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Institutions, Development, and Patterns of Trade

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Institutions, Development, and Patterns of Trade *

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Abstract

This study investigates how easing international transactions through improved legal institutions can result in divergent trade patterns for different economies. We provide evidence that the level of development governs the relevance of intellectual property rights (IPR) institutions in determining a country's comparative advantage. While IPR protection changes the composition of OECD exports towards IP-intensive sectors, contract enforcement is the key driver of specialization of non-OECD exports in relation-specific inputs. The findings suggest a concentration of innovation activities in the OECD, with non-OECD countries serving as potential outsourcing destinations. We exploit information on IPR reforms over time to show the robustness of our results through both an instrumental variable and a difference-in-difference approach. We extend the analysis to a bilateral framework to show that better IPR quality could nevertheless encourage technology transfer by encouraging imports of IP-intensive goods into non-OECD countries.

JEL classifications: F13, F14, F63, O34, D23
Keywords: Intellectual property rights, Rule of law, Comparative advantage, Institutions, IP-intensity, Level of development, Relation-specificity, Outsourcing

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1 Introduction

A worldwide wave of trade agreements and improvements in legal institutions has facilitated international transactions over the last decades (Antràs, 2016). The issue of intellectual property rights (IPRs) has in particular gained importance in both bilateral as well as multilateral trade talks. This has especially been true when parties at the talks include both advanced (OECD) and developing (non-OECD) economies and technology is at center stage. A proliferation of regional trade agreements with strict IPR provisions has fostered technology transfer from developed to developing countries (Santacreu, 2021a,b). Such agreements stimulate both exports in IP-intensive industries (Maskus and Ridley, 2021), and offshoring in these sectors to developing countries (Canals et al., 2021). The trade literature has in fact recognized IPR enforcement as a source of comparative advantage (Maskus and Yang, 2018). Previous related works have associated the quality of alternative institutions with comparative advantage, for example when contractual frictions create distortions in transactions between firms and their relation-specific input suppliers (Nunn, 2007; Levchenko, 2007).

Taking a step back and looking at OECD and non-OECD countries separately, an evident observation is the technological superiority of the former and the role of the latter as outsourcing locations for the procurement of intermediate inputs.[1] Protection of IPRs has been viewed as a key determinant of success in the race for latest technologies and efficient operation in IP-intensive sectors. The question we pose in this study is whether this role of IPRs holds generally for all countries, or if different institutions determine comparative advantage depending on a country's stock of knowledge or absorptive capacity. Using the same premise, we are additionally interested in exploring how IPRs influence the *direction* of trade in IP-intensive goods.

In this paper we carry out a systematic investigation to explain the alternative patterns of specialization across countries as an outcome of the quality of different institutions. We aim to shed light on whether differences in production structure, stage of development, or technological capability play a role in deciding which institutions determine a country's comparative advantage. The findings reveal a remarkable contrast in the institutional source of comparative advantage between OECD and non-OECD countries. In the former, IPR protection drives comparative

[1] Ten countries account for more than 80% of global spending on R&D and, with the exception of China, they are all developed countries (http://data.uis.unesco.org). On the other hand, the share of intermediate goods produced by developing countries has raised from 33% in 2005 to about half of the world production in intermediate goods in 2014 (https://wits.worldbank.org).

advantage in IP-intensive industries, whereas better quality rule of law institutions regulate the patterns of specialization in the latter by rendering them attractive as outsourcing locations for highly relation-specific inputs. The reasoning follows the logic that IPRs shield knowledge and create incentives in innovative industries, and contract enforcement encourages efficient supplier investment in the customization of relationship-specific inputs.

The first contribution of the analysis to the literature on the institutional sources of comparative advantage is to show that the quality of tangible and intangible property rights protection have different and mutually exclusive effects for countries at different levels of development. Acknowledging possible endogeneity of a country's IPR regime, we then address reverse causality concerns by making use of information on the timing of IPR reforms in a difference-in-difference framework, and as an instrumental variable. The results persist in a dynamic setting and reinforce our conjecture on the effect of the quality of institutions on trade patterns across countries and industries over time. The core results are robust to a host of additional checks and to a panel specification, which enables us to account for time fixed effects and time-varying country specific variables.

While the outcome may initially question the role of IPR policy as a tool to stimulate innovation in the developing world, we shift focus to imports to examine whether it can still play a role in development without affecting the export composition of these countries. Testing the standard notion of IPR in the literature as a tool to attract technology through imports, the findings suggest that IPRs encourage technology transfer by directing the import structure of developing countries toward IP-intensive goods. Looking at the effects of IPRs on both import and export patterns allows us to highlight how the same institution can have a different impact on the structure of trade for countries with dissimilar underlying characteristics: on the one hand, it is a source of comparative advantage for technologically advanced countries; on the other hand, it is an effective instrument to trigger imports in IP-intensive industries for developing countries.

This feature leads us to also look at bilateral trade flows between country pairs to investigate when and to what extent the patterns of trade of an exporting country may also be influenced by IPRs in the importing country. The results reveal a complementarity between the protection of intangible capital in the source and destination markets for promoting trade in high-tech industries. IPR institutions are an important determinant of the structure of exports (imports) for OECD (non-OECD) countries and increase trade in IP-intensive sectors from OECD to non-OECD countries. The bilateral analysis also allows to account for the standard gravity factors and control for pairwise country characteristics, providing a further robustness check for our core results.

The paper is organized as follows. The next section discusses the related literature. Section 3 describes the methodology and section 4 the data. Section 5 reports the OLS estimates and conducts robustness checks. Section 6 exploits a dynamic setting using IPR reforms to address reverse causality concerns. Section 7 shifts focus to technology transfer and introduces import patterns and the bilateral set-up. Section 8 concludes.

2 Literature

With the world economy witnessing substantial changes in the structure of international trade, new sources of comparative advantage have come to light. A direction taken by literature seeks to establish that the standard determinants of trade patterns driven by Ricardian efficiency and Heckscher-Ohlin factors are themselves an outcome of deeper political and economic processes, broadly identified as the concept of "institutions". These studies emanate from the empirical methodology introduced in Rajan and Zingales (1998), interacting industry and country-specific characteristics to show for example that countries with more developed financial markets tend to export relatively more in industries that require large amounts of external finance (Beck, 2003). Some key contributions in this category highlight that countries with better rule of law specialize in the production of more institutionally dependent goods (Levchenko, 2007) and in goods with a higher share of relationship-specific inputs (Nunn, 2007; Ma et al., 2010).[2]

A similar approach has been adopted to study the role of IPRs in the pattern of comparative advantage. Also drawing on variation in effective patent rights across countries and varied impact across industries within a country, Hu and Png (2013) finds that stronger patent rights are associated with faster growth in more patent-intensive industries. More recently, Maskus and Yang (2018) demonstrates the positive effect of domestic patent rights on export performance in high-R&D goods. Following the same rationale, we introduce IPRs next to other types of institutions to highlight how their impact on comparative advantage varies across

[2]Other related papers using this technique look at factor proportions and trade (Romalis, 2004), credit constraints (Manova, 2008), gains from division of labor and specialization (Costinot, 2009), and flexibility of labor markets (Cuñat and Melitz, 2012). Chor (2010) provides a model of comparative advantage generated from the interaction of industry and country characteristics and tests the predictions in joint presence of several sources identified in the literature. See also Nunn and Trefler (2014) for an exhaustive literature review on institutions and comparative advantage.

countries. Doing so reveals interesting insights as OECD and non-OECD economies host different production processes based on innovative and input provision activities. Consequently, the process of specialization for these groups may be determined by different institutional sources of comparative advantages, namely the protection of intangible versus tangible property rights.

Traditional IPR literature has however highlighted the role of the patent protection as an instrument to attract technology by encouraging imports.[3] Strengthening IPRs could promote technology diffusion to developing countries by increasing exports in patent-sensitive industries into those markets and facilitating access to new foreign technologies (Ivus, 2011, 2015). In a similar vein, Delgado et al. (2013) finds that trade in knowledge-intensive goods increased relative to other types of goods after the implementation of TRIPS. Looking at both cross section as well as firms' responses to six IPR reforms in a difference-in-differences framework, Lin and Lincoln (2017) show that IPR protection attracts imports of high-tech goods from technologically advanced countries. They are also the first to consider firm patenting in a gravity equation framework.

We take this path to provide a systematic analysis of the import patterns across countries. Distinguishing between the effect of IPR on OECD vis-à-vis non-OECD countries, we show that IPRs are only an important factor for the latter to attract technology-intensive goods. We also explore the significance of the interaction between the IPR policies of a source and a destination country in determining the patterns of trade using bilateral data.[4] We explicitly consider the IPR quality of the exporting country and conduct an industry-level analysis rather than aggregate levels of trade flow and development. We then simultaneously look at the IPR regime in the importing country to see if it contributes to attracting technology-intensive goods through trade among OECD countries, among non-OECD countries, or between the two regions.

[3]See e.g. Maskus and Penubarti (1995); Smith (1999, 2001); Rafiquzzaman (2002); Co (2004); Awokuse and Yin (2010).

[4]The only paper to our knowledge that touches upon the issue in a bilateral setting is Shin et al. (2016), who finds that as importing countries adopt a more stringent IPR regime, the impact on the bilateral exports of the partner nation is negatively related to the level of technology of the exporting country. They argue that IPR acts as an export barrier to trade, especially discouraging exports from developing countries that are in a catching-up phase.

3 Conceptual Framework and Methodology

It is well-known that better domestic IPR protection stimulates innovation (Qian, 2007; Chen and Puttitanun, 2005), attracts inflow of FDI (Javorcik, 2004) and boosts international technology transfer and domestic R&D (Branstetter et al., 2006, 2011).[5] These channels sum up to the notion that better quality IPR institutions encourage exports in industries more intensive in IP, as the latter are more sensitive to the protection of their intangible assets (Maskus and Yang, 2018).

Less-advanced economies that lack the initial intellectual capital are typically used as outsourcing destinations for cost reduction purposes. Nonetheless, suppliers must customize inputs to meet the required standards, i.e. engage in relationship-specific investments. In a world of contractual incompleteness, the hold-up problem leads suppliers to underinvest. Strong rule of law institutions can partially resolve the friction through contract enforcement. This issue is more crucial the higher are the specific needs because the supplier's outside option is lower and underinvestment a bigger problem. Countries with better rule of law hence have a comparative advantage in the production of goods that use intensively inputs that require relationship-specific investments (Nunn, 2007).

By offering foreign firms a minimum level of protection against expropriation, IPRs can however be an important determinant of the import patterns of developing countries and encourage an inflow of technology-intensive goods (Ivus, 2011, 2015; Delgado et al., 2013). Improved IPRs also prompt multinational firms to transfer more intangible capital to their affiliates in host countries (Branstetter et al., 2006). The effect of IPRs on technology diffusion can also be due to responses in arm's length exports and unaffiliated licensing (Ivus et al., 2016, 2017; Lin and Lincoln, 2017). Biancini and Bombarda (2021) instead argue that IPRs increase technology diffusion by encouraging vertical integration because the latter induces more knowledge spillovers. This phenomenon could build the intellectual capital required for domestic innovation over time and eventually spur industrial development (Branstetter et al., 2011).

To summarize, we expect a significant and positive effect of IPR institution on specialization in IP-intensive industries within OECD countries and we expect non-OECD countries with a better rule of law to export relatively more in industries that require higher levels of relationship-specific investments. At the same time, we expect IPR institution to be an important tool for non-OECD countries to attract foreign

[5]This may however not always be the case as IPR protection may at times hinder follow-on innovation (Scotchmer, 1991; Murray and Stern, 2007; Boldrin and Levine, 2008; Williams, 2013; Galasso and Schankerman, 2015).

technologies by increasing imports in IP-intensive sectors from OECD countries.

We test these hypotheses by estimating the following equation:

$$
\begin{aligned}
log(exp_{i,c}) = \alpha + \beta_1(IPint_i * IPR_c) + \beta_2(h_i * log(H_c)) + \\
\beta_3(k_i * log(K_c)) + \beta_4 * (z_i * RL_c) + \delta_i + \delta_c + \epsilon_{i,c}
\end{aligned}
\tag{1}
$$

where $log(exp_{i,c})$ is the natural log of export in industry i from country c to the rest of the world, IPR_c is a measure of the quality of protection of intangible capital in country c, $IPint_i$ is a proxy for the contribution of IPR to the production process of each industry i, z_i is a measure of the importance of relationship-specific investments in industry i; RL_c is a measure of the quality of contract enforcement in country c; H_c and K_c denote the endowments of skilled labor and capital of country c, and h_i and k_i are the skill and capital intensities of production in industry i. Finally, the specification also incorporates country (δ_c) and industry (δ_i) fixed effects, that capture the overall level of trade and control for unobserved country and industry characteristics. We used robust standard errors as generally applied for this methodology. Throughout the paper, we will call IPR interaction the term $IPint_i{*}IPR_c$, Nunn's interaction $RL_c{*}z_i$ and skill interaction and capital interaction the other two products from equation (1) involving human capital and physical capital. In the baseline exercise, we use export values of 2014, human and capital stocks of 2012, rule of law and Park index for 2010. We lag the institutional variables by four years with respect to trade flows to reflect the fact that legal changes likely take time to influence technological activity.[6]

This specification, introduced by Rajan and Zingales (1998) and brought in the trade literature by Beck (2003) and Romalis (2004), is particularly appealing because it allows to control for country and industry fixed effects that explain the total volumes of trade, and to focus on the mix of exports in each country: these interaction terms capture the relative difference in the export values across industries and countries and for this reason provide a complete map of specializations across countries. As an example, assume that two countries are similar in every aspect but their IPR quality. A positive coefficient β_1 would be an evidence of comparative advantage because it suggests that countries with higher-quality IPR institution tend to export relatively more in IP-intensive industries. The same reasoning applies for the interpretation of the other coefficients.[7] We use the same mechanism to study the interaction of

[6] Results are not sensitive to the choice of lag, which is made as an initial attempt to mitigate reverse causality concerns (see the section dedicated to this issue for a more comprehensive analysis).

[7] The underlying idea is that for each industry the dependence on a country variable, either a stock or an institutional quality, is a technological feature and so it is constant across countries; country features that satisfy better the needs of specific industries offer a more suitable environment

industry and country-specific characteristics on imports, i.e. whether better IPR protection in a country induces more imports in IP-intensive sectors. Finally, we explore also two alternative specifications, a bilateral framework and a panel set-up, to deepen the analysis and address new questions, as we will discuss in greater details in the next sections.

4 Data

A key variable that lies at the center of our analysis is the data for the contribution of IP at industry level. We obtain this measure, $IPint_i$ in equation (1), from the report "Intellectual property rights intensive industries and economic performance in the European Union, Industry-Level Analysis Report, October 2016 Second edition" provided by EUIPO (European Union Intellectual Property Office). The intellectual property rights considered in the European report are trademarks and patents applied at EUIPO, EPO (European Patent office) and CPVO (Community Plant Variety Office) during 2006-2010 and subsequently granted. The unit of analysis of the report is at industry level, as defined by NACE 4-digit revision 2 classification and it provides the number of IP issued for 1000 employees. We take this measure as the importance of IP to the production process of each industry. [8] Table 1 provides a descriptive summary of this variable at industry level and a list of the three most and least IP-intensive industries.

All other data are from standard sources. Other industry variables are obtained from US manufacturing database maintained by the National Bureau of Economic Research and US Census Bureau's Center for Economic Studies. These variables are updated up to 2011 and are classified under the NAICS 1997 system, that we converted to NACE 4-digits. [9] We define capital intensity as one minus the share of

for efficient operation of those industries. As a consequence, countries specialize in industries whose production needs are best matched with their factor endowments and institutional strengths.

[8] A frequent critic for the use of industry data in this setting is that it uses information on one country and assumes that industry characteristic is constant across all other countries with the argument that technology is a structural feature and hence production requires the same process regardless of its location. Even if the data we use on IP intensity is an average of all the EU countries (and so less prone to this critique), some caveats are worth mentioning. Our identification does not require that industries have exactly the same IP intensity levels in every country, but it does rely on the ranking of sectors remaining relatively stable across countries. We implement a sensitivity checks in Table 11 of the Appendix by using a dummy to split industries into high and low IP-intensive ones with respect to the median value and by looking separately at patents and trademarks to measure IP-intensity.

[9] In order to convert all the industry variables according to the NACE 4-digits classification, we match NAICS 1997 to NAICS 2007 categories and then convert this system with NACE 4-digits through an official concordance table provided by Eurostat. All the concordance between different versions of the NAICS classification are available at:

Table 1: Intellectual Property Rights statistics

Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
trademark	7.55	6.54	0.47	38.80
patent	3.30	9.98	0	109.74
sum	10.85	12.99	0.47	116.92

Top Industries	N of IP
Manufacture of power driven hand tools	116.92
Manufacture of instruments and appliances for measuring and testing	70.89
Manufacture of basic pharmaceutical products	66.38

Lowest Industries	N of IP
Manufacture of ready-mixed concrete	0.47
Manufacture of prepared meals and dishes	0.88
Processing and preserving of poultry meat	1.06

total compensation in value added in each industry, whereas skill intensity is given by the share of non-production workers relative to overall employment multiplied by the share of labor compensation in value added. Regarding z_i, Nunn's webpage directly provides the share of input that are relationship specific in each NAICS 1997 industry and, following the same procedure as previously described, we convert these data in NACE 4-digit classification. Throughout the paper, for each industry we consider the share of input that are neither reference priced nor sold in organized exchange as relationship-specific investment (Nunn, 2007).

Data on capital stocks and GDP per capita are from IMF and converted in 2011 US dollars; data on human capital stocks are from Penn tables Feenstra et al. (2015) and are defined as the average years of schooling for the population aged 25 or above. As a primary measure of rule of law, RL_c in equation (1), we use Kaufmann et al. (2009) to follow more closely Nunn (2007). It is a weighted average of a number of variables that measure individuals' perceptions of the effectiveness and predictability of the judiciary and the enforcement of contracts in each country. Since the previous variable starts from 2000, when we need older values of rule of law, we use an alternative commonly used proxy from Gwartney et al. (2008). Data on IP enforcement quality IPR_c are from Park (2008), an updated version of Ginarte and

https://www.census.gov/eos/www/naics/concordances/concordances.htm. Conversion from NAICS2007 to NACE is available from the Eurostat web page RAMON - Reference and Management of Nomenclatures. When the issue was many to many or one to many, to be more conservative, we have dropped that industry.

Park (1997) index, the most widely used proxy in the IPR literature. The index is updated every 5 years and ranges from 0 to 5.[10] In Table (2), we report the mean values and correlation between these variables. It is straightforward to see that the country level variables are highly correlated, but industry characteristics much less: the industry-country match can generate comparative advantage because institutional and endowment conditions affect production in different industries in alternative ways depending on characteristics of the industry.

Finally, trade flows disaggregated at HS12 6-digit level are provided by COMTRADE and available from 1989 to 2014; also in this case, data were converted to match NACE 4-digits system.[11] Overall, we have data for 82 countries, 33 OECD members and 49 non-OECD members, as specified in the Appendix.

Table 2: Means and correlations of stocks and industry variables

Country Variables	mean	correlations			
IPR 2010	3.58	1.00			
Human capital	2.14	0.817	1.00		
Physical capital	4.10	0.763	0.775	1.00	
Rule of law	0.31	0.754	0.690	0.765	1.00

Industry Variables	mean	correlations			
IP int.	9.84	1.00			
Skill int.	0.81	0.031	1.00		
Cap. int.	0.72	0.189	-0.686	1.00	
Relat. Specific	0.47	0.160	0.552	-0.367	1.00

5 Empirical Results

5.1 Raw data Analysis

To get a broad picture of the importance of institutions for comparative advantage, we start with a preliminary analysis of raw data. We compute an industry i's

[10] It is the unweighted sum of five separate scores that can take value up to one and each of them consists of several binary conditions which, if satisfied, indicate a stronger level of protection in that category. The five variables include several conditions to account for the degree of: coverage (inventions that are patentable), membership in international treaties, duration of protection, absence of risks of forfeiting the patent rights (for example, due to compulsory licensing or revocation of patents), enforcement of patent rights in case of an infringement.

[11] We match this classification with NACE system through a concordance table provided by ISTAT (Italian statistical Office). Every time the cross-walk from HS to NACE is not unique, we exclude the trade flow in that industry, but the number of excluded HS industries remain negligible.

Table 3: Average IP intensity of export and IPR protection level

	Whole sample	OECD	non-OECD
IPR	0.218**	0.367***	0.085
	(0.395)	(1.29)	(0.654)
Judicial Quality	0.240***	-0.287**	0.538***
	(0.280)	(0.025)	(0.019)
Number of obs.	82	33	49

The dependent variable is the average IP intensity of exports of each country in the first row and the average contract intensity of export in the second row. Standardized beta coefficients are reported, with robust standard errors in brackets. *** indicates significance at the 1 percent level.

share of total export in each country c and multiply it by the IP-intensity of the industry: this gives us the average IP-intensity of export by country. It is calculated as $\tilde{IP}_c = \sum \phi_{i,c} * IPint_i$, where $\phi_{i,c} = \frac{exp_{i,c}}{exp_c}$. This average IP-intensity of export is highly correlated with the IPR quality of the country, as highlighted by the significant and positive standardized beta coefficient in the first element of the first column of Table (3); if we do an equivalent exercise for rule of law and contract intensity, we also find a positive and significant relationship (second element of the first column). Hence, both institutions tend to matter for specialization and the structure of trade. More interestingly, however, if we split our sample between OECD and non-OECD countries, we find that the protection of intellectual capital is only decisive for advanced economies, whereas rule of law only matters for less developed countries. This initial evidence stresses the idea that countries at different stages of development, on average, have different production structures. OECD countries with better IPR institutions specialize and export in more innovation-oriented industries. On the other hand, the underlying mechanism that drives non-OECD countries' comparative advantages originates from contracting institutions that assure their full involvement in relation-specific investments.

5.2 Estimation results

The basic hypothesis we want to test is whether, other things equal, export volumes in IP-intensive sectors increase with the strength of IPR enforcement across countries. Table (4) shows our baseline regression. In the first column we include only our main interaction of interest, for which we have data on 231 industries and 82 countries.[12]

[12]Note that we exclude from the analysis missing observations and observations with trade value equal 0, which totals to 1466 observations. Considering positive exports implies that we implement

The estimated coefficient for the IPR interaction is positive and statistically significant. In the second column, we also include the standard factors endowments, and our main variable of interest remains positive and significant, reinforcing the essential role of IPR protection in production and exports of technologically intensive goods. Column III replicates Nunn (2007) and is consistent with its findings. The result shows that contract enforcement is a determinant of comparative advantage and drives specialization in contract-intensive industries. The fourth column is our preferred baseline specification and also hints at the growing link between institutions and comparative advantage with respect to the classic factors of human and physical capital.[13] Countries with better IPR protection and rule of law export relatively more in industries highly intensive in IP and in industries with a relatively higher share of relationship specific investments, respectively. Parallel to Maskus and Yang (2018), this result confirms that the protection of IPR is an effective tool to increase innovation and R&D, thus leading to specialization in sectors in which IP play a substantial role in the production process.[14]

an analysis conditional on a country exporting in an industry, and try to assess whether country characteristics explain the observed difference in trade performance across industries rather than the decision to enter and trade in an industry.

[13]The mitigating role of physical capital is also in line with related literature such as Levchenko (2007) or Maskus and Yang (2018).

[14]All four coefficients have very similar magnitudes in absolute terms, ranging from a 0.07 to 0.09 change in our dependent variable following a one standard deviation change in one of the interactions. Consider for example that if Brazil increases its IPR (3.44) up to the level in Mexico (3.88), that is about half S.D of the variation that we have for the Park index, this would lead to a 2% increase of exports of Brazil in pulp manufacturing industry (which is at 25 lowest percentile of IP intensity) whereas it would lead to a 53% increase in the manufacturing of computer and peripheral equipment (at the 75 lowest percentile of IP intensity).

Table 4: Determinants of Comparative Advantage: baseline specification

Variable	(I)	(II)	(III)	(IV)	(V) OECD	(VI) NON-OECD
IPR: $IPint_i * IPR_c$	0.0108***	0.0079***		0.0055***	0.0139***	0.0035
	(0.0018)	(0.0019)		(0.0019)	(0.0047)	(0.0034)
Skill: $h_i * log(H_c)$		8.361***	3.797**	3.416*	11.87***	0.852
		(1.596)	(1.780)	(1.785)	(3.875)	(2.276)
Capital: $k_i * log(K_c)$		-0.397**	-0.183	-0.293	-0.773	0.0718
		(0.196)	(0.215)	(0.220)	(0.549)	(0.315)
Nunn: $z_i * RL_c$			0.673***	0.635***	-0.387*	1.026***
			(0.108)	(0.110)	(0.207)	(0.221)
Observations:	17476	10621	7893	7893	3317	4576
R-squared:	0.740	0.778	0.780	0.781	0.766	0.704
Country FE:	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the natural log of exports in industry i by country c to all other countries. In all regressions, robust standard errors in brackets are reported. *, ** and *** indicate significance at the 10, 5 and 1 percent level.

To better understand the impact of IPR reforms or other determinants of trade, it is important to consider how institutions have differential consequences that depend on the environment in which they are is established (Maskus and Ridley, 2016; Shin et al., 2016; Campi and Dueñas, 2019). We now take a step further to conduct a comparative study to test whether the impact of institutions on the composition of trade, and therefore the source of comparative advantage, varies with country-specific characteristics.[15] Doing so allows us to understand the implications of the recent global improvements in IPR standards, and whether they have been beneficial in nurturing technological capability in developing countries. Specifically, we investigate whether there is a difference between the role played by IPR institution in determining the trade structure in innovation-oriented economies and in those with lagging technologies. We also evaluate whether contract enforcement has the same significance in R&D oriented developed countries, or if they instead have a more crucial meaning in attracting multinationals into creating valuable relationship-

[15]Maskus and Yang (2018) introduce a triple interaction multiplying the baseline IPR interaction with an indicator dummy to show that the impact is stronger for richer countries, whereas our aim is to disentangle diverse mechanisms that drive specialization for different countries.

specific outsourcing partnerships in developing countries involved in the vertical provision and hence exports of such intermediate inputs.

In columns V and VI we split the sample between OECD and non-OECD countries to account for differences in production structures, organizations, innovating capabilities and the stage of development. The results highlight how the basis of comparative advantage derives from different sources: OECD countries that are on average more developed and technologically advanced form their comparative advantage based on human capital and IPR protection level; non-OECD countries, with less advanced production processes that involve tangible assets, determine their specialization with property right protection and Nunn's channel of comparative advantage.

Production of IP-intensive goods are influenced by even smallest differences in IPR levels of OECD countries endowed with intellectual capital. This implies that the protection of intangible capital is an essential tool to stimulate innovation and increase the efficiency of producing R&D-intensive goods by preventing imitation. The result is in line with Qian (2007) that shows how IPR improvements foster innovation activities in the pharmaceutical sector conditional on a minimum level of development and human capital. As expected, also human capital endowment is an important driver of specialization within OECD countries compared to our complete sample in Table (4). The more OECD countries specialize in innovation and high-tech activities, the more they concentrate on IP-intensive production and outsource other tangible parts of the production process to non-OECD countries. This highlights the key role of contract enforcement (rule of law) in non-OECD countries as recipients of outsourcing activities. With a more specialized focus on tangible property and the production of outsourced intermediate inputs, the level of customization required in relationships and investment by suppliers takes primary importance. As argued by Nunn (2007), tangible property right protection is therefore an essential tool in inducing foreign firms to engage in business relationships in contract-intensive industries because it increases the efficiency of production by eliminating hold-up problems and sub-optimal investment by suppliers.

5.3 Robustness checks

Before interpreting our previous results as conclusive evidence of comparative advantage, we carry out a sensitivity analysis to address several potential concerns. An immediate issue that arises is the existence of other omitted determinants of comparative advantage not included in (1) that may be correlated with our main variable of interest. We implement a series of robustness checks to mitigate the possibility of the observed specialization in IP-intensive industries for OECD countries being driven by other industry features or for reasons unrelated to IPR quality. To deal with this, we control for a host of alternative determinants of trade flows that, if omitted, may bias the weight played by IPR institution in shaping the observed pattern of trade. Same reasoning applies to contract enforcement and subsequent specialization in contract-intensive industries.

In order to do so, we interact several industry characteristics with the log of income per capita to control for the possibility that, for reasons other than the protection of tangible and intangible capital, high income countries specialize production of certain industries. In particular, in columns 1 and 2 of Table (5) we include interactions of the log of income per capita with measures of the share of value-added of each industry and the TFP growth in the last thirty years in each industry. These two interactions allow for the possibility that richer countries have a comparative advantage in more lucrative and high value-added industries or in dynamic industries characterized by rapid technological progress. In column 3 and 4, we further include interactions of human and capital intensities with log of income per capita of the country, to control for the possibility that richer countries tend to specialize in industries that are more human or physical capital intensive.

In columns 5 and 6, we augment the specification by interacting IP-intensity and contract-intensity with the log of income per capita of the country to control for the possibility that richer countries tend to specialize in these industries merely because they are more developed and not specifically due to the institutional setting. In columns 7 and 8, aware of the possibility that our proxy of IP-intensity may be correlated with other (unspecified) industry characteristics, we include industry fixed effects interacted with the country's real per capita GDP. These interactions control for the possibility that richer countries tend to produce in industries whose (unknown) characteristics are correlated with IP or contract-intensity.

Overall, a pattern consistent with the results of Table (4) continues to emerge throughout all robustness checks and across different specifications.[16] Between developed countries, there are systematic effects on trade specialization depending on the stock of human capital and on the quality of IPR institution; as for developing countries, those with better rule of law export relatively more in industries that rely heavily on relationship-specific investments. Despite changes in the magnitude of our results, our main variables of interest remain significant, reinforcing the idea that

[16] In Appendix A.2, we provide a set of controls to assess the sensitivity of our main variable, IP intensity, to alternative definitions, and also the robustness of the baseline results to alternative ways of clustering.

specialization of production stems from different sources in developed and developing countries. As we will show in subsequent sections, the results are robust also to alternative specifications that allow to control for different levels of unobserved heterogeneity, such as the panel framework. These are rigorous specifications that help sweep out a great amount of additional variation that could generate omitted variable bias.

We next move to a panel set-up, which enables us to control for additional time-varying country characteristics and time dynamics. Our data span from 1999 to 2014 with 4 observations per industry-country at 5 years frequencies and estimate a specification similar to equation (1):

$$\begin{aligned} log(exp_{i,c,t}) = \alpha + \beta_1(IPint_i * IPR_{c,t}) + \beta_2(h_{i,t} * log(H_{c,t})) + \beta_3(k_{i,t} * log(K_{c,t})) \\ +\beta_4 * (z_i * RL_{c,t}) + \beta_5 * GDP_{c,t} + \delta_{i/c/t} + \epsilon_{i,c,t} \end{aligned} \quad (2)$$

Compared to the static framework, we also control for a time-variant country variable such as log of GDP per capita, $GDP_{c,t}$, that can explain changes in the overall volume of trade and level of development between countries over the years. Since sector trade is correlated within a country over time, we cluster the standard errors at industry-country level. IPR index is available at 5 years frequency, from 1995 to 2010. We restrict our attention to this time horizon because we want to focus on the post-TRIPS period. Again, we allow for some delay in the effect of an IPR policy change on the trade structure because we analyze trade flows four years after any update of the IPR index; same reasoning applies to contract enforcement.

This specification represents an effective robustness check for our cross-section analysis in section (5) by introducing also a time dimension, with the inclusion of year fixed effect and also time-varying country specific variables. In this specification, the variation that we assess is within countries across industries and over time, net of industry-specific patterns and world-wide business cycle fluctuations. The panel results are reported in Table (6). Also in this new set-up, IPR institutions are the main source of specialization for OECD countries: improvements of the protection of intellectual capital over time have systematically affected trade structure for developed countries, leading to more exports in IP-intensive sectors. We show once more that rule of law is a key determinant of comparative advantage in more contract-intensive industries for non-OECD countries. However, we can now observe that IPR institutions also start to play a marginal role when we account for variations over time.

Table 5: Robustness Checks

	Control I		Control II		Control III		Control IV	
Variable	OECD	non-OECD	OECD	non-OECD	OECD	non-OECD	OECD	non-OECD
IPR: $IPint_i * IPR_c$	0.014***	0.004	0.04***	0.001	0.009*	-0.003	0.009*	-0.003
	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)	(0.004)	(0.005)	(0.004)
Skill: $h_i * log(H_c)$	11.91***	0.671	12.06***	2.09	12.75***	2.67	12.82***	2.56
	(3.86)	(2.31)	(4.62)	(3.22)	(4.62)	(3.21)	(4.50)	(3.10)
Capital: $k_i * log(K_c)$	-1.05*	0.03	-2.19**	-2.14***	-2.13**	-2.09***	-2.15**	-2.06***
	(0.57)	(0.33)	(0.87)	(0.54)	(0.87)	(0.54)	(0.85)	(0.54)
Nunn: $z_i * RL_c$	-0.427*	1.028***	-0.467**	1.071***	-0.945**	1.529***	-0.941***	1.567***
	(0.222)	(0.226)	(0.234)	(0.234)	(0.332)	(0.273)	(0.327)	(0.265)
$VA_i * log(GDP_c)$:	7.7e-06*	7.1e-07	5.04e-06	-1.23e-06	4.99e-06	-3.50e-07		
	(4.6e-06)	(1.8e-06)	(4.74e-06)	(1.91e-06)	(4.72e-06)	(1.91e-06)		
$TFP_i * log(GDP_c)$:	-0.923	-0.356	-0.828	-0.324	-1.478	-0.142		
	(1.569)	(0.686)	(1.595)	(0.684)	(1.605)	(0.694)		
$h_i * log(GDP_c)$:			4.480**	1.490	1.770	2.377		
			(2.602)	(1.469)	(2.798)	(1.498)		
$k_i * log(GDP_c)$:			3.017***	3.579***	2.228*	3.316***		
			(1.182)	(0.690)	(1.216)	(0.7)		
$IPint_i * log(GDP_c)$:					0.016***	0.005**		
					(0.005)	(0.003)		
$z_i * log(GDP_c)$:					1.075	-0.754**		
					(0.683)	(0.241)		
Observations:	3317	4576	3,317	4576	3317	4576	3317	4576
R-squared:	0.767	0.704	0.767	0.706	0.768	0.707	0.778	0.721
Country FE:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
log(GDP)*Industry FE:	No	No	No	No	No	No	Yes	Yes

The dependent variable is the natural log of exports in industry i by country c to all other countries. In all regressions, robust standard errors in brackets are reported. *, ** and *** indicate significance at the 10, 5 and 1 percent level.

Table 6: Panel exercise

Variable	OECD	NON-OECD
IPR: $IPint_i * IPR_{c,t}$	0.0124***	0.0024*
	(0.0028)	(0.0013)
Skill: $h_{i,t} * log(H_{c,t})$	0.184	0.752
	(0.513)	(0.606)
Capital: $k_{i,t} * log(K_{c,t})$	0.046	0.103
	(0.103)	(0.125)
Nunn: $z_i * RL_{c,t}$	0.111	0.188***
	(0.097)	(0.062)
$GDP_{c,t}$:	0.597***	0.364***
	(0.203)	(0.120)
Observations:	8530	13494
R-squared:	0.768	0.704
Country FE:	Yes	Yes
Industry FE:	Yes	Yes
Time FE:	Yes	Yes

The dependent variable is the natural log of exports in industry i by country c to all other countries in year t. The panel data have a 5-years frequency and time ranges from 1999 to 2014. In all regressions, standard errors are clustered at industry-country level. *, ** and *** indicate significance at the 10, 5 and 1 percent level.

6 IPR Reforms

Another concern besides omitted variables that invites caution when interpreting the results is the possibility that causality runs from trade flows to IPR quality. If so, the previous results would be generated by countries that specialize in IP-intensive industries having greater incentives to develop and maintain an effective system to protect intellectual capital. Although previous research has pointed toward total trade volumes affecting the development of political, economic, and legal institutions (Acemoglu et al., 2005), the question whether comparative advantage can also affect institutions is less touched upon in the literature.[17] As the variable of interest is not at the country level, e.g. GDP, but at the disaggregated industry level, it appears less likely that a single industry can affect the institutional quality at country level. Nunn (2007) and Costinot (2009) have dealt with the presence of endogeneity regarding rule of law institutions, and Ivus (2010), Delgado et al. (2013), and Maskus and Ridley (2016) argue that the TRIPS agreement has exogenously imposed new global standards of IPR protection. While considering post-TRIPS IPR levels as exogenous may seem adequate for developing countries, it seems less reasonable if the focus is on developed countries, which were the advocates of the agreement. We thus try to address the reverse causality issue regarding IPR institutions in a more rigorous manner, exploiting a series of IPR reforms both as an IV and in a diff-in-diff set-up.[18]

The literature on IPR has extensively used a series of reforms that changed drastically the legal systems surrounding the protection of Intellectual Properties. These events have been carefully analyzed by Park (2008), who have studied the evolution of the legal systems across countries and identified specific episodes of significant changes in the legal framework protecting IP. The time span of these reforms have been expanded and documented in Ivus et al. (2017) and employed in subsequent works such as Ivus and Park (2019).

For the purposes of this section, we move to an unbalanced panel setting in which we follow the export performance of each country in a given industry over the years. In the first exercise, following Branstetter et al. (2006), Manova (2008), Delgado et al. (2013) and several other contributions, we implement a generalized diff-in-diff approach to assess how IPR changes affect the pattern of trade for a country. We estimate the following regression:

$$\begin{aligned} log(exp_{i,c,t}) = \alpha + \beta_1 * reform_{c,t} + \beta_2(IPint_i * reform_{c,t}) + \beta_3(h_{i,t} * H_{c,t}) \\ + \beta_4(k_{i,t} * K_{c,t}) + \beta_5(z_i * RL_{c,t}) + \beta_6 * GDP_{c,t} + \gamma_i + \gamma_c + \gamma_t + \epsilon_{i,c,t} \end{aligned} \quad (3)$$

We consider now yearly observations, from 1989 to 2015; reform is a binary variable equal 1 in the year of reform and all years afterwards, 0 otherwise. Since it is a time varying country measure, we can include it and its effect is not washed out neither by the country nor year fixed effects.[19] Standard errors are clustered at industry-country

[17]An example for such mechanism is Do and Levchenko (2009), who show that comparative advantage affects financial development: country's specialization affects its demand for external financing, which, in turn, affects subsequent financial development.

[18]Recall that throughout our analysis we also lag the IPR interaction term by four years with respect to trade flows that we study.

[19]Note that Nunn's interaction term varies at lower frequency than the dependent variable and

level to allow for correlation over time of an industry in a country.[20] The main effect of a legal reform - β_1 - is thus identified purely from the within-country variation over time. The coefficient of interest is β_2, which express the differential impact of IPR reforms across industries depending on their IP intensity. We expect the reform to have a stronger impact on the trade performance of IP intensive sectors compared to less IP intensive sectors, since the former are more directly affected by the consequences of the reform. In addition, the result should hold only for OECD countries. In this dynamic analysis, the identification of our main interaction of interest, and similarly for other interaction terms, comes from the combination of cross-countries and time-series variation in IPR protection status across countries and cross-industry variation in IP-intensity.

The exercise, reported in Table 7, shows that deep and exogenous legal change in the protection of IP increased exports disproportionately more in sectors intensive in IP assets only in OECD countries, suggesting that pre-reform limited IPR protection was a constraint in those countries-industries and that higher quality standards does indeed trigger a systematic change in export patterns, becoming a source of comparative advantage. Conversely, in line with the results from Section 5, changes in the protection system of Intellectual Properties are not sufficient to trigger improvements in the export performance of developing countries.

As a second strategy, we exploit these major IPR reforms as instruments for IPR quality. What is essential for us is that these episodes can be used as instruments because they can be considered as exogenous events and provide a random variation in today's IPR levels. To conduct this exercise, we consider a panel set-up from 1989 to 2014 with five-year intervals for each industry-country observation. This choice was driven by the fact that the Park index is updated every 5 years. We introduce a dummy for IPR reform that is equal to one starting from the first interval after which the reform occurred onwards.[21] It is a time-varying country variable that explains part of the variation in trade volume across time. Also in this case, we allow lags for changes in the IPR protection system to have some effects on the trade structure because trade flows of 1989 are regressed on IPR reform of 1985 and so on. In addition, since we are working with a dynamic specification, we include the log of GDP in the regression. To control for serial correlation in the export performance of

other explanatory variables. The results on our main coefficient of interest, IPR interaction, are unaffected by the inclusion of this variable.

[20]The main results are robust to the use of clusters at country level.

[21]For example, all the countries that experienced a reform between 1982 and 1985 will have the dummy IPR reform equal one from 1985 onwards, and all the countries that underwent a reform between 1986 and 1990 will have the dummy IPR reform equal to one from 1990.

Table 7: IPR reforms

Variable	All Sample	OECD	NON-OECD
$IPR\ reform_{c,t}$	-0.144***	-0.123***	-0.0770**
	(0.0196)	(0.0208)	(0.0308)
IPR: $IPint_i * IPR\ reform_{c,t}$	0.00428***	0.00690***	0.00104
	(0.00098)	(0.00108)	(0.00134)
Skill: $h_{i,t} * log(H_{c,t})$	1.562***	0.434	0.00124
	(0.349)	(0.422)	(0.469)
Capital: $k_{i,t} * log(K_{c,t})$	-0.123	0.0876	0.0492
	(0.0710)	(0.0845)	(0.0957)
Nunn: $z_i * RL_{c,t}$	0.375***	0.392***	0.218***
	(0.0292)	(0.0557)	(0.0333)
$GDP_{c,t}$:	0.748***	1.403***	0.540***
	(0.0761)	(0.155)	(0.0902)
Observations:	150074	61075	88999
R-squared:	0.782	0.756	0.686
Country FE:	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes
Year FE:	Yes	Yes	Yes

The dependent variable is the natural log of exports in industry i by country c to all other countries in year t. It is a panel exercise with yearly observations, running from 1989 to 2015. IPR reform is a dummy taking value equal one in countries that experienced a structural reform of the protection of intangible capital from the year of the reform afterwards. In all regressions, standard errors are clustered at country-industry level. *, ** and *** indicate significance at the 10, 5 and 1 percent level.

an industry in a given country, we cluster at country-industry level.[22]

In the first stage, we regress our variable of interest, IPR interaction, on the dummy IPR reform interacted with IP intensity at industry level, including again the variables described in the baseline specification (equation 1) plus year fixed effect since we now have a time dimension available. The instrument, which exploits the different timing of reforms across countries, is highly significant and strongly related to IPR values. We then use the predicted values from this first stage, $I\tilde{P}R$ interaction, as explanatory variable in the second stage. The IV is relevant, as highlighted by the statistics at the bottom of Table (8), which are all above the critical values. The test for weak instrument rejects the null hypothesis and so we can conclude that reforms are a strong instrument.[23] The results in Table (8) show that also the instrumental approach confirms our main hypothesis about the importance of IPR institutions as a key determinant of comparative advantage only for OECD countries. Overall, we believe that the emergence of a consistent and stable pattern mitigates the concerns on reverse causality.[24]

7 Technology Transfer

7.1 Imports

We have just shown that the recent improvements of IPR and the global harmonization of such standards have neither helped developing countries to boost their innovation and R&D nor had any impact in their export structure. Are there any other channels through which these reforms can bring trade-related beneficial consequences for these countries, for example by technology transfer through imports? In this section we look at the other direction of trade and assess how import patterns could be affected by IPR quality. We employ the same methodology represented by equation (1) that guarantees a systematic study of cross-industry and cross-country differences in the

[22]The results are unaffected when using robust standard errors and clustering at the level of the exporting country.

[23]To implement the instrumental variable approach, the Stata routine ivregress 2sls has been applied, In addiion, the post-estimation commands first and weakivtest have been used to compute the statistics in the second part of Table (8).

[24]In addition, we have implemented two further exercises. In Appendix A.3 we use IPR quality level in 1960 to instrument today's IPR values. Also, we replicated both the exercises reported in this section using a series of reforms identified by Branstetter (2006), confirming the results obtained using the reforms identified by Park (2008). We decided to focus on the reforms identified in the latter source because it provides information on a much larger set of countries, allowing for a separate analysis between OECD and NON OECD countries, which is the main interest of the paper.

Table 8: IV Estimation

Second Stage	All Sample	OECD	NON-OECD
$IPR\ reform_{c,t}$	-0.0444	0.0399	-0.0927
	(0.0588)	(0.0850)	(0.0967)
IPR: $IPint_i * IPR\ reform_{c,t}$	0.00195*	0.00544***	-0.000877
	(0.00106)	(0.00165)	(0.00166)
Skill: $h_{i,t} * log(H_{c,t})$	1.432*	0.0117	0.269
	(0.829)	(0.946)	(1.060)
Capital: $k_{i,t} * log(K_{c,t})$	-0.151	-0.0549	0.123
	(0.175)	(0.218)	(0.244)
Nunn: $z_i * RL_{c,t}$	0.501***	0.567***	0.329***
	(0.0806)	(0.149)	(0.114)
$GDP_{c,t}$:	0.611	0.623	0.382
	(0.383)	(1.103)	(0.373)
Observations:	31483	13090	18393
R-squared:	0.777	0.749	0.683
Country FE:	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes
Year FE:	Yes	Yes	Yes
First stage:			
$IPR_c \cdot IPint_i$:	1.4522***	1.3028***	1.2115***
	(0.07525)	(0.13054)	(0.10122)
Weak IV test:	367.9	96.69	40.82

The dependent variable in the second stage is the natural log of exports in industry i from country c to all other countries. It is an unbalanced panel exercise with five observations for each country-industry, running from 1989 to 2014. The first stage dependent variable is the interaction term between IP intensity at industry level and IPR reform dummy. Then, we use the predicted values, $\tilde{IPR}$ interaction, in the second stage. The bottom part of the table reports the coefficient of the IV from the first stage, together with the values of the F-test resulting from the first stage and the endogeneity test. All explanatory variables in the second stage are also included in the first stage, but to conserve space we only report the first stage coefficients for the instrumental variable. In all regressions, standard errors are clustered at country-industry level. *, ** and *** indicate significance at the 10, 5 and 1 percent level. In the IV exercise with IPR reforms, there are six observations for each industry-country variable, from 1989 to 2014 with five years of frequency.

sensitivity of import patterns to IPR quality.

The baseline result of our complete sample of countries is presented in column 1 of Table (9).[25] The findings are in line with IPR literature because it stresses how good institutions are an effective tool to increase imports, especially in industries where IP is used intensively and the risk of imitation is high. In other words, IPR protection could stimulate technology transfer. Once we split our sample into developed and developing countries, we find the sharp result that IPR institutions only affect the import structure of non-OECD countries: multinationals are concerned about exporting IP-intensive goods to developing countries with weak IPR enforcement, and use the latter as a critical factor to decide whether to enter those market. To this regard, it seems that stricter enforcement of IPR across developing countries has been beneficial because it has led to the arrival of more technologies and intangible capital into these countries. Developed countries with already high standards, on the other hand, are not perceived as a threat, hence their differences in imports across industries are not driven by IPR quality.

These findings show that the quality of IPR institutions has opposite effects on the pattern of trade based on the stage of development: for developed countries it helps boost R&D, innovation and the production in IP-intensive industries, thus leading to more export in these sectors; for developing countries it attracts imports of IP-intensive goods. In other words, what we found to be a source of comparative advantage for OECD countries also explains an opposite trade pattern in non-OECD countries: IPR protection stimulates trade in IP-intensive industries from developed to developing countries, motivating the next section of our analysis on bilateral trade.

7.2 Bilateral Trade Flows

We now move to data on bilateral trade flows, which allows us to augment the baseline exercise with gravity controls and reassess our findings in a more demanding specification.[26] Perhaps more important for our purposes, a bilateral framework makes it possible to conduct a deeper comparative analysis by further breaking up trade patterns for different countries and exploiting information for both sides of trade. In particular, we compare the exporting behavior of an OECD country with respect to a non-OECD country, and take the analysis at a more disaggregate level

[25]We have replicated the robustness checks implemented for exports above also for import flows, and all the results are confirmed qualitatively. The result is confirmed also clustering at country level, industry level and two-way clustering at country and industry level.

[26]See Chor (2010) and Cai and Stoyanov (2016) for a bilateral set-up of our original baseline framework.

Table 9: IPR quality and the pattern of imports

Variable	Whole sample	OECD	NO-OECD
IPR: $IPint_i * IPR_c$	0.0040***	-0.0006	0.0090***
	(0.0008)	(0.0020)	(0.0017)
Skill: $h_i * log(H_c)$	-0.991	5.020***	-1.378
	(0.824)	(1.869)	(1.043)
Capital: $k_i * log(K_c)$	-0.355***	-0.034	-0.298**
	(0.103)	(0.287)	(0.146)
Nunn: $z_i * RL_c$	0.330***	0.149	0.216*
	(0.057)	(0.108)	(0.123)
Observations:	8274	3332	4942
R-squared:	0.848	0.888	0.797
Country FE:	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes

The dependent variable is the natural log of import in industry i of country c from all other countries. In all regressions, robust standard errors in brackets are reported. *, ** and *** indicate significance at the 10, 5 and 1 percent level.

by observing whether or not the importing country belongs to OECD.

We run the following regression:

$$\begin{gathered} log(exp_{i,c,p}) = \alpha + \beta_1(IPint_i * IPR_c) + \beta_2(IPint_i * IPR_c * IPR_p) \\ +\beta_3(h_i * log(H_c)) + \beta_4(k_i * log(K_c)) + \beta_5 * (RL_c * z_i) + \delta_i + \delta_c + \delta_p + \delta_{c,p} + \epsilon_{i,c,p} \end{gathered} \tag{4}$$

where now $log(exp_{i,c,p})$ represents the natural log of exports in industry i from country c to its partner p. In this new framework, we augment the baseline model (1) to include importer country fixed effects δ_p and also country pair-wise fixed effects $\delta_{c,p}$ that should control for all the standard gravity controls. We cluster standard errors at exporter-industry level to allow for correlated shocks in the export performance of specific industries across several destination markets, but clustering at exporter level leaves the results unchanged.

The bilateral analysis is key because we have shown that IPR institutions play a role on both sides of a trade transaction, as they affect the pattern of trade both for the origin and the destination country. It allows us to combine these predictions in a more comprehensive manner as we can directly assess the impact of IPR institution of an importing country on the export patterns of its trading partner. We would expect more trade in IP-intensive industries not only with higher IPR quality of the exporting country, but also that of the importing country since in some cases better institutions serve as an important tool to attract intangible capital. We therefore introduce a triple interaction $IPint_i * IPR_c * IPR_p$ in our specification that takes into account also the IPR strength in the importing country and tells us whether or not the effects of the baseline IPR interaction are stronger for higher quality IPR in the destination. Considering the findings in previous sections, we expect the triple interaction to not play a role when the importing country is an OECD country, whereas it should be an important determinant of trade flows when the importing country belongs to the non-OECD group.

The results are reported in Table (10) and are consistent with all our previous findings, controlling also for importer country fixed effects and pair-wise country fixed effects. Our main interest lies in the sign of the triple interaction, to highlight the effect of IPR quality of the importing country on the export pattern of other countries. As expected from the aggregate import analysis, the composition of imports is affected by IPR policy in a developing country because multinational firms, particularly technology-oriented ones, require certainty with regards to the protection of their intangible capital before exporting to that market. This is especially true when flows to a developing country originate from a developed country as these transactions on average involve a higher content of technology, the stronger is the IPR regime in the exporting country. Nevertheless, importing country IPR also shifts the balance of trade between non-OECD countries toward more IP-intensive transactions. As expected, the triple interaction terms in which the importing country is a developed nation are not different from zero as entering these markets is not perceived as a threat for foreign firms due to strong IPR.

So far, our analysis has shed light on the positive effects of IPR improvements on trade in IP-intensive industries both for developed and developing countries, in one case affecting export patterns and in the other through imports. A final important consideration for a complete picture of the effects of upgrading global IPR standards is to study whether the resulting technology transfer has helped its recipients build the necessary absorptive capacity and shift their comparative advantage to innovative activities. This is the topic of our last section.

8 Conclusion

Recent contributions in trade literature have emphasized the role of institutions as a source of comparative advantage. In particular, IPR protection and rule of law have been shown to systematically affect the patterns of trade. We provide an empirical assessment of how these different legal institutions shape the patterns

Table 10: Bilateral Trade Flow analysis

Variable	(I) O-O	(II) O-NO	(III) NO-O	(IV) NO-NO
IPR: $IPint_i * IPR_c$	0.0236***	0.0211***	0.0077	0.0043
	(0.005)	(0.004)	(0.004)	(0.0034)
Triple interact: $IPint_i * IPR_c * IPR_p$	0.0003	0.0010***	0.0005	0.0011**
	(0.0002)	(0.0002)	(0.0006)	(0.0004)
Skill: $h_i * log(H_c)$	11.80**	12.99**	2.96*	3.76**
	(4.194)	(3.349)	(1.664)	(1.665)
Capital: $k_i * log(K_c)$	0.162	-0.285	1.073***	0.589**
	(0.561)	(0.500)	(0.300)	(0.263)
Nunn: $z_i * RL_c$	-0.444**	0.135	1.139***	0.726***
	(0.202)	(0.165)	(0.206)	(0.185)
Observations:	67641	83040	44237	47271
R-squared:	0.650	0.580	0.507	0.469
Exporting Country FE:	Yes	Yes	Yes	Yes
Importing Country FE:	Yes	Yes	Yes	Yes
Pair-wise Country FE:	Yes	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes	Yes

The dependent variable is the natural log of export in industry i from country c to country i. In all regressions, standard errors are clustered at industry-exporter country level and are reported in brackets. *, ** and *** indicate significance at the 10, 5 and 1 percent level. A constant term is included but not reported. Each column refers to a different sample, identified in the first row. O refers to OECD countries, NO to non-OECD; the first letter(s) identifies the exporting country, the second letter(s) the importing country.

of specialization depending on the level of economic development. We split the sample to perform a parallel analysis for OECD and non-OECD countries. We find that in OECD countries better IPR institutions drive exports in IP-intensive industries, whereas rule of law is a determinant of exports in institutionally dependent industries for non-OECD countries. This finding is consistent with the evidence that developed countries possess the initial intellectual capital necessary to engage in innovation activities; on the contrary, rule of law in developing countries that predominantly host foreign outsourced activities attract contracts for the production of relationship-specific inputs that are exported upon completion. After a preliminary cross-sectional analysis followed by related robustness checks and a panel set-up to control for additional dimensions of unobserved heterogeneity, we further test the validity of our results using IPR reforms both as an instrumental variable and in a difference-in-difference framework.

Implementing a symmetric framework to examine import flows reveals a different potential role for IPR institutions in developing countries. The findings provide evidence that better IPR institutions allow non-OECD countries to attract the technology embodied in IP-intensive goods by protecting foreign firms' intangible assets. Given that our study stresses the importance of IPRs for both export and import patterns, we supplement the predictions with a bilateral trade setting and reveal a complementarity between the role of IPRs in determining OECD exports and non-OECD imports of technology-intensive goods. Domestic IPRs lead OECD countries to specialize in IP-intensive industries and destination IPRs direct the trade of these goods towards non-OECD locations with strong IPR institutions. Progresses made in enhancing the IPR regime could thus be a driver of technology diffusion to developing countries as a first episode of specialization in IP-intensive sectors. An avenue of future research is to investigate whether with time this could eventually lead to a reversal in their source of comparative advantage, making IPR reform a relevant institutional feature to induce domestic innovation.

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A Appendix

A.1 List of Countries and the Year of IPR Reform

OECD countries	non-OECD countries
Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, South Korea, Slovakia, Spain, Sweden, Switzerland, Turkey, USA, United Kingdom	Algeria, Angola, Argentina, Bolivia, Botswana, Brazil, Bulgaria, Burundi, Cameroon, China Colombia, Congo, Costa Rica, Cyprus, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Fiji, Guatemala, Honduras, India, Jamaica, Jordan, Madagascar, Malawi, Malaysia, Malta, Mauritius, Nepal, Nicaragua, Pakistan, Panama, Paraguay, Peru, Russia, Rwanda, Singapore, South Africa, Sri Lanka, Tunisia, Uganda, Ukraine, Tanzania, Uruguay, Vietnam, Zambia, Zimbabwe

Table 11: Robustness exercise on IP-intensity

Variable	OECD	NON-OECD
$IPR_c * patents$:	0.0129***	0.0036
	(0.0047)	(0.0038)
$IPR_c * trademarks$:	0.0252*	0.0050
	(0.0136)	(0.0902)
$IPR_c * I_{IPdummy}$:	0.380**	0.141
	(0.167)	(0.114)
Country FE:	Yes	Yes
Industry FE:	Yes	Yes

The dependent variable is the natural log of exports in industry i by country c to all other countries. In all regressions, robust standard errors in brackets are reported. *, ** and *** indicate significance at the 10, 5 and 1 percent level. Each row of the Table represent an alternative estimate of our main interaction of interest $IPR_c * IPint$. In addition, even if not reported, each regression includes all the other variables specified in equation (1).

A.2 Sensitivity of the IP-intensity Measures

In this section, we propose some additional checks to validate the baseline results reported in Table 4.

First of all, we provide a further set of controls to address the sensitivity of our main variable, IP-intensity, to the use of alternative specifications. More specifically, regarding the IP-intensity measure, we first replicate our baseline specification including only the contribution of either patents or trademarks. Then, more important, in the spirit of Branstetter et al. (2006), Ivus (2010), Branstetter et al. (2011), and Delgado et al. (2013), we split the overall IP intensity in high and low IP intensity with the use of a dummy to distinguish between industries above and below the median value. Table 11 illustrates these results and shows that they are unaffected when using these alternative definitions of IP intensity.

Then, in Table 12 we show that the baseline results reported in Table 4 are robust to alternative ways of clusteting. In particular, the results remain significant, despite with lower statistical power, using respectively country, industry and two ways clustering at country and industry level.

Table 12: Robustness to alternative clustering

	Country		Industry		Country and Industry	
Variable	OECD	non-OECD	OECD	non-OECD	OECD	non-OECD
IPR: $IPint_i * IPR_c$	0.014*	0.004	0.014***	0.004	0.014*	0.004
	(0.00765)	(0.00398)	(0.0042)	(0.00302)	(0.00718)	(0.00358)
Skill: $h_i * log(H_c)$	11.87**	0.852	11.87**	0.852	11.87*	0.852
	(4.775)	(3.871)	(5.290)	(2.399)	(5.870)	(3.875)
Capital: $k_i * log(K_{c,})$	-0.773	0.0718	-0.773	0.0718	-0.773	0.0718
	(0.929)	(0.624)	(0.581)	(0.412)	(0.928)	(0.666)
Nunn: $z_i * RL_c$	-0.387	1.026**	-0.387	1.026***	-0.387	1.026**
	(0.374)	(0.413)	(0.290)	(0.278)	(0.417)	(0.439)
Observations:	3317	4576	3317	4576	3317	4576
R-squared:	0.766	0.704	0.766	0.704		
Country FE:	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the natural log of exports in industry i by country c to all other countries. In the first two columns, standard errors are clustered at exporting country level, in the following two columns, at industry level, and in the last two column, two ways clustering at country and industry level are applied. *, ** and *** indicate significance at the 10, 5 and 1 percent level.

A.3 Alternative Instrumental Variable: Historical IPR Data

We propose a further IV strategy to address the concern on reverse causality. We exploit historical IPR protection values that are highly correlated to today's values. Because each country's quality of IPR in 1960 is pre-determined and unaffected by trade flows in 2014, it can be a candidate to isolate exogenous variation in today's quality of IPR institutions. At the same time, the instrument is highly related to our potentially endogenous variable, given the persistency in the quality of institutions across countries. In particular, we regress $IPR_{c,1960} \cdot IPint_i$ on $IPR_{c,2010} \cdot IPint_i$, and used the predicted values $I\tilde{P}R$ as main explanatory variable for the second stage. All additional variables specified in equation 1 are included in the first and second stage.[27] The instrument is relevant when we look at the all sample and for OECD countries, as highlighted by the statistics at the bottom of Table (13), which are all above the critical values, suggesting that old IPR values are a valid instrument for developed countries. The IV coefficient is positive and statistically significant for the all sample and OECD countries, providing support for the importance of IPR institution in shaping comparative advantage and mitigating the potential positive feedback effect that trade might have on IPR enforcement.

[27] In this way we control for possible influences that IPR protection in 1960 could have had on trade values other than through its direct effect on IPR protection level in 2010. In fact, a possible concern for the validity of this instrument is that IPR quality in 1960 may also affect comparative advantage through channels other than IPR quality in 2010, not satisfying the exclusion restriction. For example, IPR in 1960 can be related to other country characteristics, such as GDP, that may have a direct impact on trade flows, see Ginarte and Park (1997) and Chen and Puttitanun (2005).

Table 13: IV Estimation

Second Stage	All Sample	OECD	NON-OECD
$\tilde{IPR}$: $IPint_i * IPR_c$	0.00836***	0.0241**	0.00816
	(0.00297)	(0.0101)	(0.0214)
Skill: $h_i * log(H_c)$	3.539*	12.98***	0.412
	(1.879)	(4.139)	(2.554)
Capital: $k_i * log(K_c)$	-0.300	-1.107	0.128
	(0.228)	(0.746)	(0.405)
Nunn: $z_i * RL_c$	0.615***	-0.522**	1.037***
	(0.115)	(0.228)	(0.239)
Observations:	7086	2812	4274
R-squared:	0.772	0.771	0.671
Country FE:	Yes	Yes	Yes
Industry FE:	Yes	Yes	Yes
Year FE:	Yes	Yes	
First stage:			
$IPR_{c,1960} \cdot IPint_i$:	0.61443***	0.33323***	0.1489
	(0.06923)	(0.0398)	(0.12407)
Weak IV test:			
Effective F-statistic	80	75	1.5

The dependent variable in the second stage is the natural log of exports in industry i from country c to all other countries. The first stage dependent variable is the interaction term between IP intensity at industry level and IPR protection quality in 1960. Then, we use the predicted values, $\tilde{IPR}$ interaction, in the second stage. The bottom part of the table reports the coefficient of the IV from the first stage, together with the values of the F-test resulting from the first stage and the endogeneity test. All explanatory variables in the second stage are also included in the first stage, but to conserve space we only report the first stage coefficients for the instrumental variable. *, ** and *** indicate significance at the 10, 5 and 1 percent level.