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How firms make boundary decisions: The role of hierarchy span and expertise span

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Abstract

We report findings from an analysis of 234 firm boundary decisions that a manufacturing firm has made during a 10 year period. Extensive interviews with all major decision makers allow us to examine (a) who was involved in each boundary decision, and (b) how the firm arrived at a particular transactional choice in each decision. We find that decision makers extensively adapt decision structures in order to effectively make governance mode choices.

They adapt hierarchy span, i.e. the number of hierarchical levels involved, and expertise span, i.e. the number of same-level decision makers with dissimilar knowledge basis. We observe that decision makers heavily rely on varying hierarchy and expertise span in order to improve the quality of the decision outcome. Central to the adaption of decision structures is that decision makers, over time and as novelty decreases, substitute hierarchy span with expertise span. We conclude that this substitution mechanism is core for our understanding of how decision structures are used when

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Key words: Firm boundaries, Decision making, Transactional alignment, Expertise span, Hierarchy span

INTRODUCTION

How do firms make boundary decisions? Research concerning transactional governance modes is firmly rooted in Transaction Cost Economics (TCE), which identifies markets, hierarchies and hybrid forms as basic governance modes (Williamson 1991), and provides fundamental rationales for deciding which governance mode to select for a given transaction (Williamson, 1985). While the classic TCE literature has mainly examined the logic of the *make-or-buy* choice (Williamson 1985), more differentiated boundary choices such as *make-and-buy (*Williamson 1991, 1999, Bradach 1997), tapered integration (Harrigan 1983), mixed modes, plural forms (Heide 2003), or concurrent sourcing (Parmigiani and Mitchell 2009) have drawn much attention in recent years.

Both classic and more recent contributions to TCE examine the logic that explains *why* a firm may chose a particular governance mode. Only recently research has started to focus on the '*how*' of firm boundary design by studying *how* entrepreneurs use boundary design to construct markets (Santos and Eisenhardt 2009) and *how* organizational structure can lead to transaction misalignment (Bidwell 2010). While some studies have explained *why* such misalignment can occur, e.g. as a result of contractual commitment, bargaining power, or path dependence in the choice of governance modes that arises from past governance choices (Nickerson and Silverman 2003, Argyres and Liebeskind 1999), only Bidwell's (2010) study focuses squarely on *how* processes of firm boundary decision making may lead to misalignment.

Moreover, prior research equates the firm's choice of governance mode with the decision of the boundary decision maker(s). Considering firms as unitary actors, most studies of firm boundaries blackbox the actors that actually make the boundary decisions. Crucially, many firm boundary decisions are, however, taken jointly by several decision-makers (Judge and Zeithaml 1992, Cyert and March 1963), for instance in vertical scope decisions in

boardrooms (Golden and Zajac 2001). This empirical fact is not yet reflected in our theories of firm boundaries. If several actors are involved in making boundary decisions, this immediately demands attention to *how* these several actors are involved in making boundary decisions. This paper addresses this gap.

Using a single-business firm in the wind turbine industry we examine one firm's entire value chain and identify all boundary decisions that the firm has made between 2001 and 2010. We study these decisions on all levels of the organizational hierarchy to develop an accurate account of how these boundary decisions came about. We systematically identify all the actual decision makers on all hierarchical levels involved, and we analyze the decision makers' specific rationale(s) for selecting a particular transactional governance mode for a given transaction. Identifying *why* certain decisions were made, we thereby follow the basic concern of TCE. We also go beyond extant research and develop an understanding of *how* firm boundary decisions are made, i.e. how decision makers select and adapt governance choices based on the firm's strategic objectives. We use a multi-method case study research design and employ qualitative data analysis as well as regression analysis.

We find that all decisions identified in our case study can be explained with basic rationales that follow TCE and related theories. Decision-makers mostly use cost and capability considerations to justify their choice of governance in our setting. In addition, we also find that they take into account different forms of risk or uncertainty (Schilling and Steensma 2002, Richardson 1996), strategic choices regarding innovation and vertical scope (Wolter and Veloso 2008), and do choose plural forms (Bradach and Eccles 1989). A main insight deriving from our study is that in making boundary choices over time, decision-makers adapt the organizational decision structure. We find that most governance mode choices involve multiple decision makers. Our case shows a number of different decision making structures with which managers involve multiple people on several levels of the firm's hierarchy. We

analyze how decision makers select and adapt decision structures, and we find that decision makers rely on two main mechanisms: First, they vary the *hierarchy span*, i.e. the difference between the highest and lowest hierarchy level involved; second, decision makers vary *expertise span*, i.e. the number of decision makers with different knowledge bases involved at the same hierarchy level. Our data shows that the variation of hierarchy and expertise span is used to facilitate the pooling of decision rights and knowledge within the organization. Most importantly, we find that the firm substitutes hierarchy span with expertise span as related decisions are taken repeatedly and as decision criteria become better understood by the firm. In general, this substitution effect facilitates the delegation of decision rights and organizational decentralization. We conclude that firm boundary decisions heavily rest on the firm's ability to select and adapt its decision structures.

The paper is structured as follows. In the subsequent section we briefly discuss theories on firm boundary design and transactional misalignment. We then introduce our methodology and the setting in section three. Section four discusses the case analysis and the results. In section five we elaborate on implications, limitations and we conclude.

THEORETICAL BACKGROUND

TCE suggests that the choice of governance mode depends on the firm's ability to achieve "discriminating alignment", i.e. adopting the transactional governance mode which economizes on the sum of transaction and production costs (Williamson 1991). Central to this logic is that the firm is capable of assessing (discriminating) the cost of alternative governance modes and of making choices that allow for the minimization of transaction costs. If one mode of governance fails, the firm shifts to another governance mode over a certain period of time (Williamson 1985). Thus, economic organization pursues a quest for the discriminating match (Williamson 1988). Interestingly, much attention has been focused

on criteria for achieving such a match. The decision process itself has been rather neglected in this quest, even though this omission was noted by Williamson (1988)

> "process mechanics are rarely displayed … [because] … the analysis of process requires considerable knowledge of the nanoeconomic details ... Many economists have been loath to take this step, expressing the hope that it can be avoided" (p.76).

The present paper aims to address this gap using process research to examine how a firm selects and adapts its governance modes over time.

A wealth of studies confirm that the basic rationale of TCE holds in many settings (David and Han 2004), and have considered additional aspects, such as the role of bargaining power, contractual difficulties, path dependence in the choice of governance modes that arises from past governance choices (Argyres and Liebeskind 1999, 2002, Mayer and Nickerson 2005), institutional isomorphism (Nickerson and Silverman 2003), and the importance of productive capability differences (Jacobides and Hitt 2005). Hybrid governance modes in particular, i.e. the simultaneous usage for internal and external resources for the exact same product or service (*make and buy*), have invited much recent work. Parmigiani (2007) finds that concurrent sourcing is a distinct choice, i.e. a mode in itself. She argues that it is a result of the firm's need to simultaneously monitor suppliers, produce efficiently and improve processes. As she points out, it is particularly important if a firm wants to introduce and scale up new technology over time. Rothaermel *et. al.* (2006) find that firms use tapered integration to balance vertical integration and outsourcing in order to achieve positive effects on the firm's product portfolio, product success and ultimately the firm's performance. Other scholars have argued that tapered integration (Harrigan 1983) requires the analysis of the broader architecture of control mechanisms (Bradach and Eccles 1989). Bradach (1997) found that control and innovation processes partially compensate for the disadvantages of plural sourcing, and Dutta *et. al.* (1995) argue that plural forms allow for better control of

inhouse resources. These studies have helped to develop an accurate account of *which* of the various rationales firms use to choose specific governance modes.

As opposed to the rationales, there has been significantly less emphasis on *how* firms make governance mode choices and define firm boundaries. Santos and Eisenhardt (2009) develop a holistic perspective on boundary design by identifying "soft-power strategies" that entrepreneurial firms use to claim, demarcate and control nascent markets. Bidwell (2010) examines tapered integration by looking at how the adjustment of the ratio between internal and external sourcing of the same service (software consultants) is hampered by an organization's structure. In his case study, transactional misalignment is a function of organization design separating related decisions, thereby creating information asymmetries and incentive misalignment. Bidwell's work is important as it is the first study that differentiates between different types of decision makers, namely upper and lower level managers. It introduces the role of organizational structure as relevant for understanding the process of making boundary design and choosing governance modes.

What has not been examined by existing research is the *process* with which firms select and adapt governance modes. A focus on this aspect of decision making is important because of several reasons. First, it is well documented that strategic decisions within a firm often require board involvement or board approval (Judge and Zeithaml 1992), especially when important strategic changes, such as the alteration of scope, are made (Golden and Zajac 2001). Hence, multiple decision makers are often involved in governance mode choices. Second, we know from prior research that decision structures involving several decision-makers and the decision process influence the decision outcome (Sah and Stiglitz 1986, 1988, Knudsen and Levinthal 2007). A more realistic understanding of firm boundary decisions must, therefore, attempt to understand *how* several individuals are involved in making boundary decisions.

This makes the structure and process in which these decision makers jointly act, and how that structure changes (in particular, as a function of taking a series of boundary decisions over time), an important focus of analysis. Interestingly, the involvement of several decision makers has not been considered in studies of governance mode selection or adaption, and neither have the decision structures and processes in which they take boundary decisions. Moreover, the change of these decision structures, which is likely to occur when firms grow, technologies change or product differentiation emerges, has not been examined either.

The present paper attempts to fill this gap in our existing theories by asking 'how do decision structures influence a firm's selection and adaptation of transactional governance modes?

RESEARCH DESIGN AND SETTINGS

We conducted a longitudinal study of a major wind turbine manufacturer, which we call Viento. We used a case study research design (Miles and Huberman 1994, Yin 2003, Eisenhardt and Graebner 2007) employing a multi-method approach that combines analysis of qualitative data with regression analysis (Eisenhardt 1989). We selected Viento according to theoretical, rather than statistical sampling procedure (Eisenhardt and Graebner 2007). The case of Viento is particularly suitable for examining our central unit of analysis, i.e. the evolution of decision structures that were used to select and adapt the firm's governance modes: For one, Viento provided the opportunity to observe a series of structural changes within the firm, because the industry has been in a high growth phase between 2001 and 2010.[1] Such growth confronted the firm with a series of strategic governance trade-offs between short-term performance and the evolution of firm capabilities (Novak and Stern

[1] Wind energy is a relatively young, capital intensive, global industry. Intermediate growth of the 1990's evolved to high annual growth of 36% on average in 2004-2008 contributing to high bargaining power of sellers over buyers. Growth slowed down due to the global financial crisis in 2008 (BTM Consult 2009) and increased again in 2009. Mostly incremental innovations lead to doubling up wind turbines' Megawatt (MW) output every four years. A notable feature of the industry is that the top ten OEMs display a remarkable heterogeneity of vertical integration patterns into main components and downstream value chain stages. Viento is a successful wind turbine manufacturer existing since the industry's beginning. Viento is placed among the top 10 OEMs regarding global market share. Viento maintained high growth over the years and focuses on the technological lead within the wind industry.

2008). The tradeoffs resulted from an emphasis on internal organic growth, and led to a number of insourcing as well as outsourcing decisions. The firm also frequently engaged in tapered integration in order to accommodate for the rapid growth and technological change (Parmigiani 2007). Tapered integration frequently took the form of simultaneous use of employees and contract labor (Parmigiani and Mitchell 2009; Davis-Blake and Uzzi 1993). Moreover, we chose Viento because the firm increased the number of employees from less than 1000 to more than 5000 in the 10 year period we analyzed. This required the firm to significantly adjust its activity system in all segments of its value chain. This growth resulted in a number of vertical scope changes, required the firm to introduce additional hierarchical levels, change its organization structure from functional to divisional, and adapt its decision structures. Combined, Viento offered a unique opportunity to observe the process of governance mode selection and adaptation.

Data collection

One of the authors conducted site visits over 20 months and gathered data with the primary focus on the last ten years. A total of 104 semi-structured interviews were conducted with the current and former management and employees of Viento (see figure 1). The duration of interviews in the first, introductory round, which consisted of more open ended questions, varied from 40 to 90 minutes. As the interviews in the second round were focused on particular instances of firm boundary change, some of them lasted only 20 minutes. We interviewed key informants two or three times. All interviews have been recorded, transcribed and coded using Atlas TI software.

Insert Figure 1 about here

During the initial data collection phase we focused on gaining a thorough understanding of the wind energy value system and Viento's value chain. We focused on documenting

decisions regarding which stages of the value chain Viento participated in and we documented all firm boundary decisions taken by Viento's employees at various points in time, including the micro-level decisions. We focused exclusively on the selection and adaption of governance modes, i.e. whether the firm outsourced an activity, insourced an activity or adapted the level of tapered integration; in the latter case, we also examined the make-and-buy ratio over time. We followed the definition of transaction, which "occurs when a good or service is transferred between technologically separable stages" (Williamson 1999, p. 1089) and examined whether or not a change in governance mode resulted in changes in property rights (Hart and Moore 1990) and employment contracts (Makadok and Coff, 2009). This data collection resulted in a full account of which transactions modes the firm had chosen in all the 234 firm boundary decisions taken between 2001 and 2010. In this period, governance mode decisions varied in magnitude from low-scale outsourcing of a single stage of the manufacturing process of a single component on one end, up to insourcing component design tasks by hiring a complete engineering team from an external firm, or acquiring a component manufacturing plant, on the other end.

In the second round of data collection we comprehensively tracked the evolution of firm boundaries over time in the various departments. We focused on understanding the rationale that decision makers used to justify their choice, and the context of decision making in relation to upper and lower level decision makers, as well as decision makers in related departments. We analyzed the position of the decision makers within the organizational hierarchy and how intra- and inter-departmental structures facilitated or hampered decision making.

We interviewed nearly all decision-makers of the firm's most relevant boundary choices. They were diverse in terms of hierarchical levels, functional areas and geographical locations. Such variety helped to minimize the retrospective sensemaking bias (Eisenhardt

and Graebner 2007). We based selection of the informants on following criteria: (1) long tenure in the firm, which would provide a temporal perspective on the evolution of firm boundaries, (2) functional and hierarchical variety, ensuring we tapped into a broad range of governance mode decisions of various magnitude and ensure diversity of perspectives, (3) recommendation by other informants, ensuring access to first-hand knowledge about particular decisions. We interviewed informants both directly involved in firm boundary decision making and those knowledgeable about particular decision making instances who provided additional perspective on changes in vertical integration. Our approach allowed us to develop an in-depth account of (a) the various rationales guiding the decisions, and (b) the evolution of the firm's organizational decision structures necessary to develop the rationale and to make and implement the decision.

We ensured data triangulation by asking the same questions to several respondents, and matching information from the interviews with secondary data. Such data include minutes of meetings, internal presentations and reports, organization charts, production schedules or industry publications. In addition, we used archival data such as headcount or overview of purchase, production and sales orders in order to measure the significance of each firm boundary change and corroborate it with findings from the qualitative data. We looked for evidence that might inform existing theories on firm boundaries, and we were open to emerging constructs. After completing the major stages of data collection and analysis we presented the preliminary findings to relevant managers in order to ensure internal and external validity and improve the quality of our interpretations.

Data analysis

We simultaneously gathered, coded and analyzed data in an iterative process. We developed chronological histories and research notes for all governance mode decisions in every department. We developed tables and longitudinal graphs tracking the degree of outsourcing

and insourcing over time and the rationale behind *make-and-buy* decisions. This initial data analysis was guided by using TCE as the theoretical backbone with which we examined every transaction and how various managers reflected upon the choice of governance mode. We thereby compared decision makers' cognitive representations (Gavetti 2005) regarding how a particular governance choice would support (or not support) the firm's strategy, as well as their understanding of the actual decision making process, i.e. who was involved (or not involved), what consequences one decision had and how it influenced related or subsequent choices. This approach allowed us to corroborate existing theories and their explanatory power for rationalizing *why* boundary decision were made. It also allowed us to develop an account of the organizational decision structures that decision makers used to make governance mode decisions. In this second part of the analysis we also fine-tuned our operationalizations while developing summary tables and graphs for representing our findings. The entire analysis was based on an iterative process of moving back and forth between data, our conceptualizations and the literature, and it allowed us to refine our findings and relate them to existing theories (Eisenhardt and Graebner 2007).

CASE ANALYSIS

The qualitative data analysis resulted in identifying key constructs and basic relationships between them which are critical to understanding how organizational decision making structures influence Viento's selection and adaptation of transactional governance modes. In order to strengthen the insights emerging from the qualitative data, we compiled a dataset of 234 transactional governance mode decisions taken in Viento in the time period from 2001 to mid 2010 (see Table 1 for a general overview). We coded identified constructs into variables (described below) and analyzed the data with an ordered logit regressions.

Insert Table 1 about here.

Table 1 contains a series of important immediate insights. First, the rationales used for making boundary choices are indeed those described in the literature. In our sample, decision makers always used some of the baseline theories (as described in the theory section) to justify their boundary choices. Second, over the 10-year period, Viento made a boundary choice every 2.2 weeks, on average. This is remarkable and indicates that boundary choices are not just rarely-occurring boardroom events but can happen quite frequently. Third, boundary decisions typically involve more than one person. In only 20 cases (8.5%) a decision was made by one unitary decision maker. All other cases involved more than one person. Fourth, many boundary choices involved some degree of novelty which often resulted in decision makers realizing the inadequacy of existing decision structures.

These basic insights emerged from the first round of data analysis and the compilation and categorization of the 234 boundary decisions. In this context we also searched for variables that captured the shifting of decision structures, and we identified hierarchy and expertise span as useful structural variables. *Hierarchy span*[2] refers to the difference between the highest and lowest of hierarchy levels. *Expertise span*[3] considers the number of same-level decision makers with dissimilar knowledge bases. Both hierarchy and expertise span are concise and unambiguous which allows a straightforward coding of each individual boundary decision. Moreover, the variables can easily be verified by triangulating interview data with other internal documentation such as protocols or process handbooks.

We used a regression analysis to examine which variables explain hierarchy span and expertise span. Our dependent variables are the two key variables of interest, *hierarchy and*

[2] Hierarchy span counts the span of hierarchical levels involved in each individual transactional governance mode decision. We use a five-point Likert scale where 1 indicates involvement of one hierarchy level and 5 indicates involvement of 5 or more levels. We coded the variable by mapping decision makers onto the organizational charts of Viento. The hierarchy span does not indicate the absolute hierarchy level where decisions were taken, although we recorded that information as well.

[3] If there are multiple decision makers on more than one hierarchy level, we code the highest expertise span. We use five-point Likert scale and coded the variable using the same method as for hierarchy span.

expertise span. Our independent variables derive from baseline explanations concerning transactional choices. *Transaction value* measures an estimated total Euro value of the transaction.[4] *Novelty* counts how many aspects of a decision situation are novel to decision makers. Novel aspects may include the transaction, market segment in which transactional governance mode decision is taken, and lastly, a combination of rationales (decision variables) applied in given instance of decision making[5]. While *novelty* captures a change in combination of decision variables, c*omplexity* counts the number of decision variables, such as cost or capability considerations, that decision makers used to base their decision on.[6]

Control variables derive from our setting and nature of the transactions. *Upstream* is a dummy variable coded as 1 for upstream transactions (i.e. wind turbine installation) and 0 for downstream transactions (i.e. production and engineering). *Region* is a categorical variable distinguishing geographical divisions that Viento addresses with own divisions. *Year* indicates the year when a given decision was taken. *Outsourcing* is a dummy variable, capturing whether the transaction involves outsourcing or insourcing.[7] Table 3 presents descriptive statistics and correlations between our variables.

Insert Table 2 about here

The results section is structured as follows. At first we introduce decision-making structures used in upstream and downstream value chain segments. Next we show how hierarchy and expertise span change over time and as decision novelty decreases. Then we discuss the

[4] Examples include the cost of one wind farm (i.e. number of turbines), the cost of a component (i.e. the equivalent of 2-years' of production), or the cost of an engineering team (i.e. the equivalent of employing the engineers for 3 years). The variable is log transformed.

[5] Novelty also uses a 5-point Likert scale and examines whether decisions for a particular transaction have been made before, whether the market segment is new and whether the combination of TCE rationales is new. It is coded as '5' when the all three aspects are new. Novelty is '4' when two of the aspects are new, it equals '3' if one aspect is new, it equals '2' when all aspects have been covered in other decisions and it is coded as '1' for all repeated instances.

[6] *Complexity* corresponds to theoretical drivers of changes in vertical integration. We coded interview data in Atlas TI to count the number of decision variables mentioned by decision makers. We use a five-point Likert scale, where decisions based solely on e.g. capacity considerations are coded as 1, and a decision based on cost, capacity and asset specificity is coded as 3 etc.

[7] For cases of tapered integration, increasing the average make-and-buy ratio in favour of inhouse production is insourcing; decreasing it is outsourcing.

effect of the remaining variables on hierarchy and expertise span for novel and non-novel decisions separately and elaborate on the effect of substitution of hierarchy span with expertise span. We analyze the effect of each variable with the regression analysis and support the findings with qualitative evidence.

Results

Since our dependent variables are ordinal, we used an ordered logit regression model[8]. Table 3 reports the coefficient estimates for variables explaining hierarchy and expertise span in our full sample of 234 governance mode decisions.

Insert Table 3 about here

We begin the analysis by exploring decision structures used in different segments of the value chain. The variable *upstream*, which indicates whether the decision concerns upstream or downstream value chain segment, is significant in both our regression models. Hierarchy span increases for upstream decisions (β= 1.238, $p<0.05$) and expertise span increases for downstream decisions (β=-3.587, $p<0.01$). This finding shows that Viento develops different decision structures for up- and downstream value chain segments. This suggests that there are different mechanisms at play, which reflects the corporate strategy for production, engineering, logistics and sales.

Decisions concerning engineering and production are taken at the headquarters and typically involve high hierarchy spans including senior management. At the same time, they involve narrow expertise span, pooling very few people on the same level. This is due to the

[8] We conducted Brant test to examine whether our models violate the key assumption of ordered logit regression model: the proportional odds/parallel lines assumption. The assumption was violated in model 4 reported in table 5. We remedy the violation by using partial proportional odds model (gologit2) which lifts the proportional odds assumption for variables for which it is not justified (Williams 2006). Lifted proportional odds assumptions mean that these variables have different effects when moving between categories (values) of the dependent variable, and need to be interpreted separately when crossing thresholds between each category. For brevity, we do not report the partial proportional odds model results that largely consistent with reported results and provide additional details. The results are available from the authors.

decisions being taken by engineering specialists and involving approval of the CEO. For example, a decision to insource the design tasks of a key component by buying the intellectual property rights and hiring an engineering team from a supplier involved a decision structure with a hierarchy span of two levels: an engineering manager, his direct boss and the CEO, and an expertise span of zero:

> *"That was my decision. [A subordinate] (Hierarchy Level 3) was strongly involved and our CEO (HL1)." (Engineering, hierarchy level 2)*

The differences between decision-making structures upstream and downstream reflect the nature of capabilities residing in these segments of the value chain. Viento management considers engineering and (some parts of) production as embedding capabilities that are unique and critical for Viento's long term competitive advantage. Upstream boundary decisions, including the one illustrated above, involve discussions about Viento's key resources and capabilities, as a manager summarized:

> *"This idea to build up competencies so that we could get a leading edge by being on the technology front, that has been the driving reason for the development of our knowledge base. We need to insource competences, because that is the only way we can get the leading edge. Therefore many things that people traditionally have been doing using consultants, we have insourced." (Engineering, hierarchy level 2)*

Downstream decisions concern governance mode choices for wind turbines installation activities. Firm boundary design downstream involves tapered integration into installation tasks, where Viento either makes or buys installation tasks for particular wind farms. These decisions are taken individually for each wind farm sold by Viento and reflect conditions specific to market segments. Decisions are usually taken in a decentralized manner by sales and project management teams which are organized in geographical organizational units. Decision structures typically involve less hierarchy levels and more managers on the same

level than boundary decisions for engineering and production. The most frequently used decision structure downstream involves two persons on the same hierarchy level who contribute to decision making with expertise about technical and commercial aspects:

> *"(…) The Project Manager (HL4) and the Commercial Project Manager (HL4) assigned to execute the project will decide who actually do the installation activities - whether the project should be staffed with only Viento employees, or if we rather should have subcontractor to do the installation." (Project Management, HL3)*

Boundary decision-making downstream relates to capabilities that are less unique in the industry, i.e. where there is an increasing number of industry players capable of and competing for supplying them. These industry players include suppliers, customers and competitors. In this context it is interesting to note that competitors display high variability in patterns of vertical integration into installation activities[9].

Decision-making regarding activities that rely on non-core capabilities do not require control of top management, but instead demand expertise of several same-level managers. Hierarchy span is used as a control mechanism for strategically relevant elements in vertical architecture, while expertise span is used for less strategically relevant decisions. Having introduced basic differences between decision making structures in upstream and downstream value chain segments, we now move to analyzing how they change over time.

How decision structures change over time: year and novelty

We find that *year* has positive impact on expertise span (β= 0.318, $p<0.001$) and negative impact on hierarchy span (β=-0.266, $p<0.001$), what demonstrates that decision structures are not static and change over time on both structural dimensions: hierarchy span reduced and

[9] Viento uses three main modes to govern installation transactions: it performs installation using inhouse resources, it outsources the installation tasks to suppliers, or it transfers responsibility for installation to customers. Regardless which party is responsible and provides resources for executing the installation tasks, Viento always takes over completed installation task from the executing party, performs final quality control and sells wind turbines as complete, installed products. Therefore no matter which governance mode for installation task is chosen, installation is always treated as an input to the final product.

expertise span increased over time. This finding is related to high growth that Viento experienced during the 10-year analysis period, when the number of employees increased about ten-fold. In the early years top management was involved in many boundary decisions. As the organization grew, the distance between front line managers involved in decision making and senior management increased, and top management withdrew from participating in less strategic decisions that are delegated to lower levels. At the same time, loss of senior management attention is compensated with more expertise, i.e. with involvement of more same-level colleagues. We observe similar effects when analyzing decision structures in series of related decisions over time, which is captured through the variable *novelty*.

The positive impact of *novelty* on hierarchy span (β=1.441 $p<0.01$) and its negative impact on expertise span (β=-0.663, $p<0.01$) confirm the above finding: novel decisions have higher hierarchy span and narrower expertise span. Hierarchy span flattens and expertise span increases in series of related decisions where novelty gradually decreases for subsequent instances of decision-making. This finding shows that there is no one optimal decision-making structure for a whole series of decisions and that Viento adapts its decision-making structures as decision criteria become well understood and uncertainty decreases.

With the following example we illustrate how a team of managers repeatedly deciding on outsourcing or inhouse execution of installation tasks in one region not only flattened their decision making structure, but also increased expertise span as they transitioned from novel to repeated decisions over time. One of the first large scale outsourcing decisions in the market segment was motivated with a novel set of rationales compared to prior decisions, adding demand seasonality and union labor environment to the decision criteria used in prior decisions[10]. This instance adopted a decision-making structure with high hierarchy span and low expertise span: it spanned across three hierarchy levels, from a Project Manager at level

[10] We illustrate this difference between decision criteria in the section discussing complexity

four up to the divisional CEO at level two and involved one or two persons on each level. One of involved managers reports that this particular decision required approval of a higher level:

> *"Before we entered into actual subcontract, we had to go through appropriate reviews and approvals within the organization, so my boss (HL2) was an approver for the subcontract of that decision. However, at that time, the internal installation technicians were actually in service organization at the headquarters, so (…) [Head of Service] (HL2) was involved in decision-making". (Project Management, HL3)*

Subsequent, repeated governance mode decisions were taken with a very different decision making structure which does not involve the authority of top management; it spans across only two hierarchy levels and has high expertise span with more than 5 people on the lower level. One of Project Managers in charge of managing individual wind farms explains how decision-making is organized in his team:

> *"The [Head of Project Management] (HL3) gets together with us, Project Managers (HL4), and we all look at the projects together and talk about it together with the Manager of Site Execution (HL4) [who is responsible for all our installation technicians], and decide: here is the best way to staff these projects [with internal or external technicians]". (Project management, HL 4)*

Interviewees report that all of these repeated decisions were taken considering the same combination of decision criteria, including cost, balancing capacity utilization, capabilities and firm-specific knowledge as well as labor environment; therefore managers do not face novelty in these instances. Consistently with the regression results, senior managers were not involved in taking repeated decisions. This instance of decreasing hierarchy span and increasing expertise span shows the substitution effect between the two variables.

We now provide more details on the mechanisms that reduce hierarchy span for repeated decisions. Below we illustrate an instance of high novelty of decision situation when Viento gave up installation tasks to two medium and large customers. While giving up installation tasks to customers had been done in the past, the novelty arises from the fact that it is done for the first time in the two market segments of these customers. Moreover, the combination of rationales behind these decisions differ from prior cases, as bargaining power of increasingly important customers in a consolidating market, as well as the vertical integration patterns of competitors, suppliers and customers become important decision factors. In two of such novel cases the decision-makers approached a decision by involving 3 hierarchy levels spanning from the front line Sales Manager all the way up to the corporate CEO:

> *"[Giving up installation tasks] was managed and pushed by the regional division: myself (HL3) and the head of the region (HL2), and accepted eventually by the organization and the headquarters. (…) CEO (HL1), through the [decision rights] process, obviously had ultimate approval of what we did, so he was integrally involved in the decision." (Sales, hierarchy level 3)*

Once the members of top management had been involved, the decision process consisted in jointly revising multiple rationales speaking for and against giving up installation tasks to customers. Top management decided on prioritization of decision rationales and gradually paved the way for subsequent decisions. Managers reduced the number of relevant decision factors to two: customer demand and assessment of customer's capabilities, thus rendering previously dominant combination of rationales obsolete.

The new combination of rationales was applied in subsequent decision-making instances. Therefore, in subsequent instances, the novelty of decision situation gradually decreased, as both the set of decision criteria and the activity that was an object of the boundary decision were the same. The only novel aspect concerned new customer segments in which such

decisions were taken. This stabilization of decision-making factors was reflected in the hierarchy span engaged in decision-making. In the cases where decision criteria were stable, but the customer segment was new, neither the corporate level CEO nor the regional CEO participated in boundary decision making. By that point, however, the organization was in a growth phase and its hierarchical structure expanded and decision-making primarily took place at level 4, where the front line Sales Managers are located:

> *"We did not ask the [CEO of regional entity] (HL2) for approval of [customer from segment C] doing installation. It was approved by the Head of the Sales department (HL3)" (Sales, hierarchy level 4)*

Another manager explains that reduction of the hierarchy span came about in a gradual process:

> *"During the contract approval meetings (…) it was kind of a gradual discussion ongoing and then we (HL4) got permission (from HL3 and HL2) on let's say quite a few jobs to do the "customer installation" scope, and then it was understood that we could go ahead and do that on our own (as front line managers on HL4)." (Sales, hierarchy level 4)*

As Viento was gaining experience with customers performing installation tasks, allocating turbine installation tasks to customers has gradually become accepted as a standard division of labor between Viento and customers:

> *"I think after [we sold several wind farms without installation tasks to customer Lobo] it kind of became standard offering that we were able to offer a similar package to other [customers], and it has become a standard offer." (Sales, hierarchy level 3)*

The fact that managers accepted customers taking over the installation to be a "standard" solution reflects a decreasing level of novelty concerning these decisions. A manager describes an element of the standard operating procedure which highlights the relationship

between such absence of novelty and hierarchy levels at which decision making takes place. The procedure specifies that decisions concerning standard solutions regarding wind farm sales projects are decided by the sales managers on hierarchy level 4:

> *"We have 'standard' scope that is approved, where generally [customer installation] and full scope (Viento installation) is approved in advance, so (…) you kind of do a 'blank' approval as long as it is a standard project, standard country, standard size, standard customers; then it is up to the sales team (HL4) whether it is [customer installation] or full scope. (…) We allow the individual sales managers to make that determination" (Sales, hierarchy level 2)*

As standard solutions do not require higher hierarchy level approval, at that point, decision rights were de facto delegated to the front line sales managers on hierarchy level 4 and top managers withdrew from decision making. A manager describes how such flat decision making structure is implemented in practice:

> *"[The new task split for this project] came as clear customer request, and it was discussed between the Technical Sales Managers (HL4) and Commercial Sales Manager (HL4) and then we said: ok, we will go that road". (Sales, hierarchy level 4)*

The examples above illustrate how hierarchy span of decision structures gradually decreased and stabilized on a single hierarchy level as Viento took a series of similar governance mode decisions with decision novelty decreasing over time. It illustrated the micro-mechanism of one element of the substitution effect – reduction of the hierarchy span. This illustration demonstrates that Viento finds stable decision making structures that do not require involvement of senior management. In the following section we investigate other factors that help to understand why hierarchy span gradually decreases and becomes substituted with increasing expertise span.

Highly significant coefficients for novelty as well as the illustrations above make the point that novel decisions are substantially different from non-novel decisions and that these differences are crucial for understanding drivers of hierarchy and expertise span, and therefore the substitution between the two. In order to investigate these differences, which would be obscured otherwise, we split our dataset into two subsamples of novel decisions and repeated decisions that lack novelty. Table 4 reports ordered logit regression results for novel and repeated decisions.

Insert Table 4 about here

The most immediate observation from table 4 is that novel decisions rely more on the hierarchy span mechanism than on expertise span: we obtain higher R^2 for hierarchy span (Pseudo $R^2 = 0.232$) than for expertise span (Pseudo $R^2 = 0.118$) and we find more variables to have statistically significant explanatory power for hierarchy span than expertise span of novel decisions. Novel decisions have a more strategic nature and are controlled by senior managers at the top of the hierarchy, and strategic issues are resolved by authority of senior management rather than by adding additional knowledge bases.

Signs and significance levels for many independent variables vary between novel and repeated decisions, confirming that the degree of novelty is an important characteristic determining the decision-making structure for boundary decisions. In the following section we explain these results in detail and support them with qualitative evidence.

Cross-divisional differences: transaction value and complexity

We begin this section by showing how corporate structure impacts decision structures for novel and repeated boundary decisions. Then we analyze how complexity and transaction

value contribute to explaining these differences. Finally, we examine difference between outsourcing and insourcing decisions.

Geographically defined organizational entities provide frames within which managers can develop their decision structures that adapt them to local conditions. Such local conditions among others include value of transactions handled by the regional organizations and boundary decision complexity.

The variable *region* is not significant in regression models for novel decisions, showing that changing hierarchy and expertise span is a firm-wide behavior when novelty is high. *Region* becomes significant in the models explaining both hierarchy (β= -0.924, $p<0.05$, Table 4) and expertise span (β= -1.456, $p<0.01$) for repeated decisions. It means that once novelty decreases, decision criteria are well understood and decisions are taken repeatedly, geographical organizational units develop their own decision structures for boundary decision making fairly independently of headquarters and other regions. Managers have degrees of freedom in developing decision-making structures for repeated decisions and adapt them to local conditions.

Below we illustrate that we attribute regional differences in expertise span primarily to the decision complexity, and differences in hierarchy span to the value of transactions typical in given regions. As all geographical division of Viento govern installation decisions, we draw on the installation examples again.

At first we describe a transition of responsibility for decision-making from headquarters to a regional division, and show how the regional organization faced greater decision complexity and developed its own unique decision-making structure with higher expertise and hierarchy span. After providing the qualitative evidence, we support the finding with the regression analysis results.

An initial decision-making structure, was used when governance mode decisions were taken by managers located at the headquarters, consisted of two same-level decision-makers. One of the managers reports:

> *"We hired local labor to help us out, and decision-making in that respect, that was between myself (HL4 at that point in time) and the Site Manager (HL4). We agreed about what we need and we went out to local companies who supply labor. (…) I was manager for that project.*
>
> *- Was any higher level manager involved in approving that decision?*
>
> *For my projects? Not really, no". (Project Management, HL3)*

He explains that decision criteria were simple:

> *"Capacity and cost, these were the reasons." (Project Management, HL3)*

Such decision-making structure with relatively low expertise span was dominant for installation governance mode decisions taken at the headquarters. A few years later, the responsibility for wind farms in that region was transferred to a local geographical division, where the local project management organization developed its own dominant structure for decision-making. The structure, which was already described previously, not only has higher hierarchy span and higher expertise span than the structure adopted by the headquarters, but also considers a broader set of decision criteria:

> *"We look across all our projects for planning purpose, but then we consider the specific conditions of each project. [Individual project managers](HL4) make recommendations, those recommendations come to me (Hl3) and then I look across my organization and get all the right inputs, both the contract terms and the local specific conditions of the labor environment, then we make a collective decision." (Project Management, HL3)*

Besides the above mentioned labor environment, this larger set of decision criteria includes cost, capacity utilization, the schedule for installing multiple wind farms within a time frame as well as the capability level required for particular tasks, so that activities requiring higher level of skills and more firm-specific knowledge are kept inhouse. The sheer amount of decision criteria has clearly increased in comparison to the earlier decision making instances operated by the headquarters, which were based solely on cost and capacity.

We now substantiate the above observation with a regression analysis with the variable *complexity*, which captures the number of decision criteria. Increasing *complexity* drives hierarchy span up for both novel and repeated decisions ($\beta=0.579$, $p<0.05$) and $\beta=1.791$, $p<0.05$). However, increasing complexity increases expertise span only for repeated decisions ($\beta=3.081$, $p<0.01$), not for novel ones, as expertise in this case is not significant in the regression model. This means that increasing decision complexity in novel cases is not resolved by adding additional knowledge bases. Instead, upper managerial levels decide. Where decisions-makers are challenged by a large number of rationales involved in making a decision (high complexity), they involve other agents, either drawing on their decision rights or on differential expertise they hold. In the case of novel decisions, they turn to increasing hierarchy span.

We now turn to examining the effect of *transaction value*. Transaction value of installation activities is driven by wind farm size. We observe that divisions handling large wind farms (103,66 and 94,21 turbines per wind farm on average) adopt decision-making structures spanning across two hierarchy levels, while divisions in market segments with low average transaction value due to small wind farm size (3,79 and 30,14 turbines on average) develop decision-making structures involving managers on one hierarchy level only.

The regression analysis shows that *transaction value* positively influences hierarchy span for repeated decisions ($\beta = 1.212$, $p<0.05$), and is not significant in other cases. This financial decision variable is linked to decision rights that managers on different hierarchy levels have, defined in terms of value in Euro. Transaction value determines the highest absolute hierarchy level that needs to be involved in decision-making. Repeated decisions are taken on the hierarchy level where most relevant expertise resides, which does not necessarily overlap with decision rights as defined in monetary terms. If decisions are de-facto taken on a hierarchy level where managers lack decision the rights to sign contracts of given monetary value, hierarchy span increases.

This finding demonstrates that increasing hierarchy span is a mechanism of control over the financial impact of boundary decisions that are taken repeatedly. Lack of significance of transaction value in explaining expertise span demonstrates that this financial control mechanism is unrelated to the expertise pooled in the decision-making process. Not only does it show that expertise span is not driven by monetary value of boundary decisions, but it also demonstrates that there are no rules pre-defined by management regarding how many persons with distinct knowledge bases are involved in decision-making process. Interestingly, monetary impact is not a key decision variable for novel decisions. Other aspects drive involvement of decision rights and additional knowledge bases when the organization needs to cope with novelty. These findings imply that understanding of firm boundary decision-making cannot be reduced to the financial aspect alone.

Decision structures for outsourcing vs. insourcing decisions

Finally, we analyze how the direction of boundary decisions, i.e. outsourcing vs. insourcing, affects decision-making structures. Outsourcing has a statistically significant effect only on hierarchy span for novel decisions ($\beta=1.309$, $p<0.05$). The positive sign means that novel outsourcing decisions involve higher hierarchy span than novel insourcing decisions.

Interestingly, novel outsourcing decisions in Viento are often initiated at lower hierarchy levels and escalated to the top levels because they tend to depart from established vertical integration strategy. An example of such a case is the first decision taken in Viento to outsource a complete set of installation tasks for a large wind farm. The decision was initiated by a Project Manager at level 4 and escalated up to the Head of Projects at level 2, while typically installation related decisions are taken solely on hierarchy level 4.

Why do novel insourcing decisions have a lower hierarchy span than outsourcing decisions? This is because they were consistent with the vertical integration strategy of Viento. Upstream insourcing decisions are in harmony with the strategy of building up key capabilities. Downstream insourcing decisions are consistent with the early strategy of Viento to keep installation tasks under its own responsibility. The data shows that novel insourcing decisions are taken either at the highest levels, and therefore involve low hierarchy span, or are taken at lower levels and are not escalated. Outsourcing is not significant for repeated decisions, because these are individual decisions that gradually implement strategy that was established through novel decisions. We therefore conclude that departure from previously established vertical integration strategy drives hierarchy span up.

Figure 2 summarizes the drivers of hierarchy and expertise span analyzed in this section.

Insert Figure 2 about here

Having explained how each of our independent variables affects decision structures of Viento, we conclude that the most important insight deriving from our study is the *substitution effect*: decision makers substitute hierarchy span with expertise span over time and as decision novelty decreases. Figure 3 visualizes the substitution effect by showing how average hierarchy span decreased and every expertise span increased over time.

Insert Figure 3 about here

This substitution mechanism shows that organizations display a tendency to increase the expertise available for decision-making even if appropriate decision rights are already involved. Decision novelty plays a key role in triggering the substitution effect, as we find that hierarchy span gradually decreases and expertise span increases as subsequent instances of taking related decisions gradually bear fewer aspects that are novel to decision-makers. In the next section we discuss these results in the light of related literature.

DISCUSSION AND CONCLUSIONS

In the present study we analyze how organizational decision-making structures change when a firm selects and adapts its transactional governance modes. Our most immediate insight is that very few transactional governance decisions were taken individually by a single decision maker. Typically, the decision maker involves others in the decision-making process. This finding confirms prior research, namely that firm boundary decisions (Golden and Zajac, 2001) and other decisions in firms are typically joint decisions (Judge and Zeithaml, 1992; Cyert and March, 1963). In our study, we cast light on a number of aspects of joint decision making that add to prior research on firm boundary decision making. We elaborate on those below.

We find that the decision structures which decision makers use have remarkable variation in the composition of groups of decision makers. Two important dimensions that display variation are the number of hierarchical levels involved in decision-making (hierarchy span) and the number of colleagues involved at the same hierarchy level (expertise span). The fact that these two dimensions emerged as the most meaningful and important from the qualitative analysis, and as statistically significantly correlated with a set of variables that are central for firm boundary decision making, contributes to recent research on which variables impact firm

boundaries. It supports the idea that both decision rights and authority (Milgrom and Roberts, 1991; Makadok and Coff, 2009), but also knowledge, competences, and learning (Brusoni et al., 2001; Takeishi, 2001, 2002; Santos and Eisenhardt, 2005; Jacobides and Billinger, 2006) matter for explaining firm boundaries. Notably, our study also shows this bears out when observing firm boundary decision making behavior.

Our central finding is that decision makers systematically adjust these two features of decision-making structures in two ways as they face series of boundary decisions. They adjust the number of hierarchical levels involved in decision-making (hierarchy span) or the number of colleagues involved at the same hierarchy level (expertise span). We find that hierarchy span is a mechanism for infusing decision-making structures with authority, control and decision rights of higher hierarchy levels, while expertise span brings distinct knowledge bases and allows to pool expertise distributed in the organization. Decision novelty plays the key role in how decision makers adapt the decision structures: decision makers use substantially different decision structures for taking novel and repeated decisions. Our key insight is that there is a regularity in how they adapt decision structure: they substitute hierarchy span with expertise span as decision novelty decreases. The substitution mechanism shows that organizations display a tendency to increase the expertise available for decision making even if appropriate decision rights are already involved in decision making. It takes place especially when decision makers need to consider many decision criteria simultaneously. Why do we observe such a substitution effect? There are several reasons. One possible explanation is that growing organizations employ an increasingly fine-grained division of labor that results in specialization, which, in turn, drives up the expertise span. An alternative mechanism that could produce this effect is that substitution of authority with expertise is necessary to compensate for limited attention of senior management (Cyert & March, 1963). Yet another potential explanation is suggested by the notion of organizational

routines (Nelson & Winter, 1982): once a decision mode has been repeated several times, less deliberate attention is required, in our case, less attention of higher-level managers. Identifying the causes of the substitution effect and verifying them in other settings, such as firms that do not grow at high rates, is a task for further research.

Our insights on the substitution effect contribute to the discussion of the role of authority and decision rights vs. competences for firm boundaries, and their relation in firm boundary decisions (Makadok and Coff, 2009; Santos and Eisenhardt, 2005). In particular, it identifies that there are systematic relationships that open up interesting research questions concerning the conditions under which substitution makes sense, whether there is a particular 'substitution rate' at which expertise and competences can compensate for decision rights, or what our finding of substitution means for potential complementarities between decision rights and competences.

Our findings on how decision makers adapt decision structures over time also contributes to prior knowledge on how firm boundaries change over time. The classic contributions to the firm boundary literature trace changes in firm boundaries to changes in key decision variables, such as asset specificity, uncertainty (Williamson 1985) and relative capabilities. We found that in addition to how these variables directly have an impact on *which* governance mode is chosen, there is an indirect impact on governance modes, too: *changes* in these decision variables increase the novelty of a decision that managers face (as compared to preceding decisions they faced). The novelty of decision influences the decision structure used in joint decision making – independently of the *direct* influence of key decision variables as identified in firm boundary theories (cost, capacity etc.) on the outcome of the decision process, i.e., the governance mode adopted for a given transaction. In extant research on firm boundaries, the focus has been almost exclusively on explaining the outcome of firm boundary decisions by considering the key decision variables that are

supposed to directly determine the governance mode. Our findings show that yet another variable, novelty of decision, is important because it shapes the decision structure adopted for any given firm boundary decisions. Who participates in a boundary decision (in particular, what decision rights and what expertise are present in the group) can also have an effect on the outcome of firm boundary decisions, novelty of decision should be added to the set of variables that need to be considered in understanding firm boundary decisions. Our study adds to Bidwell's (2010) argument that structure plays an important role for firm boundary decision making, specifying not just what dimensions of structure matter, but also, that decision novelty is one of the key variables that drive decision structure.

It is noteworthy that decision novelty is a variable that is longitudinal – novelty of a decision as compared to preceding decisions the decision maker faced earlier. The impact of decision novelty on decision making structures does, therefore, represent a dynamic effect of firm boundary decisions, i.e., an effect that is explained by precedents and prior history of decisions, rather than by contingency variables such as complexity, capacity etc. Addressing a call for the longitudinal studies of firm boundaries (Santos and Eisenhardt 2005, Jacobides and Billinger 2006), we have thus identified how the intertemporal structure of firm boundary decisions, i.e., the series of boundary decisions over time, provides an additional explanatory factor that can improve our understanding of firm boundary decision making in firms. We thus add to prior research on intertemporal influences on governance mode decisions (Argyes & Liebeskind, 1999). Argyes & Liebeskind (1999: 49) argued that 'firm's past governance choices significantly influence the range and types of governance mechanisms that it can adopt in future periods' and thus, that path dependence applies to the choice of governance mechanisms at different points of time. This would predict that firms would to some extent stick to particular governance modes once they had adopted them in the past. Their argument, therefore, is on the level of the *outcome* of the decision process, i.e. the governance modes

adopted. Adding to their insight on intertemporal interdependence, we identify a mechanism generating intertemporal interdependence on the level of the *decision structure*. What firm boundary decisions have been met by decision-makers previously defines how novel the decisions that they meet are for them. As we have shown, this has an impact on how decision-makers adapt decision-making structures. This, in turn, can have an impact on the outcome and thus on what governance mode will be chosen (Bidwell, 2010). The feature of path dependence, and that past choices influence future choices, is one of the hallmarks of organizational routines (Nelson & Winter, 1982). Our look at the 'process mechanics' (Williamson 1988, p.76) has therefore uncovered that firm boundary decision processes are to a certain extent impacted by the history of past decisions and thus, to some extent have the characteristics of organizational routines. Our study thus also adds to studies of the emergence and change of organizational routines (Feldman and Pentland, 2003), for instance, by contributing insights on the circumstances under which stabilization of the decision structures in which multiple agents make decisions (decision routines) sets in, and identifying factors that disturb such stable decision routines and trigger adaptation. We also provide data that allows considering to what extent routines are adapted marginally or are discarded in favor of radically different decision structures.

Our study therefore provides a number of insights on how firm boundary decisions are taken, adding to the only empirical study of how firm boundary decision are made (Bidwell, 2010). In his recent study Bidwell (2010) found that decision making structures used for making repeated governance mode choices have an impact on firm performance, and more precisely, on the ability to achieve transactional alignment (Williamson 1991).

While Bidwell (2010) analyzed how the differentiated organization structure separated decision makers and thus contributed to transactional misalignment, we identify in detail how decision makers use decision structures to pull together the different individuals that are

engaged in firm boundary decision making from the differentiated organization structure, and identify that in adapting these structures, decision makers substitute authority with expertise when decisions become decreasingly novel to them as they recur.

By identifying which decision structures firm use, and identifying the substitution effect as the central regularity in how decision makers adapt them in order to assemble the decision rights and expertise considered appropriate to achieve transactional alignment, we extend Bidwell (2010), who has shown 'how the interaction between multifaceted problems and differentiated organizational structures can lead related decisions to be assigned to different parts of the organization', with the consequence that 'no actor has full control over transaction alignment, or fully considers all of the issues needed to achieve discriminating alignment'. We thus add specific detail on 'how organizations can foster higher quality decision making around firm boundaries', an 'important topic for future research' (Bidwell, 2010: 373).

Several additional insights appear noteworthy and contribute to prior knowledge on firm boundary decision making. First, the detailed insights on how decision makers respond to decision novelty contribute to understanding how decision structure and adapting it help boundedly rational actors cope with novelty and the challenges for decision making that arise from it. Second, the adaptation of the decision structures that is a central part of firm boundary decision making is not the result of deliberation on the top management level; rather, it happens incrementally. Third, there might be interesting interactions between the structural features of the organization that determine the distribution of decisions to actors, and the distribution of decision rights and expertise in the organization. We now address these in turn.

Theories of firm boundaries that are based on organizational economics assume that firms select the most efficient transactional governance modes (Parmigiani 2007). Many of these

theories subscribe to the idea that human decision makers are boundedly rational (including Williamson, 1985). So far, the implications of this assumption have not really been spelled out and integrated in theories of firm boundaries, however. For two reasons, this has been quite difficult (and not been missed very much either). First, the often implicit assumption of the firm as a unitary actor hides from view (and analysis) the fact that many boundary decisions are taken by several actors – they are joint decisions. Moreover, it also projects the image of an abstract actor, which does not urgently beg the question what her cognitive capabilities are. Hiding the individual, the unitary actor assumption also hides the cognitive limitations of human actors. Second, attention has so far been focused on the rationales underlying firm boundary decisions but has skirted the decision-making process. Bounded rationality leaves its empirical signatures in the process, however. An omniscient actor with perfect rationality could factor an unlimited number of variables into her algorithms and could process them with the speed of light in making a decision. In order to make up for the constraints on their cognitive resources, boundedly rational actors resort to structuring the process of decision making in time. For instance, they sequence parts of the decision in order to achieve coordination (March & Simon, 1958); in applying satisficing rather than optimizing, they select the first alternative that meets their aspiration level in the sequence in which they encounter alternatives (March & Simon, 1958); they apply procedural, rather than substantive, rationality (Simon, 1978). Hiding the process thus means to largely hide away from view and analysis the empirical traces boundedly rational actors will leave when they make decisions. The empirical signatures that boundedly rational actors leave are signs in processes over time; ignoring the decision-making process means it becomes very difficult to detect and say anything about bounded rationality and how it impacts firm boundary decision making. As the Carnegie School has always pointed out, decision processes are the entry point for understanding the implications and workings of bounded rationality (March &

Simon, 1958; Cyert & March, 1963). Following up on this lead, we have provided support for this idea by adding to our understanding of how firm boundary decision processes happen. The fact that decision makers adapt decision structures systematically means that there is a system or 'procedure' for arriving at satisfactory boundary decisions, which decision makers rely on when it is difficult to assess whether a boundary decision is satisfactory according to the stipulated decision criteria (for instance, when complexity, novelty and bounded rationality make such an assessment difficult).

In this light, our finding that decision structures and adapting them were very important features of firm boundary decision making means these structures provide (the most) important measures that boundedly rational actors use to cope with limitations to their cognitive resources. This is consistent with earlier research on team structures (Marschak & Radner, 1972; Sah & Stiglitz, 1986; 1988; Knudsen & Levinthal, 2007; Christensen & Knudsen, 2010), which has identified the effect of team structures on decision making (for instance on how structure impacts evaluation capabilities). These insights have not yet been linked to firm boundaries, providing a great opportunity for further research. For instance, the ability to assess production and transaction cost under alternative governance modes is a key assumption of TCE, and this ability can be fostered by decision structure adopted for particular decision making instances. An item for further research would thus be to test the predictions of those models on the firm boundary decision structures that can be found in firms, and to examine how decision making structures influence the ability to achieve discriminating alignment.

Passing on to the second additional insight, an interesting observation follows from the fact that decision structures are not just malleable, but that decision makers (including lower-level decision makers) do in fact adapt them to address challenges of boundary decision making. Which decision structures they adapt and how depends on several factors: who in the

organization is called upon to make a boundary decision, and to what extent that person is challenged by the decision and in which way (by limits to her decision rights or her expertise). In more abstract terms, the development of decision structures for firm boundary decisions thus appears to depend on the distribution of decision rights and expertise in the organization (across and within the hierarchical structure) and the distribution of firm boundary decisions in the organization. An opportunity for further research would be to look into how the relationship between the distribution of decision rights and expertise on the one hand and the distribution of decisions in the organization on the other shape the dynamics of the adaptation of decision structures (some hypotheses might be derived from the literature on the 'mirroring hypothesis' between product and organization architecture; Sanchez & Mahoney, 1996; Colfer & Baldwin, 2010). Coming to the third of the additional insights, we note that *which* decision structures are used to make boundary decisions – and *how* these are adapted over time – is not something that is designed deliberately by top management; rather, it is something that evolves incrementally. This is possible because decision making structures are malleable to an important degree. Malleability is particularly pronounced with regard to involvement of actors because of their expertise, while the involvement of bearers of decision rights is more regulated. Possibly, this is simply because it is much more difficult to specify rules for the involvement of bearers of particular knowledge (as indicated by the finding that hierarchy span is statistically significantly correlated to transaction value, a variable that is very easily measured). This observation raises a number of questions. For one, it poses a limit to organization design by top management. Given that rules on the involvement of experts are more difficult to formulate, this organizational design dimension might be more left to low-level decision makers and those who have the requisite knowledge about who has what expertise, than high-level managers (as captured for instance in transactional memory systems, Brandon & Hollingshead, 2004). It would also corroborate

ideas of emergent strategy (Mintzberg & Waters, 1985), and of continuous rather than punctuated change (Romanelli and Tushman, 1994) in the area of firm boundary decisions. The observations that (a) decision making structures are malleable and might actually be adapted even without following a rule sanctioned by (or perhaps even known to) top management and (b) that they might be adapted by decision makers that 'just happen' to be called upon to make a boundary decision point to forces of path dependence, stickiness or even 'inertia' in the process of firm boundary decision making (David, 1985; Argyres and Liebeskind, 1999; Hannan and Freeman, 1989) that might make it difficult for management to adapt firm boundaries very rapidly, or even 'at once'. This is further supported by the fact that in most cases, the decision making structures involve several actors. Especially decisions relying on expertise span as the main mechanism thus require a consensus among decision makers. As we know from prior research, such decision structures have the proclivity to maintain the status quo (Hannan & Freeman, 1989) and low proclivity to implement changes. Changes might break what Nelson & Winter (1982) have identified as 'truce', and might require bargaining, negotiation, and political processes between the actors involved (March, 1994; Kaplan, 2008). We have thus identified yet another reason why firm boundary decision making might have the quality of organizational routines, which adapt only slowly (Nelson & Winter, 1982). We also identify a specific research question for investigating how negotiation and political processes have an impact in firm boundary decisions, i.e., how does the decision structure influence the possibilities for negotiation between the involved actors, and what is the impact on firm boundary decisions?

On a final note, an open question that remains is whether decision-making structure is a result of novelty or vice versa. An organization facing minimal novelty can sustain with minimal coordination across hierarchy levels, and decision structures stabilize and become a template for subsequent decision-making instances. As novelty increases, the need for coordination of

strategic action arises. In response, hierarchy span increases and provides coordination by authority. Hence, with increasing novelty, hierarchy span goes up. Further research is needed to investigate whether increase of hierarchy span invites novelty, for instance, by inviting new combinations of decision criteria to be considered by decision makers.

Summing up, we finpd that managers use two structural variables in order to adapt transactional governance modes over time. They manipulate the hierarchy and expertise span of participants in firm boundary decision making in order to accommodate the demands of boundary choices they are confronted with. While these mechanisms relate to constructs such as centralization and delegation of decision rights, we observe that decision behavior is not pre-defined by the organization structure and that it involves substitution of authority provided by hierarchy span with expertise on lower levels as the novelty of decision situation decreases. Managers navigate in the structure of distribution of knowledge and decision rights to pool relevant resources when needed. The extent to which we can generalize from our study to other settings and to decision making contexts other than related to firm boundaries, requires additional research.

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FIGURE 1: Sources of evidence throughout the project

Phase 1: April 2009- December 2009

Primary focus of the interview	Functional department	Hierarchy level of informant*								Secondary sources of data
		1	2	3	4	5	6	7	total	
Introductory value chain understanding	engineering		2						2	industry reports
	procurement			2	1				3	Firm newsletters
	production		1		1				2	Annual reports
	project management			5	1				6	Press releases
	sales			2		1			3	analyst reports
	strategy		4	3	2				9	
Total # interviews in phase 1		1	9	15	9	6	6	7	25	

Phase 2: January 2010- April 2011

Primary focus of the interview	Functional department	Hierarchy level of informant*								Secondary sources of data
		1	2	3	4	5	6	7	total	
engineering boundary decisions	engineering		2	3	3	1			9	Firm newsletters
	procurement				2	1			3	organization charts
	strategy	1							1	minutes of meetings
production boundary decisions	engineering						3		3	internal presentations
	procurement			2	5	7	6		20	internal reports and documents
	production			1	4	2	4	3	14	production schedules
installation boundary decisions	project management		1	4	12	4			21	purchase, production and
	sales		4	3		1			8	sales orders overviews
Total # interviews in phase 2		1	7	13	26	16	13	3	79	headcount data
Grand Total: interviews per hierarchy level		1	14	25	31	17	13	3	104	

* Level 1=CEO; 7= lowest level

FIGURE 2: Drivers of hierarchy and expertise span in firm boundary decision-making structures

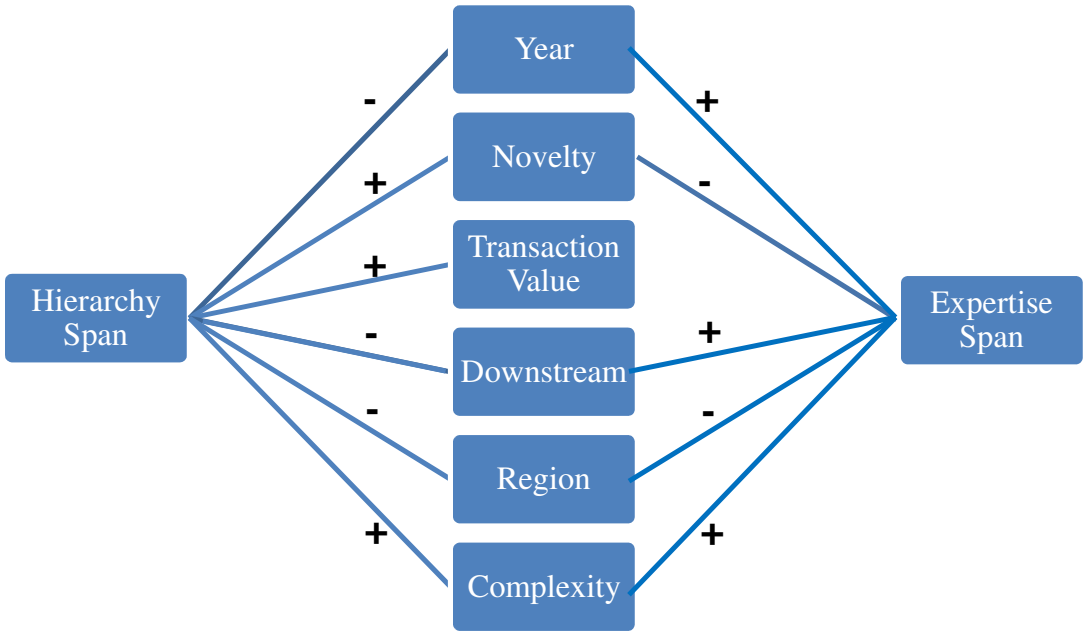

FIGURE 3: The evolution of hierarchy span and expertise span for firm boundary decisions

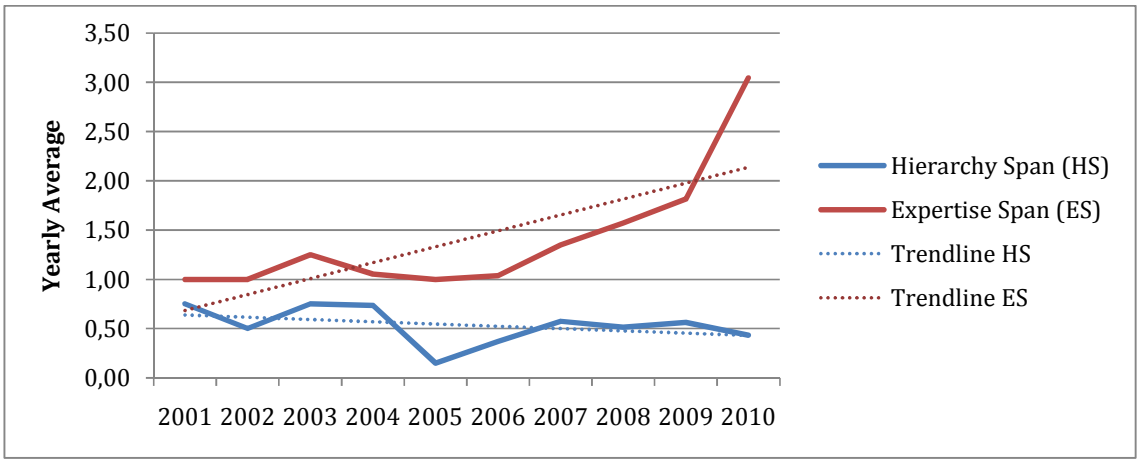

TABLE 1: Overview of Viento's firm boundary decisions over 10 years period

			# decisions per hierarchy span			# decisions per expertise span		
Task	**Time period**	**Main decision criteria**	**0**	**1**	**2+**	**0**	**1**	**2+**
Installation	01-04	capabilities		2		1	1	
		learning in new country, capabilities, flexibility			1		1	
	2005-2007	capabilities	5				5	
		cost, capacity, capabilities		3	1	1	3	
		cost, capacity, capabilities, union environment		5	1		1	5
		customer demand, entry barriers, capability, operational flex, vertical scope integrity			1			1
	2008-2010	cost, capacity, capabilities, demand seasonality		1				1
		cost, capacity, capabilities, union environment		18				18
		customer bargaining power, entry barriers, capability, operational flex, vertical scope integrity			1			1
		customer demand	5					5
		customer demand, capabilities	5	1	1			7
		customer demand, entry barriers, capability, operational flex, vertical scope integrity			1			1
		learning (prototype)		1				1
Inst-allation	01-04	customer demand, capabilities, technical interdependencies			2			2
	05-07	customer demand, capabilities, technical interdependencies		2			2	
	08-10	cost, learning in new country, knowledge preservation		4				4
Installation	01-04	capabilities	2				2	
	05-07	capabilities	4	2			6	
		capabilities, capacity		2				2
	2008-2010	capabilities, capacity		6	1			7
		capacity	1					1
		customer demand, capabilities, technical interdependencies			1		1	
Engin-ering	01-04	capabilities, key knowledge, innovation strategy			1	1		
	05-07	capabilities, key knowledge, innovation strategy		1		1		
	08-10	capabilities, key knowledge, reduce dependendce on supplier, innovation strategy			1	1		
Installation	2001-2004	capacity, capabilities	16				16	
		cost, capacity, capabilities		1				1
		customer demand, capabilities, technical interdependencies			3			3
	2005-2007	capacity, capabilities	23	1			24	
		capacity, financial outcome of project, growth, internal cost insrease			1			1
		complex technology b	2				2	
		complex technology a	5				5	
		cost			1		1	
		Cost, capacity ,growth		1				1
		cost, capacity, capabilities	5				5	
		customer demand, capabilities, retain business model with old customer	1	1			2	
		do not deviate from current strategy	8				8	
	2008-2010	capacity	1					1
		capacity, learning in new country	1					1
		complex technology a	1				1	
		cost	1	2		3		
		cost, capacity, capabilities	31	1	1	1		32
		cost, risk sharing, capabilities	1			1		
		do not deviate from current strategy	6				6	
		learning (prototype)	1					1
		learning in new country		1			1	
Production	2001-2004	capabilities, innovation strategy, customer demand, kn leak protection, time pressure		1			1	
		capabilities, operational flexibility	1			1		
		capacity, core competence focus		1	2	1	2	
	2005-2007	capacity	1			1		
		capacity, core competence focus		2	2	2	1	1
		operational flexibility	5	1		4	1	1
	2008-2010	align vertical scope across factories		1				1
		capacity, capabilities, core competence focus		1				1
		capacity, core competence focus	4	3		4	2	1
		capacity, core competence focus, cost		1			1	
		operational flexibility	8			8		

TABLE 2. Descriptive Statistics and Correlations (n=234)

	Variable	Mean	Std. Dev.	Min	Max	1	2	3	4	5	6	7	8	9
1	expertise span	1.414	.856	0	3	1								
2	hierarchy span	.482	.669	0	2	0.2782*	1							
3	complexity	2.106	1.165	1	5	0.6223*	0.5058*	1						
4	transaction value(log)	13.286	2.182	7	18	0.4140*	0.4308*	0.4099*	1					
5	outsourcing	.632	.483	0	1	0.1624*	0.0999	0.1844*	0.2467*	1				
6	year	2007.192	2.277	2001	2010	0.4190*	-0.0330	0.3610*	0.0459	0.0294	1			
7	region	31.709	1.255	1	4	-0.5334*	-0.3846*	-0.4116*	-0.4675*	0.0191	-0.2503*	1		
8	downstream	.841	.365	0	1	0.4708*	-0.1075	0.1103	0.3367*	0.1555*	0.0109	-0.2868*	1	
9	novelty	1.589	.923	1	4	-0.2020*	0.5302*	0.1327*	0.2268*	-0.0220	-0.1971*	0.0163	-0.3583*	1

* p<0.05

TABLE 3: Ordered logit estimates for regression analysis predicting hierarchy span and expertise span; full sample of boundary decisions.

VARIABLES	Model 1 Hierarchy span	Model 2 Expertise span
upstream	1.238**	-3.587***
	(0.601)	(0.597)
year	-0.266***	0.318***
	(0.093)	(0.080)
novelty	1.441***	-0.663***
	(0.240)	(0.238)
region	-0.442***	-0.435***
	(0.165)	(0.157)
complexity	0.772***	1.225***
	(0.202)	(0.189)
transaction value (log)	0.375***	0.084
	(0.126)	(0.093)
outsourcing	0.341	0.133
	(0.385)	(0.323)
expertise span	0.852***	
	(0.297)	
hierarchy span		0.724**
		(0.339)
Constant, cut1	-524.457***	639.890***
	(186.937)	(161.200)
Constant, cut 2	-520.867***	644.181***
	(186.816)	(161.323)
Constant, cut3		648.157***
		(161.402)
Observations	234	234
Pseudo R^2	0.432	0.434
Prob > chi2	0.0000	0.0000

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 4: Logit and ordered logit estimates for regression analysis predicting hierarchy span and expertise span for novel and repeated decisions

	Hierarchy span		Expertise span	
	Model 1	Model 2	Model 3	Model 4
VARIABLES	Novel decisions	Repeated decisions	Novel decisions	Repeated decisions
upstream	1.083*	8.207***	-1.513**	-12.715***
	(0.607)	(3.006)	(0.609)	(2.497)
year	-0.223**	-1.294***	0.112	1.121***
	(0.108)	(0.404)	(0.097)	(0.313)
region	-0.306	-0.924**	-0.095	-1.456***
	(0.235)	(0.431)	(0.239)	(0.565)
complexity	0.579**	1.791**	0.288	3.081***
	(0.258)	(0.889)	(0.237)	(0.735)
transaction value (log)	0.196	1.212***	0.015	-0.046
	(0.137)	(0.416)	(0.124)	(0.315)
outsourcing	1.309**	-1.071	0.447	0.482
	(0.589)	(0.771)	(0.548)	(0.854)
expertise span	0.468	4.719***		
	(0.319)	(1.484)		
hierarchy span			0.253	5.549
			(0.615)	(2.101)
Constant, cut1	-444.886**	2,579.018***	225.855	2,252.653***
	(216.352)	(806.413)	(195.419)	(627.950)
Constant, cut2	-442.298**		228.114	2,265.609***
	(216.257)		(195.458)	(630.062)
Constant, cut3				2,277.635***
				(631.818)
Observations	75	159	75	159
Pseudo R^2	0.232	0.722	0.118	0.850
Prob > chi2	0.0000	0.0000	0.0081	0.0000

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Models 1,3 and 4 are ordered logit regression models, model 2 is logit