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The impact of intellectual property rights on labor productivity: do constitutions matter?

This is the final peer-reviewed author’s accepted manuscript (postprint) of the following publication:

Published Version:
Carbonara, E., Gianfreda, G., Santarelli, E., Vallanti, G. (2021). The impact of intellectual property rights on labor productivity: do constitutions matter?. INDUSTRIAL AND CORPORATE CHANGE, 30(4), 884-904 [10.1093/icc/dtab003].

Availability:
This version is available at: https://hdl.handle.net/11585/821961 since: 2021-06-16

Published:
DOI: http://doi.org/10.1093/icc/dtab003

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02 January 2025

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The final published version is available online at:

https://doi.org/10.1093/icc/dtab003

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The Impact of Intellectual Property Rights on Labor Productivity: Do Constitutions Matter?*

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Abstract
Focusing on a sample of 22 industries and 22 OECD countries and controlling for a full set of year-, industry- and country fixed effects (and their interactions), we first show that intellectual property rights (IPRs) protection, by means of both constitutional provisions and ordinary laws, is positively associated with the dynamics industry-level labor productivity. Disentangling the impact of constitutional provisions from that of ordinary laws, we then show that constitutional provisions protecting IPRs positively affect the differential in labor productivity between high and low R&D intensive industries. This effect is driven by the mutually reinforcing impact of constitutional IPRs protection and R&D investment in the high R&D intensive industries. Furthermore, the impact of constitutions appears to be stronger in those countries where IPRs protection by ordinary laws is weaker.

JEL Classification: D24; K10; O47.
KEY WORDS: Constitutions; Intellectual Property Rights; R&D; Labor productivity; OECD countries.

* We thank Tom Ginsburg for providing us with the data from the Comparative Constitutions Project. We also thank Cristiano Antonelli, Umberto Michele Carbonara, Giovanni Dosi, Maria Laura Di Tommaso, Hans-Bernd Schäfer, and Stefan Voigt for helpful suggestions. A special thank goes to The Editor (Carliss Baldwin) for her detailed and insightful comments. Previous versions of this paper have been presented at the 36th Annual Conference of the European Association of Law & Economics (Milan), the 14th Annual Conference of the Italian Society of Law and Economics (Lecce), the Bucerius Law School (Hamburg), the 60th Annual Conference of the Italian Economic Association (Palermo), and within the seminar program in Economics of Innovation and Knowledge at Collegio Carlo Alberto (Turin).

1 - Introduction

This article investigates the relationship between a country's legal protection of intellectual property rights (IPRs) and its labor productivity in different industries. Controlling for a full set of year-, industry- and country-fixed effects (and their interactions), we show that constitutional provisions protecting IPRs are positively correlated with labor productivity at industry level. The correlation is strongest in industries characterized by a high level of R&D investment. The main questions we ask are: 1) Is constitutional protection of IPRs positively associated with firms' labor productivity and is this effect related to R&D investment? 2) Is the association larger or smaller when IPRs are also protected by ordinary laws (lower-rank norms)?

Consistent with a Schumpeterian analytical framework, R&D is a key driver of economic growth (Aghion and Howitt, 1996). Its direct link to productivity has been demonstrated extensively in a number of studies since the publication (in Griliches, 1984) of the papers presented in the Fall of 1981 at the NBER conference on *R&D, Patents, and Productivity*, and the seminal article on the propensity to patent by Scherer (1983). The implicit theory underlying our analysis extends this literature by assuming that the impact of constitutions on productivity is mediated by R&D. Specifically, we hypothesize that the constitutional environment in which firms operate shapes their attitude toward R&D investment and the likelihood that such investments will be translated into enhanced labor productivity. Thus, we test whether constitutional protection is more highly correlated with labor productivity in industries where firms rely more on in-house R&D activities and in the countries where such industries are based.

Most previous studies of the economic effects of constitutional norms are based on cross-country regressions and suffer from reverse causality as well as omitted variable problems. One way to make progress on causality is to focus on the mechanisms through which IPRs protection affect productivity. IPRs protection may help firms internalize the positive spillovers of their innovative activity and protect them from opportunistic behavior, thus giving firms incentives to increase their R&D effort. In this case, IPRs protection should differentially affect firms (and industries) whose performance is more dependent on R&D investment. We construct the test as follows. First, we proxy industries' R&D dependence with an indicator of R&D intensity which is industry specific and constant across countries and time. Then we test whether industries that are intrinsically more R&D intensive have relatively higher labor productivity in countries where legal IPRs protection is stricter.

We apply these tests to a sample of 22 industries and 22 OECD countries over the period 2000 to 2013. We find that constitutional protection of IPRs positively correlated with labor productivity in industries where the R&D intensity is higher. Our results hold after controlling for the presence of lower-level legislation (ordinary laws) protecting IPRs.

We also find an interaction between constitutional protections and ordinary laws: In those countries where IPRs are protected by constitutional norms, lower-rank norms have no significant impact on the labor productivity differential between high and low R&D intensive industries. Furthermore, the measured correlation of constitutions with labor productivity in high R&D industries decreases as the extent of protection by ordinary laws increases and vanishes in the presence of very high levels of protection by ordinary laws.

These results suggest that constitutional protections and ordinary laws regarding IPRs may tend to cluster together.

The primary contributions of our study are twofold. First, we identify the impact of constitutional provisions concerning the protection of intellectual property rights on cross-country and cross-industry differences in labor productivity. Second, we consider the moderating effect of ordinary legislation protecting IPRs on the relationship between constitutions and productivity. We explicitly address endogeneity issues, by means of both instrumental variables and fixed effects. We also control for de facto enforcement of IPRs protection and, as a robustness check, for the presence of other labor market institutions and product market regulations that may affect the correlation between labor productivity and R&D investment.

The paper is organized as follows. Section 2 surveys the relevant literature. Section 3 presents the main research hypotheses and outlines the econometric strategy. Section 4 describes the dataset. Section 5 presents the main results. Section 6 proposes some robustness checks. Finally, Section 7 concludes, discussing our results, highlighting possible policy recommendations and directions for future research.

2 - Literature review

2.1 – The economic effects of constitutions

Economic analysis of the link between some of the provisions contained in its constitution and the economic performance of a country extends the tradition of the public choice literature, which focused its attention on the impact of different constitutional settings on the size of government and the composition of public expenditure (see Buchanan and Tullock, 1962; Brennan and Buchanan, 1980; Olson, 1982; North and Weingast, 1989; and, for a general overview, Mueller, 2003; and Voigt, 1999). Starting from the assumption that a strong constitutional structure is the institutional arrangement that better allows markets to operate freely, Buchanan (1987; as cited in Prosser, 2014, p. 10) encouraged economists to study the constitutional principles and rules that affect economic agents, thus singling out the economic effects of a constitution.

The analysis put forward in the public choice literature is however theoretical in nature and does not provide empirical support to the idea that economic constitutions introduce effective (and possibly efficient) principles of economic conduct in the institutional framework of a country. In early 2000s, the gap between theory and empirical evidence started to be filled when Persson and Tabellini (2003) studied the causal links between the constitutional characteristics of a country and its economic performance.

Persson and Tabellini (2003 and 2006) focus mainly on the constitutional principles regulating the organization of a state and the exercise of power. They study how different forms of government (presidential and parliamentary system) and different electoral systems (majoritarian and proportional) affect fiscal policy, rent extraction (perceived corruption of executive), and economic productivity (measured by both labor and total factor productivity).

Carbonara et al. (2016) and Carbonara et al. (2018) are the first empirical studies aimed at estimating the relationship between constitutional protections and economic outcomes. Dealing with the constitutional determinants of entrepreneurship, Carbonara et al. (2016) show that some of the provisions contained in national constitutions – including right to conduct/establish a business, right to strike, consumer protection, anti-corruption, and compulsory education - are positively and significantly associated to a standard measure of entrepreneurial dynamics such as the rate of new business density. They also find that other constitutional provisions which may be likely to impose a burden on or just to limit entrepreneurial freedom – such as IPRs protection - are negatively and statistically significantly associated to new business density. In light of this somewhat puzzling finding on the relationship between constitutional protection of IPRs and entrepreneurial activities, it is therefore of particular interest to explore the direct or indirect effect of such constitutional provisions on innovative activity.

Carbonara et al. (2018) find that cross-country differences in new business density are explained by constitutional principles protecting economic activity (like the right to own property, the right to conduct/establish a business, the right to free/competitive markets, and the independence of the judiciary) and by a population's psychological characteristics (in this case, a country's endowment of agency culture). They prove that both factors are important predictors of new business density and that the positive impact of agency culture is moderated by the economic constitution, becoming stronger as the constitutional protection of economic rights increases.

2.2 - Institutions, IPRs protection, and productivity

A different strand of literature studies the impact of institutions (including - but not limited to - IPRs protection) on productivity. Correcting for the size of the shadow economy, Dreher et al. (2014) find a significant although weak relation between the quality of institutions aimed at protecting property rights and total factor productivity for a group of OECD countries. Using a sample consisting of 28 transition countries in Eastern Europe and Central Asia over the 2002–2009 period, Della Malva and Santarelli (2016) find that differences in the strength of IPRs protection systems measured along several dimensions affect a firm's propensity to engage in R&D activities.

2.3 IPRs, R&D investment, and productivity

Many studies have analyzed the relationship between R&D investment and invention patenting as drivers of firm and industry dynamics. For example, Coe and Helpman (1995) show that domestic productivity is partly explained by international R&D spillovers. Corroborating the Schumpeterian idea of technological innovation as a key driver of economic growth, Crepon et al. (1998) show that the elasticity of productivity with respect to the intensity of product innovation is positive. Contributing also from a methodological viewpoint to this line of investigation, Crepon et al. (1998) correct for selectivity and endogeneity in earlier work by explaining productivity within a structural model (see also Lööl et al., 2017).

In a subsequent paper, Coe et al. (2009) show that countries where the ease of doing business is higher, IPRs protection stronger, and the legal system resembles the French or Scandinavian systems are more likely than other countries to exploit both their own R&D and international R&D spillovers, and are also exhibit higher levels of total factor productivity. Other papers in this tradition show that the elasticity of productivity with respect to R&D investment is positive and statistically significant in both the manufacturing and the service sectors and in both advanced and developing countries (Samaniego, 2006; Venturini, 2015; Raymond et al., 2015; Ugur et al., 2016; Santarelli and Tran, 2017; Audretsch et al., 2020). For example, Kogan et al. (2017) find that medium-run fluctuations in total factor productivity are mostly driven by technological innovation, whereas Battisti et al. (2018) find that 46% of labor productivity growth is associated with increases in technological productivity.

A related line of empirical research considers the relationship between intellectual property rights protection (patents, trademarks and copyright), R&D investment, and the economic performance of countries. For example, Kumar et al. (1999) find a positive relationship between patents and firm size in R&D intensive industries. Png (2017) demonstrates the positive impact of the Uniform Trade Secrets Act (USTA) on R&D. Brown et al. (2017) use data on IPRs, tax incentives and financial market from a broad sample of OECD countries to assess the impact of domestic policies and institutions on country-level measures of R&D investment. In general, findings of these and other studies show that strong IPRs protections combined with improved accounting standards and contract enforcement are positively correlated with R&D investment.

3 - The identification strategy

3.1 - The basic specification

Focusing on 22 OECD countries and 22 industries, we assess the impact of the institutional arrangements that favor IPRs protection on labor productivity. On the one side, we assume that dynamic complementarity is in operation between institutional protection (both through constitutional provisions and ordinary (lower rank) laws) of IPRs, R&D intensity, and labor productivity. On the other side, following a well-established literature on cross-industry differences,[1] we assume that the effect of such complementarity may be greater for industries in which firms rely more on in-house R&D activities as a source of innovation. Dynamic complementarity can therefore give rise to two causal chains. First, IPRs protection may provide incentives to make R&D investments, which lead to higher labor productivity. However, lawmakers may also respond to powerful constituent interests "requesting" IPRs protection by means of ordinary laws. High labor productivity in turn may contribute to the wealth and political influence of these industries. Although one may take for granted that the chains combine to make a self-reinforcing cycle, it would be interesting to explore how the impact of constitutions - the source of higher-rank norms, which exert a strong influence on the institutional arrangements regulating the economic activity in a country - differs from the impact of ordinary laws.

Our identification strategy exploits industry specificities under the assumption that protection of intellectual property rights may be positively associated with firms' productivity to an extent that is industry specific. Following the approach set forth by

Kumar et al (1999), we use industry-specific R&D dependence to identify the effect of IPRs on firms' outcome. The assumption is that the constitutional protection of intellectual property has a stronger effect in those industries which rely more on innovation and therefore on R&D investment. Following this approach implies estimating a standard diff-in-diff specification, exploiting cross-country/cross-industry data. Therefore, the model specification is the following:

$$y_{cst} = \beta_1(const_c \; x \; innov_s) + \boldsymbol{D}_{cst} + u_{cst} \tag{1}$$

where y_{cst} is value added per hour worked (in log) in country *c*, industry *s* at time *t* (see Section 4.1 below), $const_c$ is a dummy for the presence of constitutional provisions in country *c* (see Section 4.2.1 below), $innov_s$ is a proxy of R&D dependence of industry *s* (see Section 4.3 below), and $\boldsymbol{D}_{cst}$ is a matrix of dummies which includes industry and country-by-year dummies. Country-by-year fixed effects "absorb" any unobservable attributes (both time variant and time invariant) at the country level (including the non-interacted main effect of the dummy for the presence of constitutional provisions $const_c$). Finally, u_{cst} is the error term.

Equation (1) estimates the average effect of constitutional provisions exploiting variability at the country-industry-time level. The coefficient β_1 in Equation (1) captures the effect of constitutional protection on productivity. Typically, there is a difference in productivity between two industries characterized by high and low R&D intensity. Then, the coefficient β_1 is the difference in such differential between countries with constitutional protection of IPRs and countries without protection.

The main advantage of our specification is that we make predictions about within-country differences between industries based on the interaction between country and industry characteristics. Therefore, we can control for country (time-variant) and industry fixed effects and we will be less subject to criticism about an omitted variable bias or model misspecification.

3.2 The enforcement of IPRs by other sources of legislation

IPRs protection may be enforced by ordinary laws or by other sources of legislation (e.g., international treaties), irrespective of the presence of specific constitutional norms.

Based on the same identification strategy illustrated above, in order to capture the differential effect of protecting IPRs at the constitutional level rather than through different sources of legislation, we augment our baseline specification (1) by including an index of legal protection different from constitutional norms (i.e., *lower-rank* norms protecting IPRs) interacted with the index of R&D intensity, which is intended to assess the relevance of the constitutional norms in those countries in which IPRs are also protected by other laws and regulations.[2]

We then estimate the following specification:

$$y_{cst} = \beta_1(const_c \; x \; innov_s) + \beta_2(law_c \; x \; innov_s) + \beta_3(const_c \; x \; law_c \; x \; innov_s) + \boldsymbol{D}_{cst} + u_{cst} \qquad (2)$$

where law_c is the index measuring IPRs protection by lower-rank norms in country *c* (see Section 4.2.2 below) and $\boldsymbol{D}_{cst}$ is the matrix of industry and country-by-year dummies, to control for omitted country specific-time variant factors that could bias our coefficients.[3]

The coefficient β_3 of the third-level interaction term captures the effect of constitutional provisions on productivity in industries with different R&D intensity in countries with different degrees of patent protection. A positive interaction term would imply *complementarity* between constitutional and lower-rank legal norms, while a negative coefficient indicates *substitutability* between the two sources of legal protection.

4 – Data, variables, and descriptive statistics

4.1 Dependent variable: Productivity data

The dependent variable labor productivity is calculated as industry value added per hour worked. Data at industry level are drawn from the EUKLEMS database, which provides information on value added and hours worked for 34 industries and 8 aggregates according to the ISIC Rev. 4 (NACE Rev. 2) industry classification. Our final sample includes 22 industries for 22 countries over the period 2000-2013.[4] The level of aggregation for each industry has been chosen in order to guarantee the consistency of data across all countries over the sample period (2000 to 2013).

Table 1 shows descriptive statistics for labor productivity for both the whole sample and for the high and the medium-low R&D intensity subsamples, as defined according to the GV classification and obtained as described in section 4.3 below.

Table 1: Descriptive statistics for labor productivity (log)

Labor productivity (output per hour worked)				
Mean	Std. Dev.	Min	Max	Observations
All industries				
3.93	1.53	-2.05	10.38	7377 (22 industries)
High R&D dependent industries				
3.81	1.38	-0.41	7.15	1981 (5 industries)
Medium and Low R&D dependent industries				
3.99	1.58	-2.05	10.38	5396 (17 industries)

4.2 Independent variables: Constitutional provisions and legal protections of IPRs

4.2.1 Const

We draw the data on the constitutional norms protecting IPRs from the Comparative Constitutions Project dataset (Elkins et al., 2009). The Project contains information on "nearly every active national constitution in the world".[5] It provides data on form and content of constitutions and tracks their main revisions over time. Among the others, we find indication on which constitutions protect trademarks, patents and copyrights and on the year in which protection was introduced. The three main types of IPRs protection - patents, trademarks, and copyright - have been shown to represent important drivers of innovativeness. Accordingly, and consistent with the findings of the literature *á la* Griliches (1984; useful surveys can be found in Lööl et al., 2017; Mohnen and Hall, 2013), their full protection increases the likelihood that firms and industries with a high R&D intensity turn their innovative performance into increased competitiveness and productivity (see also Aguiar and Gagnepain, 2017).

For the purposes of our empirical analysis, we construct a dummy variable (*const*) which takes the value of 1 if the country has some form of constitutional IPR protection (either patents, or copyright or trademark), 0 otherwise.

Column 1 in **Table 2** reports the type of protection of IPRs from constitutional provisions for the countries in our sample.

Table 2: Constitutional and legislative protection of IPRs

	IPR Constitutional Protection	IPR legal Protection	
		Ginarte and Park Index	IPRI Index
Austria	p, c, t	4.33	8.25
Belgium		4.67	8.06
Bulgaria	p,c	3.83	4.85
Cyprus		3.48	6.10
Czech Republic		3.96	6.41
Denmark		4.63	8.33
Finland		4.63	8.55
France		4.67	8.02
Germany	c	4.67	8.40
Greece		4.36	5.78
Ireland		4.67	7.81
Italy		4.56	6.74
Lithuania	p,c	3.70	5.18
Luxembourg		4.14	7.67
Netherlands		4.67	8.25
Poland		3.88	5.88
Portugal	c	4.21	6.84
Slovak Republic		3.68	6.42
Spain		4.33	6.87
Sweden		4.54	8.06
United Kingdom		4.54	8.22
United States	p,c	4.88	8.30
average		4.26	7.25
sd		*0.42*	*1.21*

p = patent; c = copyright; t = trademark.

In the period under analysis (2000-2013) and for the countries in our sample 6 constitutions (Austria, Bulgaria, Germany, Lithuania, Portugal, United States) protect copyrights, 4 constitutions protect patents (Austria, Bulgaria, Lithuania, United States) while only Austria protects also trademarks.

4.2.2 Law and Law1

We use two indicators (*Law* and *Law1*) to measure the overall legal protection of IPRs: the updated values of the Ginarte and Park index (Park, 2008) (*Law*) and the IPRI index by Property Rights Alliance (*Law1*) (respectively, columns 2 and 3 in **Table 2**).

Law captures the degree of patent protection granted by laws and regulations enforced in a country. The index is the unweighted sum of five separate scores for: i) coverage (inventions that are patentable); ii) membership in international treaties; iii) duration of protection; iv) enforcement mechanisms; and v) restrictions (e.g., compulsory licensing in the event that a patented invention is not sufficiently exploited). The index has been originally calculated for the 1960–1990 period, broken down into 5-year intervals, and is updated on a quinquennial basis. Consistently with the time span covered by our estimation, we use the average of the index over the 2000-2010 period (thus excluding the value of the index for 2015, which falls outside our reference interval) as a measure of IPRs protection resulting from legislative sources other than constitutional norms.

In order to test the robustness of our results and to control for *de facto* protection, we re-estimate our model using a different index of IPRs strength (*Law1*), i.e., the International Property Right Index (IPRI, developed by the Property Rights Alliance). The IPRI is an indicator of property rights protection across the world. The overall score consists of three core components: i) legal and political environment; ii) physical property rights; iii) intellectual property rights. Given that we are interested in intellectual property exclusively, we take only the third component. Differently from the Ginarte and Park index, in measuring physical and intellectual property rights, the IPRI accounts for both *de jure* and *de facto* outcomes. In fact, in the assessment of the protection of IPRs, the IPRI includes the Ginarte and Park index (*de jure*) as well as two *de facto* components: i) an opinion-based measure of the protection of intellectual property (drawn from the World Economic Forum's 2016-2017 Global Competitiveness Index) and ii) the level of piracy in the IP industry (based on the BSA Global Software Survey, "The Compliance Gap"). The latter estimates the volume and value of unlicensed software installed on personal computers, and reveals attitudes and behaviors related to software licensing, intellectual property and emerging technologies. The IPRI is available from 2007. As for the Ginarte and Park index, we use the average of the indicator (in this case, considering the years from 2007 to 2013).

4.3. Measuring industry-specific R&D dependence: innov

To estimate the model in equation (1), we need appropriate measures to categorize industries according to their reliance on in-house R&D activities, independently from the country characteristics. Data on the actual R&D at industry level cannot be used as a proxy since the latter is one potential channel through which constitutional provisions affect productivity. We then postulate that there are technological differences across industries and that such differences in technology explain why some industries rely more on R&D investment than others. We also assume that these cross-industry technological differences are the same across countries and time.

Accordingly, we construct a measure of R&D intensity at industry level using the new OECD Taxonomy of Economic Activities as an indicator of reliance on R&D.[6] Such an indicator is industry-specific and is intrinsically related to the technological characteristics of a given industry independently of the country of origin.

We also estimate an alternative indicator from a regression that seeks to isolate the common industry-specific R&D intensity from country-specific factors such as the legislative environment, the cultural characteristics and the human capital endowment at the country level.

4.3.1 Industry-specific R&D intensity based on the OECD Taxonomy

Our main industry-specific R&D intensity indicator is based on the OECD Taxonomy of Economic Activities, which clusters manufacturing and non-manufacturing activities according to their level of R&D intensity, defined as the ratio of R&D expenditure to value added (Galindo-Rueda and Verger, 2016). Using data from 27 countries and 2011 as the reference year, Galindo-Rueda and Verger (2016, henceforth GV) identify 5 groups, i.e. high, medium-high, medium, medium-low, and low R&D intensity industries.

One major problem of matching our data on labor productivity with the GV classification is the level of aggregation at industry level. Even using the GV classification at two digit-level (which comprises 34 industries and is the closer to our data on productivity, which includes 24 industries),[7] it is not always possible to unambiguously assign the GV index to all the industries considered in our sample. To avoid measurement errors, we take a conservative stance and include among high R&D industries only those falling entirely in the "high-or-medium-high" R&D intensity group in the GV taxonomy. For example, GV classify Pharmaceuticals (21) among high R&D intensive industries and Chemical products (20) among the medium-high; our aggregate industry (20-21) then falls in the "high and medium/high industries". Therefore, we define the index $innov_s$ as a dummy taking value 1 for industries having a high ("high or medium-high" in the GV taxonomy) R&D intensity and 0 for all the other industries ("medium", "medium-low" and "low" in the GV taxonomy).[8]

Table 3: GV classification (two-digit level), R&D intensity index, and R&D dependence index

Industries	GV classification	R&D intensity index $innov_s$	R&D dependence index *Innov1*
	(1)	(2)	(3)
20-21 Chemicals and chemical products	High; Medium-high	**High**	2.793
31-33 Other manufacturing; repair and installation of machinery and equipment	Medium-high	**High**	2.134
19 Coke and refined petroleum products	Medium-low	Low	2.016
29-30 Transport equipment	Medium-high	**High**	2.000
26-27 Electrical and optical equipment	Medium-high	**High**	1.978
M-N PROFESSIONAL, SCIENTIFIC, TECHNICAL, ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	High; Medium-low	n.c.	1.940
28 Machinery and equipment n.e.c.	Medium-high	**High**	1.876
K FINANCIAL AND INSURANCE ACTIVITIES	Low	Low	1.787
22-23 Rubber and plastics products, and other non-metallic mineral products	Medium	Low	1.540
24-25 Basic metals and fabricated metal products, except machinery and equipment	Medium; Medium-low	Low	1.068
J INFORMATION AND COMMUNICATION			1.062
58-60 Publishing	High; Medium-low	n.c.	
61 Telecommunications	Medium-low	Low	
62-63 ICT services	Medium-high	**High**	
10-12 Food products, beverages and tobacco	Medium-low	Low	0.837
A AGRICULTURE, FORESTRY AND FISHING	Low	Low	0.816
16-18 Wood and paper products; printing and reproduction of recorded media	Medium-low	Low	0.779
13-15 Textiles, wearing apparel, leather and related products	Medium-low	Low	0.714
F CONSTRUCTION	Low	Low	0.663
G WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	Low	Low	0.637
L REAL ESTATE ACTIVITIES	Low	Low	0.357
H TRANSPORTATION AND STORAGE	Low	Low	0.164
D-E ELECTRICITY, GAS AND WATER SUPPLY	Low	Low	0.106
B MINING AND QUARRYING	Medium-low	Low	0.041
I ACCOMMODATION AND FOOD SERVICE ACTIVITIES (base)	Low	Low	0.000

Note: n.c. is for "not classified"

In **Table 3** we report the correspondence between the GV classification (column 1) and our broader classification (column 2) for 24 industries as defined in the dataset from which we draw our sample. As shown in the table, we end up with six high R&D intensive industries: Chemicals and chemical products (10-21), Other manufacturing; repair and installation of machinery and equipment (31-33), Transport equipment (29-30); Electrical and optical equipment (26-27); Machinery and equipment n.e.c (28), IT and other information services (62-63).

4.3.2 Industry-specific R&D intensity based on a regression approach

We construct an alternative measure of R&D dependence by applying the Ciccone and Papaioannou methodology (2006, 2009). Following their approach, we estimate a measure of industry reliance on R&D activities that does not reflect idiosyncratic factors specific to a country or to a constitutional/legislative environment.[9] Based on data from the OECD ANBERD database, we first calculate R&D intensity (as the ratio of R&D expenditure over value added) for 23 industries in an (unbalanced) sample of 18 countries from 1998 to 2013 and then estimate the following regression

$$RD_{cst} = \alpha_s + \gamma_{ct} + \delta_s const_c + \theta_s law_c + \omega_{cst} \qquad (3)$$

where RD_{cst} is industry and country specific R&D intensity at time *t*, α_s are industry dummies, γ_{ct} are country x year dummies, $\delta_s const_c$ are industry dummies interacted with the constitution indicator (and $\theta_s law_c$ are industry dummies interacted with an index of legal IPR protection - which is not at the constitutional level – as specified in the next section). The estimated vector $\widehat{\alpha_s}$ reports a measure of the extent of R&D intensity which is industry specific and exogenous with respect to country specific institutions protecting IPR. We then use $\widehat{\alpha_s}$ in our empirical model as an alternative measure of R&D dependence at industry level.

Column 3 in **Table 3** tabulates the value of the estimated R&D dependence index for each of the 23 industries, as resulting from the estimation of equation 3, where the value corresponding to the base industry in regression (2) - Accommodation and Food Service Activities- is normalized to 0.

The same aggregation problems which prevent us to use the GV taxonomy directly in our estimation also affect the comparison between our R&D indicator and the GV one, making it not very clear cut in some cases. Nevertheless, the correspondence between the GV classification and our estimated index appears to be quite good. The five industries classified by GV as high or medium-high R&D intensive are among the first seven industries according to our estimated R&D intensity index.[10]

4.2.3 Endogeneity issues and instrumental variables

For all the countries included in our sample constitutional provisions concerning IPRs protection have been introduced decades before the period under investigation. However, most constitutions were ratified after World War II, while traditions of intellectual property protection and productivity-enhancing R&D investment are much older. For example, in the UK, the US, Germany and Austria, and other European nation-states, one has to go back to the early and middle of the 19th centuries (or before) to see the beginnings of R&D intensive technologies, which benefited from legal protection of intellectual property in both ordinary law and constitutional law.

Table 4 shows the year in which constitutional provisions protecting IPRs have been introduced, as well as the year in which the constitution was enacted or modified.

Table 4: Constitutional provisions protecting IPRs and year of introduction

	Constitutional provisions protecting IPRs			Constitution
Country	Patent	Copyright	Trademark	Year
Austria	1920	1920	1920	1945
Belgium				1831
Bulgaria	1970	1970		1991
Cyprus				1960
Czech Republic				1993
Denmark				1953
Finland				1999
France				1958
Germany		1949		1949
Greece				1975
Ireland				1937
Italy				1947
Lithuania	1992	1992		1992
Luxembourg				1868
Netherlands				1815
Poland				1992
Portugal		1976		1976
Slovak Republic				1992
Spain				1978
Sweden				1809
United Kingdom				1789
United States	1789	1789		1789

Among the countries in our sample, six have included IPRs protection in their constitution *ab origine*. The most recent example is Portugal, whose constitution dates back to 1976. In two countries (Austria and Bulgaria), IPRs protection was included also in the previous charter, so it even predates the present constitution.

Therefore, given the time span considered in our estimates (namely, from 2000 to 2013), we can rule out the possibility of reverse causality between the constitutional protection of IPRs and labor productivity. Reverse causality might represent a problem for studies dealing with developing and transition countries that have recently introduced such provisions in their constitution. Moreover, in the empirical analysis we include country specific-time variant fixed effects which control for any omitted variable at country level that could potentially bias our results. Therefore, we can exclude that constitutional protection of IPRs and changes in labor productivity are driven by common unobserved factors at the country level. The exogeneity of constitutional provisions is also supported by a standard test on endogeneity. [11]

However, this argument does not necessarily apply to the protection of IPRs resulting from lower-rank legislation, as current values of the index of IPRs protection may be determined by the productivity dynamics of high R&D intensive industries, so that the exclusion restriction would not hold in this case. In order to tackle a possible reverse causality or omitted variable bias in specification (2), we instrument the IPRs index (and its interaction with constitutional norms) with a set of instruments that are widely known and used in the literature, namely an indicator of a country institutionalized democracy (*democ*), an indicator of regime durability (*durable*), and the distance from the equator (*latitude*).

The first two variables (*democ* and *durable*) are indicators of political institutions and are both taken from the Polity IV dataset developed by the Center for Systemic Peace and coding authority characteristics of states with a total population of 500,000 or more.[12] *Democ* is an eleven-point indicator derived from the coding of variables such as the competitiveness of political participation, the openness and competitiveness of executive recruitment and the constraints on the chief executive; *durable* refers to the number of years since the most recent regime change or since the end of a transition period defined by the lack of stable political institutions. The choice of political variables as instruments for laws protecting IPRs is based on the "hierarchy of institutions" hypothesis, according to which constitutional/political rules set the stage for economic institutions (Acemoglu et al. 2005). Political institutions change slowly, exhibit persistence over time and have a negligible direct impact on output; as a result, they are particularly suited to instrument institutional characteristics of developed economies.

Table 5: The instruments (2000-2013)

Country	democ	durable	latitude
Austria	10	60.5	47.5
Belgium	9	62.5	50.5
Bulgaria	8.93	16.5	42.7
Cyprus	10	32.5	35.1
Czech Republic	9.43	13.5	49.8
Denmark	10	61.5	56.2
Finland	10	62.5	61.9
France	9	37.5	46.2
Germany	10	16.5	51.1
Greece	10	31.5	39.1
Ireland	10	85.5	53.4
Italy	10	58.5	41.8
Lithuania	10	15.5	55.1
Luxembourg	10	61.5	49.8
Netherlands	10	61.5	52.1
Poland	9.9	15.5	51.9
Portugal	10	30.5	39.3
Slovak Republic	9.6	13.5	48
Spain	10	28.5	40.4
Sweden	10	89.5	60.1
United Kingdom	10	126.5	55.3
United States	10	197.5	37
mean	9.80	53.59	48.35
sd overall	*0.45*	*42.89*	*7.30*
between	*0.36*	*43.63*	
within	*0.28*	*4.04*	

Latitude is a geographical characteristic intended to measure the extent to which an economy is influenced by Western Europe, the first region of the world to implement broadly an institutional setting that favors economic growth (Hall and Jones, 1999).

As a robustness check, we also instrument the endogenous variable(s) with the average values of both the Polity IV instruments across the 2000-2013 period. Our main results are remarkably robust (see Section 6).

Table 5 displays descriptive statistics for the variables used to instrument the IPRs index. The values of *democ* and *durable* as reported in column 1 and 2 are averaged over the sample period.

5 – Empirical results

5.1 Main results

Controlling for pre-sample labor productivity (**Table 6)**, we have indication of dynamic causality, namely the fact that IPRs protections, both constitutional and ordinary, R&D investment, and industry-level labor productivity are plausibly super-modular complements: more of one makes the others more valuable and/or more likely (Milgrom and Roberts, 1990, 1995). On the one hand, the presence of constitutional and ordinary protections makes R&D investments more valuable, likely contributing to labor productivity in R&D-intensive industries. Conversely the presence of R&D- intensive industries with high labor productivity increases the "demand" for both constitutional protections and "ordinary" IPRs.

Table 7 shows the results of regressing labor productivity on the constitutional dummy and IPRs index as discussed in the previous sections. Columns 1-4 present OLS estimates and columns 5-7 IV estimates. As discussed in the previous session, in the IV estimates the term $law_c\ x\ innov_s$ is instrumented with the political variables *democ* and *durable* (both interacted with $innov_s$). In order to run the over-ID test, we added the instrument *latitude* in the full specification (column 7).

Table 6: The effect of constitutional norms protecting IPRs on labor productivity controlling for the log of pre-sample industry productivity

	IV		
	1	2	3
productivity (log) 1998	0.674***	0.673***	0.668***
	0.017	0.017	0.017
const x innov		0.06***	2.004***
		0.018	0.437
law x innov	0.273***	0.267***	0.489***
	0.036	0.036	0.054
const x law x innov			-0.444***
			0.099
r2	0.865	0.866	0.862
Industries	22	22	22
Countries	22	22	22
Obs.	6794	6794	6794
Industry FE	YES	YES	YES
Country × Year FE	YES	YES	YES
underid	790.617	765.708	547.647
Chi-sq(2) P-val	0	0	0
overid	1.54	0.244	0.222
Chi-sq(1) P-val	0.2146	0.6216	0.6375

Notes: Robust standard errors in parentheses; ***significant at 1%, **significant at 5%, *significant at 10%. Law: Ginarte and Park patent protection index (average 2000-2013). Instruments for *Law*: democ and durable (5, 6, 7), latitude (7). All instruments are interacted for *innov*

In both OLS and IV regressions the impact of constitutional norms protecting IPRs on labor productivity in high R&D intensive industries is positive, also when the IPRs index is accounted for, though less precis estimated.

Table 7: The effect of constitutional norms protecting IPRs on labor productivity

	OLS				IV		
	1	2	3	4	5	6	7
Const x innov	0.128		0.152**	1.102		0.153	3.412
	(0.079)		(0.07)	(0.758)		0.022***	0.574***
Law x innov		0.291**	0.306***	0.378***	0.341***	0.327***	0.71***
		(0.108)	(0.093)	(0.11)	(0.044)	(0.044)	(0.072)
Const x law x innov				-0.22			-0.753
				(0.21)			(0.133)
r2	0.649	0.652	0.653	0.654	0.652	0.653	0.65
Industries	22	22	22	22	22	22	22
Countries	22	22	22	22	22	22	22
Obs.	7377	7377	7377	7377	7377	7377	7377
Industry FE	YES	YES	YES	YES	YES	YES	YES
Country × Year FE	YES	YES	YES	YES	YES	YES	YES
Underid					915.47	838.57	497.78
Chi-sq(2) P-val					0	0	0
Overid					0.153	0.019	2.248
Chi-sq(1) P-val					0.698	0.889	0.134

Notes: Robust standard errors in parentheses; ***significant at 1%, **significant at 5%, *significant at 10%. Law: Ginarte and Park patent protection index (average 2000-2013). Instruments for *Law*: democ and durable (5, 6, 7), latitude (7). All instruments are interacted for *innov*

The triple interaction term is negative in all cases (column 4 and 7). This result suggests a substitution effect between constitutional norms and lower-rank sources of legislation, as the presence of ordinary law reduces the differential impact of constitutions on high R&D intensive industries (and, vice-versa, constitutional protection dampens the effect of ordinary law).

Based on the results in column 7 (the fully interacted model), we can assess, on the one side, the effect of constitutional norms on industry productivity depending on IPRs protection and, on the other side, the effect of the IPRs index depending on the presence of constitutional norms.

Let us focus on the effect of the IPRs index first. Taking the first derivative of (3) with respect to *law* we obtain:

$$\frac{\partial y_{cst}}{\partial law_c} = (\beta_2 + \beta_3 const_c) \times innov_s \qquad (4)$$

which shows that the effect of ordinary law on the productivity differential between high and low R&D industries depends on the presence of constitutions. Therefore, $\widehat{\beta_2}$ is the estimated effect in countries with no constitutional protection, while $\widehat{\beta_2} + \widehat{\beta_3}$ is the effect when constitutional norms are present.

To this respect, two conclusions can be drawn from the findings in column 7. First, in those countries where IPRs are also protected by the constitution, the IPRs index has no significant impact on the labor productivity differential between high and low R&D intensive industries, as the effect of *law* on the dependent variable (i.e. $\widehat{\beta_2} + \widehat{\beta_3}$) is quantitatively small (-0.043) and not statistically significant. On the other hand, the effect turns out to be positive and quantitatively relevant in countries without constitutional protection, $\widehat{\beta_2}$ being equal to 0.71. Quantitatively, the effect of increasing IPRs protection by ordinary law by one standard deviation (which is 0.42, around 10% of the average value) would be an increase of labor productivity in high R&D intensive industries relative to low R&D intensive industries of about 30% in the absence of constitutional IPRs protection.

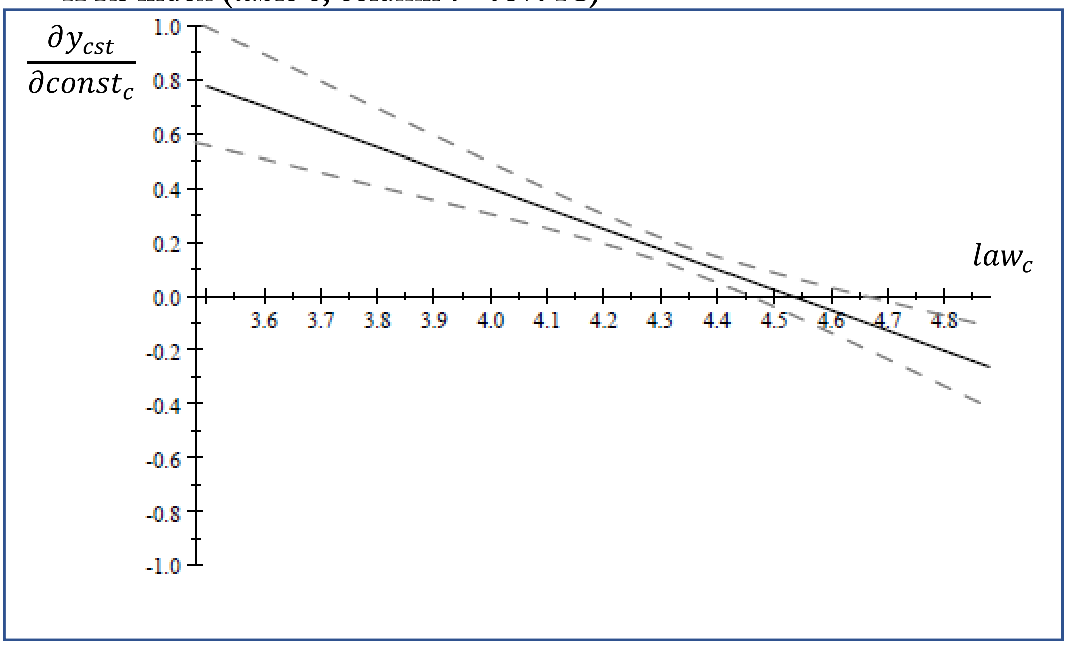
In a similar way, we can quantify the effect of constitutional provisions by taking the first derivative of (3) with respect to *const* and obtain:

$$\frac{\partial y_{cst}}{\partial const_c} = (\beta_1 + \beta_3 law_c) \times innov_s \tag{5}$$

According to the first derivative in (4), the marginal effect of the presence of constitutional norms protecting innovation depends on the IPRs index. Since the IPRs index assumes continuous values, we can graphically represent the estimated effects (and statistical significance) of constitutional provisions on labor productivity in high R&D intensive industries for different values of the IPRs index distribution.

Results are displayed in Figure 1, which shows clearly that constitutional and ordinary legal norms are substitutes, the marginal effect of constitution being positive and statistically significant for an IPRs index lower than 4.45 (that is for half of the countries in our sample). The differential impact of the constitutional norms for labor productivity in high R&D intensive industries is on average around 20%.

Figure 1: The effect of constitutional provisions protecting IPRs on labor productivity in high R&D intensive industries for different levels of the IPRs index (table 6, column 7 - 95% IC)



5.2 IPRs legal protection and R&D investment

The results reported in **Table 7** suggest that high innovative industries are relatively more productive in countries with a strong protection of intellectual property derived either from constitutional provisions or lower-rank laws. In this section we want to explore the channel through which IPRs protection affect industry productivity. To this aim we test whether and to what extent legal protection creates favorable conditions for undertaking research on and developing innovative ideas.

Table 8: The effect of constitutional norms protecting IPRs on R&D intensity

	IV		
	1	2	3
Const x innov		0.297***	1.251
		(0.053)	(3.657)
Law x innov	0.508***	0.358***	0.44
	(0.114)	(0.117)	(0.363)
Const x law x innov			-0.213
			(0.818)
r2	0.839	0.84	0.84
Industries	20	20	20
Countries	18	18	18
Obs.	3716	3716	3716
Industries FE	YES	YES	YES
Country × Year FE	YES	YES	YES
Underid	465.203	672.406	106.49
Chi-sq(2) P-val	0	0	0
Overid	0.576	0.816	0.735
Chi-sq(1) P-val	0.4479	0.3663	0.3912

Notes: Robust standard errors in parentheses; ***significant at 1%, **significant at 5%, *significant at 10%. Law: Ginarte and Park patent protection index (average 2000-2013). Instruments for *Law*: democ and durable (5, 6, 7), latitude (7). All instruments are interacted for *innov*

Based on the same identification strategy illustrated above, we estimate specification (2) by using the log of R&D intensity at industry level as a dependent variable.

Results are reported in **Table 8**. Column (2) shows that both constitutional provisions and lower-rank laws' IPRs protection have a significant positive effect on R&D intensity. The presence of constitutional provision enhances R&D intensity and, hence innovation effort, by around 30% in those industries which have a higher R&D intensity. Similarly, if we increase the index of IPRs legal protection by 1 standard deviation, R&D intensity grows by around 15 percent. The triple interaction term (column 3) is negative as in the productivity specification; this result seems to suggest once again a substitution effect between constitutional norms and lower-rank sources of legislation in stimulating innovation.

6 - Robustness

To check the robustness of our results, we run our main regressions using an alternative specification of industry reliance on R&D activities, the IPRI (International Property Rights) Index, different specification of the instruments and including institutional arrangements that may affect industry productivity performance (namely labor and product marker regulation and the characteristics of the industrial relations system).

6.1 - Robustness to the R&D dependence index

In this section we refine our identification of industry reliance on R&D, by using the R&D dependence index reported in **Table 3** (column 3). Our model is therefore reestimated interacting *law* and *const* with the *innov1* index. The results shown in **Table 9** are remarkably similar to those presented in **Table 7**. Considering the full specification (column 3), the average effect of the constitutional norms protecting IPRs on labor productivity is around 16%. The effect of increasing the IPRs index by one-standard deviation is around 20% in countries with no constitutional protection, and the effect turns out to be very small and statistically not significant in the countries with IPRs protection.

Table 9: Robustness to R&D dependence index

	IV		
	1	2	3
const x innov1		0.104***	2.189***
		(0.013)	(0.366)
law x innov1	0.232***	0.22***	0.465***
	(0.026)	(0.025)	(0.048)
const x law x innov1			-0.481***
			(0.085)
r2	0.664	0.666	0.658
Industries	20	20	20
Countries	22	22	22
Obs.	6781	6781	6781
Industry FE	YES	YES	YES
Country × Year FE	YES	YES	YES
underid	888.065	824.174	563.601
Chi-sq(2) P-val	0	0	0
overid	0.042	0.217	0.55
Chi-sq(1) P-val	0.8373	0.6415	0.4582

Notes: Robust standard errors in parentheses; ***significant at 1%, **significant at 5%, *significant at 10%. Law: Ginarte and Park patent protection index (average 2000-2013). Instruments: democ and durable (5, 6, 7), latitude (7). All instruments are interacted for *innov*.

6.2 - Robustness to the International Property Rights Index

The Ginarte and Park index captures the degree of patent protection resulting by various types of norms (legislations, international treaties, and so on). However, the actual level of IPRs protection in a country may also be the result of de facto situations which are related to the legal environment or to the quality of the enforcement, but which are not immediately encompassed in official rules.

Table 10: Robustness to the facto IPRs protection (IPRI 2007-2013)

	IV		
	1	2	3
const x innov		0.17***	1.999***
		(0.027)	(0.416)
law1 x innov	0.109***	0.104***	0.225***
	(0.021)	(0.019)	(0.026)
const x law1 x innov			-0.254***
			(0.058)
r2	0.675	0.677	0.676
Industries	22	22	22
Countries	22	22	22
Obs.	3596	3596	3596
Industry FE	YES	YES	YES
Country × Year FE	YES	YES	YES
underid	595.463	514.865	169.541
Chi-sq(2) P-val	0	0	0
overid	0.569	1.4	0.205
Chi-sq(1) P-val	0.4507	0.2367	0.6509

Notes: Robust standard errors in parentheses; ***significant at 1%, **significant at 5%, *significant at 10%. Law: Ginarte and Park patent protection index (average 2000-2013). Instruments: democ and durable (5, 6, 7), latitude (7). All instruments are interacted for innov.

We check the robustness of our findings using an alternative IPRs index, the IPRs component of the International Property Rights Index (IPRI). The IPRI is a composite indicator which is based on the Ginarte and Park measure of IPRs strength, but it also includes two measures of *the facto* IPRs protection, an opinion-based measure of the protection of intellectual property and the level of piracy in the IP industry. Therefore, differently from the IPRs index used in the main regressions, the IPRI captures the level of actual protection (*de jure* as well as *de facto* protection) which is granted in a country as a result of the institutional settings at large.

The IPRI is published by the Property Rights Alliance on an annual basis since 2007. We calculate the average of the indicator over the year 2007-2013 and use it to re-estimate our model in equation (3). Here again, the results reported in **Table 10** are remarkably similar to those shown in **Table 7**.

6.3 - Robustness to an alternative instrument specification

We also estimate our IV model replacing the (time variant) instruments *democ* and *durable* by their average along the 1998-2013 period; **Table 11** shows the results of our estimation, thus confirming also in this case the robustness of our findings.

Table 11: Robustness to alternative instrument specification (democ and durable: average 2000-2013)

	IV		
	1	2	3
const x innov		0.151***	3.598***
		(0.022)	(0.557)
law x innov	0.305***	0.292***	0.693***
	(0.043)	(0.043)	(0.07)
const x law x innov			-0.797***
			(0.129)
r2	0.652	0.653	0.65
Industry	22	22	22
Countries	22	22	22
Obs.	7377	7377	7377
Industry FE	YES	YES	YES
Country × Year FE	YES	YES	YES
underid	923.546	845.375	518.512
Chi-sq(2) P-val	0	0	0
overid	0.006	0.248	2.046
Chi-sq(1) P-val	0.9406	0.6186	0.1527

Notes: Robust standard errors in parentheses; ***significant at 1%, **significant at 5%, *significant at 10%. Law: Ginarte and Park patent protection index (average 2000-2013). Instruments: democ and durable (average 2000-2013, columns 1, 2 3), latitude (3). All instruments are interacted for innov.

7 – Discussion

Taking hints from the strands of literature focusing on the impact of constitutions on economic activity and on the relationship between a country's legal protection of IPRS, industry reliance on R&D and productivity dynamics, this paper contributes to the scientific and policy debate in the broad interdisciplinary area of research on legislation, legislative processes, and regulation on various measures of economic performance. It shows that, in countries where intellectual property rights receive constitutional protection, high R&D intensive industries exhibit higher productivity levels than the other industries. According to our findings, in those countries already endowed with a constitution containing provisions in support of IPRs protection, legal norms hierarchically subordinate to constitutional norms do not necessarily strengthen the impact of higher-rank norms. We find that constitutional protection of IPRs has a positive impact on productivity which is relative larger for high- R&D intensive industries.

Constitutions delineate the pillars of the legal and the institutional systems that govern organizations and entities in a country. Typically, they embody values and principles that are considered of the utmost importance for a country and whose protection is prioritized. As such, constitutional status represents a signal, to both citizens and foreigners, that the principles behind those rules are granted the utmost protection. Insomuch as the provisions playing a crucial role for economic activity are enshrined in a country's constitution and not simply set for by lower-rank legislation, we should expect a stronger relationship with productivity. Such relationship should be even stronger in those industries that benefit most from IPRs protection, namely high R&D intensive ones.

A second, interesting result that we prove is that constitutions and lower-rank laws are substitutes.

Our findings show that constitutions seem to play a role in the absence of a specific law. In other words, constitutional law seems to play, in the application of IPRs, a "supplementary" or "residual" role. The constitutional provisions regarding IPRs protection acquire importance and exert a distinctive impact on labor productivity in the absence of specific ordinary law or standing a limited protection by ordinary law. Constitutional provisions thus fill the gap left by the lack of specific legal rules applicable to IPRs protection, possibly through judicial revision procedures.

These results are interesting and raise questions on a) the mechanisms that might justify them; b) their generality. Substitutability between constitutional and lower-rank norm might, in fact, characterize some rights, whereas complementarity might be the distinctive feature of others.

Generally speaking, legal norms have the double function of 1) including principles and norms that reflect commonly shared values and social norms, to legitimate them and, 2) include principles that do not reflect shared values, to signal the political intention to change the common practice, aligning it to the new principles, and to commit to their enforcement (Carbonara, 2017).

Constitutions are a particularly powerful way to achieve the above results. They are special laws, with a special rank and a special force. Principles protected by constitutions are preserved from change by supermajority rules or aggravated procedures. By giving a law constitutional status, lawmakers make a strong commitment to their enforcement and give their statement a substantial weight.

When constitutions embody principles that diverge from current social values, conformity is particularly difficult and strong enforcement may be required to achieve it (Carbonara et al., 2012). Thus, higher- and lower-ranked rules are likely to be complements in this case, insofar as ordinary law strengthens the protection of constitutional rights by adding to the available remedies.

When constitutions include principles reflecting generally shared values, on the other hand, such values are already represented in common practice and conformity is likely to be guaranteed by social norms (Carbonara, 2017). Whereas including those principles in the constitution might have the symbolic value of legitimating both the principles and the social norms on which they are founded, a special force is not needed for their enforcement and lower-rank norms are sufficient. In this case, lower and higher-rank norms are substitutes and the presence of ordinary laws protecting IPR reduces the positive impact of constitutional provisions.

It is highly likely that the countries included in our sample fall within this latter case. Most of the OECD countries in our sample are developed countries that have a long-lasting tradition of pro-market commercial practices and that have helped designing the current methods of investment protection and appropriability of research results that form modern protection of intellectual property rights.

Finally, in this paper we have used data at the industry-country level rather than at firm-country level. This was done in accordance with the vast majority of the literature on institutions and economic performance. To test the impact of institutions, we need enough variance in the sample, so the analysis must necessarily include quite several countries with differing institutional frameworks. Therefore, we had to keep our study at industry level, and we attributed to each industry an "average" level of R&D intensity.

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Appendix 1

A1. Robustness to the inclusion of labor market institutions and product market regulation

One of the channels through which institutions affect productivity and growth is via the labor market dynamics (see Gianfreda and Vallanti, 2017 and 2020). Thus, we also check the robustness of our results for the possible effect of other institutional arrangements that may impact the productivity performance of innovative firms and industries. The results are reported in **Table A1**.

Table A1: Robustness to the inclusion of product and labor market regulatory institutions (PMR, EPL) and union density (UD)

	IV		
	1	2	3
const x innov		0.186***	8.848***
		(0.032)	(1.605)
law x innov	0.137***	0.041	1.037***
	(0.071)	(0.068)	(0.217)
const x law x innov			-1.985***
			0.368
PMR x innov	0.339***	0.334***	0.257*
	(0.062)	(0.061)	(0.137)
EPL x innov	-0.037*	-0.055**	-0.212***
	(0.021)	(0.021)	(0.035)
UD x innov	-0.001	-0.002**	-0.002**
	(0.001)	(0.001)	(0.001)
r2	0.643	0.644	0.632
Industry	22	22	22
Countries	20	20	20
Obs.	6765	6765	6765
Industry FE	YES	YES	YES
Country × Year FE	YES	YES	YES
underid	816.63	751.66	279.71
Chi-sq(2) P-val	0.00	0.00	0.00
overid	0.065	2.473	2.527
Chi-sq(1) P-val	0.80	0.12	0.11

Notes: Robust standard errors in parentheses; ***significant at 1%, **significant at 5%, *significant at 10%. Instruments: democ and durable (average 2000-2013, columns 1, 2 3), latitude (3). All instruments are interacted for innov.

The overall effect of regulatory institutions on industry performance is captured by country by year fixed effects in our main specification. However, to the extent that product and labor market policies impact differently industries with different R&D dependence, not controlling for such institutions may bias our results. Following Bassanini and Ernst (2002), we include three indicators for product and labor market regulation provided by the OECD database: (a) an economy-wide index of Product Market

Regulation (PMR) form the OECD, (b) an indicator of the strictness of employment protection legislation (EPL) as a proxy of labor adjustment costs; and (c) union density (UD) as a proxy for union strength. All the three institutional variables are then interacted with the industry R&D dependence index. We then estimate the following specification:

$$y_{cst} = \beta_1(const_c \, x \, innov_s) + \beta_2(law_c \, x \, innov_s + \beta_3(const_c \, x \, law_c \, x \, innov_s)$$
$$+\boldsymbol{\gamma}(\boldsymbol{inst_c} \, x \, innov_s) + \boldsymbol{D}_{cst} + u_{cst} \qquad (A.1)$$

where $\boldsymbol{inst_c} = (PMR, EPL,$ UD).

The effect of constitutional provisions is remarkably robust to the inclusion of the regulatory variables. Both the simple interaction and the triple interaction are statistically significant, and the magnitude of the coefficients is comparable with the one in the main specification. The coefficient of IPRs legal protection remains positive though not always statistically significant. This result can be explained by the fact that at a country level there is a close relationship between the regulatory stance concerning administrative procedures (captured by the PMR index) and that concerning protection of IPRs (Bassanini and Ernst, 2002).

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[1] For example, comparing 14 European countries industries with significant differences in productivity, Subramanian and Megginson (2018) find that the effect of employment protection laws on privatization is disproportionately greater in less productive industries.

[2] The IPRs-protection indexes that we use in our model will be described in section 4.2 below.

[3] We also include the log of the pre-sample values of the dependent variable calculated for the year 1998 to account for initial conditions and the potential bias from omitted industry-country specific factors. Estimated coefficients reported in Table A1 in Appendix are remarkably similar to main results.

[4] As specified in footnote 7, we start from a sample of 24 industries (according to the classification employed by EUKLEMS) and we drop the broad industries "Publishing, audiovisual and broadcasting activities" and "Professional, scientific, technical, administrative and support services activities" (M-N), as they do not fit neither in our "High" nor in our "Low" R&D intensity classifications.

[5] See http://comparativeconstitutionsproject.org/about-constitute/.

[6] Analogously, Keller and Yeaple (2013) use R&D intensity aggregated at industry level as a proxy of knowledge intensity.

[7] Data on productivity at industry level are drawn from the EUKLEMS database, which provides information on value added and hours worked for 34 industries and 8 aggregates according to the ISIC Rev. 4 (NACE Rev. 2) industry classification. Our

final sample includes 24 industries for 22 countries over the period 2000-2013. The level of aggregation for each industry has been chosen to have consistent data across all countries over the sample period.

[8] Even classifying each industry either in the high or low group, the correspondence between GV classification and our broader classification is not always clear-cut. In a few cases, the broader category comprises industries having a very different R&D intensity. This is the case of Publishing, audiovisual and broadcasting activities (58-60) and Professional, scientific, technical, administrative and support services activities (M-N). For example, GV classify Publishing activities (58) as a medium-high R&D intensive industry, while "Audiovisual and broadcasting activities" (59-60) as a low R&D intensive industry. As a consequence, the broader industry "Publishing, audiovisual and broadcasting activities" (58-60) is assigned neither to the high/medium-high nor to low/medium-low R&D group. For similar reasons, also the industry "Professional, scientific, technical, administrative and support services activities" (M-N) is not assigned. Both industries are dropped when performing estimates. Robustness checks assigning the two industries to the "low" group have also been performed. Results do not change.

[9] See also Cingano et al. (2010) for an application of this methodology to the construction of a job reallocation index.

[10] Notice that "Publishing activities" and "IT and other information services", which are classified by GV as medium-high, have assigned no R&D index since data on R&D used in regression (2) are available at a higher level of aggregation The broader category Information and communication (J) for which the R&D index is available also includes industries which are classified by GV as medium low and low.

[11] The endogeneity test statistics is 0.585 with a p-value is 0.4442. Results are available upon request.

[12] http://www.systemicpeace.org/polityproject.html.