Can firms be both broad and deep?

Exploring the interdependencies between horizontal and vertical firm scope

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Abstract

Firms can be horizontally diversified, with considerable breadth, or vertically integrated, with great depth. This study explores how breadth and depth affect each other as influenced by capability requirements and coordination demands. Using construction industry data, we assess the interdependence between contractors’ portfolios of building types (horizontal scope) and the extent of integration of the activities needed to complete each project (vertical scope). We find that vertical and horizontal scope have a negative interdependency only when contractors face managerial constraints due to coordination challenges. Without these constraints, horizontal and vertical scope are independent. This highlights the role of managerial capacity as an important bottleneck for firms attempting to be both broad and deep.
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INTRODUCTION

Firms come in different shapes. Some are horizontally broad, with many product lines in different markets; others are vertically deep, integrated into several stages of value chain activities upstream or downstream. Other firms may be tightly focused in a single market or value chain activity; whereas some may be both broad and deep. Research has found that horizontal breadth improves performance due to scope economies, synergistic use of resources, and leveraging of complementary assets (Palich, Cardinal, & Miller, 2000; Panzar and Willig, 1981; Tanriverdi & Venkatraman, 2005; Teece, 1982;), but that coordination, adjustment and execution costs can limit these benefits (Brahm, Tarziján, & Singer, 2017; Hashai, 2015; Wan, Hoskisson, Short, & Yiu, 2011; Zhou 2011). Likewise, vertical integration helps firms to improve the governance of their activities and exploit strong internal capabilities, (Argyres, 1996; Leiblein & Miller, 2003; Prahalad & Hamel 1990; Williamson, 1985), but the benefits of vertical depth are limited by the costs of hierarchical governance, such as coordination and monitoring (Perry, 1989; Williamson, 1985).

Although the choice of horizontal breadth and vertical depth are among the most important decisions in corporate strategy, we don’t fully understand the relationship between them. At a basic level, these scope choices can be independent or interdependent. The few studies that have addressed this relationship have found interdependencies, but arrive at different conclusions. Some studies have suggested positive interdependencies between depth and breadth
(Chandler, 1962; Tanriverdi & Lee, 2008; Zhou & Wan, 2016), while others have documented negative interdependencies (Rawley & Simcoe, 2010; Van Biesenbroeck, 2007; Zhou, 2011). In addition to these conflicting results, all of these studies investigated how a change in one type of scope subsequently influenced the other scope dimension. Although the nature of these decisions would imply mutual influence and simultaneity (Argyres & Zenger, 2012), no studies have yet explored if breadth and depth do affect each other simultaneously.

Building on previous studies, we investigate the simultaneous relationship between vertical and horizontal boundary choices. We base our arguments in the resource-based view (RBV) of the firm and the capabilities perspective, as the set of firm capabilities will drive boundary choices and their interdependence (Argyres, 1996; Kogut & Zander, 1992; Penrose, 1959; Teece, 1982; Wan et al., 2011). We start with the premise that many resources and capabilities are specific to a particular scope direction, such as marketing skills leading to more horizontal diversification and production expertise leading to greater vertical integration, as prior work has indicated (Li & Greenwood, 2004; Lorenzoni & Lipparini, 1999; Perry, 1989; Tanriverdi & Lee, 2008; Teece & Pisano, 1994; Vorhies, Morgan, & Autry, 2009). However, we further recognize that more general, higher-order managerial capabilities involving the ability of the firm to administer, orchestrate and coordinate the entire set of activities executed by the firm can affect both breadth and depth (Adner and Helfat, 2003; Helfat & Peteraf, 2015; Sirmon, Hitt, Ireland, & Gilbert, 2011). If these managerial capabilities are relatively unconstrained, then we should observe independence between breadth and depth, as firms can handle managing these differing activities. However, if this managerial capacity becomes congested, such as from coordination challenges, we would then see negative interdependency between breadth and depth.
We test our arguments through an investigation of the Chilean construction industry, using an extensive and rich database that spans 355 firms nearly 40% of the projects built in the country over an eight-year period. Our data allow us to precisely measure horizontal scope based upon the types of projects each contractor executes (e.g., residential housing, educational facilities, hospitals, etc.) and the contractor’s vertical scope as indicated by the extent of vertical integration in specialty trade activities performed (e.g., plumbing, painting, formwork, etc.). This is a mature industry, with no dominant players, but with heterogeneity among approaches, as some firms are vertically deep, some horizontally broad, some quite focused, and still others both broad and deep. This high level of variation in terms of scope choices allows us to study breadth and depth simultaneously. Another advantage is that our industry setting has very distinguishable capabilities that can be cleanly connected to vertical or horizontal scope decisions, such that these measures can be used as instruments in our simultaneous model. Our results support our premise and indicate that horizontal and vertical scope decisions based on scope-specific capabilities are essentially independent. However, we find that when coordination challenges are high, there is a significant negative trade-off between vertical scope and horizontal scope. That is, the greater the coordination demands, the more challenging it is for firms to be both broad and deep, affirming our predictions involving managerial constraints. As a reality check, we verified our results by interviewing industry executives who corroborated our findings and supported our proposed mechanisms.

Our paper contributes to the strategy literature by tackling the relationship between vertical and horizontal scope decisions and by proposing mechanisms that drive this interdependency. First, we study the simultaneous interdependency of scope boundaries, reflecting more accurately the realities and intricacies of these choices. We provide both
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Theoretical logic about this relationship and rigorous empirical testing that indicates the importance of both scope-specific and broader managerial capabilities. Second, we provide a mechanism based upon constrained managerial capacity due to coordination demands that drives the relationship between breadth and depth. When these demands are modest, breadth and depth will be independent and can co-exist. However, when these demands are more severe, managers cannot attend to all of the details and varied activities involved, resulting in a negative and simultaneous relationship between breadth and depth. This implies the importance of understanding both types of capabilities, as well as the influence of coordination demands, which should be incorporated into firm boundary studies.

**THEORY AND HYPOTHESES**

Our study focuses on the interdependencies of horizontal and vertical scope in firms. Interdependencies can be positive or negative. They are positive if an expansion in horizontal (vertical) scope results in an expansion in vertical (horizontal) scope and they are negative if an expansion in horizontal (vertical) scope results in a reduction in vertical (horizontal) scope. Empirical evidence on scope interdependence is mixed. Recently, Zhou and Wang (2016) used a detailed econometric case study of a soft-drink concentrate producer to show that vertical integration in the bottling industry improves product-level efficiency for the integrated company, increasing the incentives to expand its horizontal scope. This result is similar in spirit to Chandler’s classic study (1962), and to Tanriverdi and Lee’s (2008) work in the software industry, who found that related diversification in software product-markets is complementary to increased scope in the vertical domain of operating systems platforms in improving sales and market share. In contrast, Rawley and Simcoe (2010) and Zhou (2011) argue that, due to social comparison costs and constraints in coordination capacity, a negative relationship between
horizontal and vertical scope arises. Further, Van Biesebroeck (2007) analyzed automobile plants and found that vertical and horizontal scope are substitutes with respect to productivity.

Thus far, studies on this topic have only addressed unidirectional relations. Zhou (2011) examined the complexities and interdependencies among horizontal scope choices, finding that outsourcing existing activities along the vertical value chain may free up coordination capacity for horizontal diversification. Similarly, Zhou and Wan (2016) found that vertical integration, by aligning incentives and facilitating information sharing along the value chain, plays a positive role in coordinating diversification, thus increasing the willingness to expand horizontally. Demonstrating how breadth affects depth, Rawley and Simcoe (2010) show that taxicab firms who diversify into the limousine business subsequently increase outsourcing, shifting their fleet composition toward more owner-operator drivers, which frees up managerial attention. Thus, we have studies that indicate that depth affects breadth and that breadth affects depth. In contrast, our study looks at the simultaneous relationship between breadth and depth which more accurately reflects the nuances and trade-offs of these boundary choices.

**Capabilities as drivers of scope choices**

To unpack the relationship between horizontal and vertical scope decisions, we focus on the capabilities possessed by the firm. Consistent with explanations offered by the resource-based view (RBV), an important driver of horizontal breadth involves the utilization of excess indivisible resources or capabilities to expand into multiple products and obtain economies (Panzar & Willig, 1981; Penrose, 1959; Teece, 1982; Wan et al., 2011). The literature on vertical integration has also shown that firms are more likely to integrate if they possess stronger capabilities than external suppliers to efficiently undertake upstream or downstream activities (Argyres, 1996; Brahm and Tarzijan, 2014; Grant, 1996; Kogut and Zander, 1992).
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generally, the resources and capabilities that provide the foundation for horizontal and vertical scope differ. Horizontal expansion is enabled by the ability of the firm to leverage capabilities that can be applied to different types of products or markets, whereas vertical expansion is enabled by the ability of the firm to leverage capabilities across different stages of the value chain. Capabilities leveraged across horizontal domains are typically related to marketing skills, such as product knowledge, sales, branding, reputation, and customer service (Vorhies et al., 2009), and skills to manage demand complementarities in customers and markets (Li and Greenwood, 2004; Tanriverdi & Lee, 2008; Ye et al., 2012). The literature shows that experience and capabilities in a specific product or project can be helpful in related activities (Helfat & Raubitschek, 2000; Tanriverdi & Venkatraman, 2005).

on the other hand, capabilities involving vertical scope tend to be associated with production and process expertise, such as technology selection, asset utilization, risk reduction, supply chain management, and procurement (Lorenzoni & Lipparini, 1999; Perry, 1989; Teece and Pisano, 1994). These capabilities can also include skills related to managing interdependent stages and timing, since activities in the value chain often involve sequential or reciprocal activities, with a desire for smoother transitions and greater control (Brahm & Tarzijan, 2014; Eccles, 1981; Thompson, 1967).

the dedicated nature of capabilities for horizontal and vertical activities is not absolute, as some capabilities are more fungible than others. Fungibility is an attribute of a capability that facilitates its application to different organizational and market settings (Anand & Singh, 1997; Levinthal & Wu, 2010). Few, if any, capabilities are perfectly fungible, but we would expect greater fungibility in more closely related applications (Maritan & Lee, 2017). If the firm’s horizontal capabilities are more easily devoted to other product markets rather than to vertical
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activities, that means they have greater within-scope than across-scope fungibility. Likewise, if vertical capabilities are more easily devoted to other vertical stages than to product markets, then they would also have greater within-scope than across-scope fungibility. We posit that, due to the fundamental differences in horizontal and vertical capabilities, within-scope fungibility will tend to be greater than across-scope fungibility.

When within-scope fungibility is greater than across-scope fungibility, the choices of breadth or depth expansion driven by capabilities will be independent from each other. For breadth, the value generated by applying horizontal capabilities to additional product markets would be considerably higher than the value generated by applying those capabilities in new value chain stages. For depth, the value generated by applying vertical capabilities to additional value chain stages would also be considerably higher than the value generated by applying those capabilities in more product markets. As the positive difference between within-scope and across-scope fungibility gets larger, the breadth and depth expansions derived from scope-specific capabilities will be increasingly independent. Therefore, as capabilities are more specific (i.e., within-scope fungibility is greater than across-scope), an expansion in the horizontal (vertical) scope of the firm driven by horizontal (vertical) capabilities will have a lesser affect on its vertical (horizontal) scope.

The corollary of the fungibility assumption within and across scopes is that in order to obtain an interdependency, something additional is required. This simplifies the theoretical and empirical analysis, as these new additional drivers can be studied without the complication of any first-order effects of scope-specific capabilities. We propose that a crucial driver of breadth and depth interdependence are higher-order managerial capabilities.
Higher-order managerial capabilities and scope

Firms’ higher-order managerial capabilities can generate an interdependency between horizontal and vertical scope, since these impact the overall management of the firm. These capabilities are related to the ability to broadly manage the firm, that is, the ability to plan, coordinate, execute and monitor all firm activities. These capabilities include resource orchestration and parenting skills, such as the capacity to make decisions to expand, allocate, and redeploy resources across businesses and activities (Adner & Helfat, 2003; Helfat & Martin, 2015; Sirmon et al., 2011). As such, these managerial capabilities are used to manage the activities and tasks that are executed across scopes, as well as to guide the firm more broadly. The strategic management literature has highlighted the relevance of the higher-order managerial skills, which usually reside at the top of the organization (Finkelstein, Hambrick & Cannella, 2009; Helfat & Peteraf, 2015).

These higher-order capabilities differ from the capabilities specific to each scope. The latter are more related to operational and technical ability, and to the execution of the production tasks (Winter, 2003). Higher-order managerial capabilities are more general, so they can be applied to managing and coordinating many different activities. Therefore, fungibility is higher for managerial capabilities than for horizontal or vertical specific capabilities. However, managerial capabilities are not scale-free; their value diminishes with the magnitude of the operations and activities to which they are applied. This generates opportunity costs in their deployment and thus their allocation to different activities becomes relevant and highly consequential to performance (Levinthal & Wu, 2010).

We focus on two sources that generate the non-scale free nature of these higher-order managerial capabilities (Zenger, Felin, & Bigelow, 2011). First, information problems become more prevalent when scale increases, as information that is passed on from operations to
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management can be distorted. This happens unintentionally, as a by-product of passing the information across more layers (Williamson, 1985), or intentionally, when information is misrepresented and/or withheld due to delegation in larger organizations (Gibbons, Matouschek, & Roberts, 2013). In addition to information distortion, information processing also suffers with scale. As organizations grow larger or more complex, the amount of information that is required to be processed by managers increases. However, managers’ information processing capacity is limited (Eggers & Kaplan, 2013; Radner, 1992) and the amount and distortion of information affects the cognitive capacity of managers. The strategic management literature has studied managerial cognitive capacity in great detail. Helfat and Peteraf (p. 835, 2015) defined this cognitive capability as “the capacity of an individual manager to perform one or more of the mental activities that comprise cognition”. They posit that this capacity or capability has an important context- or domain-specific aspect. Given limits to managers’ cognition, managers tend toward inertia and similar decision-making processes based upon the context (Eggers & Kaplan, 2013; Shepard, McMullen & Ocasio, 2017; Tripsas & Gavetti, 2000;). Thus, as a firm gains experience in a particular set of dominant activities or capabilities, managers accumulate knowledge in that particular domain, specializing their cognition and increasing the difficulty to optimally addressing other activities or capability sets that the firm might decide to pursue. For instance, Ocasio (1997) shows that managers are more effective when focusing their managerial time, attention and efforts on a single product category, rather than when they are required to split their time, attention and efforts between tasks related to multiple products.

Another source of non-scalability of higher-order managerial capabilities is related to moral hazard and effort. When organizations grow larger, monitoring and incentivizing effort become more difficult. Even if information is not distorted and managers would have infinite
processing capacity, the amount and complexity of activities still generates the problem of imperfect observability and divergence of objectives between workers and the firm (Canback, Samouel, & Price, 2006; McAfee and McMillan, 1995; Zenger, 1994). Further, credible delegation as a mechanism to align and strengthen incentives within firms is often infeasible, due to the difficulty of selective interventions (Foss, 2003; Williamson, 1985).

Becoming broad and deep will consume managerial capabilities available to the firm. This claim on managerial capabilities will not be overly costly if the firm is not taxed with many other demands. However, if the company’s management is already close to full capacity-utilization, then the effectiveness of managerial capabilities will become impaired. Managers will be cognitively taxed and monitoring employees will become harder to accomplish. In turn, this will generate pressure to offload activities to reduce firm scope. Since managerial capacity is domain-specific, they likely will reduce activities in the more “different” area, suggesting a negative relationship between breadth and depth.

Therefore, when higher-order managerial capabilities are taxed, for example by greater coordination demands, a trade-off between breadth and depth can result. For example, in project-based industries, the number of projects and their diversity will increase coordination demands due to information problems arising from activities that are lumpy, time-dependent, challenging to plan, and hard to monitor. Specifically, in the construction industry, additional building projects represent big jumps in administrative work, with many more details to manage, and geographic distance generates agency problems, as the lack of physical proximity makes it more difficult to effectively monitor subcontractors and coordinate project execution (Eccles, 1981; Kiesler & Cummings, 2002).
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One potential solution to address this capacity problem could be to hire more executives to cope with the increasing cognitive demands of larger and more diversified firms. However, the same limitations mentioned previously, involving information distortion, communication problems, strategic behavior and moral hazard, would continue to plague the interface between the managerial layers. That is, the size of the management team is limited due to diseconomies of scale driven by communication distortions and bureaucratic insularity (Camback, et al., 2006; Williamson, 1981). Moreover, it is costly and lumpy to add managerial capacity, as talented executives can be difficult to find and integrate into the firm.

To summarize, when coordination demands are modest, managers can handle both horizontal and vertical scope activities, such that these will be independent. However, as these demands increase, managerial capabilities become taxed and less effective. To cope with the managerial constraints imposed by activity in one direction, firms will have the incentive to free-up managerial capacity by reducing the scope in the other direction. That is, we predict a negative relationship between breadth and depth when these coordination demands are high. The argument overall argument we have laid out is symmetric. Therefore, under condition of taxed managerial capacity, this implies a bi-directional, simultaneous interdependency between breadth and depth. This leads to the following hypotheses:

**H1**: When the coordination demands on higher-order managerial capabilities are high, an increase (decrease) in the horizontal breadth will cause a decrease (increase) in the vertical depth of the firm. This negative relationship will increase as these demands increase.

**H2**: When the coordination demands on higher-order managerial capabilities are high, an increase (decrease) in the vertical depth will cause a decrease (increase) in the horizontal breadth of the firm. This negative relationship will increase as these demands increase.
EMPIRICAL SETTING

We analyze the hypotheses of this study within the context of the Chilean construction industry, focusing our attention on building contractors, who build multiple residential or commercial projects. These projects tend to be varied and customized with heterogeneity in design, specifications, geographic location, size, and other attributes. Typically, a building contractor creates a project for an owner/developer according to specifications provided by the architect or designer. Projects are the “production units” for contractors. They assign resources to projects, control and monitor performance, and coordinate administrative tasks, such as procurement, logistics, warehousing and staffing across projects. The contractor’s managerial team spends an important part of its time coordinating and overseeing the project portfolio.

We have detailed information about all relevant project types: housing complexes, office buildings, residential buildings, health facilities, educational facilities, hotels, industrial buildings, commercial projects (e.g., banks or supermarkets), religious buildings, and single-family houses. Horizontally, diversification of contractors increases with the type of projects they undertake. For each project, we also have detailed information regarding the contractors’ sourcing decisions for nine distinct specialty trade activities: 1) building and installing the metallic structure, 2) building the formwork, 3) installing electrical services, 4) installing plumbing and water services, 5) installing heating and cooling systems, 6) framing and installing windows, 7) painting, 8) installing gas services, and 9) building and installing furnishings and appliances. These activities account for the vast majority of building project activities (Riley, Varadan, James, & Thomas, 2005) and each requires a considerable amount of specific expertise (Ng & Tang, 2010). The greater the number of vertical activities performed by the contractor, aggregated over its total project portfolio, the deeper its vertical integration.
Because we study a single industry with clearly defined and observable horizontal and vertical activities, we can distinguish which capabilities are more prone to horizontal or vertical activities and which ones are useful for both types of activities. In addition, this industry provides plenty of variation in terms of breadth and depth of contractors: some are vertically depth but horizontally narrow, some are vertically shallow and horizontally wide, and others are either “deep and wide” or “shallow and narrow”.

**DATA AND VARIABLES**

We used a unique database provided by ONDAC S.A. This firm collects detailed data on construction projects and sells this data to construction suppliers and building material manufacturers. The database covers the period from January 2004 to October 2012 and includes 46,420,398 square meters built in 12,272 projects. The database covers approximately 40% of the total square meters constructed in Chile during that period. We had to compute lags on some variables, thus losing the first four years in our database. Our final sample included 355 contractors, with an average of three years of data per contractor.

The primary unit of analysis in our estimation is the firm-year. The firm (contractor) is a collection of projects. For each project, detailed information about the contractor was available (i.e., executives’ names and the contractor’s website, address and company name). In addition, for each project we obtained data that characterize each project, such as size in square meters, geographic location (state, city), starting and ending dates, stage of construction, project name, detailed comments regarding project characteristics, and sourcing data on the nine specialty trade activities. To obtain firm-year information, we used the start date of the project as the criteria to aggregate the collection of projects into a firm-year panel data structure.
Variable measurement

**Dependent variables.** We have two dependent variables, one measuring the contractor’s breadth of project types and another measuring their depth of vertical activities.

*Breadth of horizontal portfolio.* We measure horizontal scope by the degree of diversification based on the ten types of projects, which we calculate annually using the Herfindahl-Hirschman Index (HHI). To compute the HHI, we first calculate the share of the total square meters built by the contractor for each project type and then sum the squares of these shares; since the HHI reflects concentration, we then take 1-HHI to create a final variable to measure horizontal breadth.

*Depth of vertical activities.* To measure the vertical scope, we aggregated at the contractor-year level all the sourcing choices made at the different specialty trades in all the different projects. First, each of the nine activities took the value of 1 if integrated and 0 if outsourced. Second, across all contractors we standardized this measure for each activity. Then, we averaged the standardized measure across activities for each contractor and each year. This results in a vertical scope measure that is equal to the standardized percentage of integrated specialty trade activities at the contractor level.

**Independent variables.** We have three sets of independent variables. The first are three variables that proxy for coordination demands; the second and third sets measure specific horizontal and vertical capabilities. These latter two sets allow for the instrumental variables technique that is required to: i) map our empirics to our theoretical framework, and ii) address endogeneity using a simultaneous equation model.

**Coordination demands.** The three measures for coordination demands are:
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Number of projects. The number of projects that a contractor is simultaneously managing affects the ability of managers to efficiently manage and coordinate the projects. First, projects are lumpy units of activity and very often contractors do not add extra managers due to risk considerations (typically, related to the high cyclicality of the industry). This generates attention and capacity shortages, which are compounded by looser monitoring and therefore agency problems at the project level. Second, more projects also imply more transitions within and between projects and more difficulties in allocating resources and in transmitting and processing information. Since projects typically last over a year, we used the number of projects started in each year to measure each contractor’s simultaneous project load.

Project distance to headquarters. The distance from the contractor’s headquarters to each project will affect coordination demands, because project oversight and coordination of exceptions are difficult, as they must be done on-site due to the unique nature of each project and the difficulty in remotely transmitting accurate information of the specifics of the situation that needs senior management’s attention (Navon & Sacks, 2007). For each contractor, we observe the county location for the headquarters and the specific location of each project. Using the latitude and longitude coordinates (i.e., global positioning), we compute the distance between each project to headquarters for each year, then take an average and convert this figure to its natural logarithm plus one (the logarithm of zero is undefined; see Kalnins, 2003 for similar variable construction).

Distance between projects. Coordination among geographically distant projects is harder, particularly for allocating resources between projects and generating common understanding in terms of procedures, administrative processes and informal rules. To estimate the distance between projects, we compute the geographic centroid of the contractor’s set of projects by year.
This centroid is the latitude and longitude that minimizes the weighted distance of the projects, weighted by project size (measured in square meters). We compute the average distance of the projects to this centroid, again transforming this to its natural logarithm plus one.

**Horizontal capabilities.** The experience of project designers and administrators are important capabilities required in construction companies. We measure the extent to which the designers and administrators have prior experience in different types of projects as follows:

**Designer experience in different project types.** To measure the experience of the designers utilized by the contractor, we first compute the diversification level of each designer in our database across different project types, using the formula of one minus the HHI index. We calculate the HHI index as the sum of the squares of the percentages of the designer’s square meters built in each type of project. This generates a measure of experience across project types for each designer. Then, for each contractor in each year, we compute the average diversification of the designers that the contractor used in the projects they started in that year.

The designers can be either internal or external to the contractor. This could generate an endogeneity bias in the estimations due to reverse causality, particularly for the case of internal designers. Several considerations help mitigate this concern. First, the frequency of contractors with internal designers is small. According to Brahm and Tarzijan (2013), in this setting there are approximately 8% contractors with integrated design. Moreover, more than 90% of these cases are present in the “housing sector”, a variable that we include as a control. Second, we executed a robustness analysis excluding the contractors with internal designers and the results did not change. Regarding the case of external designers, they possess their own independent decision-making process regarding scope, which limits the problem of contractor’s breadth choice affecting theirs. The low correlation of 0.21 between contractor breadth and designer experience
is consistent with this fact (see Table 1). Of course, repeated interactions among contractors and external designers could generate some contractor influence; however, measuring designer experience across the entire years of the sample partly mitigates this issue.

**Project director experience in different project types.** Project directors are an important resource for contractors, since they lead on-site project execution. For example, Brahm and Tarzijan (2016) find that trust on the project director is crucial in order for the contractor to delegate procurement decision rights to the project (away from central headquarters). We compute experience across project types for each director by computing a dummy variable with value 1 if the director had been involved with more than one project type over the last three years (from t to t-2) and 0 otherwise. This mitigates partly the concerns for endogeneity. For each contractor-year, we compute an average such that the resulting measure reflects the percentage of a contractor’s project directors with broader experience. We chose this option instead of an HHI index because only 20% of the directors had experience in more than one type of project.

**Vertical capabilities.** We use two measures for vertical capabilities: expertise in a vertical trade activity and prior interactions with suppliers. Well supported in the empirical literature, greater trade expertise drives greater integration and greater prior supplier interaction drives less integration (Brahm and Tarzijan, 2014; Mayer & Salomon, 2006; Mayer et al., 2012). These measures capture two well-established “vertical” capabilities: the former proxies for productive capabilities (Jacobides & Winter, 2005), while the latter proxies for contracting capabilities (Mayer & Argyres, 2004).

**Trade expertise.** This variable is associated with experience and know-how in the vertical activities. For each specialty trade activity within each region, we compute the total historical volume (in square meters) of that trade conducted by the contractor and by all subcontractors in
that specific trade. To capture the correct notion of comparative capabilities (Jacobides & Hitt, 2005), we then compute the volume percentile for the focal contractor, considering the total volume for each activity in periods t-4 to t-1, omitting year t to avoid reverse causality. Then, we average these percentiles across specialty trades to obtain a contractor-year measure of overall vertical trade expertise. In simple terms, we rank all the “players” in a specific trade using previous volume, both subcontractors and the internal teams, and then we obtain the percentile at which the internal team of each contractor is placed. Then, we average across trades.

Prior interactions with suppliers. We compute this variable by measuring the number of interactions between each pair of contractors and suppliers prior to the focal firm-year. For each trade activity and region, we created adjacency matrices between contractors and suppliers to obtain the number of projects each contractor executed with each supplier over the prior four years (from t-1 to t-4). If the contractor had no prior projects with a supplier in a particular trade activity, we set this variable to zero. To obtain a measure at the contractor-year level, we average across region and specialty trades the repeated interactions for each contractor-year. This measure captures each contractor’s repeated interactions with suppliers.

If persistence in the dependent variable is present, then simply lagging the (potentially endogenous) independent variable might not be enough to avoid reverse causality. In order to mitigate these concerns regarding the previous two measures of trade expertise and prior interactions (as well as project director experience), we executed robustness checks in our estimations where we included lags on the dependent variable. The results remained unchanged.

To complement these two capability measures, we also add a third determinant of vertical scope, namely the thinness of supplier market. In construction, suppliers specialize geographically (Ball, 2003) and by project type (Somerville, 1999). Thus, we measure supplier
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market thinness using the market concentration of firms in each specialty trade activity for each project type by region using the HHI. A high HHI indicates that a few suppliers dominate the market, increasing their bargaining power and promoting vertical integration (Brahm & Tarzijan, 2014). The HHI measure was computed for a two-year window. For an aggregate measure for each contractor-year, we average the HHI index across trades by region and then compute a weighted average for each contractor based upon their total square meters built in each region.

Consistent with the notion that geographical specialization can increase market concentration in this (otherwise competitive) industry (Ball, 2003), our HHI index has an average of 0.23, typically considered “moderately concentrated”. This could potentially generate endogeneity problems, but we addressed this in several ways. First, we include contractor size and market share (measured at the region level) as control; conditioning on the influence of the contractor at the region level should facilitate that market thinness is indeed capturing an exogenous influence on depth. The inclusion of “geographic dispersion” and “metropolitan focus” also help to control for this possibility (see our appendix for additional details). Second, the use of lagged supplier market thinness yields consistent results. Finally, our instrumental variable estimation does not change if we drop market thinness from the analysis.

**Control variables.** We include control variables at various levels. For contractors, we include size, market share, geographic dispersion, metropolitan focus, and housing sector focus. At the market level, we include project type uncertainty, demand imbalance, and market size. We also include year fixed effects to control for average changes in scope over time. See our appendix for a summary of our controls. Table 1 provides descriptive statistics and correlations for our dataset.

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EMPIRICAL ANALYSIS

The appropriate econometric modeling strategy to address our question must incorporate the interdependency between vertical and horizontal scope. To do so, we use the following simultaneous equation model at the firm-year level:

\[ \text{Breadth}_i, t = \alpha_0 + \alpha_1 \times \text{Depth}_i, t + \alpha_1 \times \text{Hor}_i, t + \text{Controls} + \theta_i + \pi_i + \mu _{i,t} \]  
\[ \text{(1)} \]

\[ \text{Depth}_i, t = \beta_0 + \beta_1 \times \text{Breadth}_i, t + \beta_2 \times \text{Vert}_i, t + \text{Controls} + \theta_i + \pi_i + \mu _{i,t} \]  
\[ \text{(2)} \]

In equation (1), the breadth of the horizontal portfolio of contractor \( i \) in year \( t \) is modeled as a function of the depth of vertical activities, the horizontal capabilities (i.e., designer and project manager experience), control variables, and time effects. In equation (2), the depth of vertical activities of the contractor \( i \) in year \( t \) is modeled as a function of the breadth of the horizontal portfolio, the vertical capabilities (i.e., trade expertise, prior interactions and market thinness), a set of control variables, and time effects. The terms \( \pi_i \) are estimated using random-effects.

The coefficients \( \alpha_1 \) and \( \beta_1 \) are prone to endogeneity bias driven by reverse causality, (i.e., the number of vertical activities affects the breadth of horizontal portfolio and vice-versa), and by potential omitted variable bias. To correct for these biases, we use an instrumental variable (IV) technique (Bascle, 2008). This procedure requires an estimation of endogenous variables using instruments that are both valid and strong (Murray, 2006). The ideal candidates for instruments in our setting are the sets of variables that drive vertical depth in equation (2) and...
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those that drive horizontal breadth in equation (1), because these are specific to each boundary choice (strength condition) and do not affect the other decision (validity condition).

In Equation (1), we instrument $Depth_{Vert_i}$ using $Vert_{Cap_i}$. $Vert_{Cap_i}$ is not present in equation (1), satisfying (in principle) the validity condition and is present in equation (2), satisfying (in principle) the strength condition (shortly, we empirically check both conditions). Analogously, we use the instrument of $Hor_{Cap_i}$ for $Breadth_{Hor_i}$ in equation 2. As the following results show, the tests recommended by Bascle (2008) confirm the validity and strength of our instruments (i.e., Hansen test).

It is important to highlight that our modeling strategy maps our theoretical logic. Our theory indicates that: i) capabilities are scope specific and thus should affect only its own scope, ii) given their specificity, and absent other constraints such as high coordination demands, a capability driven decision in breadth should not affect depth. The simultaneous equation estimation using capabilities is able to capture these two theoretical arguments.

In Table 2, we present the results of the estimations that test the baseline relationship between breadth and depth. Model 1 does not include the instrumental variables and is presented only as a naïve, baseline random effects model. The results of this model support our drivers of horizontal depth in that greater designer experience across project types and broader project manager experience are both associated with a greater breadth in the horizontal project portfolio. Also, more trade expertise, fewer interactions with suppliers, and thin supplier markets are all associated with greater vertical depth, as expected. This provides support for using these sets of variables as instruments.

In Model 2, we present the instrumental variable (IV) estimation, which, as discussed above, fully conforms to our theoretical model. To evaluate the validity and strength assumptions
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of our instruments we evaluated the F-test of the first stage and computed the Hansen test (Bascle, 2008). The F-test shows that the instruments have strength (i.e., they explain the endogenous term), surpassing the threshold proposed by Stock and Yogo (2002). The Hansen test indicates that our instruments are valid (i.e., they do not explain the dependent variable, conditional on covariates). This is in line with our contention that horizontal and vertical capabilities are scope-specific. These results indicate that we are effectively testing our theoretical model, as we are testing how scope changes generated by capabilities affect each other.

Part of the theoretical justification for the exogeneity of these instruments was the use of lags in the measurement of capabilities, particularly for project director experience, supplier expertise and prior interactions. However, if breadth and depth are persistent, lagging might not be enough. In order to address this concern, we included in Model 1, lagged measures for breadth and depth as controls (for t-1, t-2 and t-3). Results, which are available from the authors upon request, do not change. This provides additional confidence on the empirical strategy⁹.

The main results of Model 2 indicate the changes in breadth and depth generated by capabilities are independent. This agrees with our baseline assumption. Capabilities at each scope are distinct and uniquely influencing its own scope. When no other constraint is present, then the firm need not trade-off vertical and horizontal scope.

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Insert Table 2 about here

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The role of coordination demands

To explore Hypotheses 1 and 2, we add the interaction effects of the coordination variables, using the following equations:

\[
\text{Breadth}_{\text{Hor},t} = \alpha_0 + \alpha_1 \cdot \text{Depth}_{\text{Ver},t} + \alpha_2 \cdot \text{Hor}_{\text{Cap},t} \\
\quad + \alpha_3 \cdot \text{Depth}_{\text{Ver},t} \cdot \text{Coord}_{\text{Demands},t} + \text{Controls} + \theta_t + \mu_{i,t} \tag{3}
\]

\[
\text{Depth}_{\text{Ver},i,t} = \beta_0 + \beta_1 \cdot \text{Breadth}_{\text{Hor},i,t} + \beta_2 \cdot \text{Vert}_{\text{Cap},i,t} \\
\quad + \beta_3 \cdot \text{Breadth}_{\text{Hor},i,t} \cdot \text{Coord}_{\text{Demands},i,t} + \text{Controls} + \theta_t + \mu_{i,t} \tag{4}
\]

Equation (3) is identical to equation (1), except for the inclusion of the interaction term between vertical depth and coordination demands. The same applies for equations (2) and (4), which include the interaction term between horizontal breadth and coordination demands. The individual term for coordination demands is included in the controls. The coefficients \(\alpha_3\) and \(\beta_3\) must be evaluated to gauge support for Hypotheses 1 and 2. To correct for the potential endogeneity problem of interaction terms, we use the technique suggested by Wooldridge (2002: 236-237)\(^{10}\).

The results are displayed in Table 3. Again, for all models, the Hansen test and the F-test of the first stage indicate that our instruments are valid and strong. In Models 3, 4 and 5 we introduce the interaction terms for each type of coordination demand. In Model 3, we include the interaction with the number of projects. The results show that the interaction terms are negative and with p-values of 0.006 and 0.080, which mean that, assuming a null impact, the likelihood of detecting these interactions in our sample is 1% and 8%. Figure 1 shows that a one standard deviation increase in vertical depth is associated with a decrease of a quarter of a standard deviation in horizontal breadth when the number of projects is large (defined as one standard deviation above the mean). In contrast, when the number of projects is low, vertical depth has
little effect on horizontal breadth. Figure 2 shows that a one standard deviation increase in horizontal breadth decreases vertical depth by a third of a standard deviation only when the number of projects is large, but it is less impactful when this number is low. In Model 4, we include the interactions term with the distance to headquarters, whose coefficient are negative with p-values of 0.55 and 0.29. In model 5, we include the interaction terms with the distance between projects, whose coefficients are negative and have a p-value of 0.02 and 0.052 (i.e., unlikely to be found in our sample if we had assume they weren’t there). These results, displayed in Figures 3 and 4, indicate that a one standard deviation increase in vertical depth (horizontal breadth) decreases horizontal breadth (vertical depth) by a quarter (third) of a standard deviation.

As a robustness test, we also checked whether contractor market share could be driving vertical scope through its effects on horizontal scope (for example, market share may increase market power), and found no support for this. We also replaced the number of projects with contractor size and obtained consistent results. All in all, our results provide support for Hypotheses 1 and 2, showing that the interdependency of vertical depth and horizontal depth appears to only exist in the presence of coordination demands.

Corroboration by senior managers

In order to improve our understanding and to help confirm the mechanisms driving our results, we reached out to seven senior executives of different construction companies. Our correspondence contained a summary of our empirical findings without any interpretation regarding the underlying mechanisms. Then we asked the executives to respond to two non-
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leading questions regarding our findings: 1) Is this finding consistent with what you know of the industry? 2) Why do you think that these patterns arise? We obtained six replies, each about three pages long. Given the tenure of our respondents, we estimate that collectively these executives have experience in managing over 100 projects. Overall, their answers are consistent with our interpretation of the findings, as summarized below.

- **Differences in capabilities.** When companies grow horizontally, they tend to use and leverage similar resources and capabilities (e.g., contract management, monitoring, capacity to adapt and manage teams, etc.). A typical example was that the systems to control and supervise the management of the different types of projects performed by a company (which are essential to grow horizontally) are the same across the different project types. Executives also mentioned that when firms grow vertically by performing different activities, they need different sets of technical capabilities, because many capabilities required in one type of vertical activity are different from those required in another activity.

- **Constraints to breadth and growth.** As the number, variety and dispersion of projects grows, executives indicated that complexity increases, putting pressure on the capacity to monitor, control and administer the myriad of contracts, particularly in terms of quality control and timing (e.g., transitioning between tasks and projects). Executives also pointed to the key role of top management team cohesion and experience in the success of any given project. Given their key role, executives indicated that when coordination demands increase, it is generally better to give away the benefits of internally performing vertical activities in favor of not losing the management team capacity to supervise and coordinate the many activities that need to be performed to complete a project. For firms growing vertically, the opposite is true. In order to
increase the number of vertical trades performed internally, firms have to free-up capacity by decreasing project variety.

**DISCUSSION AND CONCLUSION**

In this study, we explored the interdependencies between vertical and horizontal scope, grounding our arguments in the effects of capabilities and coordination, which have been widely used to explain firm boundaries. We theorize and empirically show that the capabilities underlying horizontal and vertical scopes are scope-specific (i.e., vertical capabilities impact depth but not breadth, and horizontal capabilities impact breadth but not depth), and therefore, breadth and depth are independent. However, we did find a negative interdependency between horizontal and vertical scope when coordination is more challenging, due to constraints on higher-level managerial capabilities. Our results, and their underlying mechanisms, were further validated by senior executives with considerable project experience.

We seek to contribute to a slim literature that has analyzed interdependencies between scope choices (Chandler, 1962; Rawley & Simcoe, 2010; Tanriverdi & Lee, 2008; Van Biesenbroeck, 2007; Zhou and Wan, 2016). However, we go a step further by studying the simultaneous and bi-directional influence of vertical and horizontal scope, and by measuring capabilities that are specific to horizontal or vertical scope. We also measure variables that are associated with constraints associated with higher order managerial capabilities that are required for both types of scope. Thus, our findings inform the understanding of managing different scope choices and the mechanisms that enable and constrain boundary expansion, suggesting what potential barriers firms have to overcome if they want to be both broad and deep. We also answer calls for the need to use information on multiple companies to draw more general conclusions about the relationship between horizontal and vertical scopes (Zhou & Wang, 2016).
Our work provides several theoretical contributions and implications. Through our simultaneous analysis of horizontal and vertical boundaries, we contribute to theories of the firm as a system of activities, supporting the notion of coherence and interrelatedness among firm activities (Porter & Siggelkow, 2008; Teece & Pisano, 1994). By finding that coordination is the key factor that limits bi-directional growth, we also contribute to recent work that emphasizes the costs of diversification over its synergies (Hashai, 2015; Sakharov & Folta, 2014; Zhou, 2011). Our results also imply that there may be some underlying fungible managerial capability, such as resource orchestration or parenting skills (Adner & Helfat, 2003; Sirmon et al., 2011), that can enable both breadth and depth, perhaps more likely in younger, smaller firms. Extending the work on the co-evolution of capabilities and boundaries (Argyres & Zenger, 2012; Brahm and Tarzijan, 2014; Mayer, et al., 2012), we add the importance of coordination and posit that these skills may also co-evolve and be intertwined with scope choices, supporting a coordination-based theory of the firm (Kogut & Zander, 1996; Srikanth & Puranam, 2014).

Several managerial implications emerge from our study. First, the tensions and trade-offs between vertical and horizontal growth appear to be real, but arise from coordination challenges and congested managerial capacity, not clashes of capabilities. Thus, managers should focus particular attention on managing costs of coordination rather than on gaining synergies from shared capabilities when considering both horizontal and vertical decisions (Hashai, 2015; Sakarahov and Folta, 2014; Zhou 2011). Managers should also be conscious of the limitations of monitoring far-flung operations and recognize when they are becoming constrained in their abilities to administer and coordinate a diverse firm.

Our study is not devoid of limitations, which we hope stimulate research extensions. Construction is a relatively mature, low technology industry with well-established horizontal and
vertical activities and capability drivers; it would be intriguing to replicate our study in a rapidly changing context to see if our results hold. Another limitation is that by considering project-based firms, we do not consider the case of traditional manufacturing sectors. In that context, there may be significant gains from economies of scale and a difficulty in securing suppliers, which may be more likely to drive a positive correlation between horizontal expansion and vertical integration (Chandler, 1962; Van Biesebroeck, 2007). Project-based firms typically have relatively thick supply markets, perform projects that require a unique combination of inputs that are coordinated on-site, involve projects with various stages that use the work of other stages without incorporating this work into an intermediate product, and have less significant scale economies (Eccles, 1981; Hobday, 2000). Thus, it is possible that the strong impact of coordination is less pronounced in contexts where production stages are more independent and/or less temporally connected.

Endogeneity is always an issue when studying organizational matters such as the interdependency of scope choices. While we cannot claim that we fully addressed this issue, we are confident in the three techniques we used to mitigate this concern. First, we add a set of well-behaved instruments that are coherent with the prescriptions of strategic management theory (vertical capabilities as instruments for vertical scope and horizontal capabilities as instruments for horizontal scope). Second, we add a wide set of control variables and performed some robustness checks, which confirmed our results. Third, we corroborated the causal mechanism between our main variables of interest with senior executives.

In conclusion, we find that horizontal and vertical scope are independent, until coordination demands become significant when we find a negative interdependency. Thus, we these dimensions of firm scope should not be addressed or studied in isolation, particularly when
senior managers become constrained with coordination demands. As strategic management has long recognized, the fit between strategic choices is a key determinant of a firm’s competitive advantage (Porter & Siggelkow, 2008; Teece & Pisano, 1994). Our study indicates that choices about breadth and depth should considered simultaneously and include both scope-specific capabilities and overall managerial capacity. In sum, the joint analysis of vertical and horizontal boundaries is under-researched, and we hope that our study motivates additional work in this important area.
REFERENCES


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FOOTNOTES

1 To keep our analysis parsimonious, we have chosen not to emphasize transaction costs, although we recognize that these are important drivers of vertical and horizontal scope (Lafontaine & Slade, 2007; Silverman, 1999; Williamson, 1985). Rather, we focus our discussion on capabilities, as these have been shown to be influential for scope decisions and are intertwined with transaction costs (e.g., Argyres & Zenger, 2012).

2 Bennett and Feldman (2017) use a similar logic to explain the higher than expected use of sequential spinoffs and acquisitions. They suggest that firms use this pattern to optimize the allocation of limited managerial attention.

3 We checked whether our results are robust to two alternative measures of breadth, the “entropy” measure and a simple “count” measure of the number of different types of projects. The results, which are available from the authors upon request, remained unchanged.

4 Standardization is required at the contractor level due to some missing data at the project level and because the average level of integration of each trade activity varies (e.g., average integration in building the metallic structure is higher than in installing gas services). By standardizing, we avoid biases of nonrandom missing data that would then bias the aggregated percentage at the contractor level.

5 Whether to use internal or external designers depends on the owner or developer of a given project: if not experienced, the owner might contract with a contractor that also designs; if experienced, the owner can use separate players. Design, whether it is internal or external to the contractor, is a key capability for horizontal scope decisions. Our analysis is coherent with Teece (1982), who indicates that to support economies of scope a resource does not
Can firms be broad and deep? Need to be internal to the company. See Brahm et al. (2017) for another example of such a situation.

6 We also computed a variable with the experience of t-1, t-2 and t-3 (not considering the focal year) and the results remained consistent in terms of size and sign. However, we lose more than half of the sample, which hurts statistical significance. The alternative solution of using t-1 and t-2 is not ideal as project last typically more than a year –typically one or two years– and therefore only a small portion of project director present more than one project. Given that this leaves some reverse causality problems in our models, we rely on the Hansen test to empirically argue for the validity of the use of “project director experience” and “designer experience” as instruments.

7 By measuring prior experience relative to the experience of available subcontractors in the local market, we obtain a measure of the relative position of the contractor. Given that a relative position in a market is not easily affected by an increase in the integration of the previous projects, this variable captures more neatly a medium to long-term contractor’s expertise.

8 While this variable is not a capability, adding it allows for diminishing the local average treatment effect in our IV estimation. The results do not change if this variable is dropped.

9 Of course, absent a clean theoretically “exogenous” shock/instrument is hard to be fully certain, based only on the Hansen-test and other empirical analysis, about the validity of the IV strategy. This issue is particularly salient when trying to test more complex –but arguably more complete– theoretical models such as ours (cf., the one-directional model of Rawley & Simcoe, 2010). This trade-off between structure in the model to be tested and the clean
identification that one can afford is a long standing issue in econometrics (Angrist & Pischke, 2010; Nevo & Whinston, 2010).

We multiply the predicted value of the breadth of horizontal portfolio obtained from model 1 estimated by OLS (excluding the depth of vertical activities) with the interaction variable, and use the results as an instrument for the endogenous interaction term: “breadth of horizontal portfolio * coordination demands”. An analogous procedure was followed for the interaction between depth of vertical activities and coordination demands.
**APPENDIX: CONTROL VARIABLE DESCRIPTIONS**

**Contractor Size.** The natural logarithm of the total square meters built by contractor by year.

**Uncertainty in the contractor’s focal type of project.** Uncertainty in the contractor’s focal type of project can affect diversification through the “risk mitigation” logic (Wang & Barney, 2006). The focal type of project is based on the greatest percentage of square meters built in the current and prior year. Based on Leiblein and Miller (2003), we measure uncertainty as the squared sum of errors for a linear regression of the monthly building permits for each type and each region for the past ten years. Due to seasonality, the data were adjusted using the Arima X-12 procedure.

**Demand imbalance across project types.** Since firms may tend to diversify away from stagnant markets into growing ones, we controlled for this demand imbalance. We computed the yearly growth of the building permits for each contractor’s focal project type for all other types and computed the ratio of the former on the later. If this ratio is lower than one, diversification might be required to maintain a given sales volume.

**Contractor market share.** A contractor with market power might possess the ability to influence the behavior of suppliers and thus not need to vertically integrate (Shervani, Frazier, & Challagalla, 2007). In construction, market power appears to exist at the geographical level (Ball, 2003; Somerville, 1999). We measure market share by contractor by comparing its total square meters built to that built by all contractors in their region, using a weighted average.

**Geographic dispersion.** The geographic dispersion of the contractor might affect its monitoring ability and thus, its vertical and horizontal scope. The geographic dispersion is computed by the HHI index, using the square meters built by contractor by year in the different regions.
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**Metropolitan region focus.** Chile is divided in 15 regions, with the main metropolitan region accounting for roughly half of the economic activity and having thicker supplier markets. For each contractor-year, we computed the percentage of square meters built in this region.

**Housing sector focus.** In the construction industry, there is a natural segmentation and specialization between housing and infrastructure/commercial sectors (Brahm & Tarziján, 2013), with horizontal diversification being easier within versus between sectors. To control for this, we computed the percentage of square meters built in housing for each contractor-year.

**Market size.** The size of regional markets is measured as the square meters in building permits approved in each region of Chile. This information is supplied yearly by the Chilean Ministry of Statistics. To measure of market size at the contractor, we sum the sizes of the markets in which a contractor is executing a project, and then take the natural logarithm of this measure.

**Time and contractor fixed effects.** We include time dummies to control for time-varying unobserved heterogeneity. For example, during 2009 and 2010 there was an important downturn in the construction industry, which may bias our results if not accounted for. We also include contractor dummies to control for time-invariant unobserved contractor heterogeneity.

REFERENCES (Not included in the main text)


## Table 1
Correlation matrix and descriptive statistics.

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<td>Metropolitan region focus</td>
<td>-0.17</td>
<td>0.05</td>
<td>0.06</td>
<td>0.04</td>
<td>-0.09</td>
<td>0.27</td>
<td>-0.29</td>
<td>0.04</td>
<td>-0.10</td>
<td>-0.09</td>
<td>0.02</td>
<td>-0.13</td>
<td>0.00</td>
<td>-0.41</td>
<td>-0.19</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housing sector focus</td>
<td>0.09</td>
<td>-0.23</td>
<td>0.02</td>
<td>-0.10</td>
<td>0.12</td>
<td>0.06</td>
<td>-0.05</td>
<td>0.03</td>
<td>-0.03</td>
<td>-0.07</td>
<td>0.01</td>
<td>0.11</td>
<td>-0.07</td>
<td>0.07</td>
<td>-0.05</td>
<td>-0.02</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Market size</td>
<td>-0.25</td>
<td>0.29</td>
<td>0.11</td>
<td>0.01</td>
<td>-0.07</td>
<td>0.33</td>
<td>-0.33</td>
<td>0.36</td>
<td>0.26</td>
<td>0.40</td>
<td>0.26</td>
<td>-0.19</td>
<td>0.08</td>
<td>-0.20</td>
<td>0.34</td>
<td>0.72</td>
<td>-0.01</td>
<td>1.00</td>
</tr>
</tbody>
</table>

| Observations | 815 815 815 815 815 815 729 729 815 815 815 815 815 815 815 815 815 815 | 815 815 815 815 815 815 729 729 815 815 815 815 815 815 815 815 815 815 |
| Mean          | -0.14 0.15 0.12 0.18 0.27 1.43 0.23 3.05 2.91 1.79 9.12 0.64 0.99 0.03 0.11 0.54 0.72 15.09 |
| Standard deviation | 0.55 0.22 0.16 0.33 0.19 1.02 0.10 3.02 1.98 2.21 1.79 0.29 0.20 0.06 0.21 0.46 0.40 0.96 |
| Min           | -1.33 0.00 0.00 0.00 0.00 0.00 0.05 1.00 0.00 0.00 0.24 0.14 0.64 0.00 0.00 0.00 12.37 |
| Max           | 1.24 0.79 0.65 1.00 0.93 8.41 0.87 29.00 7.00 6.90 13.62 1.00 1.54 0.43 0.75 1.00 1.00 16.42 |
Can firms be broad and deep?

### Table 2

Naïve and instrumental variables models for horizontal and vertical scope.

(Note that these are simultaneous models, encompassing two regressions: ‘a’ for horizontal; ‘b’ for vertical)

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2 – Instrumental Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variable:</strong></td>
<td>Breadth of horizontal portfolio</td>
<td>Breadth of horizontal portfolio</td>
</tr>
<tr>
<td><strong>Method:</strong></td>
<td>Random Effects</td>
<td>Instrumental Variables</td>
</tr>
<tr>
<td>Depth of vertical activities</td>
<td>-0.046 (0.000)</td>
<td>-0.046 (0.184)</td>
</tr>
<tr>
<td>Breadth of horizontal portfolio</td>
<td>-0.199 (0.018)</td>
<td>-0.455 (0.307)</td>
</tr>
<tr>
<td>Designer experience in different project types</td>
<td>0.173 (0.000)</td>
<td>0.158 (0.000)</td>
</tr>
<tr>
<td>Project director experience in different project types</td>
<td>0.077 (0.000)</td>
<td>0.079 (0.000)</td>
</tr>
<tr>
<td>Trade expertise</td>
<td>0.300 (0.002)</td>
<td>0.583 (0.000)</td>
</tr>
<tr>
<td>Prior interactions with Suppliers</td>
<td>-0.174 (0.000)</td>
<td>-0.185 (0.000)</td>
</tr>
<tr>
<td>Thinnness of supplier market</td>
<td>0.418 (0.082)</td>
<td>0.452 (0.137)</td>
</tr>
<tr>
<td>Number of projects</td>
<td>0.018 (0.000)</td>
<td>0.018 (0.000)</td>
</tr>
<tr>
<td>Distance to headquarters</td>
<td>-0.012 (0.000)</td>
<td>-0.013 (0.000)</td>
</tr>
<tr>
<td>Distance between projects</td>
<td>0.040 (0.000)</td>
<td>0.041 (0.000)</td>
</tr>
<tr>
<td>Contractor size</td>
<td>0.011 (0.006)</td>
<td>0.009 (0.056)</td>
</tr>
<tr>
<td>Uncertainty of main project type</td>
<td>0.066 (0.310)</td>
<td>-0.200 (0.232)</td>
</tr>
<tr>
<td>Demand imbalance</td>
<td>-0.044 (0.250)</td>
<td>-0.032 (0.372)</td>
</tr>
<tr>
<td>Contractor market share</td>
<td>-0.231 (0.147)</td>
<td>-0.044 (0.784)</td>
</tr>
<tr>
<td>Geographic dispersion</td>
<td>-0.069 (0.402)</td>
<td>-0.037 (0.632)</td>
</tr>
<tr>
<td>Metropolitan region focus</td>
<td>-0.013 (0.651)</td>
<td>-0.044 (0.889)</td>
</tr>
<tr>
<td>Housing sector focus</td>
<td>-0.116 (0.000)</td>
<td>-0.115 (0.000)</td>
</tr>
<tr>
<td>Market size</td>
<td>0.008 (0.578)</td>
<td>0.005 (0.733)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.186 (0.389)</td>
<td>-0.084 (0.719)</td>
</tr>
<tr>
<td>Year fixed effects?</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>815</td>
<td>1033</td>
</tr>
<tr>
<td>R-Squared</td>
<td>43.71%</td>
<td>27.59%</td>
</tr>
<tr>
<td>Instruments?</td>
<td>Trade expertise, Prior interactions, Market thinness</td>
<td>Design experience, Project director experience</td>
</tr>
<tr>
<td>F-test first stage</td>
<td>27.79</td>
<td>17.01</td>
</tr>
<tr>
<td>Hansen test (p-value)</td>
<td>0.38 (0.82)</td>
<td>0.07 (0.78)</td>
</tr>
</tbody>
</table>

(†) p < 0.1 *; p < 0.05 **; p < 0.01 *** (‡) Exact p-values in parentheses. (¥) The IV correction of endogenous interaction terms follows Wooldridge (2002).
Table 3
Panel data and instrumental variables models for horizontal and vertical scope
(Note that these are simultaneous models, encompassing two regressions: ‘a’ for horizontal; ‘b’ for vertical)

<table>
<thead>
<tr>
<th></th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a)</td>
<td>(b)</td>
<td>(a)</td>
</tr>
<tr>
<td>Dependent Variable:</td>
<td>Breadth of horizontal portfolio</td>
<td>Depth of vertical activities</td>
<td>Breadth of horizontal portfolio</td>
</tr>
<tr>
<td>Method:</td>
<td>Instrumental Variables</td>
<td>Instrumental Variables</td>
<td>Instrumental Variables</td>
</tr>
<tr>
<td>Depth of vertical activities</td>
<td>0.013 (0.696)</td>
<td>-0.030 (0.443)</td>
<td>-0.006 (0.859)</td>
</tr>
<tr>
<td>Breadth of horizontal portfolio</td>
<td>-0.109 (0.746)</td>
<td>-0.242 (0.573)</td>
<td>-0.164 (0.702)</td>
</tr>
<tr>
<td>Depth of vertical activities*</td>
<td>-0.019 (0.006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of projects</td>
<td>-0.122 (0.080)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breadth of horizontal portfolio*</td>
<td>-0.007 (0.554)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of projects</td>
<td>-0.085 (0.290)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth of vertical activities*</td>
<td>-0.030 (0.022)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance between projects</td>
<td>-0.171 (0.052)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breadth of horizontal portfolio*</td>
<td>-0.064 (0.066)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance between projects</td>
<td>0.017 (0.114)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of projects</td>
<td>0.012 (0.006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance to headquarters</td>
<td>-0.013 (0.000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance between projects</td>
<td>0.043 (0.879)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rest of covariates?</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>(including capabilities and constant)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year fixed effects?</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>729</td>
<td>729</td>
<td>729</td>
</tr>
<tr>
<td>R-Squared</td>
<td>45.55%</td>
<td>28.93%</td>
<td>44.40%</td>
</tr>
<tr>
<td>Instruments?</td>
<td>Trade expertise, Prior interactions, Market thinness</td>
<td>Design experience, Project director experience</td>
<td>Trade expertise, Prior interactions, Market thinness</td>
</tr>
<tr>
<td>F-test first stage</td>
<td>21.49</td>
<td>9.51</td>
<td>18.85</td>
</tr>
<tr>
<td>Hansen test (p-value)</td>
<td>0.39 (0.82)</td>
<td>0.03 (0.86)</td>
<td>0.60 (0.73)</td>
</tr>
</tbody>
</table>

(†) p < 0.1 *; p < 0.05 **; p < 0.01 *** (‡) Robust standard errors in parentheses. (¥) The IV correction of endogenous interaction terms follows Wooldridge (2002).
Can firms be broad and deep?

**Figure 1**
Interaction effect between “depth of vertical activities” and “number of projects”

**Figure 2**
Interaction effect between “breadth of horizontal portfolio” and “number of projects”
Can firms be broad and deep?

**Figure 3**
Interaction between “Depth of vertical activities” and “distance between projects”

**Figure 4**
Interaction between “breadth of horizontal portfolio” and “distance between projects”.