Working Paper

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Fragmenting global business processes: A protection for proprietary information

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Highlights

- ▮ We study the substitution effect between three types of protection for firms' proprietary content in service operations within international value chains: legal protection, internalization and the fine-slicing of foreign activities.

- ▮ We show that firms respond to the lack of legal protection and internal controls by fragmenting the operations entrusted to foreign production units.

- ▮ We find that firms increasingly rely on the protection mechanism of fragmentation as they accumulate host-country experience and as they source activities of higher content value.

RESEARCH AND EXPERTISE
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▌ Abstract

With the progress of information and communication technologies, the cost and efforts to remotely exchange information have drastically fallen. It has created new opportunities to leverage comparative advantages by reorganizing value chains along the geographic dimension and by reconsidering the organizational boundaries of the firm (i.e. the governance model of operations). However the global disaggregation of the firm's processes tends to increase the dispersion of firm's proprietary information and knowledge across locations and intermediate producers. Firms are potentially exposed to higher levels of misappropriation hazard and forced to elaborate protection strategies to mitigate that risk. This study shows that firms adjust the fragmentation of activities entrusted to foreign services production units to adapt their information and knowledge protection strategy to the availability of strong legal protection (from the local institutions) or internal control mechanisms. We hypothesize and empirically support that, when the above mechanisms are not available, firms use the substitute protection mechanism of fragmenting global business processes across multiple services production units. Through their capabilities to integrate the multiple fragments that compose production processes, firms can exploit the complementarities between these fragments while reducing the misappropriation hazard of individual fragments. We find also that the propensity to turn to this alternative protection mechanism increases with firm's host country specific experience and with the alternative value of the proprietary information.

▌ Keywords

Fragmentation, Misappropriation, Services, Information, Institutional environment, Outsourcing.

▌ JEL

F23, O34, L8.

Working Paper ▌

Fragmenting global business processes: A protection for proprietary information

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1. Introduction

Thank to the advances of information and communication technologies (ICT), firms have reorganized their value chain configuration to exploit previously untapped comparative advantages, in particular for their service activities. This reorganization not only tends to increase the geographic dispersion of the activities, but also affect the governance of the activities with the ability to further transfer activities to third party providers (in arm's length relationship). This disaggregation potentially exposed firms to higher levels of misappropriation hazard as the dispersion of firms' proprietary information and knowledge increases. To the extent that many production locations present a weak legal environment for the information/knowledge protection and that internalizing the foreign production (with a hierarchical model) may not be efficient, firms are forced either to develop alternative protection strategies, or to renounce to produce in risky locations or to outsource activities. This research addresses this issue of misappropriation hazard for service activities, and it shows that firms adjust the fragmentation of activities entrusted to foreign services production units to adapt their information and knowledge protection strategy to the availability of institutional protection or internal control mechanisms.

Together with the rise of new economies as potential host markets or trade partners, rapid improvements in information and communication technologies (ICT) have drastically lowered the cost and effort to exchange information remotely (Roberts, 2000; Forman, Goldfarb and Greenstein, 2005). The resulting ease of distant coordination and transaction has created unprecedented opportunities for firms to choose, and possibly completely rethink what is the best delivery location for every value chain activity; whether at home or abroad, and whether inside or outside organizational boundaries (e.g. Gereffi, Humphrey and Sturgeon, 2005; Buckley and Ghauri, 2004; Contractor, Kumar, Kundu and Pedersen, 2010; Mudambi and Venzin, 2010). Consequently, the nature of multinational enterprises (MNE) activity has evolved from the direct control over foreign subsidiaries to the coordination and integration of interdependent activities distributed across countries and possibly under ownership of other firms (Buckley, 2009). Such global disaggregation of firms' value chains across both geographical and organizational boundaries is associated with multidirectional flows of information and knowledge across the entities involved in the international network of MNEs

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(Mariotti, Piscitello and Elia, 2010; Piscitello, 2011), which, without proper protection, exposes firms to higher levels of misappropriation hazard (e.g. Martinez-Noya and Garcia-Canal, 2011).

Since many destinations offering comparative advantages for global sourcing of business services provide weak institutional environments, the use of regulative institutions as protection mechanism is often challenged (Delios and Henisz, 2000; Contractor et al., 2010). Internalization of the offshore operations may also not be feasible or efficient if, for instance, it requires major capital investments in risky and fast evolving environments (e.g. Kapler and Puhala, 2011), or if firms seek to access knowledge or capabilities that a market supplier owns (e.g. Kedia and Mukherjee, 2009; Alcacer and Chung, 2002). In these cases, protection through internal control may not be possible or desirable. According to Cohen, Nelson and Walsh's study (2000) on manufacturing innovation, firms seeking intellectual property protection in such context of high misappropriation risk have an alternative. They can exploit the complementarities that exist between tasks by separating them in different production units. Without the knowledge involved in the complementary tasks, the alternative value of the knowledge (i.e. its potential value in the hands of a competitor or a third party) involved in any individual production unit is limited (see also Zhao, 2006).

It means that, for instance, a pharmaceutical company involved in global drug development can reduce the risk of misappropriation by dispersing individual segments of the R&D process in multiple units. Clinical testing activities are often distributed across multiple countries and suppliers, each working on a specific type of trial, while downstream activities, like data compilation and analysis, are in turn outsourced to another provider at home or abroad (see Contractor, Kumar, Kundu and Pedersen, 2011, for more on this example). Thanks to their integration capabilities, pharmaceutical companies are able to exploit the complementarities that exist between the activities of the global drug development process. But the individual production units performing narrow tasks of the process cannot access and exploit the knowledge complementarities beyond the fragment of the process that they execute (see also Brusoni and Prencipe, 2001).

It follows that, when designing global value chains (e.g. Jensen, Larsen and Pedersen, 2013), firms facing high misappropriation hazard could substitute the lack of institutional protection and/or internal control by fragmenting processes and limiting the scope of activities entrusted to individual foreign production units, while using their integration capabilities to continue benefiting from the complementarities between the globally dispersed activities. We therefore hypothesize and find empirical support for the fact that both the lack of efficient host-country legal institutions and/or the absence of internal control push firms to react to the risk of misappropriation by limiting the scope of exposed activities – what we call "fragmentation". We find also that the host country-specific experience of firms and the alternative value of the knowledge and information involved in globally dispersed processes further increase the propensity to turn to the alternative "fragmentation" protection mechanism when legal protection is not available and/or internalization not desirable.

The empirical validation of the hypotheses is based on a unique dataset of the Offshoring Research Network (ORN). The sample of 581 foreign services implementations covers companies originating from 19 countries, with services production units initiated over the period 1995 to 2012 in 59 host-countries. Complemented with independent measures of legal protection from the International Intellectual Property Alliance (2013) and Park (2008), we test the hypotheses using two empirical techniques – nonlinear regressions and matching methods – and address potential endogeneity concerns.

Our unit of analysis is the foreign services production unit, defined as a delivery center located in a foreign country where a focal firm sources one or more functional activities. It can be a subsidiary of the focal firm, or belong to an external service provider with whom the focal firm has signed an outsourcing contract. We follow Davenport and Short (1990) definition of a business process as a "set of logically related tasks performed to achieve a defined business outcome" (p. 12) and study whether, in function of the risk of misappropriation of proprietary information, foreign services production units are likely to be entrusted entire business processes (i.e. all logically related tasks) or only portion(s) of processes (i.e. one or more logically related task(s) but not all).

That means we see the fragmentation of global business processes as an operational level adjustment variable to respond to the risk of misappropriation of proprietary information that results from the strategic level decision of sourcing part of a service functional area in a foreign country. As Kumar et al. (2009) describe, whereas at the strategic level sourcing decisions concern "what parts of the work cycle to move offshore, and when and where to move it" (p. 643; see also Lewin & Peeters, 2006), the operational level is concerned with the implementation of these decisions. The later requires choosing "exactly which parts of the work activities to keep collocated and which to distribute to foreign locations" (Kumar et al., 2009, p. 643). The operational partitioning of the work is what we study in this paper. It is similar to Oxley and Sampson's conceptualization (2004) of R&D alliances, according to which after establishing the overarching R&D goal of an alliance, partner firms must still decide how to organize the activities, and specifically what to exactly put within the scope of the alliance.

For example, a Western company may decide to outsource part of its IT function to India to take advantage of lower costs and a large market of experienced service providers. If, among other activities, the offshoring strategy involves an application development process that is made of 2 tasks – coding and testing –, the company can choose to: i) source both tasks from the same foreign subsidiary or service provider's center, ii) split the process between two sites – one responsible for coding, the other for testing, or iii) source one task abroad (coding for instance) but keep the testing part at home. Since coding and testing are complementary tasks, fragmenting the process across two sites, like in the first two options described, reduces the exposure of the proprietary information to the risk of misappropriation compared to the first option where the entire process is performed in the same foreign services production unit.

Complementing extant research on the growing disaggregation of firms' global value chains, this paper suggests that when foreign capabilities firms seek to access reside within countries that offer weak legal protection or within external market suppliers, they are more likely to fragment the processes across multiple services production units to adjust their

information protection strategy to the risk of leakage and misappropriation of proprietary information (data, knowledge or other forms of proprietary content). It is the first study that integrates process fragmentation to the other forms of protection mechanisms, and empirically validates the partial substitution between them in the context of global services value chains. It provides an illustration of how organizational design decisions (in this case the fragmentation and scoping of international value chain activities) can contribute to the control over knowledge processes in MNEs (see Foss and Pedersen, 2004, for a call for more research on this topic). A central contribution of this paper is therefore to propose fragmentation of business processes as a useful complement to the internalization of knowledge flows across countries (Buckley and Casson, 1976; Hennart, 1982; Rugman, 1981).

Moreover, the particular empirical context of the study, which includes a wide range of service activities, demonstrates that proprietary information protection considerations are relevant not only for the organization of global R&D and product development activities (e.g. Arundel, 2001; Cohen et al., 2000; Zhao, 2006), but for the internationalization of any service value chain activity that involves proprietary information (Lewin and Peeters, 2006; Jandhyala, 2013).

The next section links the risk of misappropriation of proprietary knowledge and information to the growing dispersion of value chain activities that progress in ICT enables. Section 3 builds the theoretical foundations for the adjustment of foreign activity scope as a partial substitute to internal control and legal protection; and develops the conceptual model with hypotheses and moderating factors. Section 4 presents the data and empirical model, before we comment on the results and perform additional robustness checks in Section 5. We conclude and discuss the contribution and potential limitations of the paper in Section 6.

2. From ICT enabled global value chains to risk of information misappropriation

Widespread adoption of ICT driven by a major drop in cost of IT has made distant communication and collaboration much cheaper and easier (Contractor et al., 2011). For instance, although the use of internet does not completely replace face-to-face interactions, it reduces the need for international travel for communication, coordination, and control. This makes the management of cross-border relations much cheaper and less time-consuming. In fact, progress in ICT has unleashed the potential of comparative advantages as never before, with firms incorporating into their strategy the systematic exploitation of location specific advantages including factor cost differentials across countries (Gereffi, 1999; Beugelsdijk, Pedersen and Petersen, 2009). In addition, in order to tap into external capabilities and achieve efficiency gains (Gilley and Rasheed, 2000; Amiti and Wei, 2009; Coucke and Sleuwaegen, 2008; Holcomb and Hitt, 2007; Hijzen, Inui and Todo, 2010), firms more and more tend to concentrate on specific parts of the value chain and transfer the other segments to external specialized providers (Quinn, 2000; Mol, 2005; Manning, Massini and Lewin, 2008). As a result, from a concentrated set of internalized activities, the value chain evolves towards a network of services production units spread across both national and organizational boundaries (Ghoshal and Bartlett, 1990; Zenger and Hesterly, 1997; Contractor et al., 2010; Piscitello, 2011), with mixed ownership / contracting modes of procurement (Buckley and Ghauri, 2004).

The generic logic behind value chain disaggregation and dispersion (Contractor et al., 2010) consists in the exploitation, for every individual task, of the most efficient production unit available across firms and locations. The geographic location of comparative advantages dictates the spatial configuration, while the location of capabilities inside or outside organizational boundaries conditions the governance model (internalization or outsourcing) chosen for a particular segment of the value chain (Jacobides and Winter, 2005). Such reasoning could lead to a complete disintegration of the value chain into molecular units (e.g. Zenger and Hesterly, 1997) spread along geographic space and organizational boundaries. However, the disaggregation and dispersion of value chain activities does not come without transaction, communication and coordination costs (e.g. Kumar et al., 2009; Contractor et al., 2010; Gooris and Peeters, 2013). The optimal slicing of the value chain is therefore determined by the tradeoff between the benefits of using the most efficient producer and the costs of integrating dispersed value chain activities (Coase, 1937; see also Jensen et al., 2013).

Moreover, due to the growth in information flows across countries and third-party intermediaries (Markus, Sia and Soh, 2012), the disaggregation and dispersion of value chain activities increase the risk of leakage and misappropriation of firms' proprietary information. In the context of global sourcing of business services, proprietary information includes but is not restricted to: technical and process knowledge, strategic direction of the firm and information about feasibility and profitability of certain options, customer-related data, as well as information about operational routines and key practices. The scoping of foreign services production units should therefore reflect not only the tradeoff between the benefits of fragmentation and cost of integrating globally dispersed activities, but also the protection of firms' proprietary information.

Several studies in economics and international business have demonstrated the positive impact of intellectual property protection on the attractiveness of countries for FDI (Lee and Mansfield, 1996; Javorcik, 2004; Khoury and Peng, 2011; Jandhyala, 2013). However, legal protection is not the only mechanism to protect firms' proprietary knowledge. For instance, Oxley (1999) found that, in countries where that type of protection is deficient, firms tend to internalize the activities to limit appropriation hazard through internal control (see also Williamson, 1991). This is consistent with Cohen et al.'s empirical study (2000) that identified legal protection (such as patent systems), secrecy, and the use of complementarities as the main mechanisms used by firms to protect proprietary R&D knowledge. While the first two mechanisms seek to avoid the misappropriation of the economic rent derived from proprietary knowledge, the use of complementarities seeks to reduce the alternative value of the knowledge and therefore lower the motivations for misappropriation (see Zhao, 2006).

3.   Information protection as determinant of the fragmentation of global business processes

Protecting proprietary information flows via secrecy may not be possible if a firm decides to outsource a portion of its value chain to a third party service provider. Only when the activities are internalized can firms use internal controls to guarantee secrecy (Oxley, 1999 – see also Williamson, 1991). Arundel (2001) therefore shows that there is a substitution of secrecy protection by legal protection when a key knowledge asset is not hold internally by one firm, but shared between two different organizations. But, as Oxley (1999) and Zhao

(2006) showed, legal protection is not always an option since its effectiveness depends on the quality of the regulative setting and the enforcement mechanisms that the host location offers (Lee and Mansfields, 1996; Delios and Henisz, 2000; Meyer, 2001; Javorcik, 2004). Firms could then turn to an alternative mechanism of intellectual protection whereby the value of activities conducted in weak IPR countries is unleashed only when combined, using strong internal linkages, with other complementary activities and knowledge of the value chain (e.g. Zhao, 2006 – and see also Cohen et al., 2000). This suggests that fragmenting business processes across different units (organizationally and/or geographically dispersed) such that the value of the proprietary information of one unit is limited without the proprietary information of the other process fragment(s), offers a third information protection mechanism when secrecy and/or legal protection are no appropriate options.

Although modularity enables the fragmentation of processes (Sanchez and Mahoney, 1996; Baldwin and Clark, 2000), perfect modularity whereby the fragments of a process are completely independent is indeed a very rare case (Ceci and Prencipe, 2013). Most of the time fragments of processes are interdependent (Kumar et al., 2009) and their integration across distance is what enables firms to capture the added value of the dispersed production units. Moreover, the growing modularity of products and their underlying processes (Sako, 2003) does not correlate with modularity of knowledge involved in the processes (Brusoni and Prencipe, 2001). In other words, modularity of process fragments does not imply independence of the associated proprietary knowledge and information. Firms therefore act as "system integrators" (Brusoni, Prencipe and Pavitt, 2001) that consciously coordinate knowledge and information flows across both the network of firm units and external providers. This view builds on the notion of architectural knowledge that allows firms to exploit knowledge linkages between different pieces of a product design while giving individual designers access only to the knowledge component they need (Henderson, 1992). It follows that the management of interfaces is a source of value creation that individual services production units cannot leverage because they do not understand the knowledge dependencies between them.

We therefore argue that limiting the scope of activities entrusted to foreign services production units to fragments of processes instead of entire processes is a way for firms to leverage information and knowledge complementarities to reduce the risk of misappropriation of proprietary information. Instead of operating an entire process in a single production unit, the process is fragmented to reduce the alternative value of the information involved.

Our core argument is thus that with geographically-bounded location advantages and external capabilities that are not easily transferable inside the firm, when a given activity of the value chain is best located (e.g. to access superior capabilities or leverage favorable resource endowments) in a host-country providing weak legal protection and/or outsourced to an external party, exploiting the complementarities between activities by adjusting the scope of activities entrusted to foreign production units may provide a substitute of protection mechanism for proprietary information.

It means that the fragmentation of relocated activities depends on the protection mechanisms available to prevent the misappropriation of proprietary knowledge and information. If legal protection is available and/or firms can use internal control to guarantee secrecy, they are more likely to bundle tasks and relocate entire processes – for instance to benefit from

economies of scope or reduce transaction costs. If legal protection is weak and/or internal controls are not possible, firms are more likely to protect their proprietary information by relocating fragments instead of entire processes. We further hypothesize that these relations are moderated by firm past experience with given locations and with the outsourcing model, as well as the value of the information involved in a particular segment of the value chain.

3.1. Fragmentation as substitute to legal protection of proprietary information

According to North (1990), regulative institutions have the central function of reducing transaction and information costs. They provide a stable structure that reduces the uncertainty of exchanges and secure property rights (see also Hoskisson, Eden, Lau and Wright, 2000; Meyer, 2001). For globally dispersed activities, efficient institutions are expected to ensure that proprietary knowledge and information flows are not subject to misappropriation hazard. However, in many destinations host-country institutions fail to provide such protection (Meyer, 2001; Javorcik, 2004; Zhao, 2006). Because of the location-bounded character of the advantage sought by firms (Dunning, 1998, and specific to international service sourcing: Jensen and Petersen, 2013), they will look for alternative protection mechanisms to reduce the protection hazard. Following Cohen et al. (2000) and Zhao (2006), we hypothesize that an alternative is to limit the scope of activities entrusted to a foreign production unit to process fragments instead of entire processes:

> H_1: The weaker the content protection offered by host-country regulative
> institutions, the more likely the foreign production unit will concentrate on
> process fragment(s) rather than being responsible for an entire process.

3.2. Fragmenting as substitute to secrecy through internalization

The internalization theory states that "the exploitation of firms' knowledge-based assets across national boundaries is often most efficiently undertaken internally within the hierarchical structure of the multinational enterprise" (Buckley and Strange, 2011, see also Buckley and Casson, 1976; Gereffi et al., 2005). Internal control is a key factor for protecting the secrecy of knowledge and intangibles, especially when institutions are unable to provide that protection (Oxley, 1999). But when the capabilities needed for a particular activity are located outside firms' organizational boundaries, internalizing the activity to reduce the protection hazard of knowledge and proprietary information flows may be costly (e.g. buy-out) and not the most effective strategy (e.g. Jacobides and Winter, 2005; Kapler and Puhala, 2011; Kedia and Mukherjee, 2009). Unless the firm renounces to use the superior external capabilities, it has to safeguard its proprietary information by alternative means. We therefore hypothesize that firms can substitute the protection that could have been provided by internalization with a reduction of the scope of activities entrusted to individual foreign production units:

> H_2: In the absence of internal controls, the foreign production unit is more
> likely to concentrate on process fragment(s) rather than being responsible for
> an entire process.

3.3. Experience as moderating factor

Experience helps reduce coordination and transaction costs. This leads firms to increase the scale of business services offshoring as well as offshore more knowledge-intensive activities (Jensen, 2009). It also modifies the balance between the cost of integrating fragments of processes and the gains from accessing specialized providers for every fragment of process. In addition, firms learn to align the organizational design of globally dispersed activities with the greater complexity of their offshoring strategies (Larsen et al., 2013). Specifically, they are likely to gain experience in dealing with local institutions and their imperfections (Delios and Henisz, 2003), and also learn from their model specific experience to develop organizational expertise for the particular governance model they have implemented (Hutzchenreuter, Lewin and Dresel, 2011). Hence, transaction costs diminish as firms accumulate experience in a particular host-country and develop capabilities to integrate external parties in their value chain (Jacobides and Winter, 2005; Quinn, 2000; Mol, 2005; Manning et al., 2008). We therefore expect experience to reduce the cost and effort needed to coordinate fragmented processes globally. At the same time, firms' ability to identify and leverage the fragmentation of global business processes as information protection mechanism is likely to increase. As Henderson's (1992) discussed, firms need to first acquire experience with a problem before they are able to fragment it into components without losing critical information. Hence, we hypothesize that, in order to access the most efficient producers – be they internal, external or globally dispersed – for every task of their value chain, firms increasingly identify the potential of fragmenting business processes to by-pass deficient legal protection and the absence of internal controls:

> H_{3a}: *The positive association between the lack of legal protection and the likelihood of fragmenting globally sourced business processes is higher for firms with high host-country specific experience than those with low host-country specific experience.*

> H_{3b}: *The positive association between the absence of internal controls and the likelihood of fragmenting globally sourced business processes is higher for firms with high outsourcing experience than those with low outsourcing experience.*

3.4. Value of the proprietary information as moderating factor

Activities involving specialized knowledge or information are particularly subject to misappropriation hazard because they tend to have a high value for third parties (Buckley and Casson, 1976). This is typically the case of creative and innovative functions (Kumar, Van Fenema and von Glinow, 2009; Zaheer, Lamin and Subramani, 2009; Contractor et al., 2010; Martinez-Noya et al., 2012). Since a greater alternative value reinforces the incentive for misappropriation and the subsequent loss incurred by the owner (Williamson, 1975), we expect the value of the proprietary information involved in an activity to directly affect the need for protection.

Indeed, foreign investments in activities with high knowledge value have been found more sensitive to weak legal protection than other activities (Lee and Mansfield, 1996; Javorcik, 2004). Knowledge intensity would also increase the propensity to internalize foreign

operations (Meyer, Estrin, Bhaumik and Peng, 2008). But firms may still have strong incentives to outsource (Contractor et al., 2010) if the best capabilities reside outside of their boundaries (e.g. Jacobides and Winter, 2005). In such environment, alternative mechanisms of protection provide essential substitutes to mitigate the institutional hazard that would otherwise constrain firms to stay away of certain countries, or refrain from outsourcing. Hence, we hypothesize that the greater the value of the proprietary information involved in an activity, the more likely a firm is to substitute weak legal protection or lack of internal control with a limitation of the process fragments entrusted to foreign production units:

> H_{4a}: *The positive association between the lack of legal protection and the likelihood of fragmenting globally sourced business processes is higher for activities with high alternative value of the involved proprietary information than for those with low alternative value of the proprietary information.*

> H_{4b}: *The positive association between the absence of internal controls and the likelihood of fragmenting globally sourced business processes is higher for activities with high alternative value of the involved proprietary information than for those with low alternative value of the proprietary information.*

4.   Empirical implementation

4.1. Data sources and sample

The dataset we use for the empirical study comes from an international and longitudinal survey conducted between 2005 and 2012 as part of the Offshoring Research Network (ORN) project[3]. The ORN global dataset is built on a common collection process whereby academic partners collect data in their respective countries (mostly U.S., Europe, and Australia). Firms of both manufacturing and service industries are represented, with no restriction on the host countries of sourcing initiatives. But only the international sourcing of business and technical service functions are reported, which excludes foreign manufacturing production activities.

For every intermediate service located outside of a firm or business unit's home country, the survey asks information about the strategic drivers that led to locate the particular service in a foreign country, what particular country, the activities involved (including the fragmentation of processes), the internal or outsourced governance model chosen, as well as information related to risks and performance outcomes. For this research, we use information on the scope of activities performed in individual foreign services production unit, the governance model, the location of both the home and host countries, the date when the activity was first located in the particular foreign country, and variables related to location choice drivers and firms' motivations for global sourcing. We complement the survey-based information with external sources of data for the institutional protection of content (at the country-level).

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[3] The Offshoring Research Network (ORN) is an international research project directed by Duke University Center for International Business Education and Research. Initiated in 2004, it aims at tracking the evolution of firms' sourcing practices for intermediate services. Different versions of the ORN survey dataset have been used in past studies (e.g. Hutzschenreuter et al., 2011, Lewin et al., 2009).

Using the foreign services production entity (delivery center where a focal firm sources a given type of service activity) as unit of observation enables assessing the impact of the availability of different protection mechanisms on the fragmentation of globally sourced processes, while controlling for other drivers of costs and benefits of value chain slicing. The 581 offshore implementations (i.e. service production units) of our sample cover 59 host-countries and 19 home-countries. With both in-house and third-party production units, we adopt a functional view of the value chain that does not exclude segments because of the nature of the producer (i.e. the firm or an external provider). The heterogeneity of the sample in terms of host locations (see the distribution of host-country regions in Appendix - Table A), type of functions (see the breakdown provided in Appendix - Table B) and firm industry (see Appendix - Table C) reinforces the general applicability of the findings.

A sample of international service activities is particularly suited for a study on the use of complementarities as protection mechanism through business process fragmentation. First, the need for interaction is a key characteristic of service production activities that differentiates them from most manufacturing production activities (Gallouj and Weinstein, 1997), and reflects the existence of complementarities between the activities (Arora and Ceccagnoli, 2006). Second, strong complementarities between internal and external service delivery sites have been documented in the context of service outsourcing, whether domestic or international (e.g. Gadrey and Gallouj, 2006; Doh et al., 2009; Kumar et al., 2009). Looking at our ORN sample, data reveal the existence of strong coordination needs among interdependent service production units: Only 5% of respondents strongly agree (and 8% somewhat agree) with the statement that the foreign services implementation requires only a small degree of coordination between the captive or outsourced offshore center and other company units. The coordination is what makes firms able to exploit complementarities between individual services production units while protecting the underlying fragmented proprietary information.

4.2. Variables and econometric methodology

The dependent variable reflects whether a focal service production unit performs only a subset of the tasks that make up a business process, or the entire process. Coded via a dummy variable, the value is set to *1* when the production unit performs one or multiple fragments (but not the entire process), and to *0* in case of an "entire process". The number of observations in both categories is relatively well-balanced with 44% and 56% of fragments and entire processes respectively (see Appendix - Table B). The measure of fragmentation has the advantage of not measuring the volume of activity performed. It means that foreign units can be dedicated to a specific fragment of a process (e.g. invoicing in the accounting function or product testing in product development), but have a large scale of operations and use large headcounts.

Figure 1 helps visualize the fragmentation choice we study. It shows the example of a process made of two related tasks. In all cases the firm has decided to relocate at least part of the process to a foreign country using one or more service production units which can be owned subsidiaries (represented in black) or service providers' facilities (represented in white), and can be located in the same or different countries.

Figure 1 – Choice of fragmentation for a 2-task process (coding of the dependent variable)

	Foreign service production unit 1	Foreign service production unit 2	Fragmentation coding - dependent variable
Entire process relocated to single production unit	■ ■	☐ ☐	0
		■ ■	0
	☐ ☐		0
		☐ ☐	0
Entire process relocated but to different production units	■	■	1
	■	☐	1
	☐	■	1
	☐	☐	1
Only part of the process is relocated	■		1
		■	1
	☐		1
		☐	1

Note: ■ refers to owned service production subsidiaries
☐ refers to service providers' facilities

For the explanatory variables, we capture the lack of internal control with a dummy variable set to *1* when the activity is contracted out to an outsourcing provider ("No_Internal_Control"), and *0* if the firm has internal control over the foreign activity using a wholly owned foreign unit or a joint-venture[4].

The measure of legal protection must reflect our broad definition of proprietary information that includes not only intellectual property and knowledge but also any private data. In addition, since property right laws are not always enforced (Jandhyala, 2013), we want to capture both the regulative framework and its effective enforcement. For that reason, following Javorcik (2004) and Zhao (2006), we use the "United States Trade Representative's Special 301 Watch List" based on the recommendations for intellectual property protection of the International Intellectual Property Alliance (2013)[5]. We compute a moving average looking at the annual presence, or not, of host-country *i* in the "Watch List" over the last five years before the launch year of the foreign unit[6]. We then obtain the

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[4] Joint ventures represent less than 3 % of the sample.

[5] See alternative measures of institutional protection in Section 5 – Additional analyses and robustness checks.

[6] Prior to the computation of the moving averages, we coded the annual presence of host country *i* in the list with a score of *1* if it is in the Watch List in year *t,* and *0* otherwise.

explanatory variable "Content_legal_Risk" that measures the risk of deficient host-country institutions at protecting proprietary content. Compared to Zhao (2006), who simply codes the presence of the host-country in the Watch List in a given year, we use a moving average on the lagged values, which has the advantage of being less influenced by punctual shocks[7] and of referring to the period that precedes the location of the activity in the particular country. Our index is thus less volatile and better aligned with the decision timeframe of the decision maker.

Using the ORN survey data, we develop two indicators of experience. First, we measure firms' country-specific past experience by counting the number of service production units already initiated in the same country in the past (variable: "Country_Experience"). Second, to reflect the extent to which firms are used to lacking internal control to safeguard the secrecy of proprietary information, we measure firms' outsourcing-specific experience by counting the number of outsourced service units launched prior to the focal unit, irrespective of the host country. We denote the variable "Outsourcing_Experience". Both experience variables serve as basis for splitting the sample between firms that have low or high country/outsourcing past experience. For each experience indicator, we obtain two subsamples with, on one side, observations with below median value, and on the other side, observations with above median value.

To capture the alternative value of the proprietary information, we build upon the innovative and knowledge intensive nature of the foreign unit's activity, and follow recent work by, for instance, Zaheer et al. (2009), Kumar et al. (2009), Contractor et al. (2010), Jensen and Petersen (2011) and Martinez-Noya et al. (2012), to split the sample using functional categories. The "low alternative value" subsample includes contact center activities, administrative services, procurement, information technologies (IT) services, and software development[8]. The "high alternative value" subsample includes knowledge services and product development, which is made of R&D, design and engineering services. We test alternative sample splits as robustness checks. Appendix - Table B presents the distribution of production units across the functional categories.

In order to differentiate the specific effect of legal information protection from the overall quality of the host-country regulative institutions (defined by their ability to reduce the transaction costs, see North, 1990 and Meyer, 2001), we add a control variable measuring the overall institutional risk (i.e. not specific to information protection). We use the index "rule-of-law" from the World Bank Governance indicators (see Kaufmann, Kraay and Mastruzzi, 2010) given for the launch year of the foreign entity. We then take the opposite values to capture the institutional *inefficiency* (variable denoted "Institutional_Ineff"), instead of the quality of institutions.

Similarly, to differentiate the country and model specific experience from the general global services sourcing experience of firms, we control for the number of foreign services

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[7] Many authors use this smoothing technique, such as Van Pottelsberghe and Frank Lichtenberg (2001) on FDI flows and innovation, or Hutzschenreuter and Voll (2008) on the relation of performance and cultural distance

[8] To further assess the stability of our results with respect to this sample split, an alternative categorization of the foreign functions is performed in the robustness checks of Section 5.

production units, whether outsourced or not and irrespective of the host country, launched prior to the focal unit (variable: "Global_Sourcing_Experience").

We control also for other factors that may affect fragmentation decisions, possibly through an impact on the choice of location and/or governance mode for the foreign services production unit. We control for the size of the firm in the home-country (variable "Firm_Size") using the logarithm of the number of employees working for the firm in the home-country. Following Lewin et al. (2011), we control for the launch year of the foreign unit to account for external dynamics such as the growing maturity of service providers over time. We use three time periods, each covering approximately one third of the observations. That means we introduce in the regressions two binary variables: "Before_2005" for units launched until 2004 and "After_2006" for those launched since 2007. To avoid a potential home-country bias, we add a binary variable, called "US_Home_Country", set to *1* if the firm's home-country is the US, and *0* otherwise (66% of the foreign units have the US as home-country, while no other home-country represents more than 10% of the sample). Since the configuration of the value chain may be influenced by the functional area of the service performed by the foreign production unit as well as the industry of the firm (Lewin and Peeters, 2006; Contractor et al., 2010; Liu, Feils and Scholnick, 2011), we include eight functional dummies (see Appendix - Table B) and three industry dummies ("Manufacturing", "Financial_Services", and the non-financial service industry as baseline, see Appendix - Table C).

Finally, we control for the motivations behind the international sourcing of services strategy and for the determinants of the location choice using the related ORN survey results. The importance of these factors is coded as binary variables equal to *1* if the motivation was a key driver to use a foreign services unit rather than a domestic one for a particular activity (otherwise *0*). We cover the following potential motivations: "Competitive pressure", "Business process redesign", "Contributing to a broader global strategy", "Labor cost savings", "Exploit location-specific advantages", "Access to new markets" and "Domestic shortage of qualified personnel". Regarding the location choice, we account for the following potential drivers (based on respondents' scores on a 1-to-5 Likert scale),: "Low cost of labor", "Government incentives", "Low costs (besides labor costs)", "Access to local market", "Talent pool available" and "Location of the best service provider".

The descriptive statistics, correlations and variance inflation factors (VIF) of the explanatory variables are reported in Appendix - Table D[9]. Despite significant correlations between certain variables, the VIF values indicate that our estimations do not suffer from multicollinearity. The mean VIF does not exceed 1.5 and the maximum VIF remains at 2.0 (associated with the variable controlling the importance of labor costs). All VIF values are therefore well below the accepted limit of 10 (see Neter, Wasserman and Kutner, 1983).

We use a binary logistic regression model that estimates the probability for the foreign services unit to be given responsibility for one or more *process fragment(s)* (dependent variable = *1*), instead of an *entire process* (dependent variable = *0*), conditional on the knowledge and information protection variables and the controls. We use cluster-robust standard errors (see Arellano, 1987; Rogers, 1994) at the company level to correct for the

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[9] Descriptive statistics, correlations and VIF values for the internationalization drivers and locational factors are available from the authors upon request.

positive correlation of fragmentation decisions between different foreign services production units of a same company (i.e. intra-group correlation).

We also integrate the risk of endogeneity via two complementary methods. First, we address the potential simultaneity or reverse causality of the effect of host-country choice on the fragmentation of business processes. This potential endogeneity issue may emerge if what drives the reconfiguration of the value chain through global sourcing of services is to redesign the production process instead of the possibility to leverage host-country comparative advantages. Therefore, to avoid the fragmentation decision to affect the legal protection of proprietary information (via the host-country choice), we use additional information from the ORN survey to include in the analysis only global services sourcing initiatives motivated by the exploitation of locational advantages. The criteria we use to keep a foreign services production unit in the sample is to have a score of 4 or 5 on a 5-points Likert scale for the importance of labor arbitrages or the access to qualified personnel in the host country (see Gooris and Peeters, 2014, for a similar approach). The restriction has moderate effect on the sample size with only 8% of the foreign services production units that do not fulfill the criteria. Second, we use another method to address the risk of endogeneity that arises from the variable capturing the lack of internal control. Fragmentation decisions might affect the choice of the governance model and the ability to exert internal control. To tackle this potential issue, we use a matching method based on the comparison of similar global sourcing initiatives that differ only in the governance model of the foreign services production unit (see in Section 5 "Additional analyses and robustness checks" for further details).

5.   Results

5.1. Main models

We estimated the logit model for ten configurations that are presented in Table 1.1 (with the marginal effects in columns (1'), (2'), (3') and (4')) and Table 1.2. In the first table, Model (1) presents a configuration that includes only the control variables. Models (2) and (3) introduce respectively the variables "Content_Legal_Risk" (for the lack of legal protection of proprietary information) and "No_Internal_Control" (for the outsourcing governance model). The variables "Content_Legal_Risk" and "No_Internal_Control" are then introduced simultaneously in Model (4).

The regressions in Table 1.2 test the moderating effect of host country experience (Models (5) and (6)), outsourcing experience (Models (7) and (8)), and information value (Models (9) and (10)). To test hypothesis H_{3a} on host country experience, Model (5) is estimated using the subsample given by observations with below median country experience (variable: "Country_Experience"). Estimations for Model (6) are given for the complementary subsample of the top 50% implementations in terms of country experience. Model (7) and (8) follow the same construction, but using the median of outsourcing experience (variable: "No_Internal_Control_Experience") in lieu of the host country experience. The last two configurations test hypothesis H_4 on the moderating effect of information value using functional categories to split the sample.

Table 1.1 - Estimation results of the logistic models

Logit model – Fragments of process	(1) Controls only	(1') Marginal effects for "Controls only"	(2) Legal protection of content	(2') Marginal effects for "Legal protection of content "	(3) No internal control	(3') Marginal effects for "No internal control"	(4) Main model	(4') Marginal effects for "Main model"
Content_Legal_Risk			1.526*** [0.000]	0.313*** (0.073)			1.485*** [0.000]	0.298*** (0.069)
No_Internal_Control					0.818*** [0.003]	0.171*** (0.056)	0.782*** [0.006]	0.157*** (0.054)
Global_Sourcing_Experience	0.068 [0.119]	0.015 (0.009)	0.097** [0.010]	0.020** (0.008)	0.081* [0.060]	0.017* (0.009)	0.111*** [0.005]	0.022*** (0.008)
Firm_Size	-0.033 [0.545]	-0.007 (0.012)	-0.060 [0.279]	-0.012 (0.011)	-0.038 [0.476]	-0.008 (0.011)	-0.064 [0.239]	-0.013 (0.011)
Institutional_Ineff	0.571*** [0.009]	0.123*** (0.045)	0.461** [0.029]	0.094** (0.043)	0.503** [0.021]	0.105** (0.045)	0.409** [0.049]	0.082** (0.041)
Software_Development	-0.041 [0.901]	-0.009 (0.070)	0.011 [0.973]	0.002 (0.068)	-0.140 [0.678]	-0.029 (0.070)	-0.098 [0.774]	-0.020 (0.068)
Contact_Centers	-0.990** [0.018]	-0.213** (0.087)	-0.988** [0.018]	-0.202** (0.083)	-1.053** [0.013]	-0.221*** (0.085)	-1.067** [0.012]	-0.214*** (0.082)
Admin_Processes	-0.720** [0.048]	-0.155** (0.077)	-0.753** [0.046]	-0.154** (0.077)	-0.600 [0.116]	-0.126 (0.079)	-0.643 [0.101]	-0.129* (0.078)
Procurement	-0.173 [0.775]	-0.037 (0.130)	0.121 [0.834]	0.025 (0.119)	-0.048 [0.942]	-0.010 (0.140)	0.249 [0.699]	0.050 (0.129)
Product_Development	-0.639 [0.134]	-0.137 (0.091)	-0.544 [0.200]	-0.111 (0.086)	-0.571 [0.184]	-0.120 (0.089)	-0.483 [0.259]	-0.097 (0.085)
Knowledge_Services	-0.625 [0.234]	-0.134 (0.112)	-0.541 [0.311]	-0.111 (0.109)	-0.610 [0.228]	-0.128 (0.104)	-0.533 [0.301]	-0.107 (0.102)
Manufacturing	0.052 [0.895]	0.011 (0.084)	0.082 [0.836]	0.017 (0.081)	-0.073 [0.858]	-0.015 (0.085)	-0.040 [0.921]	-0.008 (0.082)
Financial_Services	-0.256 [0.482]	-0.055 (0.078)	-0.367 [0.298]	-0.075 (0.072)	-0.406 [0.277]	-0.085 (0.078)	-0.504 [0.173]	-0.101 (0.073)
Before_2005	-0.220 [0.472]	-0.047 (0.065)	-0.061 [0.830]	-0.013 (0.058)	-0.290 [0.334]	-0.061 (0.062)	-0.132 [0.638]	-0.026 (0.056)
After_2006	-0.241 [0.428]	-0.052 (0.065)	-0.240 [0.433]	-0.049 (0.062)	-0.350 [0.251]	-0.073 (0.063)	-0.354 [0.249]	-0.071 (0.061)
US_Home_Country	0.219 [0.474]	0.047 (0.065)	0.169 [0.569]	0.035 (0.061)	0.151 [0.629]	0.032 (0.065)	0.107 [0.723]	0.021 (0.060)
Internationalization drivers dummies	Included	Included	Included	Included	Included	Included	Included	Included
Loc. factors variables	Included	Included	Included	Included	Included	Included	Included	Included
Observations	581	581	581	581	581	581	581	581
Log likelihood	-359.5		-346.2		-352.5		-340.1	
DF	27		28		28		29	
χ2 test	52.35		83.03		57.68		82.65	
Pseudo R²	0.09		0.10		0.11		0.14	

Note: Cluster robust p-values in brackets: *** p<0.01, ** p<0.05, * p<0.1.

For the marginal effects, cluster robust standard errors are reported in parentheses.

Baseline function: IT; baseline industry: Services; baseline launch year period: 2005-2006. All specifications have a constant term.

The marginal effects for binary variables are based on the discrete change from the base level (from value *0* to *1*).

Source: own computations based on ORN data.

Table 1.2 - Estimation results of the logistic models (continued)

Logit model – **Fragments of process**	(5) Low country experience	(6) High country experience	(7) Low outsourcing experience	(8) High outsourcing experience	(9) Low value content	(10) High value content
Content_Legal_Risk	0.858**(a)	4.333***(a')	1.851***	0.970	1.208*** (c)	1.793** (c')
	[0.034]	[0.000]	[0.000]	[0.158]	[0.006]	[0.038]
No_Internal_Control	0.319	1.653***	0.817** (b)	1.224 (b')	0.406 (d)	2.647*** (d')
	[0.359]	[0.004]	[0.020]	[0.118]	[0.206]	[0.000]
Global_Sourcing_Experience	0.191***	0.178**	0.107*	0.175**	0.128***	0.118
	[0.000]	[0.022]	[0.081]	[0.040]	[0.008]	[0.112]
Firm_Size	-0.039	-0.184	-0.090	-0.009	0.027	-0.193
	[0.552]	[0.117]	[0.122]	[0.930]	[0.655]	[0.180]
Institutional_Ineff	0.545**	0.282	0.611**	0.165	0.334	1.216*
	[0.021]	[0.639]	[0.016]	[0.698]	[0.207]	[0.097]
Software_Development	0.127	-0.806	-0.474	0.269	-0.046	
	[0.767]	[0.238]	[0.272]	[0.633]	[0.893]	
Contact_Centers	-1.314***	-0.700	-1.118**	-0.628	-1.050**	
	[0.009]	[0.340]	[0.023]	[0.412]	[0.015]	
Admin_Processes	-1.126**	-0.045	-0.232	-1.126	-0.717*	
	[0.029]	[0.944]	[0.648]	[0.129]	[0.061]	
Procurement	0.213	0.532	0.336	0.242	0.182	
	[0.834]	[0.584]	[0.672]	[0.848]	[0.765]	
Product_Development	0.017	-0.997	-0.428	-0.938		
	[0.973]	[0.221]	[0.388]	[0.173]		
Knowledge_Services	-0.455	0.334	-0.614	0.548		-1.219
	[0.423]	[0.687]	[0.239]	[0.562]		[0.135]
Manufacturing	-0.379	-0.296	0.169	-1.089	0.188	-0.780
	[0.375]	[0.726]	[0.670]	[0.157]	[0.721]	[0.287]
Financial_Services	-0.422	-1.039	-0.204	-1.780***	-0.581	0.596
	[0.283]	[0.120]	[0.587]	[0.010]	[0.130]	[0.509]
Before_2005	-0.386	0.470	0.356	-0.699	-0.344	0.913
	[0.296]	[0.376]	[0.341]	[0.118]	[0.292]	[0.221]
After_2006	-0.532	-0.577	-0.248	-0.588	-0.247	-0.785
	[0.168]	[0.314]	[0.525]	[0.297]	[0.479]	[0.271]
US_Home_Country	-0.051	0.248	0.074	0.689	0.092	-0.308
	[0.886]	[0.699]	[0.806]	[0.284]	[0.769]	[0.742]
Internationalization drivers dummies	Included	Included	Included	Included	Included	Included
Loc. factors variables	Included	Included	Included	Included	Included	Included
Observations	348	233	338	243	435	146
Log likelihood	-193.5	-111.6	-193.4	-117.3	-252.8	-62.44
DF	29	29	29	29	27	24
χ^2 test	82.00	114.1	67.19	154.0	69.16	57.28
Pseudo R²	0.181	0.31	0.17	0.27	0.15	0.38

Note: Cluster robust p-values in brackets: *** p<0.01, ** p<0.05, * p<0.1.
Baseline function: IT; baseline industry: Services; baseline launch year period: 2005-2006. All specifications have a constant term.
Source: own computations based on ORN data.

With a positive and significant coefficient for the variable "Content_Legal_Risk", Models (2) and (4) confirm hypothesis H_1 that the lack of legal protection pushes firms to limit to fragments of processes the service activities they entrust to individual foreign production units (instead of entire processes). Models (3) and (4) also validate Hypothesis H_2 with the

variable capturing the absence of internal control (due to outsourcing) that displays a positive and significant coefficient. When firms cannot use internal control mechanisms to safeguard the secrecy of proprietary information, they tend to adjust by limiting the scope of activities entrusted to foreign units. While the estimates and their p-values indicate respectively the direction of the effect of the variable and the statistical significance, the marginal effects[10] (see Table 1.1) indicate the magnitude of the effect. Based on Model (4') "main model", the propensity to perform process fragments (instead of entire processes) increases by 29% on average (the results are based on linear approximations) when the quality of the legal protection jumps from the weakest countries of the sample in that dimension to the best ones (i.e. using respectively the minimum and maximum values for the variable measuring the risk of legal protection). Similarly, lacking internal controls when an activity is outsourced instead of performed internally adds 15% chances of fragmenting processes across production sites.

Models (5) and (6) confirm H_{3a} that firms' past experience in the host country reinforces the effect of weak legal protection found in the previous model. The coefficient of the weak legal protection variable is significant in Model (5), but at a lower level than the one of Model (6). A χ^2 test (using cluster-robust variances) further confirmed that the estimates (a) and (a') are significantly different (p-value < 0.001). This indicates that the impact of weak legal protection on the likelihood of fragmenting international business processes is significantly higher for firms that have experience in a particular host-country than for firms that have no experience in the particular host-country. The greater the country-specific experience, the more firms become aware of legal protection weaknesses; and the more likely they are to exploit complementarities between tasks by limiting the scope of activities entrusted to individual service production units.

In contrast, past outsourcing experience does not seem to modify how the lack of internal control influences firms' process fragmentation decisions (Models (7) and (8)). The χ^2 test reveals that estimates (b) and (b') are not significantly different (p-value = 68%). Hypothesis H_{3b} is not verified: Whether firms have already accumulated outsourcing experience or not, we cannot differentiate them in terms of propensity to substitute the impossibility to safeguard the secrecy of proprietary content due to the lack of internal control with the fragmentation mechanisms.

Turning to the effect of the alternative value of the proprietary information, we find that it does not significantly affect the impact of weak legal protection on the likelihood of fragmenting international processes. The effect remains significant in both subsamples: estimates (c) and (c') are not significantly different, meaning that H_{4a} is not verified[11]. But as hypothesized in H_{4b}, the effect of the lack of internal control variable ("No_Internal_Control") is significantly higher in the case of high information value activities: (d) and (d') are significantly different (p-value of χ^2 difference test < 0.001)[12]. Firms seem particularly sensitive to the risk of

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[10] The marginal effects reported in Table 1.1 are the average marginal effects. The marginal effects are first estimated for each observation of the sample. Then the mean of these probability changes is reported in columns (1'), (2'), (3') and (4'). The marginal effects for binary variables are based on the discrete change from the base level (from value *0* to *1*).

[11] Estimation results also indicate that legal risk has a significant impact on the fragmentation decisions related to the "low information value" functions.

[12] We also considered the inclusion of "Software Development" in the group of "high information value", instead of the group "low information value". The modification of the sample split corroborates the previous results on the moderating

misappropriation and how process fragmentation can help mitigate it when they outsource activities that involve information of high alternative value, such as product development and knowledge services.

5.2. Additional analyses and robustness checks

To check the stability of the results, we have tested several variations of the previous empirical models. We have also conducted additional tests to make sure our conclusions do not suffer from endogeneity problems.

First, since the measure of legal risk of each country varies over time, we can further validate hypothesis H_1 by adding host-country fixed effects (i.e. we capture the time variation only, instead of the host-country/time variation of the legal risk). This allows separating host-country effects not related to the legal risk that may affect the propensity to fragment international processes and potentially bias our estimations. As reported in Model (i) in Appendix - Table E, the addition of country-fixed effects does not alter the results pertaining to the host-country legal risk variable nor the lack of internal control variable.

Second, to ensure that the validation of hypothesis H_1 is not specific to the particular measure of legal protection used so far (constructed based on the recommendations of the International Intellectual Property Alliance 2013), we tested Model (4) with two alternative measures of intellectual protection. We first substituted the original measure with the index of Ginarte and Park (variable denoted "Park_Content_Risk", see Ginarte and Park, 1997; Park, 2008) - a well-known index of the intellectual property protection provided by patents. However, the index received the critic that it overlooks the effective enforcement of the protection framework (Branstetter, Fisman and Foley, 2006). As a second alternative measure, we used the product of the Ginarte and Park index with the World Bank governance index of "rule-of-law" (Kaufmann et al., 2010), following the logic that rules without enforcement are useless, and vice versa for enforcement without rules (variable denoted "Park_Enforced_Content_Risk"). The results related to the alternative measures are presented in Models (ii) and (iii) in Appendix - Table E. They confirm the results of Models (2) and (4) in Table 1.1.

Third, we considered the possibility of interaction effects between the two main variables of the model. The combination of low values for the legal protection variable with an outsourcing model could have a stronger effect than the sum of the individual effects of these variables. Unfortunately, interaction estimates of non-linear regressions (such as Logit regressions) cannot be directly interpreted as cross-derivatives (see Norton, Wang and Ai, 2004; Greene, 2010). But using the adequate method to compute the observation-specific cross-derivatives (taking into account the value of the other independent variables, see Norton et al., 2004), none of the interaction specifications we tested returned a significant effect[13]. The absence of significant interaction could reflect that the substitution between the

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effect of the information value: the difference between the estimates of the lack of internal control variable in both subsamples (d. and d'. in Table 1.2) is even more significant, and the difference between estimates of the legal protection variable (c. and c'. in Table 1.2) remains not significant.

[13] We tested interactions using the variable "Content_legal_Risk" in its linear form, but also using various discrete transformations.

three protection mechanisms is only partial (Cohen et al., 2000). But according to Greene (2010), the adequate estimation technique[14] is "*generally uninformative and sometimes contradictory and misleading*". This explains why, for the moderating factors, we followed Greene's recommendation (2010) to address interaction effects through model design (in our case, split samples with χ² tests of difference between coefficients across subsamples), rather than by estimating interaction coefficients at the analysis stage.

Fourth, to check the stability of the experience effects, we replicated the estimations using alternative sample splits based on different experience thresholds. Instead of using the median value of the country experience and outsourcing experience variables, we split the sample to have on one hand the 33% lowest values of each experience variable and on the other hand the remaining 66% highest values. We then switched the thresholds to have the lowest 66% in one subsample and the highest 33% in the other subsample. Results remain unchanged at the exception of a loss of significance in the χ^2 test related to the difference of the estimated coefficients for the legal protection variable using the 33% threshold sample split (from less than 0.1% to 33%)[15]. In line with Mudambi (2008) who identified the extremes of the value chain as high value-added activities, we modified also the sample split related to the information value by transferring marketing activities to the high alternative value information subsample. It did not affect the results pertaining to the two main variables of the study.

Fifth, we wanted to rule out the possibility that the arbitrage between the three protection mechanisms is influenced by the legal protection available in the *home-country,* which could introduce an omitted variable bias. When the legal protection risk of the *home-country* is included in Model (4) "Main Model" (using the same indicator as for the host-countries' legal protection risk)[16], the effects and significance levels of the estimates of the focal variables – "Content_Legal_Risk" and "No_Internal_Control" – remain unchanged, as reported in Model (iv) in Appendix - Table E. In addition, we find no significant association between the risk of misappropriation in the *home-country* and the likelihood that firms use the process fragmentation protection mechanism (p-value of 51%).

Sixth, we verified that our results do not capture scale adjustments (i.e. reduction in local commitment) of foreign services production units instead of the fragmentation of global business processes to respond to the risk information and knowledge misappropriation. Although the information was available for only 456 units out of 581 in the full sample, we tested the hypotheses with an additional control variable for the size of the foreign services production unit (measured as the log of the number of employees). Results related to all four hypotheses remained unchanged[17].

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[14] Bowen (2012) developed a method to evaluate interactions in logit models that distinguish the structural effect of the interaction (i.e. due to the non-linearity) and the secondary effect (i.e. the desired intrinsic effect of the interacted term). This promising approach was not applicable to our empirical setting because the statistic routine only addresses continuous variables at the present date.

[15] Regression results and χ^2 tests are available from the authors upon request.

[16] To be consistent with the construction of Model 4, we also controlled for the overall quality of the *home-country* regulative institutions "Institutional_Instab_For_Home_Country".

[17] Regression results and χ^2 tests are available from the authors upon request.

Seventh, we checked that the combination of the focal variables with the multiple controls for internationalization motivations and drivers of location choices does not create spurious effects. As reflected in Model (v) in Appendix - Table E, removing these controls does not affect the main results.

Last, the sequence of decisions for the configuration of international value chains has until now been discussed based on the firms' internationalization logic in light of prior evidence found in the literature. Against this background, country choices (with the related content risk) and governance model decisions come before scope adjustment choices (e.g. Kumar et al., 2009; Oxley and Sampson, 2004). To avoid the potential endogeneity bias that could affect the results if the strategic choice of the host country was affected by the operational decision of process fragmentation, the main model already limits the estimations to global sourcing initiatives primarily driven by the exploitation of locational advantages. Similar to Gooris and Peeters (2014), this ensures that the country risk a firm faces does not result from activity scoping motivations. This restriction reduced the sample by 7 %, but the results pertaining to the key hypotheses and the moderating effects are the same with both the restricted and unrestricted samples (in level, sign or significance)[18].

To further check potential simultaneity or reverse causality issues, we follow the recommendations of Reeb, Sakakibara and Mahmood (2012) and Roberts and Whited (2011) to use a propensity scoring matching approach as an alternative to the discrete choice regressions. Results for the "No_Internal_Control" variable would suffer from endogeneity if the decision to outsource or internalize foreign services production was affected by the process fragmentation choices firms make (i.e. non-random assignment of governance models). The regression approach adopted previously does not prevent this causation issue so we address it by approximating a randomized-controlled experiment using a matched sample approach (in our case, a propensity score matching – PSM – method). The logic is to create a pseudo-random distribution of the treatment effect – No_Internal_Control – and then evaluate the fragmentation decision outcome (for details on the PSM procedure, see Abadie and Imbens, 2006; Caliendo, M. and Kopeinig, 2008). Compared to regressions (both linear and discrete ones), the matching method provides comparable production units that differ only in the presence or not of internal control. We can then test the potentially higher propensity to fragment international processes that are outsourced. It also relaxes the linear specification of the latent variable used for the logit/probit models via the use of a non-parametric approach. We provide more details on the implementation of the PSM method in the *"Technical appendix"*. As reported in Appendix – Table F, the results of the PSM method confirm that firms that outsource foreign services production units have a higher propensity to fragment international processes. Jointly with the sample restriction that ensures that location is chosen first, it minimizes the risk that the variables of interest would suffer from endogeneity issues.

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[18] The estimation output for the unrestricted sample is available from the authors upon request.

6.   Concluding discussion

Fast improvements in ICT reduce the coordination and transaction costs of managing global value chains. But the resulting dispersion of proprietary knowledge and information increases the misappropriation hazard that firms face.

For a long time IB research has highlighted how the strategic choice of host country as well as internalization of foreign operations can help firms mitigate that risk. But to the extent that internalizing an activity may not be the most effective option if the best capabilities for that activity do not reside within the firm (Jacobides and Winter, 2005; Buckley, 2009; Hennart, 2009; and see also Alcacer and Chung, 2002), and in contrast to what Oxley (1999) suggests, hierarchy should not be the only answer to the lack of legal protection for proprietary content in a host country. Similarly, since comparative advantages are location-bounded, avoiding a particular location because of the weak legal protection may not be the best option if the location offers the best capabilities, knowledge, or lowest cost for the activity (Cantwell and Mudambi, 2005). Staying away from the country could deprive the firm from a source of competitive advantage. How to adapt knowledge and information protection practices in function of the host country and governance model of global sourcing initiatives then becomes a central operational question in the orchestration of global value chain networks (see also Piscitello, 2011).

In that context, our study of 581 foreign services production units suggests that fragmentation of business processes across multiple service production units can act as a partial substitute protection mechanism to legal protection or internalization. The reason is that the limited content associated with a process fragment instead of an entire process has a low, or no, outside value as standalone content, which reduces the incentives for misappropriation (see also Zhao, 2006).

As often with empirical research, study limitations open avenues for further research. For instance, we look only at individual foreign services production units and not the entire value chain including service production units located in a firm's home country. We also do not have a continuous variable to represent the degree of process fragmentation instead of just the existence of fragmentation. But keeping in mind technical and data constraints, we trust that our results add novel and empirically valid insight into the protection of proprietary knowledge and information in global value chain networks.

Specifically, a central contribution of the paper is to suggest that internalization is not the only answer to a lack of legal protection in a host country. When internalization is not desirable and legal protection is weak, the scoping of activities entrusted to foreign production units offers an alternative adjustment variable that allows companies to not renounce to the most appropriate host country or governance model because of the misappropriation risk it generates.

Moreover, in addition to complementing internalization theory, our findings offer empirical evidence to Contractor et al.' concept (2011) of "*judicious outsourcing*", according to which firms would share only discrete bits of entire processes so contract providers are unable to "put the whole system together to become a competitor" (p. 1423). The use of task complementarities as protection mechanism though process fragmentation has already been

documented in the context of global R&D activities (e.g. Cohen et al;, 2000; Zhao, 2006). Our results based on a broader sample of service activities suggest that knowledge and information protection considerations apply to other categories of services as well, not just to the R&D function.

Finally, the study points to a dynamic learning effect whereby firms progressively identify and leverage the process fragmentation protection mechanism as they build country-specific experience. The more firms are exposed to a particular host country's legal protection deficiencies, the more they develop the capability to cope with it by adjusting the scope of activities of their foreign services production units in that country. This is not the case with outsourcing-specific experience probably because of two effects going in opposite direction: At the same time as firms understand that process fragmentation could help reduce vendor opportunism, they probably build trust in the outsourcing model and feel more comfortable entrusting even entire processes to external service providers.

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Appendix

Table A - Distribution of international sourcing implementations by host region

Host Region	Freq.	Percent
Africa	12	2.07
Australia & New Zealand	5	0.86
Central America	33	5.68
China	40	6.88
East Asia	2	0.34
Eastern Europe	58	9.98
India	281	48.36
Latin America	25	4.30
Middle East	5	0.86
North America	34	5.85
South East Asia	62	10.6
Western Europe	24	4.13
Total	581	100

Source: own computations based on ORN data.

Table B - Distribution of international sourcing implementations by function

	Service activities	Total	Fragmented process	Entire process
Low information value	Administrative Functions	87	42	45
	Contact Center	91	39	52
	IT	104	67	37
	Marketing and Sales	24	19	5
	Procurement	20	13	7
	Software Development	109	71	38
	Sub-total	435	251	184
High information value	Knowledge Services	66	28	38
	Product Development	80	48	32
	Sub-total	146	76	70
Overall total		581	327	254

Source: own computations based on ORN data.

Table C - Distribution of international sourcing implementations by industry

Industry	Total	Fragmented process	Entire process
Services (non-finance)	282	164	118
Finance	171	87	84
Manufacturing	128	76	52
Total	581	327	254

Source: own computations based on ORN data.

Table D: Descriptive statistics, correlations and VIFs of the explanatory variables

		Mean	S.D.	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	VIF
(1)	Content_Legal_Risk	0.78	0.37	0.00	1.00	1.00																1.38
(2)	No_Internal_Control	0.57	0.49	0.00	1.00	0.25 (0.00)	1.00															1.46
(3)	Global_Sourcing Experience	2.82	3.34	0.00	16.50	-0.13 (0.00)	-0.17 (0.00)	1.00														1.36
(4)	Firm_Size	7.74	2.88	0.00	12.61	0.21 (0.00)	0.10 (0.01)	0.12 (0.01)	1.00													1.65
(5)	Institutional_Ineff	-0.18	0.63	-1.93	1.21	0.29 (0.00)	0.22 (0.00)	-0.14 (0.00)	-0.06 (0.16)	1.00												1.59
(6)	Software_Development	0.19	0.39	0.00	1.00	0.02 (0.69)	0.18 (0.00)	-0.18 (0.00)	-0.18 (0.00)	0.10 (0.02)	1.00											1.68
(7)	Contact_Centers	0.16	0.36	0.00	1.00	0.04 (0.34)	0.09 (0.03)	-0.01 (0.84)	0.11 (0.01)	0.09 (0.02)	-0.21 (0.00)	1.00										1.63
(8)	Admin_Processes	0.15	0.36	0.00	1.00	0.14 (0.00)	-0.10 (0.02)	0.09 (0.04)	0.21 (0.00)	0.01 (0.83)	-0.20 (0.00)	-0.18 (0.00)	1.00									1.63
(9)	Procurement	0.03	0.18	0.00	1.00	-0.09 (0.03)	-0.07 (0.11)	-0.06 (0.18)	-0.01 (0.76)	0.06 (0.14)	-0.09 (0.03)	-0.08 (0.05)	-0.08 (0.06)	1.00								1.26
(10)	Product_Development	0.14	0.34	0.00	1.00	-0.10 (0.01)	-0.08 (0.05)	-0.03 (0.43)	-0.20 (0.00)	0.02 (0.69)	-0.19 (0.00)	-0.17 (0.00)	-0.17 (0.00)	-0.08 (0.07)	1.00							1.68
(11)	Knowledge_Services	0.11	0.32	0.00	1.00	-0.13 (0.00)	-0.11 (0.01)	0.13 (0.00)	0.11 (0.01)	-0.23 (0.00)	-0.17 (0.00)	-0.15 (0.00)	-0.15 (0.00)	-0.07 (0.10)	-0.14 (0.00)	1.00						1.66
(12)	Manufacturing	0.22	0.41	0.00	1.00	-0.10 (0.02)	-0.01 (0.75)	0.03 (0.41)	0.04 (0.37)	-0.08 (0.05)	-0.06 (0.12)	-0.01 (0.77)	-0.03 (0.54)	0.13 (0.00)	0.26 (0.00)	-0.15 (0.00)	1.00					1.5
(13)	Financial_Services	0.29	0.46	0.00	1.00	0.18 (0.00)	0.17 (0.00)	0.17 (0.00)	0.41 (0.00)	-0.03 (0.54)	-0.10 (0.02)	0.13 (0.00)	0.12 (0.00)	-0.06 (0.15)	-0.23 (0.00)	0.05 (0.19)	-0.34 (0.00)	1.00				1.77
(14)	Before_2005	0.33	0.47	0.00	1.00	-0.13 (0.00)	0.00 (0.93)	-0.18 (0.00)	-0.06 (0.15)	-0.16 (0.00)	0.05 (0.21)	0.07 (0.11)	-0.11 (0.01)	0.01 (0.88)	0.06 (0.18)	-0.15 (0.00)	0.15 (0.00)	-0.01 (0.83)	1.00			1.71
(15)	After_2006	0.39	0.49	0.00	1.00	0.01 (0.85)	0.05 (0.19)	0.16 (0.00)	-0.07 (0.07)	0.13 (0.00)	-0.03 (0.48)	-0.03 (0.45)	0.02 (0.58)	-0.05 (0.20)	-0.02 (0.63)	0.16 (0.00)	-0.18 (0.00)	0.01 (0.88)	-0.56 (0.00)	1.00		1.76
(16)	US_Home_Country	0.66	0.47	0.00	1.00	0.19 (0.00)	0.14 (0.00)	0.09 (0.03)	0.24 (0.00)	0.11 (0.01)	0.02 (0.56)	-0.00 (0.91)	0.07 (0.08)	-0.05 (0.27)	-0.01 (0.77)	-0.18 (0.00)	0.03 (0.40)	0.16 (0.00)	0.03 (0.44)	-0.15 (0.00)	1.00	1.28

The lower diagonal matrix indicates the correlation coefficients and their statistical significance in parentheses.

Descriptive statistics and correlations for the internationalization drivers and location factors variables are available from the authors upon request.

Source: own computations based on ORN data.

Table E: Estimation results for additional models

Logit model – Fragments of process	(i) Main model with host-country fixed effects	(ii) Main model with Park measure	(iii) Main model with Park and enforcement	(iv) Main model including legal risk for home-country	(v) Main model without int. drivers and location factors
Content_Legal_Risk	1.840*			1.256***	1.016***
	[0.050]			[0.000]	[0.002]
Park_Content_Risk		0.513**			
		[0.015]			
Park_Enforced_Content_Risk			0.282**		
			[0.016]		
No_Internal_Control	0.720**	0.795***	0.796***	0.730***	0.611***
	[0.020]	[0.004]	[0.004]	[0.010]	[0.009]
Content_Legal_Risk For_Home_Country				-0.008	
				[0.990]	
Global_Sourcing_Experience	0.133***	0.084**	0.088**	0.129***	0.097***
	[0.003]	[0.045]	[0.038]	[0.003]	[0.006]
Firm_Size	-0.067	-0.052	-0.052	-0.015	-0.084*
	[0.238]	[0.347]	[0.340]	[0.789]	[0.082]
Institutional_Ineff	-0.368	0.394*	-0.778	0.325	0.424***
	[0.813]	[0.087]	[0.195]	[0.113]	[0.009]
Institutional_Ineff_For_Home_Country				-2.146**	
				[0.014]	
Software_Development	-0.049	-0.064	-0.070	-0.176	-0.035
	[0.890]	[0.849]	[0.836]	[0.606]	[0.909]
Contact_Centers	-1.080**	-1.063**	-1.065**	-1.084**	-0.923**
	[0.018]	[0.014]	[0.014]	[0.011]	[0.024]
Admin_Processes	-0.567	-0.448	-0.471	-0.740*	-0.703**
	[0.176]	[0.240]	[0.215]	[0.061]	[0.032]
Procurement	0.334	0.116	0.096	0.211	0.368
	[0.593]	[0.863]	[0.884]	[0.742]	[0.483]
Product_Development	-0.399	-0.582	-0.599	-0.536	-0.224
	[0.396]	[0.177]	[0.165]	[0.209]	[0.575]
Knowledge_Services	-0.338	-0.513	-0.489	-0.288	-0.531
	[0.543]	[0.327]	[0.345]	[0.561]	[0.248]
Manufacturing	-0.253	-0.106	-0.113	-0.254	0.134
	[0.539]	[0.792]	[0.780]	[0.528]	[0.713]
Financial_Services	-0.618*	-0.358	-0.364	-0.738**	-0.347
	[0.089]	[0.340]	[0.331]	[0.043]	[0.314]
Before_2005	0.062	-0.626**	-0.609*	-0.113	-0.226
	[0.836]	[0.050]	[0.051]	[0.690]	[0.384]
After_2006	-0.119	-0.158	-0.166	-0.342	-0.399
	[0.730]	[0.619]	[0.594]	[0.269]	[0.138]
US_Home_Country	-0.040	0.114	0.093	0.227	0.183
	[0.904]	[0.725]	[0.771]	[0.494]	[0.510]
Internationalization drivers dummies	Included	Included	Included	Included	NOT Included
Loc. factors variables	Included	Included	Included	Included	NOT Included
Host-country fixed effect	Included	Not included	Not included	Not included	Not included
Observations	547	577	577	581	709
Log likelihood	-308.8	-345.6	-345.2	-331.1	-435.2
DF	54	29	29	31	16
χ² test	0.173	68.85	69.07	90.08	78.56
Pseudo R²	0.17	0.12	0.12	0.17	0.10

Cluster-robust p-values in brackets: *** p<0.01, ** p<0.05, * p<0.1. Baseline function: IT; baseline industry: Services; baseline launch year period: 2005-2006. All specifications have a constant term.
Source: own computations based on ORN data.

Technical appendix

The propensity score matching technique (PSM) uses variables that are suspected to simultaneously influence the treatment status (absence or presence of internal control) and the outcome (fragmentation decisions) to match comparable foreign services units that have different treatment status. Specifically, the PSM model estimates, based on the legal risk variable and all the control variables of the "Main Model" in Table 1.1., the likelihood of outsourcing (i.e. No_Internal_Control = 1). In turn, we associate each outsourced service production unit (treated observation) with one or multiple comparable internalized units (untreated observation) such that the potential outcomes are independent of the outsourcing status conditional on the background variables used at the previous stage. We then test the difference in fragmentation decisions between the treated and untreated observations. The composition of our sample, with the even distribution of outsourced and internal cases, reinforces the quality of the matching process.

We perform the matching process using different values of tolerance for the maximum distance between matches (i.e. the caliper value used to impose common support restrictions)[19] with different numbers of nearest neighbors for each tolerance level (i.e. 1 neighbor, the most used value, and three neighbors for the comparable matches associated to treated observations). The results for the average effect on the treated observations (ATT) are provided in Table F in appendix. For all tolerance levels and numbers of nearest neighbors, the matching method statistically confirms that the outsourced services production units have a higher likelihood to perform fragments of processes (instead of entire processes) compared to internalized units.

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[19] The lower the tolerance – low caliper values –, the better the quality of the matches. It reduces the bias due to the non-random sampling at the cost of an increased variance.

Table F – Propensity score matching method: difference in process fragmentation between outsourced and internal units

Caliper value (tolerance)	Nb of observations on common support (over a total of 581)	Nb of nearest neighbors	ATT on "Fragmented process"			
			Difference (Process fragments $_{treated}$ – Process fragments $_{untreated}$)	Standard error	T-stat	P-value
0.1	581	1	0.19	0.094	2.05	3.9%
		3	0.21	0.088	2.45	1.4%
0.01	542	1	0.16	0.080	1.98	4.7%
		3	0.19	0.075	2.56	1.0%
0.001	343	1	0.16	0.087	1.90	5.7%
		3	0.15	0.085	1.78	7.4%

ATT: Average treatment effect on treated