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EXAMINING THE RELATIONSHIP BETWEEN STRATEGIC ALLIANCES AND IMPROVED PERFORMANCE

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Abstract

Despite growing research attention to systemic products and systems integration, there is still a dearth of research on the performance benefits that firms can attain from increased systems integration capabilities. We address this research gap using a longitudinal sample of 245 first-tier automotive suppliers and find that an increased systems integration capability positively affects financial performance. By considering the crucial role of manufacturing alliances, we also find evidence that vertical alliances with buyers positively moderate the relationship between systems integration capabilities and performance, while horizontal alliances have a negative moderating effect. These results contribute to the dynamic capabilities literature by providing empirical evidence that systems integration capability is a relevant predictor of firm performance, and expands the current understanding of how system manufacturers should manage their business-to-business (B2B) relationships.

Keywords: Systems integration, Organizational capability, Strategic alliances, Buyer-supplier relationships, Dynamic capabilities.

Introduction

Systems integration (henceforth: SI) is an organizational capability that has become imperative to many technology-intensive industries as the capacity to outline, combine, and redesign all the necessary inputs of a given system allows manufacturers to attain unique competitive advantages (Davies, Brady, & Hobday, 2007; Hobday, Davies, & Prencipe, 2005). From aircraft carriers to smartphones, from healthcare to logistics, effective manufacturing and delivery of a wide array of products and services depend upon seamlessly putting together a multitude of components. For instance, an Airbus A380 consists of about four million parts manufactured by around 1500 suppliers from 30 countries, while FedEx operates more than 85,000 vehicles, 679 airplanes and delivers more than 6 million packages every day.

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Indeed, scholars have argued that systems integrators can achieve a more powerful position in the value chain and increase value creation from the assimilation of multiple technologies, skills, and the development of architectural innovations (Ahuja, Lampert, & Novelli, 2013; Galunic & Eisenhardt, 2001). Firms like Boeing, Samsung, and IBM have achieved a dominant role in their respective industries due to superior SI capabilities, which are also considered an important industrial marketing strategy (Artto, Valtakoski, & Karki, ¨ 2015; Mattsson, 1973). However, performance benefits of SI may decline due to increased operational, managerial, and adjustment costs (Davies & Brady, 2000; Prencipe, 2000). Manufacturers, therefore, have faced the dilemma of pursuing SI versus individual component specialization, which require different capabilities in terms of internal and external production routines.

Surprisingly, despite early works acknowledging the important role of SI in many industries along with the case-based evidence establishing SI as a capability that provides firms with competitive advantages (Davies et al., 2007; Hobday et al., 2005), as well as the recent calls for the study of mechanisms underlying the benefits attained from SI (Gholz, James, & Speller, 2018), there is still a dearth of empirical evidence and theoretical clarity on how increased SI capabilities affect financial performance. In this study, we attempt to fill this gap by investigating the following research question: Can manufacturers improve performance by increasing their SI capabilities? Our investigation focuses specifically on the case of SI performed by component suppliers, which revolves around the capacity to produce subassemblies or complete final products composed ofof multiple interrelated parts.

Previous research has found that SI rests upon several internal and external competencies such as broad technological knowledge, internal orchestration of routines, and supply chain management (Brusoni, Prencipe, & Pavitt, 2001; Davies et al., 2007). Therefore, SI is a capability intrinsically related to the management of vertical integration and outsourcing decisions. It involves the "twin" processes of concomitantly producing in-house and obtaining input from suppliers as well as further integrating systemic solutions downstream (Artto et al., 2015; Hobday et al., 2005; Paliwoda & Bonaccorsi, 1993).

As SI implies sourcing of several inputs and requires increased coordination with vertical partners, system integrators must attain not only superior internal capabilities but also successfully manage their multiple relationships across the supply chain. Hence, the degree to which SI capabilities can result in superior firm performance may be contingent upon how well firms manage their interorganizational relationships. To this end, system integrators may need to develop close relationships with their vertical and horizontal supply chain partners in the form of strategic alliances. Strategic alliances represent an important mechanism of knowledge transfer and interfirm coordination that can play a crucial role in a firm's learning, productivity and, profitability, also shaping the development of SI capabilities (Khanna, Gulati, & Nohria, 1998; Rindfleisch & Moorman, 2001; Rothaermel, 2001).

Drawing on a longitudinal sample of 245 automotive first-tier suppliers (i.e., suppliers that supply parts and or systems directly to original equipment manufacturers like Ford, Toyota, BMW, etc.), we assess how increasing the manufacturing of systemic products influences firm performance. Moreover, we also investigate how manufacturing alliances with buyers and other suppliers can influence how suppliers reap performance benefits from increased investments in SI since such alliances can serve different purposes based on their vertical or horizontal orientation. The automotive industry is an ideal setting for the investigation of SI manufacturing given that its supply chain structure has clearly-defined production roles and interorganizational relationships are very important for manufacturing due to the increased complexity and technological interdependencies of vehicles and components (Jacobides, MacDuffie, & Tae, 2016; MacDuffie & Fujimoto, 2010).

Our findings provide important theoretical contributions. First, we extend the dynamic capabilities literature by offering empirical evidence that increased SI capability results in superior firm performance and identify two important contingency factors influencing the link between SI and firm performance. We highlight that SI is a dynamic capability that requires successful management of multiple within- and interfirm competencies to lead to competitive advantages, contributing to the notion that dynamic capabilities should be viewed under a more holistic lens (Teece, 2018). Second, our findings also contribute to the literature on the effects of SI and complex product management on firm performance, and more importantly, how manufacturing alliances moderate this relationship (Davies et al., 2007; Prencipe, 2000). Lastly, we advance knowledge on business-to-business (B2B) relationships by providing empirical evidence on the role that strategic alliances play on value capture from SI.

Conceptual development

SI and industrial marketing

Scholars have defined SI as the capability to design, integrate, and coordinate multiple components, tasks, and technologies, internally or externally, into systemic solutions (Davies et al., 2007; Hobday et al., 2005; Salonen, Gabrielsson, & Al-Obaidi, 2006). Therefore, systems integrators have to develop superior manufacturing and knowledge integration capabilities, including a broader and deeper range of knowledge of the product technologies produced in-house as well as the technologies of outsourced components (Brusoni et al., 2001; Prencipe, 2000). Hobday et al. (2005) argue that SI is a core capability of successful modern high-technology firms that can convert the integration of multiple technologies and components into competitive advantages.

SI is a capability needed in complex product industries, and as such, it has received a great amount of attention in the industrial marketing literature (Grant, 2019). For example, studies on the aircraft, automotive, and computer industries provide a description of how the evolution of products' design and life cycles caused firms to adjust their organizational boundaries and capabilities, leading to producttechnology specialization and SI (Jacobides et al., 2016; Jacobides & Tae, 2015). Moreover, SI can also result from a deliberate strategy to increase value capture via integration of horizontal, upstream, or downstream activities (Crespin-Mazet, Romestant, & Salle, 2019; Salonen et al., 2006).

Studies on SI in the context of industrial marketing have identified several characteristics pertaining to this capability (Davies et al., 2007; Salonen et al., 2006). Davies et al. (2007) point out that some firms operate as pure systems sellers (i.e., vertically integrated firms controlling the production of all components of a system), while some others act as pure systems integrators (i.e., firms that design and outsource components and integrate them using the market to select inputs). However, a clear-cut distinction may not always be observable. More importantly, they provide evidence that firms can combine both characteristics, concluding that "a more complex pattern of organizational forms is emerging, combining elements of both systems selling and systems integration" (Davies et al., 2007: 192). Likewise, in this study, we view systems integrators as firms having traits at the intersection between pure systems seller and pure systems integrator. That is, we focus our study on firms that manufacture most of their key individual components in-house but also manage strategic manufacturing relationships with suppliers and buyers.

Likewise, systems are composed of multiple components and technologies embedded in a single overarching function and can be managed via vertical integration, outsourcing, or both, therefore requiring multiple internal and external competencies in terms of assembly, design, and managerial coordination of complex systems (Crespin-Mazet et al., 2019; Davies et al., 2007). For example, Fourcade and Midler (2004) note that migrating from single-component manufacturing to the production of automotive systems, like the front-end module (which comprises headlamps, radiator, condenser, fans, and motor), involves the acquisition of new technological and manufacturing capabilities. In doing so, firms can attain competitive advantages from SI as they are able to provide a superior solution to customers via efficient integration of a network of internal and external routines, in contrast to other suppliers of specialized, nonintegrated solutions.

SI is a capability best suited for competitive advantage when products are complex and costly to assemble, modularization is limited, and there are no well-defined standards for outsourced components in the industry. However, SI capabilities can offer little advantage to firms in industries where component interfaces are standardized across products and modular designs are the norm. That is because when modularization is well advanced, the value-added in the task of assembling standardized components and modules is reduced significantly (Bhattacharya, Gupta, & Hasija, 2018; Jacobides, Knudsen, & Augier, 2006). For example, scholars have investigated how value-creation and -capture capabilities migrated upstream from systems integrators to component specialists in the computer industry as modularization and standardization of components evolved and the SI capabilities of firms such as Dell and Compaq became less valuable and easily replicated (Jacobides & Tae, 2015). Thus, it is important to note that the arguments we develop further in this manuscript mostly, albeit not exclusively, apply to industries in which, for various reasons (see Jacobides et al., 2016), there are limits to modularization and product standardization (e.g., automotive, aircraft, military systems, aerospace, etc.). In such industries, scholars have noted that systems integrators are able to raise the value of their products due to increased product differentiation and reduced imitation (Hobday, 1998; Salonen et al., 2006). However, there is still a lack of empirical assessments validating the theoretical assumptions of the positive effects of increased SI capability on firm performance and a lack of theoretical development on the potential contingencies influencing this relationship.

Theoretical framework and hypotheses

The SI literature has its theoretical underpinnings grounded on the resources/capabilities-based view (Chandler, 1992; Helfat & Winter, 2011; Hoopes & Madsen, 2008; Wernerfelt, 1984), as SI requires firms to develop and orchestrate several capabilities related to supply chain management, product manufacturing, and knowledge management (Brusoni et al., 2001; Davies & Brady, 2000; Hobday et al., 2005). In particular, dynamic capabilities are conceptualized as the "capacity of an organization to purposefully create, extend, or modify its resource base" (Helfat et al., 2007: 4) and are based on a "stable pattern of collective activity through which the organization systematically generates and modifies its operating routines" (Zollo & Winter, 2002: 340). These capabilities alter the way the firm makes its living and "promote economically significant change" (Helfat & Winter, 2011: 1249). As Schilke, Hu and Helfat (2018: 26) note: "Dynamic capabilities are proposed to confer a competitive advantage by adding unique value to the firm through systematic change".

Hobday et al. (2005: 1110) suggest that SI is an "empirical instantiation of a firm's dynamic capabilities, and therefore key to the broader competitive strategy of the firm", given that SI requires the reconfiguration of a firm's resources and alteration of routines (Prencipe, 2000; Teece, Pisano, & Shuen, 1997). Previous research, based on case studies, has found that increasing SI capabilities is an important driver of competitive advantages, however building this capability involves substantial costs associated with supply chain coordination, upgrade of manufacturing practices, and learning (Brusoni et al., 2001; Hobday et al., 2005). This suggests there exists a tension between value creation via SI and value capture due to the increased costs involved in the sustenance of this capability. In this study, we seek to shed light on this research stream by quantitatively testing the assumption that increased SI capabilities will provide firms with performance benefits.

This study is based on the notion that SI is a dynamic capability which needs to be successfully managed internally and externally. That is, as systemic products require coordination of multiple production routines developed not only in-house but also with suppliers and customers, system manufacturers have to properly manage the integration of components into a final product together with the challenges of tacit knowledge transfer routines. Past research has recognized strategic alliances as viable means for firms to improve efficiency and innovativeness with their partners (Hamel, Doz, & Prahalad, 1989; Lavie & Rosenkopf, 2006; Sluyts, Matthyssens, Martens, & Streukens, 2011; Wong, Tjosvold, & Zhang, 2005). Drawing from a social capital perspective (Alejandro Portes, 1998; Baker, 1990; Nahapiet & Ghoshal, 1998), scholars have noted that when a firm increases its network size in terms of the number of strategic alliances, it can access different knowledge pools and the complementary assets necessary to create new products and increase productivity (Lahiri & Narayanan, 2013; Lavie, 2007; Rothaermel & Deeds, 2004; Terjesen, Patel, & Covin, 2011). Moreover, collaborations via strategic alliances also foster the acquisition and development of new knowledge and resources otherwise not available to isolated firms (Ahuja, 2000). In this context, since collaborative activities formed in B2B relationships with vertical and horizontal partners have an important role in allowing systems integrators to achieve their goals of streamlined production and learning (Adams & Graham, 2017; Mitchell & Singh, 1996; Nobeoka, Dyer, & Madhok, 2002), it should also influence the extent to which they attain performance benefits from increased investments in SI.

Recent studies have pointed out that the performance effects of an increased portfolio of alliances are dependent on the context and firmspecific attributes that can shape significantly the costs and benefits attributed to managing multiple alliances (Bos, Faems, & Noseleit, 2017; Hashai, Kafouros, & Buckley, 2018). In the case of systems integrators, the literature has suggested that alliances could facilitate the deployment of complex products more efficiently (Dosi, Hobday, Marengo, & Prencipe, 2002). However, there still exists a lack of clarity and empirical evidence on how and what type of alliances are more beneficial to the performance of systems integrators. In this study, given our focus on vertically integrated component suppliers, we specifically address the moderating role of suppliers' vertical manufacturing alliances with buyers and supplier-supplier horizontal manufacturing alliances. The theoretical framework for this study, therefore, is grounded on the dynamic capabilities and alliances management literature which combined represent the conceptual basis of our hypotheses' development.

SI and firm performance

As explained above, SI is a dynamic capability in which internal resources need to be reconfigured, which is a costly process. Firms will engage in this endeavor only if its prospective benefits, however uncertain, are likely to exceed reconfiguration costs. In this context, , the boundary conditions of our theoretical development revolve around the firm's product manufacturing capabilities to generate superior value via integrated product solutions. We conjecture that increasing SI capabilities should allow suppliers to increase performance mainly for two reasons. First, SI is an instrument of value creation as the firm becomes capable of providing more holistic solutions and cost reductions to their customers (Davies et al., 2007; Mattsson, 1973; Salonen et al., 2006; Slywotzky, 1995). For example, computer and mobile phone component manufacturers such as IBM and Ericsson have evolved from the manufacturing of specific components to the production of complete final products by expanding activities downstream using a customercentric approach (Davies et al., 2007; Gerstner, 2002). System suppliers are usually required to work closely with their customers so as to reduce coordination costs and leverage knowledge-sharing gains (Crespin-Mazet et al., 2019; Hobday et al., 2005). This increased interaction with clients allows systems suppliers to absorb important technological knowledge and learn about its customer's preferences (Alcacer & Oxley, 2014). Therefore, increasing SI necessitates building important capabilities related to the reorganization of its internal manufacturing and learning processes, which, in turn, allows firms to successfully deploy customer solutions.

Second, SI also requires firms to develop increased upstream technological capabilities that foster value creation via innovation and design control. In the automotive industry, for example, scholars have pointed out that as automakers began to increasingly delegate the manufacturing and design of complete modular systems to first-tier suppliers, suppliers had to invest heavily in system manufacturing capabilities which in turn allowed them to retain technological control of systems (Whitford & Zirpoli, 2014). As automotive suppliers started to assume responsibility for R&D projects outsourced by automakers via black box developments (Srinivasan & Brush, 2006), they have increasingly leveraged technological capabilities resulting in superior profit margins (Berret, Mogge, & Schlick, 2016). Systems suppliers, therefore, have become more proactive in terms of new product developments and have increased investments in more complex, technologically advanced products (Jacobides et al., 2016). In sum, SI is an activity that involves the formulation of customer-centric solutions and the generation of relevant product innovations. As a dynamic capability, SI fosters the development of superior managerial, technological, and problem-solving skills (Davies et al., 2007; Mitchell & Singh, 1996; Novak & Eppinger, 2001; Salonen et al., 2006).

However, systems are intrinsically related with higher levels of product complexity, which raises difficulties for the development of new products, heuristic learning, and coordination between supply chain partners (Ethiraj, Ramasubbu, & Krishnan, 2012). Scholars have suggested that systems integrators face increased costs associated to upgrading manufacturing capabilities and investing in knowledge absorption across several component technology areas (Magnusson, Tell, & Watson, 2005; Prencipe, 1997). Although these costs can hamper the performance benefits that increased SI may bring, we theorize that the aforementioned advantages attained from SI should overcome these costs as the firm strengthen this capability. Indeed, several case studies have provided detailed evidence that although firms face many challenges to upgrade their product manufacturing capabilities after deciding to produce systems , the inherent superior value-adding attributes of systems to buyers and the potential for architectural innovation and design control still allow systems integrators to attain increased financial performance (Fourcade & Midler, 2004). Yet, systems are more difficult to imitate and reverse engineer due to their increased complexity (Lippman & Rumelt, 1982; Pil & Cohen, 2006). In this context, the substitution of systems suppliers can be very costly since both the buyer and supplier need to sustain high levels of knowledge sharing and deploy large fixed-asset investments, which increase the bargaining power of system suppliers (Davies et al., 2007; Salonen et al., 2006). Thus, we hypothesize that:

Hypothesis 1. The greater a supplier's SI capability, the greater its financial performance.

The moderating role of vertical manufacturing alliances

As previously alluded to, SI is an activity that demands investments in knowledge-sharing routines with external partners due to the increased complexity involved in integrating multiple components and a diverse set of technologies (Dosi et al., 2002). Previous research on SI has found that although these firms must build strong in-house manufacturing capabilities, they also need to strengthen their relationship with external players such as buyers and suppliers in order to streamline production and absorb critical knowledge from these partners (Dosi et al., 2002; Kamuriwo & Baden-Fuller, 2016; Prencipe, 2000). Strategic alliances, therefore, can be a very useful mechanism in which systems integrators can leverage efficiency and learning gains from their relationships.

Indeed, scholars have pointed out that an increase in the firm's network size, also seen as the structural dimension of a firm's social capital (Nahapiet & Ghoshal, 1998), can generate benefits to the firm's learning and operational activities (George, Zahra, Wheatley, & Khan, 2001; Lahiri & Narayanan, 2013). Managing a portfolio of alliances has also been considered a dynamic capability since it involves the reconfiguration of a firm's resources and higher-order managerial capabilities (Helfat & Winter, 2011; Schilke, 2014). Strategic alliances provide firms with access to key resources and knowledge, which, combined with the firm's internal capabilities, can become an important competitive advantage. Alliances also tend to strengthen as firms reinforce asset commitment and relational embeddedness over time (Inkpen & Currall, 2004; Uzzi, 1996). However, researchers have noted that interfirm rivalry and managerial complexity are key factors that can inhibit alliances' success due to increased coordination complexity and opportunistic behavior (Park & Ungson, 2001). This means that alliances established by firms with intense inter-partner rivalry and coordination challenges have a greater likelihood to fall short in generating their expected outputs and fail (Arslan, 2018; Asgari, Tandon, Singh, & Mitchell, 2018). In the cases of system suppliers, we posit that manufacturing alliances with buyers should benefit their systems' deployment since buyer-supplier alliances are usually characterized by increased resource complementarity and well-defined roles that are important elements of more efficient operations (Bensaou & Anderson, 1999; Wong et al., 2005).

Thus, in the case of vertical manufacturing alliances with buyers, which have the main goal of improving operational efficiency and knowledge-sharing routines (Aoshima, 2002; Dyer & Singh, 1998; Srinivasan & Brush, 2006), we expect that increasing the number of such alliances will help suppliers leverage the performance gains from SI, for several reasons. First, vertical alliances with buyers allow for efficiency gains from greater coordination of complex product manufacturing processes. The literature has shown that vertical manufacturing alliances benefit suppliers with operational and performance gains, as they are able to build trust, acquire knowledge about their customers' preferences, and improve shared routines (Adams & Graham, 2017; Dyer & Hatch, 2006; Narasimhan & Kim, 2002; Parente & Geleilate, 2016). Second, the learning benefits from vertical alliances with buyers are also useful for the supplier's development of innovative solutions from the absorption and recombination of their buyers' knowledge (Dyer & Nobeoka, 2000; Mesquita, Anand, & Brush, 2008). Yet, alliances with system suppliers also increase substitution costs to the buyer since it relies on specialized asset-specific investments from these suppliers. Thus, manufacturing alliances formed with buyers will foster efficiency gains and innovation that ultimately allow the supplier to increase its bargaining power (Lawson, Tyler, & Potter, 2015; Wong et al., 2005).

A greater number of vertical manufacturing alliances is not only a strong indicator of the supplier's key relevance to buyers (who want to secure a streamlined and reliable sourcing of strategic inputs) but also increases learning opportunities from greater exposure to important manufacturing routines (George et al., 2001). Since vertical manufacturing alliances provide coordination and collaboration gains that, in turn, increase the performance of shared operations (Gulati & Sytch, 2007; Lazzarini, Claro, & Mesquita, 2008), increasing the number of such alliances with buyers should allow systems integrators to translate these efficiency gains into superior performance as they become more efficient in their manufacturing routines. Thus, we hypothesize the following:

Hypothesis 2. The greater a supplier's investments in vertical alliances with buyers, the stronger its performance benefits attained from increased SI capability.

The moderating role of horizontal manufacturing alliances

Suppliers may engage in alliances with other component suppliers aiming to explore new technologies or share manufacturing costs (Lazzarini et al., 2008). However, previous research suggests that some horizontal alliances have both positive and negative performance consequences (Ahuja, 2000; George et al., 2001; Musarra, Robson, & Katsikeas, 2016; Nygaard & Dahlstrom, 2002; Silverman & Baum, 2002). The contrasting benefits horizontal alliances have on firm performance are based on rivalry concerns and tradeoffs between production routines performed in-house and those shared with external partners in terms of resource allocation, knowledge management, and managerial attention (Choi, Wu, Ellram, & Koka, 2002; Lahiri & Narayanan, 2013; Lazzarini et al., 2008).

In the case of SI, previous research has highlighted that since it requires the learning and coordination of several different upstream component technologies, firms should preferentially manage these activities internally due to risks of knowledge expropriation and limits to quality control (Brusoni et al., 2001; Davies et al., 2007; Kamuriwo & Baden-Fuller, 2016). Considering our research focus on vertically integrated suppliers, we expect that suppliers investing in SI capabilities should face a significant cost increase when raising the number of horizontal alliances since opportunism and managerial complexity in product manufacturing alliances with rivals are a latent issue (Kamuriwo & Baden-Fuller, 2016). Systems manufacturers must have instead technological and design control over their products and avoid too much reliance on outsourced production, as vertical integration and internally developed capabilities are key for successful manufacturing and new product developments (Adner & Kapoor, 2010; Afuah, 2001; Argyres & Bigelow, 2010; Brusoni et al., 2001). Indeed, past research suggests that vertically integrated firms are more capable of adjusting their products to new technological demands and attaining increased bargaining power against buyers due to increased customization and cost benefits (Capon, Farley, & Hoenig, 1990; Harrigan, 1984; Novak & Eppinger, 2001). Suppliers that rely more on in-house manufacturing also benefit from synergies around upstream and downstream operations that increase the value of their products and reduce costs (Novak & Stern, 2005, 2008).

When manufacturers increase their reliance on outside firms for production, they are more likely to reduce their capacity to reduce costs and also become less able to upgrade component-specific technologies (Afuah, 2001; Jacobides & Billinger, 2006). Thus, increasing the number of horizontal alliances could reduce the internal efforts towards operational improvements and in-house capability-building routines, which would detract suppliers' capacity to capture value from investments in SI. We also know that manufacturing activities developed at the intersection with outside partners are slower to adapt to environmental changes due to agency issues and contractual rigidities (Mitchell & Singh, 1996). Moreover, buyers may regard suppliers' horizontal alliances as threatening because suppliers may achieve increased bargaining power together, and buyer-specific knowledge may spill over to a buyer's rivals which, in turn, can damage current buyer-supplier relationships (Choi et al., 2002; Lazzarini et al., 2008). Thus, as the supplier increases its manufacturing alliances' portfolio with other suppliers, it should also face increased managerial and coordination costs related to curbing opportunistic behavior. Horizontal alliances are also more likely to incur increased coordination costs since the division of labor and routines need to be carefully managed as both firms have overlapping capabilities and skills that may create managerial conflicts (Park

& Ungson, 2001). We, therefore, hypothesize that the costs involved in increasing the number of horizontal manufacturing alliances would likely surpass its potential benefits in the case of suppliers increasing their SI capabilities. Fig. 1 summarizes our rationale regarding each hypothesized relationship.

Hypothesis 3. The greater a supplier's investments in horizontal alliances with other suppliers, the weaker its performance benefits attained from increased SI capability.

Method

Sample and data collection

We selected the automotive industry as the empirical setting to investigate the role of increased SI capability on firm performance. The automotive industry is a particularly appropriate research setting for our study for several reasons. First, its supply chain is one of the most complex and expansive in the world, encompassing a great number of large component manufacturers, including both systems and nonsystems suppliers. Second, the automotive industry has a well-defined structure where suppliers are hierarchically classified into "tiers" (i.e., Tier 1, Tier 2, and Tier 3, where first-tier suppliers are those directly supplying automakers, while second-tier suppliers supply to the first tier, and so forth). The automotive industry structure is also "rigid" in terms of lack of cases in which suppliers migrate up the supply chain and become automakers, and vice versa (Jacobides et al., 2016), thus providing a stable context for the assessment of suppliers' capabilities and their relationships with buyers. Moreover, limits to full modularization of components in the automotive industry also increase the value of SI capabilities (Jacobides et al., 2016).

Third, the automotive industry is also undergoing increased pressures for innovation and efficiency, stimulating product design changes—including systems solutions—across several component-technology areas (Gao, Hensley, & Zielke, 2014); this also increases the value of interfirm relationships (Schulze, Brojerdi, & Von Krogh, 2014). Although some first-tier suppliers have increasingly taken the role of systems integrators, others have decided to pursue a path of single component specialization (Fourcade & Midler, 2004; Jacobides et al., 2016). Thus, the wide range of large, specialized suppliers in a context of increasing innovation and efficiency pressures requiring not only systems solutions but also interfirm cooperative endeavors makes the automotive industry a setting well suited to test our hypotheses.

The sample selection procedure was based on the list of top 500 global first-tier suppliers provided by automotive industry data specialist MarkLines, which ranks automotive suppliers by total annual sales and includes only firms having the automotive industry as their primary business. Using this list, we were able to obtain useful information from 245 publicly traded firms for the period 2007 to 2014. This time frame includes a period of initial economic distress followed by consolidation and rapid growth (Berret et al., 2016), thus allowing us to observe a wide variance in suppliers' performances.

The suppliers' financial information was collected from COMPUSTAT and Bloomberg. The information regarding firms' strategic alliances was collected from Thomson's SDC Platinum and Lexis-Nexis databases, as well as by checking companies' websites for press releases and annual reports. Patent information was retrieved from the United States Patent and Trademark Office (USPTO). We carefully combined all firm-year information regarding each parent firm and its subsidiaries' information using a name-matching algorithm and obtained all financial information in U.S. dollars. To remain consistent with listed firms over time, we adjusted all firm-related mergers, acquisitions, bankruptcies, and alliance terminations that occurred during the sampled period. In sum, our sample encompasses 987 firm-year observations from 2007 to 2014.

Measures

Dependent variable

We measured firm performance using return on assets (ROA). We also used an alternative measure of firm performance, such as gross profit and net income, to test the robustness of our results. Firms' ROA has been one of the most widely used measures of firm performance, as it properly captures a firm's capacity to appropriate value from its valuecreating activities (Crook, Ketchen, Combs, & Todd, 2008).

SI capability

We measure the degree to which a firm has invested in SI capability by taking the sum of systems it manufactures in a given year. Information on suppliers' systems manufacturing was obtained from MarkLines automotive industry portal. MarkLines tracks longitudinally the production information of each sampled suppliers' products, including a detailed description of each component. Once a year, this firm surveys the largest 500 suppliers and obtains precise information regarding each individual product or system manufactured by each supplier. Systems are categorized in the database according to automotive industry specialists' assessment of functionality and the composition of multiple components pertaining to the system. According to the dataset classification, a system is an assembly of components put together to perform a single task (e.g., brake system) or a subsystem that is part of a larger function to be performed in the vehicle (e.g., front-end module).

This categorization is aligned with the literature, which conceptualizes systems as complex products having a large number of internal interactions and interdependencies (Hobday, 1998; Novak & Eppinger, 2001). For example, a radiator is a single component part of the engine cooling system. The whole system is composed of other interacting parts, such as hoses, a thermostat, and fans, that can be manufactured and assembled together by a single systems supplier or independently sourced by the automaker. Thus, the total number of different systems a supplier is able to successfully manufacture and commercialize is a suitable proxy to capture the firm's SI capability. This is a similar approach to the measure of a firm's capabilities, such as innovation capability, using the count of new products introduced (Katila & Ahuja, 2002; Rothaermel, 2001).

Portfolio of vertical and horizontal alliances

Past research has acknowledged that manufacturing alliances are formed mainly to advance joint operational routines and foster knowledge sharing with the goal of improving efficiency and quality (Aoshima, 2002; Dyer & Singh, 1998; Srinivasan & Brush, 2006). Therefore, we include in our measures only manufacturing alliances by analyzing each deal's announcement description regarding the business activity and objectives of the agreement. We measured vertical alliances' portfolio by taking the five-year average of all the supplier's manufacturing strategic alliances with automakers. We employed the same approach to measure horizontal alliances' portfolio, taking the five-year average of the number of manufacturing alliances established with other suppliers. Capturing the number of alliances over a wider time frame allows us to get a better grasp of these relationships' outcomes, which need time to integrate knowledge and for operations to become effective (Stuart, 2000), while also being consistent with past research measures of alliance portfolios (Lahiri & Narayanan, 2013; Rothaermel, 2001).

Control variables

We selected control variables to address potential confounding effects on suppliers' performance and SI capability. Firm age was measured by taking the number of years of experience the firm has, so we control for the effect of more experienced firms having greater performance and SI capability. For similar reasons, we also control for Firm size, which is operationalized by the total number of employees. Leverage ratio, measured as the ratio of total debt over total equity, is known to allow firms to invest in superior marketing and product development capabilities and reap greater performance, so it was also used as a control variable. We also control for technological and innovation investments, which are known to impact firm performance and the complexity of their products (Alnuaimi & George, 2016). We measured R&D intensity by taking the ratio of the total R&D expenditures over total sales and innovation output, measured as the total count of patent applications per year. We also included firm's Past performance by taking the firm's ROA in year t-1 to control for inherent past performance effects on future performance. Lastly, we control for Other alliances, measured as the fiveyear average of all nonmanufacturing-purposed strategic alliances. Table 1 provides a description of all the variables employed in the study.

Analytical procedure

The longitudinal and unbalanced configuration of the dataset is better suited for analysis with panel GLS regression. We addressed the necessity of employing a fixed-effects estimation by running the Hausman test, which indicated the use of fixed-effects estimation at $p < 0.01$. Fixed-effects models have better control for unobserved heterogeneity over random-effect models (Wooldrige, 2002). We noticed that variance inflation factors (VIFs) were low across all models (largest mean VIF = 1.54, and max individual VIF = 2.29), while the highest condition index number was 13.8, below the threshold of 30 (Belsley, 1991). We lagged by one year all independent variables to reduce the risks associated with reverse causality, and we employed robust standard errors in all models. Year dummies were also included in all models, which, in conjunction with lagged independent variables, relevant control variables, and the panel fixed-effects procedure, are helpful mechanisms to address endogeneity issues (Wooldrige, 2002). We used mean-centered variables in the interaction terms. Table 2 provides information about the descriptive statistics and pairwise correlations.

Results

Table 3 provides information on the panel regression results, which are displayed in different models following a sequential inclusion of independent variables and interaction terms. Model 1 includes control variables only, and we can observe that past performance has a negative effect on future performance ($b = -0.183$, $p < 0.01$) while a firm's innovation output is positively associated with firm performance ($b = 0.005$, $p < 0.001$).

Model 2 includes the independent variables SI capability, vertical alliances, and horizontal alliances. Hypothesis 1 predicted that increases in SI capabilities should be positively related to firm performance, and the results confirm this statement ($b = 0.496$, $p < 0.001$). Hypothesis 2 was also supported, as we can observe in Models 3 and 5 that vertical alliances have a positive moderating effect on a firm's capacity to increase performance from more SI ($b = 13.220$, $p < 0.001$). Fig. 2 provides a visual representation of the data for the effects on performance from increased SI capabilities at high and low levels of vertical manufacturing alliances.

Lastly, we observe in Models 4 and 5 that Hypothesis 3 is supported since there is a negative effect of increased horizontal alliances on a firm's performance attained from greater SI capabilities ($b = -0.714$, $p < 0.001$). Fig. 3 shows the interaction effect between SI capabilities and horizontal alliances on firm performance. Model fit changes were tested using the Wald test, and the fit improvement results for Models 2 through 5 are all significant at $p < 0.01$.

Still, the effect sizes also have economic significance. Using a margins effects estimation, we calculated that for a one standard deviation increase in SI capability, we obtain an increase of 32% in the dependent variable ROA. Analyzing this effect by considering the total sales of sampled firms, a one standard deviation increase in SI capability represents an average increase of $866.5 million in sales. Next, we perform a number of robustness tests in order to mitigate potential methodological concerns, followed by a discussion of these results.

Robustness tests

We ran several tests employing alternative models and measurements to address the robustness and validity of our model. In order to test for sampling bias in terms of selecting larger firms (which are more likely to be systems integrators), we contrasted the average total number of systems in our sample firms' portfolios with the total number of systems of a randomized sample from the list of 500 suppliers; we found no significant difference between the two samples. We note, however, that a t-test revealed that the performance of suppliers with no systems in their portfolio is lower on average than that of suppliers with one or more systems at $p < 0.05$.

We also used gross profit and net income as alternative performance measures. In both cases, the hypotheses were fully supported, with similar effects in magnitude and direction (see Appendix). Additionally, we ran a model that controlled for the possible performance advantage attained by Japanese automotive players, which are known to have more long-term and close relationships with buyers (Dyer & Nobeoka, 2000). We controlled for country-of-origin effects using generalized estimating equations (GEE) regression. This estimation permitted the inclusion of dummy variables for North America, Japan, Asia, and Europe as the main countries/regions encompassing suppliers' origins. The results using GEE regressions showed no significant effects for country of origin on suppliers' performance. We then checked if there is a difference in the hypothesized effects in different time periods.

We divided the sample into two time periods to test our models, one from 2007 to 2010 (which represents a period of global recession and recovery) and the other from 2011 to 2014, and results remained consistent with the main results reported. We also tested the results with alternative measures of upstream and vertical alliances. Instead of the five-year average, we used the yearly sum of alliances in both variables, and the results remained fully robust. Yet, given the combination of positive negative factors associated with an increased alliances' portfolio size (Jiang, Tao, & Santoro, 2010; Lahiri & Narayanan, 2013), we also tested for a curvilinear relationship between the number of vertical and horizontal alliances and firm performance. Results, however, returned not statistically significant for the square term of our alliances variables. Lastly, in another attempt to find an optimal level of alliances' portfolio size, we also tested for a combination of both vertical and horizontal alliances as moderators of the relationship between SI and performance. The results for this triple interaction did not return any statistically significant coefficient.

Discussion

Theoretical implications

This study sought to address the effect of increased SI capability on firm performance. Our results, drawing from a longitudinal sample of 245 first-tier automotive suppliers, confirm that increasing SI manufacturing capability has a significant positive effect on firm performance. We also found that systems integrators attain performance benefits from increases in vertical manufacturing alliances with their buyers. However, increases in horizontal manufacturing alliances have a hampering effect on systems integrators' performance. These findings provide important contributions to the literature on SI, dynamic capabilities, and B2B relationships.

First, we provide empirical evidence that systems integrators are able to attain benefits that surpass the costs involved in such activities. Studies have conjectured that systemic products involve highly complex operations, increasing the costs of manufacturing and coordination with suppliers and customers (Ethiraj et al., 2012; Hobday et al., 2005). On the other hand, attaining SI capabilities would allow firms to provide superior, integral solutions to their customers and, at the same time, amass a greater technological knowledge base useful for value creation (Davies et al., 2007; Prencipe, 2000). Our results shed new light on this conversation and reveal that suppliers, by increasing SI capabilities, are able to reap increased performance over time. We also address a call from past research to empirically demonstrate how firms adjust manufacturing capabilities, particularly via interfirm relationships, to reap the benefits from increased production of complex systems (Davies et al., 2007; Hobday et al., 2005).

The SI literature has conjectured that strengthening interfirm relationships via alliances is important to systems integrators since they foster knowledge transfers and operational flexibility (Dosi et al., 2002; Kamuriwo & Baden-Fuller, 2016). However, it has not yet addressed the distinction between vertical and horizontal alliances, which have different configurations in terms of resource complementarity, complexity, and division of tasks which in turn influence coordination and monitoring costs. Therefore, we highlight an important nuance for this research stream by demonstrating that while an increased portfolio of vertical alliances with buyers is beneficial to systems integrators' performance, an increased portfolio of horizontal alliances can significantly mitigate the performance benefits from SI. This difference between vertical and horizontal alliances for systems integrators corroborates the notion that complex manufacturing activities are better managed in-house and with the collaboration of downstream partners, thus shedding additional light ton the scholarly work on how systems integrators increase value capture from their operations.

Second, we advance the literature on dynamic capabilities by demonstrating that SI, a capability that encompasses the reconfiguration of several routines and technologies, is a relevant source of firm competitive advantage (Hoopes & Madsen, 2008; Karna, Richter, & Riesenkampff, 2016; Rumelt, 1991; Wernerfelt, 1984). Indeed, as Hobday et al. (2005) point out, SI has become a core capability of many firms, and it has important consequences to a firm's sustained competitive advantages. Moreover, the literature has noted that managing strategic alliances is an important dynamic capability that complements other capabilities (Schilke, 2014; Zollo, Reuer, & Singh, 2002). That is because alliance management requires building and maintaining learning and operational routines, which helps improve other capabilities but also involves significantly high costs (Lahiri & Narayanan, 2013).

In this case, given the constraints in managerial resource allocation and attention, firms seem to be at difficult odds when it comes to sustaining high levels of SI and multiple horizontal manufacturing alliances together. Our findings, therefore, complement past studies on how dynamic capabilities lead to improved performance, which have pointed out that the best results emerge when firms are able to coordinate the deployment of several capabilities concomitantly (Schilke, 2014; Teece, 2018). Moreover, it attests to the literature on buyer-supplier relationships, which has pointed out that vertical manufacturing alliances provide significant improvements in operational efficiency and, therefore, allow systems integrators to achieve gains in terms of coordination, knowledge sharing, and performance (Adams & Graham, 2017; Dyer, Singh, & Hesterly, 2018; Wagner & Hoegl, 2006).

Relatedly, this study also contributes to the theory on B2B relationships by empirically demonstrating the extent to which vertical and horizontal alliances play in systems integrators' performance. Past research has alluded to the concept of sustaining loosely coupled relationships with suppliers in order to foster innovation and reduce costs (Acharya, Ojha, Patel, & Gokhale, 2019; Gosain, Malhotra, & El Sawy, 2004). Our study complements this perspective, as we find that conducting manufacturing activities with other suppliers via formal, equitybased alliances is not the best strategy for firms pursuing increased SI.That is, increasing the number of manufacturing alliances with other suppliers will likely restrict the firm's ability to quickly reconfigure its products' design and features, in contrast to relying on vertically integrated manufacturing or loosely coupled supply relationships (Cabigiosu & Camuffo, 2012; Jacobides & Billinger, 2006). In sum, this study provides much-needed nuance to the understanding of how firms pursuing SI capabilities reap performance benefits and which contingencies are capable of influencing this relationship.

Managerial implications

Our findings also provide valuable practical information to managers. First, by showing that suppliers are able to attain superior performance from increased SI and also revealing that strategic alliances play a relevant role in the degree to which firms can capture value from SI, we clarify that SI is more rewarding to those who pursue it via vertical integration and by strengthening buyer-supplier relationships. These results, however, should not be interpreted simply as seamless direct relationships. Although we show that automotive suppliers have benefited from SI, managers need to carefully assess the substantial costs involved in such activities, particularly in cases where the firm has no prior experience with SI, and assess the industry configuration in terms of volatility in product architectures and standardization of components.

Second, we inform managers that increasing the manufacturing of systems tends to pay off over time and that alliances with buyers help firms leverage value creation and capture from this endeavor. Managers, therefore, can use our results to better understand under which conditions investing in multiple vertical and horizontal alliances provides more value to systems manufacturing since the case of increased horizontal alliances seems to generate managerial and transaction costs incompatible with these activities. Lastly, our findings encourage managers to adopt a more cautious approach regarding horizontal alliances and highlight the benefits of SI activities jointly developed with buyers. Therefore, it informs managers about the need for a well-established orchestration of both internal and external activities for SI's success.

Limitations and future research

Some limitations related to the research context and methodological procedure should be considered. First, the generalizability of our findings is limited to industries in which there are limits to product modularization and where manufacturers can create substantial value from SI. Second, while limiting our sample to one industry allows us to (1) control for cross-industry variations, (2) ensure that alliances formed are comparable across the sample (Stuart, 2000), and (3) contrast firms within the same context across the same stage of production, it also potentially decreases the generalizability of our findings to other industries. Future research attempts, by analyzing the same relationships in different contexts (e.g., pharmaceutical, apparel, consumer packaged goods industries), will enhance our understanding of the drivers and outcomes of SI. Since our sample consists of first-tier suppliers, there is also an opportunity for future studies to obtain insightful information from lead firms in downstream positions and how they manage system integration capabilities with other systems' suppliers. Moreover, although we use measures that are aligned with past research using secondary data, our alliances' portfolio data only captures the benefits and costs of alliances at an aggregated level. More refined metrics of capabilities such as SI and alliances' management could be drawn from qualitative and primary data collections in order to provide more nuance to the relationships between SI, performance, and strategic alliances.

Our results are insightful for future research in several ways. Drawing from the empirical evidence that increasing SI capabilities lead to superior performance, future research could assess if increased SI capabilities can also foster innovativeness (such as architectural innovation) or lead to increased bargaining power positions and shape the quality of vertical relationships. In this case, the nature of current established external relationships and also interdepartmental interactions may receive substantial influence from greater SI efforts. The external environment should also play an important role in how much systems integrators are able to reap performance over time.

In more dynamic and competitive environments, the costs attributed to managing complex product systems may increase due to technological shifts and the obsolescence of other strategic resources such as manufacturing and R&D activities. Organizational learning from different perspectives, therefore, should also play an important role in how much firms can benefit from SI. Thus, future research could improve the current understanding of how organizations can promote and sustain SI capabilities from an organizational learning perspective. In sum, as the role of systems integrators becomes increasingly prominent in many industries and customers demand more integral solutions, marketing relationships between firms and customers are going to continually be shaped by firms' capacity to integrate new product systems and services.

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Table 1: Variable operationalizations.

Variable	Operationalization	Source
Return on assets (ROA)	Net income divided by total assets in year t	Bloomberg and Compustat
Systems integration capability	Total number of unique systems manufactured in year t	MarkLines
Vertical alliances with buyers	The five-year average of all manufacturing alliances with automakers	SDC Platinum
Horizontal alliances	The five-year average of all manufacturing alliances with other suppliers	SDC Platinum
Firm age	Number of years since establishment	Bloomberg and Compustat
Firm size	Total number of employees	Bloomberg and Compustat
Leverage ratio	Total debt over total equity	Bloomberg and Compustat
R&D intensity	R&D expenditures over total sales	Bloomberg and Compustat
Innovation output	Number of patent applications in year t	USPTO
Past performance	Firm's ROA in year t-1	Bloomberg and Compustat
Other alliances	Five-year average of all nonmanufacturing-purposed strategic alliances	SDC Platinum

Table 2: Descriptive statistics and pairwise correlations.

	Mean	SD	1	2	3	4	5	6	7	8	9	10
1.Performance	3.33	5.49	1									
2.Age	3.70	0.96	0.02	1								
3.Size	21.421	41.324	0.01	0.08	1							
4.Leverage	95.01	321.00	-0.13	-0.02	0.00	1						
5.Past performance	3.33	5.49	0.47	0.02	0.00	-0.16	1					
6.R&D intensity	0.02	0.02	-0.01	-0.05	0.26	-0.06	-0.04	1				
7.Innovation output	15.49	80.43	0.00	0.01	0.48	-0.01	0.03	0.20	1			
8.Other alliances	0.12	0.19	-0.01	-0.02	0.27	-0.01	0.00	0.01	0.01	1		
9.Systems integration capability	0.93	3.57	0.02	0.01	0.41	0.04	0.02	0.27	0.04	0.02	1	
10.Vertical alliances	0.14	0.29	0.05	-0.01	0.04	0.01	-0.02	-0.04	0.00	-0.01	-0.02	1
11.Horizontal alliances	0.20	0.26	-0.01	-0.03	0.27	-0.03	0.04	0.08	0.10	0.03	0.16	0.07

Correlations greater than 0.04 are significant at $p < 0.05$; N = 987.

Table 3: Panel regression results.

DV: ROA	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err
Age	-0.860	(2.820)	(0.401)	(2.873)	-0.457	(2.919)	-0.616	(2.888)	-0.665	(2.894)
Size	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)
Leverage	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)
Past performance	-0.183**	(0.055)	-0.183**	(0.054)	-0.182***	(0.054)	-0.187***	(0.054)	-0.184***	(0.054)
R&D intensity	-9.167	(20.769)	-13.060	(21.602)	-12.830	(21.642)	-12.060	(21.757)	-11.130	(21.621)
Innovation output	0.005***	(0.002)	0.008***	(0.002)	0.008***	(0.002)	0.007***	(0.002)	0.007***	(0.002)
Other alliances	-8.340	(15.354)	-4.700	(14.389)	-4.315	(14.356)	-3.706	(14.175)	-3.640	(14.146)
Systems integration capability			0.496***	(0.167)	0.500***	(0.166)	0.653***	(0.164)	0.653***	(0.164)
Vertical alliances			5.506*	(8.026)	-3.927	(5.074)	-2.404	(3.042)	-4.489	(5.001)
Horizontal alliances			-0.844	(1.175)	-0.573	(1.125)	-0.158	(1.109)	-0.058	(1.111)
Systems integration capability X Vertical alliances					13.220***	(3.172)			12.912***	(3.140)
Systems integration capability X Horizontal alliances							-0.714***	(0.190)	-0.711***	(0.188)
Constant	7,941	(11.072)	6,896	(11.135)	7,138	(11.330)	7,659	(11.214)	7,808	(11.230)
Year dummies	Included		Included		Included		Included		Included	
R-square within	0.376		0.382		0.383		0.387		0.398	
R-square between	0.042		0.051		0.044		0.042		0.040	
R-square overall	0.082		0.057		0.054		0.053		0.051	

Appendix A. Panel regression results for dependent variable net income

DV: Net income	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Age	0.013	(0.025)	0.023	(0.025)	0.024	(0.025)	0.020	(0.025)	0.022	(0.025)
Size	0.001*	(0.001)	0.001*	(0.001)	0.001*	(0.001)	0.001*	(0.001)	0.001	(0.001)
Leverage	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)
Past performance	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)
R&D intensity	0.344	(0.233)	0.266	(0.195)	0.272	(0.196)	0.286	(0.199)	0.287	(0.200)
Innovation output	0.002*	(0.001)	0.002*	(0.001)	0.002*	(0.001)	0.002*	(0.001)	0.002*	(0.001)
Other alliances	-0.229	(0.557)	-0.166	(0.524)	-0.165	(0.524)	-0.162	(0.522)	-0.159	(0.521)
Systems integration capability			0.007**	(0.003)	0.007	(0.003)	0.009	(0.003)	0.009	(0.003)
Vertical alliances			0.053	(0.061)	0.015	(0.011)	0.039	(0.051)	0.092	(0.077)
Horizontal alliances			-0.016	(0.011)	-0.084	(0.071)	-0.012	(0.012)	-0.010	(0.012)
Systems integration capability X Vertical alliances					0.084***	(0.042)			0.084***	(0.045)
Systems integration capability X Horizontal alliances							-0.006**	(0.002)	0.006**	(0.002)
Constant	0.486	(0.099)	0.461	(0.099)	0.460	(0.099)	0.472	(0.100)	0.465	(0.099)
Year dummies	Included		Included		Included		Included		Included	
R-square within	0.201		0.251		0.264		0.260		0.271	
R-square between	0.016		0.018		0.017		0.022		0.022	
R-square overall	0.003		0.003		0.002		0.002		0.002	

Appendix B. Panel regression results for dependent variable gross profit

DV: Gross profit	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Age	-0.947	(0.951)	-0.849	(0.969)	-0.845	(0.970)	-0.880	(0.967)	-0.877	(0.968)
Size	0.001*	(0.001)	0.001*	(0.001)	0.001*	(0.001)	0.001*	(0.001)	0.001	(0.001)
Leverage	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)	0.001	(0.001)
Past performance	-0.008*	(0.006)	-0.009*	(0.006)	-0.009*	(0.006)	-0.009*	(0.006)	-0.009*	(0.006)
R&D intensity	-3.195	(2.998)	-4.126	(3.086)	-4.065	(3.103)	-3.843	(3.064)	-3.782	(3.081)
Innovation output	0.000	(0.001)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Other alliances	0.480	(1.472)	1,170	(1.407)	1,185	(1.409)	1,290	(1.389)	1,305	(1.392)
Systems integration capability			0.075**	(0.033)	0.075**	(0.033)	0.101**	(0.040)	0.101**	(0.040)
Vertical alliances			-2.265	(1.447)	-2.573	(1.745)	-2.417	(1.434)	-2.727	(1.719)
Horizontal alliances			-0.072	(0.257)	-0.060	(0.266)	0.017	(0.253)	0.029	(0.261)
Systems integration capability X Vertical alliances					0.849**	(1.143)			0.856**	-1,123
Systems integration capability X Horizontal alliances							-121**	(0.069)	-0.121**	(0.069)
Constant	5,825	(3.755)	5,583	(3.804)	5,568	(3.806)	5,682	(3.795)	5,667	(3.797)
Year dummies	Included		Included		Included		Included		Included	
R-square within	0.163		0.247		0.240		0.242		0.246	
R-square between	0.154		0.240		0.234		0.242		0.236	
R-square overall	0.029		0.041		0.046		0.041		0.046	