

# Sequential Supply Chains, Property Rights, and the Nonappropriability of Intellectual Assets

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## Extended Abstract

Modern value chains are becoming more and more global in nature, as they are increasingly characterized by the participation of suppliers located across different countries. Meanwhile, incomplete contracts continue to be a central issue when studying the integration versus outsourcing decision of firms in the related literature on international trade and the boundaries of firms (Antràs, 2003, 2005; Antràs and Helpman, 2004, 2008; Grossman and Helpman, 2002, 2003, 2005). Two general approaches to confront the problem of incomplete contracts have been the transaction cost theory (Williamson, 1971, 1975, 1985) and the property right theory (Grossman and Hart, 1986; Hart and Moore, 1990). Several attempts have followed to estimate how specific features of different production locations such as contract enforcement affect the organizational decision of firms. Under the transaction cost approach, better contracting institutions reduce hold-up problems associated with outsourcing and facilitate the exploitation of specialization gains from outsourcing. With the property rights approach, better contracting institutions mitigate the need to create investment incentives through outsourcing and enable a firm to reap a larger share of the revenue through integration. Empirical studies starting from Corcos, Irac, Mion, and Verdier (2013) all the way up to the very recent work of Eppinger and Kukharsky (2016) have found strong evidence for the property right theory as opposed to the transaction cost theory evincing that better institutional quality increases incidences of integration over outsourcing.

A recent seminal paper by Antràs and Chor (2013) introduces the sequential dimension of production along the supply chain into the argument, showing how the position of and the inter-relation between the stages of production impact firms' organizational decision through the structure of incentives for suppliers. In their model, if supplier investments are sequential complements, prior upstream investment by a given supplier would increase marginal returns to investment by the suppliers performing the next stages of production, whereas in the case of sequential substitutes it would reduce the marginal revenue of further investment in subsequent stages. They show therefore that upstream (downstream) stages are outsourced (integrated) when stages are sequential complements and integrated (outsourced) when they are sequential substitutes. This mechanism works under the property right approach, where outsourcing, i.e. giving a larger share of the pie to a supplier, encourages investment by that particular supplier. A follow-up to this strand of literature is the study by Alfaro, Antràs, Chor and Conconi (2015), who bring together Antràs and Chor (2013) and Antràs and Helpman (2008) to interestingly show that improved contractibility increases the propensity to integrate in the case of sequential complementarity, whereas it increases outsourcing in case stages are sequential substitutes. In line with the property right theory, the intuition behind their result is that the higher the contractibility of inputs, the less firms need to rely on outsourcing as a way to reverse the distortions associated with inefficient investment by upstream suppliers.

Regardless of the vast literature on trade, firm organization and property rights, the focus of all existing works has so far been contract enforcement and the "tangible" perception of property rights. Antràs and Rossi-Hansberg (2009) mention that the literature has concentrated on hold-up inefficiencies as the main drivers of the internalization decision of firms and underline the importance of missing research on how the non-appropriable nature of knowledge affects firm organization. The argument takes even more importance when talking about stages along the supply chain within a firm. On this, Atalay, Hortacsu, and Syverson (2014) emphasize the importance of intangible inputs within

a firm by providing evidence for an alternative rationale behind vertical integration and its role in promoting efficient intrafirm transfers of intangible inputs such as marketing know-how, intellectual property, and R&D capital. In other words, they show, in line with the property right theory, that integration is not a tool to insure a smooth flow of physical inputs from upstream towards downstream activities, but rather a strategy to secure efficient transmission of technology across stages along the chain.

A fundamental point derived from the work of Atalay, Hortacsu, and Syverson (2014) is the significance of distinguishing intangible assets from tangible ones and the role of firm organization in their movement along the supply chain. Indeed, an analysis of the sequential channel of transfer for intangible assets and how institutions influence the integration versus outsourcing decision throughout the supply chain is still lacking in the literature. This paper takes a step in this direction by building on the sequential production model of Antràs and Chor (2013) and investigating how the integration decision might be affected by the strength of intellectual property rights (IPR) enforcement in the country where the production stage is performed. In this context, the lack of effective IPR protection implies a higher risk of imitation at that stage of production, reducing profits for the final good producer as well as that of all its suppliers. Later stages are prone to larger losses from imitation as knowledge accumulates in every stage along the supply chain.

To elucidate the concept of imitation in our model, think of a supply chain with each stage of production requiring the transfer of a different blueprint by the firm in control of the chain. Every blueprint further downstream has an incremental nature and contains more technology than the previous stages. Suppose an intermediate stage of production takes place in a country with low IPR protection. The blueprint in that stage is therefore prone to imitation. A weak IPR environment enables an imitation channel allowing the diffusion of the technology embedded in the blueprint to competitors in that market, which can eventually be used to produce the same good by other final producers. As a result, incentives for investment by the specific supplier in that location and stage go down because imitation decreases the value of that blueprint, and those in the subsequent stages. Following the literature, we assume that investments made by suppliers are for the purpose of customizing the input for their final producer and do not have an outside use. In addition, the outside option of the supplier remains zero because a stand-alone blueprint has no intrinsic value for the supplier outside the relationship, but can be imitated by outsiders at zero costs under a poor IPR regime. The interaction between the supplier and the firm is therefore not affected as we are dealing with a supply chain and inter-related technologies rather than a one-to-one buyer-supplier relationship.

In line with Atalay, Hortacsu, and Syverson (2014) our findings shed light on the importance of the flow of intangible assets along the supply chain. Notably, imitation in our framework is embedded into the property right theory, where inefficiencies caused by contract incompleteness in terms of underinvestment into relation-specific inputs are present both within firm boundaries and in arm's length transactions. This mechanism works in parallel to Antràs and Chor (2013) and Alfaro, Antràs, Chor and Conconi (2015) to produce novel results in the case of non-appropriability of intangible assets. Although integration may not be used to enhance interaction among stages in a supply chain, it could promote efficient intra-firm transfers of intangible inputs, reinforcing the importance of the protection of "intellectual" property rights. We show accordingly that the lack of the protection of intellectual assets induces firms to opt for integration when inputs are sequential complements. Under a sound IPR regime firms are instead more likely to engage in outsourcing to create supplier incentives. Additionally, the degree of IPR protection tends to play a more important role in shaping the organization of the supply chain in the relatively more downstream parts of the production process. In contrast to the notion of contractibility illustrated in Alfaro, Antràs, Chor and Conconi (2015) in which stronger enforcement encourages integration and thereby intra-firm trade, IPR protection shows a shifting of strategy towards international outsourcing by final good producers. In

sum, IPRs as opposed to contracting institutions may increase outsourcing by firms, revealing a remarkable difference between tangible versus intangible assets within the property rights approach to firm boundaries and shedding light on how the non-appropriable nature of knowledge may impact the organization of global supply chains.

The mechanism works as follows. Under sequential complements, investing upstream boost incentives to invest along the next stages of production. Imitation reduces the attractiveness of outsourcing because it can no longer be used to create incentives for a supplier at a particular stage (and for those further downstream) to make the adequate investment. The final producer therefore chooses to hold on to a larger share of revenues and integrates that stage. As a result, integration occurs at an earlier (more upstream) stage of production. Improving IPRs recovers the sequential investment mechanism of Antràs and Chor (2013) and encourages outsourcing by blocking the imitation channel. In the opposite case of sequential substitutes, investments in earlier stages reduce incentives for further investments down the supply chain. At the same time, the blueprint at each stage per se is of less value because if the technology in one stage is lost, it is not that detrimental to the entire supply chain. In this case, imitation would spur more investment by the next supplier down the value chain to make up for the lost information. Imitation therefore reduces the negative effect of outsourcing on follow-up investments and increases the prevalence of outsourcing along a wider range of stages. Better IPR protection, in turn, restores the incidences of integration over outsourcing at earlier stages of production. To this end, the paper delivers clear theoretical predictions that are tested on firm-level data using a comprehensive dataset on Slovenian firms.

We use Slovenian firm level data in the 2002-2009 period and merge transaction-level trade data on Slovenian firms together with their FDI and financial data. The firm's decision to integrate suppliers in a certain market; i.e. propensity to transact inputs in a particular source country within firm boundaries, is defined based on outward FDI in a particular market. Since we can observe input imports by the core activity of a firm (the identity of the purchasing industry is known), we are able to identify the position of imported inputs in the value chain of a concrete firm's output industry. Hence, we use industry-pair specific measures of upstreamness in a manner of Alfaro, Antràs, Chor and Conconi (2015) to calculate the firm-sourcing country specific measure. To distinguish between the case of sequential substitutes and that of sequential complements, we follow the approach adopted in Antràs and Chor (2013) and Alfaro, Antràs, Chor and Conconi (2015), tracing substitutes/complements based on low/high value of import demand elasticities for each product category. In our case, we use import demand elasticities estimated for core products exported by Slovenian firms obtained from Kee, Nicita, and Olarreaga (2008) following the "production-based GDP-function" approach. Finally, the IPR enforcement index is retrieved from Park (2008).

The paper takes a step further in checking for the sequential complementarity vis-à-vis substitutability among stages of production not only by measuring the import demand elasticity (which translates into the curvature of the firm's revenue function in output) but also by creating a novel proxy to measure the degree of differentiation between the inputs used in a particular product (the extent to which they are spread across diverse industries). The results are fully robust and persist using both measures, reinforcing the crucial role of IPRs for the organizational mode along downstream "complementary" stages. To facilitate the intuition behind our original measure of stage differentiation, think of a complex modern product such as the I-pad, characterized by many different stages of production taking place in different locations, as illustrated in Antràs (2013). Every single input is necessary to complete the final product and therefore has a substantial contribution to the final variety. If IPRs are not so strong, the risk of imitation will be high and a specific differentiated input can easily be used by competitors for another variety of the product in the market. For example, the touch screen of the I-pad can be copied and used for other similar tablets. The returns to investment by the supplier producing the touch-screen is decreased and a copied, standardized, input as such also reduces returns to further downstream investments.