to indicate the signing of the TRIPS was shown to have a positive and significant effect on the level of IP protection in all the samples considered.

Table 11: Determinants of IP Protection in Plant Varieties (Pooled OLS Estimates)

Variables	Full Sample		LDCs (38)		DCs (31)	
Constant	-3.056***	(0.268)	1.022***	(0.324)	-3.066***	(0.733)
GDP per capita	0.290***	(0.037)	-0.196***	(0.04)	0.196**	(0.098)
Schooling	0.07***	(0.013)	0.196***	(0.014)	-0.088***	(0.016)
Urban Pop. / Rural Pop.	0.025***	(0.008)	0.056***	(0.01)	0.087***	(0.018)
Political System	0.008***	(0.003)	-0.01***	(0.003)	0.039***	(0.007)
Economic Freedom	0.102***	(0.018)	-0.071***	(0.02)	0.272***	(0.04)
Agr. Exp. Value Ind.	0.007***	(0.001)	0.006***	(0.001)	0.009***	(0.001)
Agr. Prod. Ind.	0.0003***	(8.39e-05)	0.0005***	(9.44e-05)	0.004**	(0.002)
Openness	-0.003***	(0.001)	-0.001	(0.001)	0.002***	(0.001)
Dummy for TRIPS	1.100***	(0.0523)	1.126***	(0.0630)	0.933***	(0.078)
Observations	1,865		964		901	
R-squared	0.646		0.707		0.633	

Notes: Dependent variable is the index of IP protection for plant varieties. Standard Errors in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

Next, we performed further estimations exploiting the panel structure of the data using fixed effects (FE) and random effects (RE) estimation methods. The Hausman test rejected the null hypothesis that individual effects are random. Thus, table 12 presents the results obtained using fixed effects estimation method for the full sample and the two subsamples.

Table 12: Determinants of IP Protection in Plant Varieties (Fixed Effects Estimates)

Variables	Full Sample		LDCs (38)		DCs (31)	
Constant	-4.646***	(0.651)	1.412**	(0.659)	-10.33***	(1.178)
GDP per capita	0.407***	(0.079)	-0.244***	(0.083)	0.792***	(0.145)
Schooling	0.085***	(0.02)	0.134***	(0.022)	0.012	(0.031)
Urban Pop. / Rural Pop.	0.158***	(0.021)	0.170***	(0.02)	0.483***	(0.043)
Political System	0.003	(0.003)	-0.0084**	(0.004)	0.0196***	(0.006)
Economic Freedom	0.0873***	(0.019)	-0.0401**	(0.02)	0.339***	(0.031)
Agr. Exp. Value Ind.	0.0042***	(0.001)	0.0054***	(0.001)	0.0003	(0.001)
Agr. Prod. Index	0.0006***	(0.000)	0.0001	(9.90e-05)	0.0001	(0.002)
Openness	0.0039***	(0.001)	5.54e-05	(0.001)	0.009***	(0.002)
Dummy for TRIPS	0.867***	(0.04)	1.064***	(0.045)	0.448***	(0.058)
Observations	1,865		964		901	
R-squared	0.756		0.787		0.821	

Notes: Dependent variable is the index of IP protection for plant varieties. Standard Errors in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

In the FE model for the full sample, all the variables were found to be positively and significantly associated with the level of IP protection for plant varieties. Once again, disaggregating the effect of these variables according to the development level, some important differences arise. The GDP per capita, economic freedom and political system were found to have opposite effects on the level of IP protection. Moreover, some variables resulted not significant when splitting the sample: schooling is not significant for DCs, which may be explained by the fact that this variable does not vary much among these countries, the agriculture export value index is also not significant for DCs and the net per capita agriculture production index is not significant for both groups. In addition, openness to trade was found not significant for the case of LDCs. On the other side, the dummy for the signing of the TRIPS is again positive and significant for the full sample and both subsamples.

To sum up, the results of the different estimated models showed that the level of IP protection for plant varieties seems to be affected by variables related with economic development such as GDP per capita, level of urbanization and schooling. Likewise, the dummy variable introduced for the ratification of the TRIPS resulted significant and positive in all the cases considered. On the other side, political and institutional factors seem to play a less significant role in determining the level of IP, as so do the economic relevance of agriculture and openness to trade. Arguably, our econometric analysis suggests that there is non-linear relation among the level of IP protection and variables such as the GDP per capita and the political system. While we may say that developed and richer countries with certain political and institutional systems tend to provide stronger IP protection for plant varieties, this does not seem to hold for countries under a certain level of development. This evidence may be explained by the heterogeneity of LDCs. Overall, these findings provide support for the hypothesis that while the strengthening of IP protection in developed countries has been mostly the outcome of an "endogenous" process, for developing countries, it was probably the result of exogenous factors. One of these factors is the ratification of the TRIPS Agreement. Our results may perhaps also suggests that some LDCs were forced to adopt standards of IP protection for plant varieties that were not appropriate to their levels of development. However, at this stage this is just a speculative hypothesis to be tested by further research.

5 Concluding Remarks

The main contribution of this paper is the construction of a new index of intellectual property protection for plant varieties for a set of countries that includes developed and developing countries. This index provides a synthetic score that summarizes the salient features of IP systems developed to protect plant varieties and, we hope, it may be employed as a useful tool for future research on innovation, productivity, growth and technology transfer in the agricultural sector. In addition, the index intends to complement other measures of IP strength that are applicable to other sectors of economic activity.

The historical evolution of the index is in line with evidences found for other kind of IPRs. There has been a progressive adoption of tighter IPRs regimes worldwide, especially since the signing of the TRIPS, which, also demanded higher protection in subjects such as plant varieties.

Our econometric exercise has established significant correlations between the index and variables such as GDP per capita, schooling, political system, openness to trade, institutional factors, and the relevance of agriculture for the economy. However, the influence of these variables is non-linear as demonstrated when examining the countries according to their developed level. LDCs are adopting stronger IP systems, despite being far from DCs in terms of GDP per capita, political system, institutional systems, and other characteristics.

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A Appendix

Table A.1: Evolution of the Index of Intellectual Property Protection of Plant Varieties

Country	1961-1970	1971-1980	1981-1990	1991-2000	2001-2011
Albania	0.00	0.00	0.00	1.00	2.64
Argentina	0.25	0.71	0.82	1.97	2.49
Australia	0.25	0.50	1.22	2.77	3.40
Austria	0.25	0.25	0.63	2.08	3.26
Azerbaijan				0.50	2.80
Belarus				0.57	3.16
Belgium	0.61	1.40	2.42	2.74	2.99
Bolivia	0.00	0.00	0.00	0.85	2.62
Brazil	0.00	0.00	0.00	0.85	2.42
Bulgaria	0.13	0.25	0.25	1.54	3.37
Canada	0.25	0.25	0.88	2.29	2.49
Chile	0.00	0.00	0.13	1.47	2.40
China			0.25	0.75	2.39
Colombia	0.00	0.00	0.00	1.50	2.79
Costa Rica	0.00	0.00	0.00	0.25	1.16
Croatia				0.63	3.52
Czech Republic			0.36	2.12	3.18
Denmark	0.09	0.52	2.06	3.50	4.41
Dominican Republic	0.50	0.50	0.50	0.50	1.80
Ecuador	0.00	0.00	0.00	1.10	2.66
Estonia				1.46	3.33
Finland	0.00	0.00	0.25	2.55	3.56
France	0.68	1.85	2.60	2.95	3.28
Georgia				1.32	2.39
Germany	1.30	2.35	3.00	3.79	4.43
Hungary	0.13	0.25	0.85	2.24	3.11
Iceland	0.00	0.00	0.00	0.63	2.56
Ireland	0.28	0.50	2.11	2.61	3.37
Israel	0.50	1.41	2.26	3.02	3.68
Italy	0.61	1.58	2.69	2.99	3.43
Japan	1.01	1.04	1.95	2.52	3.34
Jordan	0.00	0.00	0.00	0.48	2.83
Kenya	0.50	0.93	1.21	1.48	2.29
Kyrgyzstan				1.00	3.47
Latvia				1.00	3.09
Lithuania			0.50	0.75	3.09
Macedonia				1.00	1.24
Mexico	0.00	0.00	0.00	1.49	2.38
Morocco	0.25	0.25	0.25	0.79	2.38
Netherlands	1.17	1.85	2.31	3.19	4.04

Continued on next page

New Zealand	0.50	0.50	1.80	2.63	2.83
Nicaragua	0.00	0.00	0.00	0.18	1.69
Norway	0.00	0.00	0.00	1.68	2.29
Oman	0.00	0.00	0.00	0.38	1.22
Panama	0.00	0.00	0.00	0.92	2.54
Paraguay	0.25	0.25	0.25	0.94	2.18
Peru	0.00	0.00	0.00	1.59	2.14
Poland			0.70	2.03	3.48
Portugal	0.00	0.00	0.06	1.64	2.47
Republic of Korea	0.00	0.25	0.63	1.42	3.05
Republic of Moldova				1.84	3.28
Romania	0.13	0.25	0.25	1.05	3.64
Russian Federation				2.38	3.51
Singapore	0.50	0.50	0.50	1.00	2.55
Slovakia				2.57	3.06
Slovenia				1.52	3.20
South Africa	0.50	1.01	2.19	2.80	3.30
Spain	0.25	0.59	1.38	2.14	3.07
Sweden	0.25	1.45	2.10	2.75	3.39
Switzerland	0.34	1.33	2.74	3.06	3.51
Trinidad and Tobago	0.50	0.50	0.50	1.04	2.11
Tunisia	0.00	0.00	0.00	0.63	1.95
Turkey	0.13	0.25	0.25	0.63	2.10
Ukraine				2.51	3.35
United Kingdom	1.44	2.08	2.91	3.43	4.07
United States of America	0.81	1.32	2.35	2.90	3.56
Uruguay	0.25	0.25	0.25	1.38	2.53
Uzbekistan				0.50	2.74
Viet Nam	0.00	0.00	0.25	0.50	1.75

Table A.2: Classification of Countries according to Income Level, Geographic Region and Development Level

Country	income Level	Level of Development	Region	Country	income Level	Level of Development	Region
Albania	LMI	LDC	EE	Lithuania	UMI	DC	EE
Argentina	UMI	LDC	LA	Macedonia	UMI	LDC	EE
Australia	HI	DC	OC	Mexico	UMI	LDC	LA
Austria	HI	DC	EU	Morocco	LMI	LDC	ME
Azerbaijan	UMI	LDC	EE	Netherlands	HI	DC	EU
Belarus	UMI	LDC	EE	New Zealand	HI	DC	OC
Belgium	HI	DC	EU	Nicaragua	LMI	LDC	LA
Bolivia	LMI	LDC	LA	Norway	HI	DC	EU
Brazil	UMI	LDC	LA	Oman	HI	LDC	ME
Bulgaria	UMI	DC	EE	Panama	UMI	LDC	LA
Canada	HI	DC	NA	Paraguay	LMI	LDC	LA
Chile	UMI	LDC	LA	Peru	UMI	LDC	LA
China	UMI	LDC	AS	Poland	HI	DC	EE
Colombia	UMI	LDC	LA	Portugal	HI	DC	EU
Costa Rica	UMI	LDC	LA	Republic of Korea	HI	LDC	AS
Croatia	HI	LDC	EE	Republic of Moldova	LMI	LDC	EE
Czech Republic	HI	DC	EE	Romania	UMI	DC	EE
Denmark	HI	DC	EU	Russian Federation	UMI	LDC	EE
Dominican Republic	UMI	LDC	LA	Singapore	HI	LDC	AS
Ecuador	UMI	LDC	LA	Slovakia	HI	DC	EE
Estonia	HI	DC	EE	Slovenia	HI	DC	EE
Finland	HI	DC	EU	South Africa	UMI	LDC	AF
France	HI	DC	EU	Spain	HI	DC	EU
Georgia	LMI	LDC	EE	Sweden	HI	DC	EU
Germany	HI	DC	EU	Switzerland	HI	DC	EU
Hungary	HI	DC	EE	Trinidad and Tobago	HI	LDC	LA
Iceland	HI	DC	EU	Tunisia	UMI	LDC	ME
Ireland	HI	DC	EU	Turkey	UMI	LDC	EE
Israel	HI	LDC	ME	Ukraine	LMI	LDC	EE
Italy	HI	DC	EU	United Kingdom	HI	DC	EU
Japan	HI	DC	AS	United States of America	HI	DC	NA
Jordan	UMI	LDC	ME	Uruguay	UMI	LDC	LA
Kenya	LI	LDC	AF	Uzbekistan	LMI	LDC	EE
Kyrgyzstan	LI	LDC	EE	Viet Nam	LMI	LDC	AS
Latvia	UMI	DC	EE				

Notes: HI (High Income); MI (Middle Income); LI (Low Income); AS (Asia); EE (East and Central Europe); LA (Latin America and the Caribbean); ME (Middle East and North Africa); NA (North America); OC (Oceania); AF (Sub Saharan Africa); EU (Western Europe); DC (Developed Country); LDC (Developing Country).