The international platform of Ludwig-Maximilians University's Center for Economic Studies and the Ifo Institute

Working Papers

www.cesifo.org/wp

Intellectual Property Rights, Product Complexity, and the Organization of Multinational Firms

Alireza Naghavi
Julia Spies
Farid Toubal

CESIFO WORKING PAPER NO. 4430
CATEGORY 8: TRADE POLICY
OCTOBER 2013

An electronic version of the paper may be downloaded
- *from the SSRN website:* *www.SSRN.com*
- *from the RePEc website:* *www.RePEc.org*
- *from the CESifo website:* *www.CESifo-group.org/wp*

CESifo
Center for Economic Studies & Ifo Institute

CESifo *Working Paper No. 4430*

Intellectual Property Rights, Product Complexity, and the Organization of Multinational Firms

Abstract

This paper studies how the Intellectual Property Right (IPR) regime in destination countries influences the way multinationals structure the international organization of their production. In particular, we explore how multinationals divide tasks of different complexities across countries with different levels of IPR protection. The analysis studies the decision of firms between procurement from related parties and from independents suppliers at the product level. It also breaks down outsourcing into two types by distinguishing whether or not they involve technology sharing between the two parties. We combine data from a French firm-level survey on the mode choice for each transaction with a newly developed complexity measure at the product level. Our results confirm that firms are generally reluctant to source highly complex goods from outside firm boundaries. By studying the interaction between product complexity and the IPR protection, we obtain that (i) for technology-sharing-outsourcing IPRs promote outsourcing of more complex goods to a destination country by guaranteeing the protection of their technology, (ii) for non-technology-related-outsourcing IPRs attract the outsourcing of less complex products that are more prone to reverse engineering and simpler to decodify and imitate.

JEL-Code: F120, F230, O340.

Keywords: outsourcing, product complexity, intellectual property rights, technology sharing.

*Alireza Naghavi**
University of Bologna
Department of Economics
Piazza Scaravilli 2
Italy – 40126 Bologna
alireza.naghavi@unibo.it

Julia Spies
International Trade Centre
Geneva / Switzerland

Farid Toubal
Department of Economics
Ecole Normale Supérieure de Cachan
61, avenue du Président Wilson
France - 94235 Cachan cedex
ftoubal@ens-cachan.fr

*corresponding author

September 22, 2013
Research for this paper was partially funded by the European Community's Seventh Framework Programme (Project INGINEUS, Grant Agreement No. 225368, www.ingineus.eu). The authors alone are responsible for its contents which do not necessarily reflect the views or opinions of the European Commission, nor is the EC responsible for any use that might be made of the information appearing herein. The same holds for the International Trade Centre. We are grateful for valuable comments from two anonymous referees that helped us improve the paper substantially. We also thank the participants at the 2013 Conference of the Canadian Economic Association in Montreal for useful feedback.

1 Introduction

In a global survey of senior executives conducted by the Economist Intelligence Unit, 84 percent of all respondents state that they perceive the lack of Intellectual Property Rights (IPRs) protection in emerging markets as a challenge when outsourcing their R&D (The Economist Intelligence Unit Report, 2004). This qualifies IPR protection as the biggest challenge of globalized R&D among all factors listed. Yet, we continue to see actions and decisions by top managers of successful enterprises that contradict these figures. An example is Apple, the company known for boasting that its machines are "made in the USA". In 2007, it decided to outsource the production of its unscratchable glass for iPhones and iPads, to a plant in China. Today, "almost all of the 70 million iPhones, 30 million iPads and 59 million other products Apple sold last year were manufactured overseas" (New York Times, 21 January 2012). Apple's shift, or better revolution, in its organizational approach has drawn a great deal of curiosity in the business world. The company is said to be breaking a taboo by outsourcing and transferring its intellectual property to competitors and countries that offer little protection. Are IPRs truly essential to outsourcing decisions, and if so how do they influence the organizational mode through which multinational firms source inputs?

The aim of this research is to take a step in understanding the equivocal connection between IPRs and outsourcing by breaking down products into different levels of complexity and outsourcing into two types by distinguishing whether or not they involve technology sharing between the two parties. A series of influential papers on firm organization highlight the choice faced by firms between purchasing from an affiliate or from an independent supplier, where the latter gives rise to a hold-up problem when contracts are incomplete (see Antràs and Helpman, 2004, 2008 among others). The availability of firm-level data has pushed the literature forward to study the concept of heterogeneity not only among firms, but also in terms of products or tasks embedded in their production. Grover (2007) interacts the intensity of the sourced input with technology transfer costs and shows that the results from Antràs and Helpman (2004, 2008) only hold for a certain range of technological complexity of the input. More in line with our approach, Costinot et al. (2011) reinterpret the source of contractual frictions as arising from the non-routineness of tasks. Since these cannot be fully specified ex-ante, ex-post adaptation becomes necessary. Due to better communication and less opportunistic behavior among affiliated parties, outsourcing only takes place for tasks below a certain complexity threshold. Focusing on the relation between technology and the outsourcing decision, the message is clear: higher technology complicates the relation with the supplier and makes it optimal to vertically integrate.

Despite the clear findings on the relation between outsourcing and technological complexity, the role of IPR protection as a determinant of outsourcing upper parts of the value chain has attracted little attention in the economic literature. Indeed, Antràs and Rossi-Hansberg (2009) suggest that past literature has focused too much on hold-up inefficiencies as the main drivers of the internalization decision and underline the importance of the effects of the non-appropriable nature of knowledge on the internalization decision of firms. Does the IPR regime play the same institutional role as contractual enforcement when outsourcing goods embodied with more complex tasks? A limited number of earlier studies have investigated the impact of IPR protection on outsourcing (see e.g. Glass, 2004). This branch of literature, however, treats imitation in the destination country as an equal threat for all goods and is therefore only testable at the aggregate level. This makes it impossible to study the interaction between IPR protection and task complexity as a determinant of the organization of multinationals.

This paper tries to fill in this gap by studying how the IPR regime influences the way multinationals structure the international organization of their production. In particular, it sheds light on how multinationals divide tasks of different complexities across countries with different levels of IPR protection. A multinational active in a given country can choose to source an intermediate good from a related party or from independent suppliers. The outsourcing contract could be an alliance that involves technology sharing, or pure procurement of parts from a supplier. In contrast to the existing studies, we depart from the hold-up problem and emphasize the role of the prevailing IPR regime in the destination country in multinationals' international portfolio of tasks. We test existing theoretical explanations to see whether multinationals are induced to keep technologically complex tasks in the circle of related parties within firm boundaries. Moreover, we check whether a stronger IPR regime in a given country encourages a multinational to procure its intermediates from a foreign independent supplier.

But does a stronger IPR regime in a destination country encourage multinationals to outsource more complex tasks to foreign independent suppliers? The response is not obvious. Intermediates requiring more complex tasks are more difficult to copy and reproduce and therefore create less infringement concerns. We therefore expect IPR protection to be more crucial for outsourcing of less complex (easily imitable) goods. A firm can however still lose delicate information and profits when it intentionally shares complex technologies with its partner and IPR protection is low or absent. In this case intermediates containing a more complex technology are especially sensitive as they are more valuable and hence associated with a larger loss if imitated. IPR protection here mitigates imitation risk and promotes outsourcing of more complex goods. To test the validity of the above channels, we study the interaction between the IPR regime in a destination country and the complexity of tasks required in the production of intermediates in determining the decision of multinationals on the organization of their production. Evidence on the two opposing effects of complexity on the need for IPR protection was first introduced in Mansfield (1994) who surveyed 100 major US firms with international operations in 1991. He suggested that although more technologically sophisticated industries place a larger emphasis on IPRs, those that require complex inputs are self-protected from imitation and may therefore be unaffected by IPRs.

We empirically examine the choice between intra-firm trade and outsourcing by combining firm-level data on the mode choice for each transaction with a newly developed complexity measure at the product-level. The complexity of a product group is derived by merging three different data sets, (i) ratings of occupations by their intensities in 'problem solving' from the U.S. Department of Labor's Occupational Information Network, (ii) employment shares of occupations by sectors from the Bureau of Labor Statistics Occupational Employment Statistics and (iii) French make tables from Eurostat. The firm-level data comes from a French survey which provides information on import transactions at the product-level of multinational firms and their sourcing mode by country. This information is merged with balance sheet and income statement data from which we compute firm-level productivity. The French data has the advantage of dealing with firms that are part of a multinational network. This allows us to explore the decision of firms with a related party in a given country whether or not to acquire their different inputs from foreign outside suppliers. We argue that this choice is influenced by the complexity level of the tasks involved in the production of the sourced products and the IPR regime in the destination country. Conceptually, such data allows us to study how IPRs affect each firm differently rather than the widely studied hypothesis that there are fewer arms-length transactions in countries with weak IPRs.[1]

In line with the previous literature, our baseline results suggest that multinationals tend to outsource less complex inputs from foreign independent suppliers. These findings confirm that firms are generally reluctant to source highly complex inputs from outside firm boundaries. The level of IPRs however does not affect the outsourcing share of inputs with an average level of complexity. We then analyze the interaction between IPR protection and product complexity and find that more complex tasks mitigate the need for IPRs when outsourcing to independent suppliers. Firms tend to outsource more

[1]The disaggregated data allows us to study the outsourcing decision of a multinational for products (inputs) of different complexities rather than a single general dichotomous decision at the entire firm level.

complex products in countries with relatively less stringent IPR regimes as complexity itself provides a shelter against reverse engineering of goods that are simpler to decodify and imitate. This provides an explanation for the recent behavior by Apple with respect to the outsourcing of some of its most complex tasks to countries with poor records of IPR enforcement.

Using the information on the sample of transactions from external suppliers for a more in-depth study of the interaction between product complexity and the IPR protection in the destination country, we next look at the type of outsourcing to see whether sharing information on technology has an impact on the outsourcing behavior of firms. Confirming the baseline results, we find a negative and significant interaction term in the sample of outsourced imports from external suppliers without technology sharing. The share of outsourcing of more complex inputs is therefore larger in countries with lower levels of IPRs because of the lower imitation possibilities. We however find a positive interaction term in the sample of transactions that require technology sharing. The share of outsourcing of more complex inputs is therefore larger from countries with a stronger IPR regime when the transactions require technology sharing. IPRs protect firms from the risk of losing their technology (or having it used against their interest), the value of which increases with the level of complexity. In other words, in a weak IPR environment, costly intangible assets embodied in complex goods can only be effectively protected against imitation within firm boundaries. We can therefore conclude that (i) for technology-sharing-outsourcing IPR protection promotes outsourcing of more complex inputs to a destination country by guaranteeing the protection of their *shared* valuable technology, (ii) for non-technology-related outsourcing more IPR protection attracts the outsourcing of less complex inputs that are more prone to imitation.

Our work is most closely related to Ivus (2010, 2012), who adopts a different perspective as she investigates the impact of improved IPRs in the destination country on exports. She finds that patent protection increases the value of exports from developed to developing countries in patent-sensitive industries, especially for industries that rely heavily on patent protection (Ivus, 2010). This work is extended to differentiate between exports at the intensive and the extensive margin (existing and new products respectively) to find a shift from the former to the latter caused by stronger IPRs (Ivus, 2012). Another closely related paper is Canals and Sener (2012), who study the impact of IPR reform on US offshoring decisions using a measure based on intermediate goods trade. They find that intra-industry offshoring in high-tech industries is most influenced by IPR reforms. Data availability restricts their analysis to industry-level observations and to 16 receiving countries. We take the analysis to a more disaggregate level by looking at the outsourcing decision at the firm-level for products of different complexities to 99 countries. In addition, our data allows us to distinguish between different types of outsourcing by observing whether or not they involve technology sharing. Only such distinction allows us to detect the dual character of product complexity regarding imitation risk.

Considered from a different perspective, our results are also consistent with Branstetter et al. (2006) in that stronger IPRs in a destination country stimulate (direct) technology transfer by multinational firms. Finally, related empirical works on complexity include Berkowitz et al. (2006), who show that higher quality legal institutions located in the exporter's country enhance international trade in complex products. They argue this to be due to a production cost effect, assuming that the production of complex products contains some degree of outsourcing, and hence depends on contracts. Better institutions enable the exporting country to cheaply and quickly enforce contracts and resolve business disputes by reducing the likelihood of hold-up on the production chain. This in turn lowers the production costs of complex products. Since these issues are less important for simple goods, better legal institutions enhance a country's comparative advantage in complex goods. While Berkowitz et al. (2006) deals with contractual complications of business transactions involving complex products, we explore the relevance of IPRs and the appropriability of knowledge for *the type of trade* (intra- versus extra-group) undertaken by a multinational with an exporting country. In addition, we use a specific measure of complexity based on the routineness of tasks that is more adequate for our aim to differentiate products with respect to their technology content.[2]

The rest of the paper is organized as follows: Section 2 presents the theoretical framework, Sections 3 and 4 introduce the data, methodology, and the empirical analysis. Section 5 concludes.

2 Theoretical Framework

We start by developing a simple theoretical framework, which helps to pin down the main idea. Consider a multinational firm that has already born the fixed cost of being active in a country $j \in \{1, .., J\}$. The firm can import intermediate (or final) goods from a related party (insource) or an independent supplier (outsource): $X \in \{I, O\}$. As familiar in the literature, multinational firms face a trade-off when selecting their mode of procurement. Outsourcing (O) brings specialization gains that generally translate into marginal cost savings, whereas insourcing (I) carries advantages through lower initial fixed costs (Antràs and Helpman, 2004). We view this latter from the perspective that the production of inputs outside firm boundaries requires a fixed customization cost.

A two-dimensional source of heterogeneity drives the decision of a multinational: countries are heterogeneous with respect to the level of IPR protection, γ_j; products are heterogeneous with respect to the complexity of tasks required in their fabrication, z. In particular, $0 < z(p) < \infty$ is a continuous measure of technological complexity embodied in a product p. Outsourcing entails risk of imitation from reverse engineering performed on the input itself by the supplier, or directly when the multinational shares its technology with the independent supplier. The extent of the loss from these channels

[2]Berkowitz et al. (2006) uses the Rauch (1999) classification to distinguish between simple and complex products.

depends on the level of IPR protection in the destination country. We parameterize the costs associated with imitation as

$$r_j(p) = \gamma_j z(p)^{\alpha-\beta} \tag{1}$$

where $0 \leq \gamma_j \leq 1$ is the inverse measure of IPR protection, $0 \leq \alpha \leq 1$ is the rate at which the value of technology increases with complexity, and $0 \leq \beta \leq 1$ represents the rate at which complexity blocks imitation. A lower γ_j indicates a stronger IPR regime in the destination country, where $\gamma_j = 0$ denotes a country with full protection and $\gamma_j = 1$ one with no protection. Less complex products are easier to copy. Therefore β shows that complexity itself works as a shield against the infringement making IPRs less relevant for more complex goods. However, a firm can still lose valuable technology if it is openly shared with the outsourcing partner. The value of technology is increasing in complexity as implied by α, and sharing it clearly reduces costs (or difficulty) of imitation. In the absence of adequate IPR protection, the contents can be used to compete against the multinational and the damage is higher the more complex and profitable is the technology. Subsequently assuming $\beta > \alpha$ without and $\beta < \alpha$ with technology sharing, we expect imitation risk to decrease with complexity when outsourcing is characterized as a pure procurement of inputs, and to increase when it involves sharing technology with the partner. This makes IPRs a bigger concern for less complex goods when technology is not shared and for more complex goods when technology is shared.

We can represent the total profits under outsourcing in a general form as:

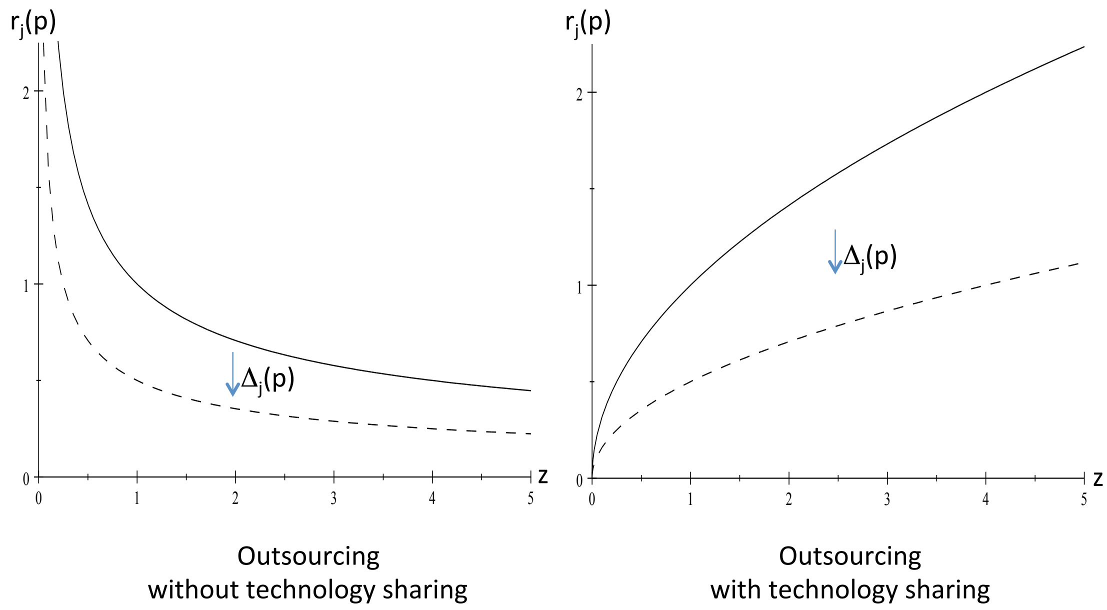
$$\Pi_X \left(z(p), \gamma_j\right) = \pi_X \left(r_j(p), c_X\right) - T(z(p)), \tag{2}$$

for $X \in \{I, O\}$, where $\pi_O \left(r_j(p), c_O\right)$ represents operating profits when outsourcing to an independent supplier is the organizational mode. Local competitors can steal a share of the market for a specific good through imitation reducing the multinational firm's operating profits. At the same time outsourcing is generally accompanied by specialization gains that translate into marginal cost savings, so that $c_O < c_I$. As a result, firms face a trade-off between higher imitation risk and lower unit costs. We assume insourcing to be the alternative organization that entails higher unit costs, but protects the multinational from imitation since it owns property rights over a product (or input) and the technology used in its own affiliate. In addition, outsourcing is accompanied by fixed customization costs $T(z(p))$ when dealing with an outside supplier that is increasing in complexity, $\frac{\partial T(.)}{\partial z(p)} > 0$. This can be thought of as training costs and the effort required to achieve a better fit of the independent supplier's production to the multinational firm's needs.

The multinational decides to outsource product p with complexity level $z(p)$ to a country with IPR protection γ_j if and only if $\Pi_O\left(z(p), \gamma_j\right) > \Pi_I\left(z(p)\right)$ in equation (2). The probability of outsourcing is therefore determined by the product and country specific characteristics of the transaction. Note that a multinational can source different inputs from a country j using different organizational modes. A firm may for instance outsource production of less complex inputs, but insource more complex inputs or vice versa. We assume certain inputs require sharing technology and others do not when outsourced, and investigate the conditions under which each type of outsourcing prevails.

Looking back at equation (1), imitation risk is increasing in the level of complexity, $\frac{\partial r_j(p)}{\partial z(p)} > 0$, if $\beta < \alpha$, and decreasing, $\frac{\partial r_j(p)}{\partial z(p)} < 0$, if $\beta > \alpha$. Property $-1 < \alpha - \beta < 1$ results in imitation risk being concave in complexity when technology is shared and convex for pure procurement activities. That is, imitation risk of very complex goods approaches zero, while they carry a maximum finite risk when technology is shared. Seen the other way around, a simple good entails little risk from technology sharing as it does not embody valuable technology, but an infinite imitation risk (under no IPR protection) that could result in perfect competition and zero operating profits. This is illustrated in Figure 1, where the two solid lines represent imitation risk of outsourcing with and

Figure 1: Imitation Risk and the Level of Complexity



without technology sharing.[3]

To see the importance of IPR protection for different complexity levels, we first note that, $\Delta_j(p) \equiv \frac{\partial r_j(p)}{\partial \gamma_j} > 0$. It is easy to see from equation (1) that $\frac{\Delta_j(p)}{\partial z(p)} \mid_{\beta>\alpha} < 0$, while $\frac{\Delta_j(p)}{\partial z(p)} \mid_{\beta<\alpha} > 0$. On the one hand, complex goods are more difficult to imitate, increasing the need for IPR protection for less complex goods. On the other hand, more complex goods contain more valuable technologies. Hence, they involve higher potential losses if the technology shared leaks, increasing the importance of IPRs. The relationship between

[3]The parameter values used to draw the figure are $\alpha = 1/2$, $\beta = 1$ for no technology sharing, $\beta = 0$ for outsourcing with technology sharing, $\gamma_j = 1$ for weak IPR protection, and $\gamma_j = 1/2$ for improved IPR protection.

IPR protection and product complexity therefore goes both directions and could be ambiguous when considering all transactions. Given the functional form of imitation risk in (1), all else equal it is more likely that the first effect dominates since $r_j(p) \mid_{\beta>\alpha, z\rightarrow 0} > r_j(p) \mid_{\beta<\alpha, z\rightarrow\infty}$ making IPRs more crucial for less complex goods on the aggregate. This can be seen more clearly in Figure 1, which illustrates strengthening of the IPR regime for each outsourcing mode as a shift from the solid to the dashed curves. The effectiveness of IPR protection in reducing imitation risk under each mode can be seen by observing the distance between the solid curve (weak IPRs) and the dashed curve (improved IPRs) for a given complexity level.

The empirical exercise in the next section aims to test the above hypothesis by investigating whether (1) firms are in general reluctant to outsource complex inputs to independent suppliers, (2) IPR protection is more crucial for the simpler inputs when outsourcing does not involve technology sharing, (3) IPR protection is instead effective in encouraging outsourcing more complex inputs when the multinational shares its technology with the foreign supplier.

3 Data

Data on the Organization of French Multinationals The empirical analysis uses a detailed firm-level survey of French multinationals containing information about the organization of their international production. The survey has been conducted by the French National Institute of Statistics and Economic Studies (INSEE) for the year 1999. It is limited to firms that trade more than one million Euro, and to industrial cross-border transactions. The firms in the survey account for 64% of French imports of manufactured goods.

The survey enquires about the country of origin of the transaction and the imported products. It reports moreover the value of imports from foreign related parties and from foreign independent suppliers.[4] We use this information to construct at the level of firm i, the share of imports of product p that is sourced from an independent supplier located in country j. We denote this share by $y_{ipj} = \frac{M^O_{ipj}}{(M^O_{ipj}+M^I_{ipj})}$ with O and I indicating the outsourcing and intra-firm modes of imports, respectively.

Importantly, the data also contains information on whether or not the relationship between the French multinational and the supplier requires technology sharing. The survey specifies if the outsourcing relationship involves technological alliances, licensing, franchising, etc., but no information concerning the amount of imports falling within these subcategories is provided. Instead, a single number reports the total value of imports from independent suppliers that involve technology sharing at the level of the firm, product and country. Our dependent variable, y_{ipj}, is the sum of the two shares of outsourcing – with and without technology sharing. Table 6 in the Appendix shows that while on average 78% of imports are sourced from independent suppliers, only 2% of these imports involve technology sharing.

The survey does not provide information on the characteristics of the imported products, and in particular on whether these are intermediate inputs. Our theoretical hypothesis concerns goods that enter the production process as intermediate inputs. We identify the type of product in the sample using the methodology proposed by Feenstra and Hanson (1996). They define the value of imported inputs as the value of goods that are sourced from a different sector than the sector of the firm. We apply this definition to the product categories in the French database.[5]

Table 1 reports the number of firms, products and countries in both estimation samples. The intermediate input sample covers 2,609 manufacturing firms, 32 product categories and 89 countries. The full sample is composed of 2,915 firms which import 32

[4]The foreign related parties are direct foreign affiliates of French firms or belong to the group which owns the French firm.

[5]The value of imported inputs is therefore defined as the value of all transactions that are classified in a 2-digit sector different from the one of the French multinational. Working at the 2-digit level is necessary to match the level of aggregation of the complexity measure. The empirical measure of the value of imported inputs is therefore rather conservative.

product categories from 99 countries. The total number of observations is 39711. The construction of the intermediate inputs sample eliminates about a third of the total number of observations. While the average product complexity is the same in both samples, the outsourcing share is slightly lower and the average IPR level slightly higher in the sample of intermediate inputs.

Table 1: Sample Characteristics

Number of:	Intermediate Inputs	Full Sample
Firms	2,609	2,915
Product	32	32
Countries	89	99
Average share of outsourcing	0.77	0.79
Average IPR level	4.21	4.15
Average product complexity	0.26	0.26
Observations	25,077	39,711

A Task-Based Product Complexity Measure Our measure of product complexity is similar to Costinot et al. (2011) and Keller and Yeaple (2009). We construct an index for each product category that captures its content of tasks that require complex problem solving skills. Data on complex problem solving skills is taken from the U.S. Department of Labor's Occupational Information Network (O*NET). Similar data is not available for France. As it is common in the literature, we assume therefore that the factor content in complex solving skills of a particular product category is the same across countries.

The O*NET data contains expert information on the level and importance of complex problem solving skills for 809 8-digit occupations as defined in the Standard Occupational

Classification (SOC).[6] Each occupation, o, embodies a complexity of

$$z_o = i_o^{0.25} + l_o^{0.75} \tag{3}$$

where the weights give the contributions of the two complexity components, importance $i \in [1, 5]$ and level $l \in [0, 7]$.[7] Higher values correspond to a higher "importance" or "level" of skills. The difference between "importance" and "level" can best be understood with an example. The subtask "problem identification" has an equal importance of 3 for both purchasing managers and vessel inspectors. Since purchasing managers are, however, more often confronted with the task of identifying problems, they are assigned a level score of 4.2 whereas vessel inspectors are assigned a score of 2.8 only. The resulting single score for the subtask "problem identification" is therefore higher for purchasing managers.

After combining the two components into a single complexity score for each occupation, we derive the complexity embodied in each industry. To this end, we use information on the employment of the different occupations by industry. In line with Costinot et al. (2011), we assume that every country in the sample uses the same technology and rely therefore on employment information from the U.S. Bureau of Labor Statistics' Occupational Employment Statistics (OES). The 1999 data contains the number of employees by occupation in every 3-digit industry k (according to the Standard Industrial Classifi-

[6]Since the skill-content of occupations may change over time, we use version 3.0 of the O*NET database, released in 2000, to match the data on French multinationals. Note that this version still distinguishes eight categories, namely "problem identification", "information gathering", "information organization", "synthesis/reorganization", "idea generation", "idea evaluation", "implementation planning", "solution appraisal", which have been from version 4.0 on summarized into a single category "complex problem solving skills" (Boese and Lewis, 2001).

[7]We normalized the different scales of the complexity components to a $[0, 1]$ scale using the min-max method, $I = \frac{i_o - \min(i)}{\max(i) - \min(i)}$ $\left(L = \frac{l_o - \min(l)}{\max(l) - \min(l)}\right)$. The weighting scheme is the same as in Jensen and Kletzer (2010). We have tried different weights that have been used in the literature (see also Blinder, 2009) without any qualitative effects on the results.

cation, SIC).[8] The occupational intensity, b_o^k, of each industry is then given by

$$b_o^k = \frac{L_o^k}{\sum_o L_o^k}, \tag{4}$$

where L_o^k is the employment level of occupation o in industry k. Although the SIC provides information on products or services which are generated under the same industry heading, it does not relate atypical (or secondary) products. In order to compute the skill content embodied in primary and secondary outputs of each industry, we employ a make table for France from 1999 (provided by Eurostat). This allows us to derive a precise complexity measure at the product-level,[9]

$$z(p) = \sum_{k \in p} \frac{x^k(p)}{\sum_k x^k(p)} \left(z_o b_o^k \right), \tag{5}$$

where $\frac{x^k(p)}{\sum_k x(p)}$ gives the share of industry k in the production of each good. Table 4 in Appendix summarizes the 32 product categories in our sample ranked according to their complexity. Alternative to our complexity measure suitable in a context of the appropriability of knowledge, Nunn (2007) develops a well-known product categorization standard of contract intensity more relevant for studying hold-up problems with suppliers. Ma et al. (2010) for example conduct an insightful application of this measure to investigate how judicial quality increases exports among firms for which relationship-specific investments are most important (high contract intensity).[10]

Intellectual Property Rights and Other Controls We use a measure of IPR protection from Park (2008) for the destination countries available in our sample. This

[8]Crop production, animal production and private households are not surveyed. After matching the O*NET data to the OES data, 695 occupations remain in the sample.

[9]Since direct concordance tables of the NACE Rev. 1.1 classification and the SIC 1987 classification are not available, correspondence is achieved via the NAICS 2002 classification. We use simple average to go from the 3-digit level of the SIC to the 2-digit of the NACE.

[10]Matching the Nunn indexes used in Ma et al. (2010) with the French data, we find a positive and significant correlation between our product complexity measure and the index of contract intensity. Calculations are available upon request.

measure of IPR protection is the updated version of the worldwide used Ginarte and Park index (Ginarte and Park, 1997). It incorporates the effects of the TRIPS agreement of 1995 and it takes into account the revisions in national patent laws required to conform to international and regional agreements (such as the North American free trade agreement (NAFTA), European patent convention (EPC), African Regional industrial property organization (ARIPO), Cartagena agreement, among others). All the technical details related to the construction of the index are explained in Park (2008). We measure the strength of IPR protection in 1995 which is available for the 99 countries of the full sample. The variable is transformed into logs. Table 5 in the Appendix summarizes the information for the countries of our sample.

The cross-country rankings of IPRs are correlated with other development-related variables such as the rule of law or the level of corruption.[11] In this case, we might be falsely attributing some effects to the IPR regime while they are in fact driven by other country characteristics. We therefore introduce other development related variables in the estimation to mitigate this concern. We control first for the rule of law. The variable measures the independence of the judiciary and the extent to which rule of law prevails in civil and criminal matters. It is taken from the *Freedom in the World* database. We also control for the level of corruption by including a measure that is taken from the *Heritage Foundation* database.[12] Because the strength of IPR enforcement varies with the overall level of economic development, we include per-capita GDPs in the estimation. The data is taken from the *Penn World Tables.*

We include other explanatory variables that might influence the sourcing decision such as the number of potential suppliers and capture it by the size of the market as measured by GDP (McLaren, 2000; Grossman and Helpman, 2002). We also include the

[11]The correlation between the IPR level and the development-related variables is above 75% as shown in Table 7 in the Appendix.

[12]This indicator is based on the Corruption Perception Index from Transparency International and assessments of the US Department of Commerce, the Economist Intelligence Unit, the Office of US Trade Representative and official government publications of each country.

distance between the location of the French firm and the destination countries to control for the overall monitoring and trade costs (Mugele and Schnitzer, 2006; Ottaviano and Turrini, 2007). Table 6 in the Appendix summarizes information related to the means and standard deviations of the variables used in the estimations.

Estimation Methodology Our analysis draws inferences on the impact of IPRs and product complexity on the organization of international production. More crucially, our theoretical framework suggests that the share of outsourcing is jointly determined by the level of IPRs and product complexity. We introduce thus an interaction term between product complexity and the IPR level in our empirical analysis.

Several characteristics of the data aid in the empirical identification strategy. A single French multinational firm often imports different inputs from different countries.[13] We use the variation in the countries of origin and imported inputs within each firm to identify which product is outsourced, controlling for firm fixed effects. Moreover, the introduction of firm-level fixed effects (ν_i) helps controlling for all unobserved firm-level characteristics that might influence the sourcing decision. We estimate the baseline equation using a linear fractional model.

$$\begin{aligned} y_{ipj} &= \lambda_1 IPR_j + \lambda_2 Comp_p + \lambda_3 \left(IPR_j \times Comp_p \right) \\ &+ Controls_j + \nu_i + \epsilon_{ijp} \end{aligned} \tag{6}$$

The standard errors are allowed to be adjusted for clustering at the country-product-level to account for heteroscedasticity and non-independence across the repeated observations across firms within a country-product pair.[14]

[13]Firms in the intermediate inputs sample import on average five product categories from about eight countries.

[14]This level of clustering is chosen as a benchmark. For robustness we have nonetheless also considered a two-way clustering of the errors at the product- and country-level. The results remain similar.

4 Results

Baseline Results Table 2 presents our basic results for the outsourcing share in the intermediate input sample. Both the IPR and the complexity variables have been centered around their mean. From column (1) to (3), we include the level of IPR protection, product complexity and the interaction term. In column (4), we introduce other country-level characteristics that may independently impact the outsourcing share, namely the rule of law, corruption, per capita GDP, market size and distance between the home and the destination country. Finally, column (5) presents the estimates for the full sample of products.

The coefficient of the IPR variable is statistically not significant, suggesting that IPRs do not affect the outsourcing share of inputs with an average level of complexity. Looking at the complexity measure, we find a negative and significant effect on the outsourcing decision of multinationals. The negative coefficient of the product complexity variable implies a lower outsourcing share for more complex inputs imported from a country with an average level of IPR protection. A one-standard-deviation increase in the complexity coefficient reduces the share of outsourcing by roughly 2.3 percentage points. This implies that for each additional unit of the complexity index, the model predicts a 16.9% decrease in the outsourcing share.[15] Corcos et al. (2013) complement these results by providing evidence that complex goods and inputs are more likely to be produced within firm boundaries. Note however that the statistical significance of this effect disappears once we include the full sample of products. Our results suggest therefore that the importance of product complexity is limited to the sourcing of inputs.

Turning to the interaction term, all specifications in Table 2 reveal that the share of outsourcing of complex inputs tends to be smaller in countries with stronger IPR regimes. The negative interaction term is robust and remains statistically significant af-

[15] We can also evaluate the elasticity at the mean values of the dependent and independent variables. A one percent increase in the complexity measure reduces the share of outsourcing by roughly 0.06% (0.169*0.26/0.78).

ter controlling for other country-level characteristics at the 10 and the 1 percent level for intermediate inputs and all products, respectively. These findings indicate that a larger share of outsourcing of complex goods can take place in countries with weak IPR protection as they are harder to imitate. Complexity itself works as a shield against reverse engineering mitigating the importance of IPR protection. Firms therefore outsource less complex products (and inputs) that are easier to decodify and imitate to independent suppliers in countries with relatively strong IPR regimes. In the case of intermediate inputs, the coefficient on the interaction term is only marginally significant, which leads us to splitting outsourcing transactions by their type in the next section for a more precise estimation.

Table 2: Baseline Results

	(S1)	(S2)	(S3)	(S4)	(S5)
IPR_j	-0.019	-0.019	-0.019	-0.035	-0.040
	(0.014)	(0.014)	(0.014)	(0.025)	(0.025)
$Comp_p$		-0.184***	-0.177***	-0.169***	-0.010
		(0.047)	(0.047)	(0.044)	(0.065)
$IPR_j \times Comp_p$			-0.404**	-0.374*	-0.540***
			(0.201)	(0.200)	(0.196)
Rule of Law_j				0.001	-0.001
				(0.002)	(0.002)
$Corruption_j$				0.004*	0.000
				(0.003)	(0.003)
Per Capita GDP_j				0.005	0.002
				(0.011)	(0.011)
Market $Size_j$				0.002	0.003
				(0.002)	(0.003)
$Distance_j$				-0.012***	-0.010***
				(0.004)	(0.004)
Firm-level FE	yes	yes	yes	yes	yes
Sample	inputs	inputs	inputs	inputs	full
Observations	25,077	25,077	25,077	25,077	39,711
Adjusted R^2	0.583	0.584	0.584	0.584	0.517

Robust standard errors clustered at the country-product identity. Standard errors in parentheses. ***, **, * significantly different from 0 at 1%, 5% and 10% level, respectively.

Main Results In the evidence presented so far, we have explored how the interaction between product complexity and the IPR regime affects the share of arms length trade without distinguishing between the type of outsourcing. The French firm-level data allows us to dig deeper and differentiate between the type of relationship that links French firms with their foreign suppliers. To do this, we use the information provided on whether or not an outsourcing relation involves technology sharing to analyze whether this has an impact on the outsourcing behavior of firms in our sample. The results are reported in Table 3. Columns (1-2) report the results corresponding to the sample of transactions from external suppliers classified as pure procurement of parts from a supplier without technology sharing, while columns (3-4) present the results using the sample of transactions that involve sharing information on the technology of multinational firms. The dependent variables are now defined as $y_{ipj}^{OTS} = \frac{M_{ipj}^{OTS}}{(M_{ipj}^{O}+M_{ipj}^{I})}$ and $y_{ipj}^{NTS} = \frac{M_{ipj}^{NTS}}{(M_{ipj}^{O}+M_{ipj}^{I})}$ where $y_{ipj}^{OTS} + y_{ipj}^{NTS} = y_{ipj}^{O}$ and superscripts OTS and NTS indicate outsourcing with and without technology sharing, respectively.

Confirming the baseline results, we find a negative and significant interaction term in the sample of outsourced imports from external suppliers without technology sharing.[16] The share of outsourcing of more complex inputs is therefore larger in countries with lower levels of IPRs because of the lower imitation possibilities and less infringement concerns. We however find a positive interaction term in the sample of transactions that require technology sharing. The share of outsourcing of more complex inputs is hence larger from countries with a stronger IPR regime when the transactions require technology sharing. IPRs protect firms from the risk of losing their technology, the value of which rises with complexity. Complex inputs involve costly R&D efforts that are likely to be more effectively protected against imitation within firm boundaries. Due to the greater amount of intangible assets embodied in complex goods, outsourcing to foreign

[16] The regression models estimated in Table 3 generate similar goodness-of-fit results regardless of the sample; note that the adjusted R^2 is nearly the same across the different specifications presented in Tables 2 and 3.

Table 3: Outsourcing with and without Technology Sharing

	External Supplier			
	Without Technology Sharing		With Technology Sharing	
	(S1)	(S2)	(S3)	(S4)
IPR_j	-0.015	-0.047*	-0.003	0.012
	(0.014)	(0.026)	(0.005)	(0.008)
$Comp_p$	-0.161***	-0.152***	-0.016	-0.017
	(0.050)	(0.046)	(0.013)	(0.013)
$IPR_j \times Comp_p$	-0.563***	-0.531***	0.159**	0.156**
	(0.202)	(0.201)	(0.071)	(0.071)
Rule of Law_j		0.000		0.001
		(0.002)		(0.001)
$Corruption_j$		0.004*		-0.000
		(0.003)		(0.001)
Per Capita GDP_j		0.013		-0.008*
		(0.011)		(0.005)
Market $Size_j$		0.002		-0.000
		(0.002)		(0.001)
$Distance_j$		-0.014***		0.002**
		(0.004)		(0.001)
Firm-level FE	yes	yes	yes	yes
Sample	inputs	inputs	inputs	inputs
	25,077	25,077	25,077	25,077
	0.592	0.593	0.543	0.543

Robust standard errors clustered at the country-product identity. Standard errors in parentheses. ***, **, * significantly different from 0 at 1%, 5% and 10% level, respectively.

independent suppliers is only a profitable option if the IPR regime is sufficiently strong to protect firms against the dissipation of their technology. This result is consistent with the alternative property-rights explanation in the spirit of Grossman and Hart (1986) and Hart and Moore (1990) provided by Carluccio and Fally (2012), who find that multinationals are more likely to integrate suppliers of more complex inputs that are located in countries with poor financial institutions. They argue this to be an attempt by multinationals to reduce exposure to opportunism in countries where financial development is low.

The results after splitting the sample according to the two outsourcing types confirm our conceptual framework and provide novel results. First, for technology-sharing-outsourcing IPR protection promotes outsourcing of more complex goods by mitigating the risk of imitation, thereby guaranteeing the protection of their technology. Second, for outsourcing contracts that do not require technology sharing, more IPR protection attracts the outsourcing of less complex products that are more prone to imitation. This is the first work to our knowledge that encompasses the dual nature of complexity and the role of IPRs in protecting intangible assets introduced in Mansfield (1994). Although more technologically sophisticated industries place a larger emphasis on IPRs, those that require complex inputs are automatically protected from imitation making IPRs instead more important for easily imitable goods. Finally, it is worth noting that the direct effect of product complexity is not significant in the technology sharing sample. The level of product complexity hence does not matter for the inputs that are imported from an average IPR country when there is an intention to share technology. We find moreover a positive effect of distance on the sourcing share of inputs from external suppliers with technology sharing. In line with the transaction-costs literature (e.g. Williamson, 1975, 1985), this finding suggests higher monitoring costs when the relationship requires technology sharing making arms length trade a more desirable option. Finally, we find a negative coefficient for the per capita GDP variable suggesting a lower share of outsourcing to less developed countries.

5 Conclusion

This paper has investigated the decision of multinational firms in the sourcing of products of different complexity levels. The analysis has proposed and tested the hypothesis that technological complexity of a product and the level of IPR protection are co-determinants of the sourcing mode of multinational firms. As measures of the technological intensity at the product-level are not available, we have built a new measure reflecting the complex problem-solving skills involved in the production of a good. The estimations confirm the predictions made about firms' decision between intra-firm trade and procurement from independent suppliers.

The results first shed light on the significance of IPRs given the nature of products or inputs. In contrast to conventional wisdom, IPRs tend to play a more important role in the outsourcing of simple goods. Our explanation for this result relies on the hypothesis offered by Mansfield (1994) that complexity may work as a self-defense mechanism against the infringement of goods. In addition, the availability of rich French firm- and product-level data has made it possible to conduct the first study on multinationals and IPRs that distinguishes between outsourcing transactions by whether or not they involve technology sharing. Doing so reveals that firms recognize IPRs as an important factor in their decision regarding the location of outsourcing, when the contract involves technology transfer. Only in this case, firms outsource highly complex products to countries where their intellectual property is recognized. Here IPRs work to protect a multinational against the dissipation of their knowledge-based intangible assets.

As much as the paper contributes to understanding the internationalization strategy of firms and the differences between intra-firm trade and outsourcing, it bears an important policy conclusion. While on average the production of 78% of imports in the sample are outsourced, only 2% involve technology transfer. The more sophisticated portion of these technologies are outsourced to countries where IPRs are reliably respected and enforced. The results suggest that attracting the upper part of the value chain requires building trust into the protection of IPRs. An obvious next step would be to endogenize the decision of multinationals on technology sharing along with their decision on organizational mode.

References

Antràs, P., Helpman, E., 2004. Global Sourcing. Journal of Political Economy 112, 552–580.

Antràs, P., Helpman, E., 2008. Contractual Frictions and Global Sourcing, in: Helpman, E., Marin, D., Verdier, T. (Eds.), The Organization of Firms in a Global Economy. Harvard University Press. chapter Contractual Frictions and Global Sourcing, pp. 9–54.

Antràs, P., Rossi-Hansberg, E., 2009. Organizations and Trade. Annual Review of Economics 1, 43–64.

Berkowitz, D., Moenius, J., Pistor, K., 2006. Trade, Law, and Product Complexity. The Review of Economics and Statistics 88, 363–373.

Blinder, A.S., 2009. How Many US Jobs Might be Offshorable? World Economics 10, 41–78.

Boese, R., Lewis, P., 2001. Combining Original Analyst O*NET Skill Questionnaire Constructs to Form More General Constructs for the Revised Incumbent Questionnaire. Technical Report. O*NET.

Branstetter, L.G., Fisman, R., Foley, C.F., 2006. Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from U. S. Firm-Level Panel Data. The Quarterly Journal of Economics 121, 321–349.

Canals, C., Sener, F., 2012. Offshoring and Intellectual Property Rights Reform. Research Paper.

Carluccio, J., Fally, T., 2012. Global Sourcing under Imperfect Capital Markets. The Review of Economics and Statistics 94, 740–763.

Corcos, G., Irac, D.M., Mion, G., Verdier, T., 2013. The determinants of intrafirm trade: evidence from french firms. Review of Economics and Statistics 95, 825–838.

Costinot, A., Oldenski, L., Rauch, J.E., 2011. Adaptation and the Boundary of Multinational Firms. Review of Economics and Statistics 93, 298–308.

EIU, 2004. World Investment Prospects. The Revival of Globalisation? Technical Report. The Economist Intelligence Units.

Feenstra, R.C., Hanson, G.H., 1996. Globalization, Outsourcing, and Wage Inequality. American Economic Association 86, 240–245.

Ginarte, J., Park, W., 1997. Determinants of Patent Rights: A Cross-National Study. Research Policy 26, 283–301.

Glass, A.J., 2004. Outsourcing under Imperfect Protection of Intellectual Property. Review of International Economics 12, 867–884.

Grossman, G.M., Helpman, E., 2002. Integration Versus Outsourcing In Industry Equilibrium. The Quarterly Journal of Economics 117, 85–120.

Grossman, S.J., Hart, O.D., 1986. The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. The Journal of Political Economy 94, 691–719.

Grover, A., 2007. The Role of Technological Complexity and Absorptive Capacity in Internalization Decision. Working Papers id:2843. esocialsciences.com.

Hart, O., Moore, J., 1990. Property Rights and the Nature of the Firm. Journal of Political Economy 98, 1119–58.

Ivus, O., 2010. Do Stronger Patent Rights Raise High-Tech Exports to the Developing World? Journal of International Economics 81, 38–47.

Ivus, O., 2012. The Quantity, Price, and Variety Response of U.S. Exports to Stronger Patent Protection. Research Paper.

Jensen, J.B., Kletzer, L.G., 2010. Measuring tradable services and the task content of offshorable services jobs, in: Abraham, K.G., Spletzer, J.R., Harper, M. (Eds.), Labor in the New Economy. University of Chicago Press, pp. 309–335.

Keller, W., Yeaple, S.R., 2009. Global Production and Trade in the Knowledge Economy. Working Paper 7175. Centre for Economic Policy Research.

Ma, Y., Qu, B., Zhang, Y., 2010. Judicial quality, contract intensity and trade: Firm-level evidence from developing and transition countries. Journal of Comparative Economics 38, 146–159.

Mansfield, E., 1994. Intellectual Property Protection, Foreign Direct Investment and Technology Transfer. Discussion Paper 19. International Finance Corporation.

McLaren, J., 2000. "Globalization" and Vertical Structure. The American Economic Review 90, 1239–1254.

Mugele, C., Schnitzer, M., 2006. Organization of Multinational Activities and Ownership Structure. Research Paper.

Nunn, N., 2007. Relationship-specificity, incomplete contracts, and the pattern of trade. The Quarterly Journal of Economics 122, 569–600.

Ottaviano, G.I.P., Turrini, A., 2007. Distance and Foreign Direct Investment when Contracts are Incomplete. Journal of the European Economic Association 5, 796–822.

Park, W.G., 2008. International Patent Protection: 1960-2005. Research Policy 37, 761–766.

Rauch, J.E., 1999. Networks Versus Markets in International Trade. Journal of International Economics 48, 7–35.

Williamson, O., 1975. Markets and Hierarchies, Analysis and Antitrust Implications: a Study in the Economics of Internal Organization. A study in the economics of internal organization, Free Press.

Williamson, O., 1985. The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting. Free Press.

A Complexity Ranking, IPR Index, and Descriptive Statistics

Table 4: Product complexity ranking

Code	Description	Complexity
72	Computer & related services	.4221271
32	Radio, television & communication equipment & apparatus	.3798102
30	Office machinery & computers	.3790194
40	Electrical energy, gas, steam & hot water	.3515674
74	Other business services	.3246673
29	Machinery & equipment n.e.c.	.3113132
31	Electrical machinery & apparatus n.e.c.	.3073564
50	Trade, maint. & repair services of motor vehicles & mtrcls; retail sale of auto fuel	.3033172
33	Medical, precision & optical instruments, watches and clocks	.3031925
92	Recreational, cultural & sporting services	.2997497
28	Fabricated metal products, except machinery & equipment	.2878633
27	Basic metals	.2786216
35	Other transport equipment	.2748125
12	Uranium & thorium ores	.2663580
11	Crude petrol. & natural gas; services incidental to oil & gas ext. excl. surveying	.2624262
34	Motor vehicles, trailers & semi-trailers	.2596836
24	Chemicals, chemical products & man-made fibres	.2580898
23	Coke, refined petroleum products & nuclear fuels	.2537238
22	Printed matter & recorded media	.2342544
10	Coal & lignite; peat	.2317005
36	Furniture; other manufactured goods n.e.c.	.2246486
13	Metal ores	.2134478
25	Rubber & plastic products	.2058220
15	Food products & beverages	.1978979
14	Other mining & quarrying products	.1938014
26	Other non-metallic mineral products	.1839178
20	Wood & products of wood & cork (excp. furniture); articles of straw & plaiting matls	.1745415
17	Textiles	.1678820
19	Leather & leather products	.1651444
21	Pulp, paper & paper products	.1634918
18	Wearing apparel; furs	.1262338
16	Tobacco products	.1146149

Table 5: Countries and Ginarte and Park IPR Index

Country	IPR	Country	IPR	Country	IPR	Country	IPR	Country	IPR
Angola	0.88	Cyprus	2.78	Ireland	4.14	Niger	1.78	Swaziland	1.98
Argentina	2.73	Czech Republic	2.96	Israel	3.14	Nigeria	2.86	Sweden	4.42
Australia	4.17	Denmark	4.54	Italy	4.33	Norway	3.88	Switzerland	4.21
Austria	4.21	Ecuador	2.04	Jamaica	2.86	Pakistan (1972-)	1.38	Syria	1.87
Bangladesh	1.87	Egypt	1.73	Japan	4.42	Panama	1.46	Tanzania	2.32
Belgium	4.54	Fiji	2.2	Jordan	1.08	Paraguay	1.53	Thailand	2.41
Bolivia	2.37	Finland	4.42	Kenya	2.43	Peru	2.73	Togo	1.98
Botswana	2.08	Gabon	2.1	Korea, South	3.89	Philippines	2.56	Trinidad and Tobago	2.33
Brazil	1.48	Germany	4.17	Liberia	2.11	Poland	3.46	Tunisia	1.65
Bulgaria	3.23	Ghana	2.83	Lithuania	2.69	Portugal	3.35	Turkey	2.65
Burkina Faso	1.98	Greece	3.47	Luxembourg	3.89	Romania	3.52	Uganda	2.85
Burundi	2.15	Grenada	1.76	Madagascar	1.85	Russia	3.48	Ukraine	3.68
Cameroon	2.1	Guatemala	1.08	Malaysia	2.7	Rwanda	1.95	United Kingdom	4.54
Canada	4.34	Guyana	1.13	Malta	1.6	Senegal	1.98	United States	4.88
Central African Republic	1.98	Haiti	2.58	Mauritius	1.93	Sierra Leone	2.45	Uruguay	2.07
Chile	3.91	Honduras	1.9	Mexico	3.14	Singapore	3.88	Venezuela	2.82
China	2.12	Hungary	4.04	Morocco	1.78	Slovakia	2.96	Vietnam	2.9
Colombia	2.74	Iceland	2.68	Nepal	1.79	South Africa	3.39	Zambia	1.62
Congo	1.9	India	1.23	Netherlands	4.54	Spain	4.21	Zimbabwe	2.28
Costa Rica	1.56	Indonesia	1.56	New Zealand	4.01	Sri Lanka	2.98		
Cote d'Ivoire	1.9	Iran	1.91	Nicaragua	1.12				

Table 6: Descriptive Statistics (Intermediate Inputs Sample: 25,077 Observations)

	Mean	Std. Dev.
Outsourcing Share	0.78	0.40
External Supplier With Tech. Sharing	0.02	0.12
External Supplier Without Tech. Sharing	0.76	0.41
IPR_j	1.42	0.19
$Comp_p$	0.26	0.06
$IPR_j \times Comp_p$	0.37	0.10
Rule of Law_j	13.76	2.50
$Corruption_j$	0.93	1.60
Per Capita GDP_j	10.13	0.47
Market $Size_j$	20.64	1.23
$Distance_j$	6.39	1.03

Table 7: Correlation Matrix (Intermediate Inputs Sample: 25,077 Observations)

	y_{ijp}	IPR_j	$Comp_p$	$IPR_j \times Comp_p$	Rule of Law_j	$Corruption_j$	Per Capita GDP_j	Market $Size_j$	$Distance_j$
y_{ijp}	1.00								
IPR_j	-0.01	1.00							
$Comp_p$	-0.09	0.05	1.00						
$IPR_j \times Comp_p$	0.01	-0.10	-0.09	1.00					
Rule of Law_j	0.00	0.75	0.01	-0.06	1.00				
$Corruption_j$	-0.01	0.77	0.04	-0.07	0.77	1.00			
Per Capita GDP_j	-0.01	0.87	0.05	-0.09	0.81	0.81	1.00		
Market $Size_j$	-0.01	0.20	0.07	0.01	-0.10	0.11	0.11	1.00	
$Distance_j$	-0.04	-0.44	0.09	0.07	-0.51	-0.46	-0.46	0.23	1.00