

Tacit Knowledge and the Dynamics of Vertical Scope: An Application to Regulated Industries

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Abstract: This paper extends existing approaches to explain vertical scope by introducing tacit knowledge as an important factor shaping processes of integration and disintegration. Considering the impact of tacit knowledge in interaction with knowledge similarities across vertical stages, we provide a resource-based view argument for the emergence of different governance modes. The paper analyzes the specific conditions, under which organizations not only chose between markets and hierarchies but implement different governance modes such as close cooperation with other companies and the integration in networks and alliances. Then, we apply this framework in the context of regulated industries. Distinguishing between three types of regulatory regimes, we assess the impact of knowledge similarities and tacit knowledge on vertical integration and disintegration in regulated sectors. Our findings suggest that knowledge similarities and tacitness generate integrative and disintegrative forces that may be in conflict with the established regulatory framework. We derive implications on some managerial and regulatory issues, and how to address them.

INTRODUCTION

The evolution of firms and industries has long been an important topic for management scholars and organizational economists alike. A central area that researchers have studied in this context is the vertical scope of organizations and industry sectors. A well-established theory to explain vertical structures at the organizational and industrial level is transaction cost economics (TCE). Drawing on Williamson's (1975, 1979, 1985) seminal contributions, many scholars have found persistent evidence that the specific characteristics of business transactions define whether they are pursued within the firm or through the market (make vs. buy decision).

Vertical scope is also a prominent topic in the resource-based view and capabilities literature. Contributions in this literature have suggested that the access to specific resources and assets is an important driver to integrate vertically (Argyres 1996; Barney 1999). More recent research has shown that the distribution of capabilities within an industry shapes to a large extent the vertical structure of firms and the dynamics of integration and disintegration in a sector (Jacobides 2005; Jacobides and Hitt 2005).

Despite vertical scope figuring prominently in the TCE and capabilities literature, there has been surprisingly little research that aims to integrate the two approaches. There are few contributions, in which organizational economists have considered processes of resource building at the firm level to explain dynamic changes in the boundaries of firms (Langlois 1988, 1992; Langlois and Robertson 1995; Langlois and Foss 1999) and the emergence of hybrids as organizational forms (Ménard 2004). Some research in the capabilities literature has recently integrated transaction cost arguments to better understand the evolution of vertical scope in industries (Jacobides and Winter 2005) and the generation of competitive advantage through contract design (Argyres and Mayer 2007).

Besides of these contributions, however, organizational economics has remained quiet about explaining the heterogeneity of governance forms emerging between markets and hierarchies. Capability approaches, on the other hand, have mainly studied competitive advantages and firm performance, but have rarely focused on how specific combinations of resources and knowledge

shape the occurrence of specific organizational forms and governance modes. One exception in this context is the recent work by Jacobides (2005), which shows that – under particular conditions – intra-firm specialization and inter-firm co-specialization of knowledge facilitate vertical disintegration and the emergence of markets. The analysis links capability arguments with governance modes, namely how knowledge similarities and dissimilarities across vertical stages determine whether integrated firm organizations or markets emerge.

In this paper, we extend this literature and argue that tacit knowledge is – in addition to the extent of knowledge similarities – an important source that shapes the dynamics of vertical scope. Specifically, by being more explicit about how different knowledge characteristics affect vertical scope in an industry simultaneously, we provide an explanation about the emergence of various organizational forms and governance modes. Our approach goes beyond explaining the existence of firms and markets but particularly allows us to provide insights why firms chose hybrid organizational forms, interact in firm networks and engage in close cooperation with other companies.

In this sense, we contribute to an integration of the capability perspective and organizational economics. In refining Jacobides' (2005) approach, we provide a resource-based view reasoning to explain the emergence of various governance modes. One of the main conceptual contributions in this paper is considering learning and tacit knowledge and what role they play in better understanding the dynamics and processes of vertical scope and industrial change.

The second central aim of this paper is to apply the framework in the context of regulated industries, in particular infrastructure sectors. The purpose is to better understand the influence of the institutional environment on vertical scope. We distinguish three regulatory regimes, which differ in their policies toward vertical integration in the respective industry. Given the regulatory regime, we assess the impact of knowledge similarities and tacit knowledge on vertical integration and disintegration in regulated sectors. Based on these results, we identify some emerging organizational and institutional issues. Our analysis shows that these issues may derive, if there is little alignment between knowledge characteristics, organizational forms and the regulatory framework.

The paper proceeds as follows. In the next section, we present some of the existing approaches and main arguments on vertical scope from organizational economics and the resource-based view

literature. In the third section, we introduce our extension of the framework. The section starts with a brief outline of the nature of tacit knowledge and derives then two propositions that are important building blocks to formulate our hypotheses later on in the paper. The second part of the third section develops a set of hypotheses on the vertical scope and the dynamics of industries. The fourth section builds on these results and examines the implications for organizations in infrastructure sectors, given the different types of regulatory policies. This section highlights particularly the importance to consider knowledge characteristics and its implications for organizational governance, when regulatory policy frameworks are formulated. Section five concludes.

THEORETICAL APPROACHES ON VERTICAL INTEGRATION: TCE AND CAPABILITIES

Tracing back to Coase's (1937) notion of market transactions being costly, transaction cost economics (TCE) has usually been discussed in the economic literature to explain the existence and the scope of firms (Williamson 1975, 1979, 1985; Klein et al. 1978). The starting point for the TCE approach was the question whether economic activities are organized in the firm or through the market. The TCE argues that transaction costs determine the boundaries of the firm. The decision for the extent of vertical integration – and therefore the size of the firm – depends on the level of uncertainty, specificity, and frequency of the contractual relationship. By arguing that the contractual relations in market transactions are costly, and that therefore some economic activities are more efficiently coordinated within a firm organization, TCE provides a prominent theoretical explanation for the level of the integration of a firm.

As the TCE argues that the cost structure of market transactions determines the optimal size of the firm, they do not intend to explain changes of the level of integration primarily. However, one may extend this approach and argue that changes in the costs of the market transaction affect the vertical scope (e.g., Baker and Hubbard 2003; Hubbard 2003). Variations in these factors drive a process in which a firm responds by adopting another optimal size. In this case firms integrate or disintegrate. But these are mere adjustment processes due to altered transaction costs (Geroski 2000). Hence, the explanation for a change in the firm size is derived entirely from variations in external

factors. Precisely, the costs and characteristics of contractual relations, which are completely determined by the market interactions, are the only defining factors for the level of integration. The underlying reason for this result is the TCE's exclusive focus on contractual relations. There is no explanation that considers the scope or systematic changes that derive from other aspects such as the internal interactions within the firm.

An important contribution of TCE is to provide a powerful framework to explain governance choices of firms, i.e. whether to pursue specific business transactions through market interactions or within the firm organization. Despite a large literature on examining what determines the decision for either governance mode (e.g., Whinston 2003; see also Macher and Richman 2008), little attention has been paid on understanding the existence of governance forms between markets and organizational hierarchies. An exception is some recent work on hybrid organizations, which introduces additional determinants of transactional relations such as trust and interrelated networks (Ménard 2004). These transaction characteristics allow scholars explaining the emergence of governance forms that are neither arm-length market transactions nor fully integrated hierarchies. In this paper, we contribute to this literature by arguing that the specific characteristics of knowledge along the value chain determine importantly the extent of vertical integration, and therefore the governance mode.

Besides of transaction cost reasoning, there are several resource- and knowledge-based arguments to understand vertical scope and how it changes (for an overview see table 1). In the strategic management field, the resource-based view of the firm and dynamic capability approaches have emerged to explain organizational behavior and competitiveness explicitly through processes of resource building and configuration decisions at the organizational level (Penrose 1959; Wernerfelt 1984; Barney 1991; Teece et al. 1997; Eisenhardt and Martin 2000; Winter 2003). Although the main focus of these approaches is on contributing to a better understanding what produces a sustained competitive advantage in a changing environment, there are several approaches that apply a resource-based view to explain vertical scope (Argyres 1996; Barney 1999; Combs and Ketchen 1999; Leiblein and Miller 2003; Gulati et al. 2005). The main argument is that firms integrate to access resources, assets and competences that contribute to sustaining a competitive advantage.

In addition, there are some contributions on integration, which have complemented the resource-based view with TCE arguments. For example, in the face of uncertainty such as economic change and innovation, integration tends to be advantageous because it mitigates costs of transferring capabilities from the market and therefore better ensures the access to the required capabilities, which may not be available through the markets (Langlois 1988, 1992). However, few advancements have been made since to further integrate the two approaches and lay out a comprehensive framework (Langlois and Foss 1999).

Other approaches have applied capability reasoning to derive arguments for integration and disintegration from knowledge specialization processes in an industry. Gains from knowledge specialization within an organization are a crucial driver for vertical scope. In an inductive study of industry evolution, Jacobides (2005) lays out a detailed theory how and why vertical disintegration occurs over time in industries. He identifies several determinants for vertical disintegration and market creation. Gains from intra-firm knowledge specialization are one central driver along the value chain that enables processes of intra-firm partitioning. If coordination becomes simplified through the partitioning process, the different units of the value chain get increasingly independent in managing their units. As a result, vertical disintegration may happen and lead to the emergence of a new market at the level of the value chain, at which the disintegration happened.

In addition to gains from intra-firm knowledge specialization, gains from trade are another central driver enabling vertical co-specialization between firms (Jacobides 2005). Capability differences between integrated firms lead to advantages to specialize in those areas of the value chain with the strongest capabilities. If information gets increasingly standardized about the services and products that the co-specializing firms offer to each other, they reduce the problems that potentially occur through market transactions. Consequently, integrated firms may vertically disintegrate, which lead to the emergence of new markets in the co-specialized business fields.

In contrast to the resource-based view argumentation above, which explains integration dynamics through the access to competences, the knowledge specialization approach focuses more on disintegration (Jacobides 2005; Jacobides and Hitt 2005). Processes of disintegration occur as firms exploit comparative advantages as they deploy their capabilities along the value chain. Variations in

the strength of capabilities favor the specialization in those levels with relatively strong capabilities. Thus, the distribution of capabilities along the value chain defines the vertical scope to a large extent.

Other research has extended this approach by including TCE arguments and shown how the interaction between capabilities and transaction costs co-evolve and therefore explain the dynamics of vertical integration and disintegration in firms and industries (Jacobides and Winter 2005). In more detail, there are two different dimensions of knowledge characteristics along the value chain (Jacobides and Winter 2005). First, if knowledge is dissimilar, latent gains from trade are effective, which tend to result in vertical disintegration. Reductions in transaction costs would further foster the disintegration. Second, if knowledge is similar, no latent gains from trade emerge. As a result, integration tends to be the most viable option. In this case, even a reduction of transaction costs does not lead to substantial disintegration. The basic argument here is that the distribution of capabilities shapes the level of scope of individual firms with transaction costs mediating the level of integration and operating on the underlying capability distribution (Jacobides and Hitt 2005; Jacobides and Winter 2005, p. 399). In other words, it is the capability distribution in the first place that defines the level of scope in a firm and in an industry with transaction cost characteristics amplifying this relationship.

In sum, scholars have long highlighted that the knowledge of the firm is central to understand the boundaries of the firm (Langlois 1988, 1992; Kogut and Zander 1992; Langlois and Foss 1999; Jacobides and Winter 2005). Specifically that the underlying characteristics that knowledge is tacit and distributed makes it difficult and – if at all possible – costly to coordinate outside the institutional setting of a firm organization. It is for this exact reason that specific knowledge and resource combinations can be unique and create a competitive advantage (Barney 1991).

A knowledge-based extension of explanations of vertical scope is important because it can explain the evolution of vertical structures as it refers to similarities and dissimilarities. Dissimilarities drive intra-firm specialization and inter-firm co-specialization of knowledge and therefore facilitate disintegration. Similarities in knowledge, in contrast, allow a firm to exploit synergies and economies of scale. In fact, if the required knowledge for operating an up- and downstream level is similar, advantages may potentially derive from pursuing activities in one level by drawing on knowledge

from another level. This is the case, when knowledge at one vertical level contributes to optimize decision-making and operational procedures at the other level. Then, synergies occur from using the knowledge across two stages. As two vertical stages draw on the same pool of knowledge and capabilities, an organization can exploit economies of using knowledge. Vertical integration results in efficiency gains. Thus, accessing a joint knowledge base produces synergies between two integrated stages. The synergies, in turn, further facilitate and strengthen the integration of the organization.

In the following, we introduce tacit knowledge as an additional dimension of knowledge that affects vertical scope in a specific way. It allows us to refine the predictions on industry evolution and derive specified hypotheses. Regarding governance forms, the introduction of tacitness as an additional knowledge characteristic – besides knowledge similarities – allows us in particular to be more precise on the emergence of different modes of governance. In this sense, we extend prior research as our approach derives some predictions on organizational governance forms that go beyond solely differentiating between integrative and disintegrative dynamics.

Insert table 1 about here

TACIT KNOWLEDGE, VERTICAL SCOPE AND THE DYNAMICS OF INDUSTRIES

The nature of tacit knowledge

By explicitly considering tacit knowledge, we extend the research on capabilities and vertical integration by introducing a second channel – in addition to knowledge similarities – through which knowledge affects the scope of organizations. As mentioned above, synergies emerge from exploiting economies of using similar knowledge across different stages. We argue that tacitness is a knowledge characteristic that influences the extent of vertical scope in a systematic different way than

similarities. We further show that the two channels play simultaneously an important role in defining the scope of organizations.

Tacit knowledge is defined as knowledge that is not codifiable. It is difficult – if not impossible – to articulate and make explicit. Tacit knowledge is acquired through learning and cumulative experience. It is therefore closely linked to individual skills and competence building. In fact, as tacit knowledge is based on learning and experience, it forms a substantial part of individual human skills (Polanyi 1967, 1969; Nelson and Winter 1982) and therefore affects the performance of individuals (Wagner and Sternberg 1985; Nonaka and Takeuchi 1995; Armstrong and Mahmud 2008).

Tacit knowledge is similarly important at the group and organizational level. A task performed by a team requires knowledge that is dispersed across different individuals forming the team (Nelson and Winter 1982; Berman et al. 2002). As team members jointly accomplish a task with each member contributing individual competences and skills, there are two emerging effects. First, team members learn about the group process and therefore expand individual tacit knowledge further. Second, through mutual experience, the team members develop a team tacit knowledge about the specific processes. This includes a group level understanding about who can perform what, when to perform a particular part of the task, how to perform it etc. These processes generate and accumulate tacit knowledge at the individual, group and organizational level, which is specific to a firm. The accumulated tacit knowledge can be a potential source for competitive advantage. Indeed, team and organization tacit knowledge has been found to be crucial for organizational performance (Prahalad and Hamel 1990; Lubit 2001).

Most importantly in the context of this paper, tacit knowledge is not separable – or only by incurring high costs. At the individual level, tacit knowledge cannot be split up and be partly transferred to another individual. At the organizational level, performing a team task needs a group, and the interactions among the group members are based on specific knowledge that they only received through their interaction and the learning thereof. The gained experience is the underlying reason for a group's current performance. Thus, if the group performance involves a tacit knowledge component to a relevant extent, splitting the group up would jeopardize the achievement of the task.

Consequently, dividing a group with strong tacit knowledge decreases the performance substantially. Furthermore, a divided group has to re-acquire the competences, which may involve long time periods of learning, during which the task is only sub-optimally performed. In the extreme case, splitting a group may even compromise accomplishing the task altogether. Thus, non-separability makes tacit knowledge systematically different from the synergy argument. As it is shown below, this is an important aspect for understanding dynamics of vertical scope and industry evolution.

If the operation at one organizational stage in an integrated firm is closely linked in terms of the used knowledge in an up- or downstream level, then it may occur that those firm members that jointly operate the two stages have implicit knowledge about decision-making processes and organizational procedures that are important for the efficient operation. In this sense, tacitness produces also a synergetic advantage between the different stages. But we distinguish this advantage from synergies that generate solely an advantage through not building the same knowledge base twice in an organization. Considering an integrated firm, an advantage of integration derives therefore not only from exploiting economies but from using implicit knowledge that firm members have accumulated over time by operating the business activities at the two levels repeatedly.

There are important implications from distinguishing between the two dimensions. Synergies derive if the knowledge is similar. Integration may then generate economies of accessing a joint knowledge pool and therefore ensure efficient operation. However, if the advantage derives merely from pure synergies, then it is possible to separate the integrated levels and operate them in two different organizations. This tends to yield short-term inefficiencies and a potential increase in transaction costs. But the main point here is that it is generally possible to split up an up- and downstream level and at the same time ensure adequate operations without compromising the quality of the production and service delivery. As a result, transaction costs occur and the disintegrated organization would not be able to exploit economies by using the same knowledge pool in one organization.

In contrast, a situation in which the knowledge at the up- and downstream level is similar but the operation between the different stages depends largely on tacitness, namely the advantage of learnt knowledge by doing, has an opposite implication. The possibility to separate the levels does not exist

without jeopardizing the operations. That is because tacit knowledge is embodied in those firm members that operate the activities at the two levels. Vertical disintegration would mean that the tacit knowledge goes to one of the separated organizations leaving the other one without the necessary knowledge to operate its business activities. Thus, splitting up two integrated levels undermines the operationability of the production and service processes entirely and is not simply going along with higher transaction costs. In fact, costs are incurred as the knowledge base has to be complemented in each of the divided units.

Most importantly, there are particular high costs as learning takes only place over a course of time. During this period, performance is comprised and therefore at sub-optimal levels because an important component of achieving the task – namely tacit knowledge – is not rebuilt yet. Performance only regains its previous level with time, which may at least temporarily lead to a substantial loss of competitive advantage. The costs and competitive disadvantages tend to be higher if the learning periods are longer. Thus, separating two stages that are linked by strong tacit knowledge is therefore not feasible or only under high costs. We formulate the implication of this argument in the following propositions.

***Proposition 1:** An up- and downstream stage in an integrated firm with synergies deriving from exploiting a joint knowledge pool can generally be split up and managed through transactions in separate organizations (even if it loses some of its economies), while vertical integrated stages that are strongly connected through tacit knowledge are more difficult to dissolve and may not only go along with higher transaction costs but tend to threatening the operationability of the separated stages.*

A second implication of distinguishing advantages from pure synergies and tacit knowledge is that they differ regarding the persistency of the effect over time. Exploiting synergies largely depends on whether different users can access the same knowledge pool without building a duplicate pool. This means, even if knowledge is used in vertically disintegrated organizations, the potential to generate synergies through integration remains effective as long as the knowledge base in the two

stages is similar. Thus, the possibility to make use of the knowledge in disintegrated organizational settings – and therefore the potential for synergies – remains persistent over time.

In contrast, the effect of tacit knowledge depends on the joint use of knowledge. But even in cases of continued joint interaction and mutual learning, teams reach a point where most of the things are learnt. Thus, learning effects have diminishing returns and the effects may start to decline (Plowman et al. 2007). The integrative impact of tacit knowledge tends to be highest in earlier rather than later periods of mutual interactions. In addition, the effect of tacitness tends to decay, if knowledge across stages is dissimilar and knowledge specialization processes begin to emerge (i.e., intra-firm partitioning and inter-firm co-specialization). As tacit knowledge is fundamentally based on ongoing learning processes, with the increasing separation of an up- and downstream level, the ongoing learning processes through jointly operating the activities in those stages decreases. Consequently, the potential to maintaining and building tacit knowledge declines and the integrative effect that it can have disappears. From these arguments, we formulate the following prediction.

***Proposition 2:** Knowledge synergies across different vertical stages are more persistent and remain important over time, while the integrative effect of tacit knowledge decreases as firm members have increasingly less possibilities to learn from joint operations across different vertical stages.*

What we have argued so far is that knowledge similarities between an up- and downstream level may produce two channels through which it affects the scope of an organization. Conceptually, we distinguish between synergies that derive from economies of jointly using a common knowledge pool and advantages that derive from a situation, in which the joint use of a knowledge base implies the emergence of tacit knowledge about the operation of the two stages through learning by doing processes over time. Different implications derive from this conceptualization of knowledge. Pure synergies between two levels tend to generate persistent advantages and economies over a long time period but can potentially be disintegrated in different organizations with the trade-off to bear the occurring transaction costs. The advantages of tacit knowledge tend to diminish over time if the chances to learn across the stage decrease. If they are strong, however, they can produce strong

diseconomies of disintegration or even make disintegration not feasible in the short run. Our propositions suggest that tacit knowledge tends to play a less important role over time but can have a dominant influence in the short run on vertical integration and disintegration patterns, and therefore on the choice of governance forms and industry evolution.

Following from these two propositions, there are a number of organizational dynamics that unfold when the effects from knowledge synergies and tacit knowledge are effective and interact. We develop a set of hypotheses that consider these interactions and particularly the role of tacit knowledge. Specifically, we argue that the dynamics of integration and disintegration change if the relevant knowledge spanning across two vertical levels is tacit.

Vertical scope and the dynamics of industries

As presented above, one main argument in prior research on capabilities, vertical scope and industry evolution is that changes in the vertical scope of firms and industries depend on the extent of knowledge similarities across different levels of the value chain (Jacobides 2005; Jacobides and Hitt 2005; Jacobides and Winter 2005). Precisely, if knowledge and capabilities are similar across two different vertical levels, firm organizations tend to integrate the two levels. The reason behind this argument is that similarities in knowledge pools are less prone to drive specialization activities. Specialization is more likely if knowledge is dissimilar across vertical stages. Then, intra-firm partitioning and inter-firm co-specialization may produce functional and organizational separation pattern, which lead – under certain circumstances – to disintegrating the previously single organizational units (Jacobides 2005).

In contrast, similar knowledge bases across vertical stages tend not to develop gains from intra-firm partitioning and trade between two co-specializing organizations. Rather another effect is more important. Knowledge similarities lead to the integration of two vertical levels in an organization taking advantage of building and accessing a joint knowledge pool. Using the same knowledge pool creates economies in using the knowledge, and therefore results in synergies. Such synergies strengthen the integration along the value chain. Therefore, knowledge similarities have an integrative effect.

If the knowledge across two vertical stages is tacit – in addition of being similar – this characteristic does not operate against the integrative dynamics potentially deriving from synergies and low incentives of exploiting gains of specialization. In fact, tacit knowledge facilitates the integrative dynamics further in the same direction. Tacit knowledge increases the effect. Thus, as strong tacit knowledge cannot be broken up (cf. prediction 1), its existence supports the integration of vertical stages if the knowledge base is similar for both levels. From these arguments, we derive two hypotheses.

***Hypothesis 1a:** If the knowledge bases of which competences are built in an up- and downstream level are similar, then there is a strong integrative effect because there are little gains from specialization and substantial effects from exploiting synergies by jointly accessing the knowledge.*

***Hypothesis 1b:** If the knowledge bases of which competences are built in an up- and downstream level are similar, then the existence of tacit knowledge further strengthens the integrative effect of non-separability deriving from knowledge similarities.*

If the knowledge base is not similar across two vertical stages, partitioning and co-specialization potentials tend to be effective (Jacobides 2005; Jacobides and Winter 2005). Furthermore, synergies are hardly to emerge if knowledge is dissimilar. This leads to processes of vertical disintegration.

However, if operating the two vertical stages involves strong tacit knowledge, the stages tend not to be able to be broken up or only by incurring high costs (cf. proposition 1). The situation of two vertical stages having dissimilar knowledge is the case, when knowledge across stages is complementary. Business tasks with complementary, i.e. dissimilar knowledge, often require from those that pursue these tasks an intimate, i.e. tacit, understanding of the operations at both stages. If so, then the existence of substantial tacit knowledge supports the direction of integration. This is in contrast to the prior literature that would have predicted that dissimilar knowledge across vertical stages results in processes of vertical disintegration. Considering tacit knowledge changes the

predicted disintegrative effect into the opposite direction. It provides therefore an explanation for an additional mechanism that shapes the dynamics of vertical scope in an organization and industry evolution.

***Hypothesis 2a:** If the knowledge bases of which competences are built in an up- and downstream level are dissimilar, then there is a disintegrative effect because gains from specialization are effective and no synergies are exploitable across the stages.*

***Hypothesis 2b:** If the knowledge bases of which competences are built in an up- and downstream level are dissimilar, then the existence of tacit knowledge counteracts the disintegrative effects from gains of specialization and tends to have an integrative effect.*

Following proposition 2, the potential effect of tacit knowledge might be short-term. If latent gains from specialization processes (intra-firm partitioning and inter-firm co-specialization) unfold partly, the effect of tacitness becomes weaker. This is because with an increasing specialization decreases the number of possibilities for joint learning interactions. Thus, the effect of tacit knowledge tends to dissolve over time and gets less effective. Forces to disintegration gain increasingly momentum. At a certain point in time, they outweigh the tacit knowledge induced effect of integration. Nevertheless, the existence of tacit knowledge has a substantial influence on the dynamics in such an organizational and industrial environment, namely it prolongs the process until disintegration forces dominate and the separation of vertical stages takes place and new markets emerge along the value chain.

***Hypothesis 3:** If the knowledge bases of an up- and downstream level are dissimilar, the integrative effect of strong tacit knowledge declines over time but it prolongs the process of specialization and therefore defers vertical disintegration.*

In sum, we argue in hypothesis 1 that tacit knowledge intensifies the integrative effect of knowledge similarities as predicted in the prior literature, namely the stronger the degree of tacit

knowledge the more likely it is that specialization patterns do not emerge. In contrast to prior literature, we argue in hypothesis 2 that the tacit knowledge works against the predicted effect. The existence of tacit knowledge tends to be a strong force that counteracts general predictions for more disintegration if knowledge between two stages is dissimilar. At least in the short-run, the integrative forces of tacit knowledge may hinder the vertical disintegration at an organizational level, as we argue in hypothesis 3. Therefore, it can have a substantial impact on the patterns of organizational structure and industry evolution.

More generally, we suggest an approach to conceptually connect knowledge characteristics with modes of organizational governance. In doing so, we build on prior work on the dynamics of vertical scope and industrial evolution but are more explicit in distinguishing two dimensions of knowledge characteristics, namely similarities and tacitness. We then assess the different effects that knowledge similarities and tacitness have on vertical scope in organizations. From these findings on the dynamics of vertical scope, we can infer some implications for the governance of organizations, and how the modes of governance align to the characteristics of knowledge (see table 2).

Insert table 2 about here

Precisely, we can argue that if there are strong knowledge similarities across an up- and downstream level in an organization, we expect integration to be a dominant organizational setting. If, in addition, the operations at the up- and downstream levels are connected through tacit knowledge, the integrative effect tends to be even stronger (see table 2). Integration is then a superior governance mode as it allows the firm to gain and maintain competitive advantage through exploiting knowledge synergies and, most importantly, using tacit knowledge in accomplishing the operations. An attempt to break up the two levels may result in the loss of these advantages.

Putting these results into the perspective of the resource-based view, high similarities and high tacit knowledge in operating two vertically integrated stages creates an advantage through the

combination of knowledge and resources. It would infer high costs – if not impossible – to appropriate the same advantage, if the firm is disintegrated and therefore unable to exploit the specific knowledge combination. The implication for organizational theory is that arguments informed by the resource-based view provide an important explanation for pursuing business activities in an integrated organizational form. Therefore, the resource-based perspective contributes to answering the make-or-buy decision in addition to transaction cost arguments.

The resource-based view reasoning applies similarly in the other synergy-tacit knowledge combinations in table 2. If similarities are high but tacit knowledge low, then there tend to be an integrative effect deriving from exploiting synergies by jointly accessing a knowledge pool with no or a limited additional effect from tacit knowledge on vertical scope. Thus, organizing economic activities inside the firm organizations tend to be preferred over market transactions and other governance forms.

In the case of low similarities and high tacit knowledge, synergies are not effective and the potential to exploit gains from specialization are increasing. Consequently, disintegrative forces tend to be high but are counteracted by the integrative effect of strong tacitness between an up- and downstream level. The organizational implications are that business activities tend to be accomplished in an organizational setting rather than through market transactions. However, as the effect of tacitness may decrease over time (cf. hypothesis 3), the disintegrative may outweigh the integrative effect and organizations may subsequently outsource specific activities and get more and more disintegrated.

Alternatively to a slowed down shift from organizational hierarchy to market transactions, the combination of low similarities but high tacit knowledge may also explain the existence of hybrid organizations from a resource-based perspective. The existence of low similarities between the knowledge at two vertical stages does not necessarily mean that the knowledge is not complementary. If the knowledge is complementary, then it tends to be dissimilar. Therefore, there is not a strong force to create a knowledge pool. Gains of specialization may be rather effective. Nevertheless, using the complementary knowledge together and jointly operating an up- and downstream level, tacit knowledge may emerge and become a substantial source of competitive advantage. Thus, one

organizational setting, in which specialization is possible and at the same time exploiting close interactions, is for example a network or a close cooperation between organizations, which are modes of governance between the organizational hierarchy and market transactions.

Following these arguments, a resource-based view and most importantly the explicit consideration of tacit knowledge can explain how in the presence of knowledge dissimilarities, which would predict disintegration, there are different types of disintegration pattern. One is a slow but substantial shift from accomplishing business activities in an organization toward more market transactions by specialization and subsequent outsourcing. The other one is the emergence of networks and close cooperation among firms that do not have knowledge similarities but complementarities and tend to gain advantages through interaction and mutual learning.

In the case that both the similarities and the tacit knowledge are low across an up- and downstream stage, disintegrative forces tend to be strongest. That is because possibilities to build a joint knowledge pool for exploiting synergies is limited. And without tacit knowledge between two vertical levels, there is also no force counteracting disintegration. Under these conditions, potential gains from specialization tend to unfold most effectively. The organizational implications are that specialized organizations emerge with no reasons to develop specific relationships to other firms because such relations would not create potential competitive advantages through tacit knowledge. Thus, specialization and disintegration result in market transactions to be the superior governance mode to accomplish specific business activities.

As seen in table 2, the influence of knowledge similarities on the governance mode in organizations is a strong factor. If similarities are high, potential advantages from exploring synergies exist. Therefore, there tend to be an integrative effect. Disintegrative dynamics tend to dominate, if the synergies are low. However, we suggest that the introduction of another central dimension of knowledge characteristics, namely whether it is tacit, is an important extension of the prior literature. Tacit knowledge plays a crucial role in moderating the effect from knowledge similarities and corresponding synergies. Tacit knowledge intensifies the integrative effect, if tacitness is high. And it may counteract – and may even foreclose – vertical disintegration, if synergies are low but tacitness substantial. From a resource-based perspective, tacit knowledge may be one central link to explain the

emergence of those governance modes that are between hierarchy and markets such as networks and close collaborations. This is because knowledge may be dissimilar enough to profit from gains of specialization causing organizations to disintegrate but tacit knowledge could be a source for generating competitive advantage by jointly learning from the use of complementary knowledge, which leads to interactions that are not pure market transactions.

AN APPLICATION TO REGULATED INDUSTRIES: THE IMPLICATIONS OF TACIT KNOWLEDGE ON VERTICAL SCOPE IN INFRASTRUCTURE SECTORS

In this section, we consider the influence of regulatory regimes on the vertical scope in infrastructure sectors. Regulatory frameworks are often explicit about the extent of vertical integration. One central implication of regulations is that they, for different reasons, change the dynamics of integration and disintegration that would occur due to the processes described in the previous section. The aim in this section is to analyze the influence of regulatory institutions on organizational governance, given the particular characteristic of knowledge across vertical stages. We derive some insights how regulatory policies have to consider knowledge characteristics across vertical stages and align their frameworks accordingly, so that the emerging organizational settings ensure adequate operations.

The extent of vertical scope is a controversially debated issue in infrastructure sectors. This is because the physical networks are natural monopolies and the implications of this feature are ambiguous. Some argue that business activities at all levels except for the transmission stage work as other markets in non-infrastructure industries. Consequently, the physical transmission networks should be the only concern for regulatory policies. All other stages could be liberalized and operate as competitive markets. Others argue that the strong interdependencies between the stages and the critical role that infrastructure services play in general for the welfare in an economy require strong regulatory oversight for the entire sector.

As a result of the wide range of perspectives on the adequate regulatory framework, the implemented regulations vary substantially between countries but also across different network

industries within the same national context. To systematically capture the broad variation, we distinguish three regulatory approaches that mainly span the continuum regarding policies toward vertical integration. First, a regulatory regime can require that utilities operate as fully integrated units in a given regional or national context. Second, a more liberal regulatory framework could allow competition at one or more specific stages. Finally, a regulatory regime may be open to liberalize the entire industry but enforces the separation and independent operation of one specific stage. The latter is typically the case in infrastructure sectors, in which regulatory institutions often require to separate the transmission stage from other operations to avoid distortions in the accessibility to the network. The third regulatory regime may, however, also be relevant in anti-trust situations in non-infrastructure industries but mostly important in network industries.

In the following, we theoretically examine the impact of tacit knowledge on the dynamics of vertical scope under the three different regulatory regimes. The analysis begins by assuming for the first two regulatory cases that the knowledge across vertical stages shows strong similarities. In a second step, we assess then for each of the two cases separately what implications follow if the knowledge bases are dissimilar. Finally, we analyze for the third regulatory regime, which requires the separation of one specific stage, the situation of similar and dissimilar knowledge bases. After each step and as a result of these analyses, we discuss the institutional implications of the derived insights.

Consistent to the prior literature and arguments above, if there is similar knowledge across different stages, then strong forces exist to integrate vertically. This is not the case for the third regulatory regime, which requires vertical separation. In the other two cases, however, the prediction would be that similar knowledge bases tend to result in vertical integration. The extent of tacit knowledge, i.e. whether it is strong or weak, affects this dynamic toward vertical integration positively because the effect of tacitness is integrative and goes therefore in the same direction.

Hypothesis 4: *Given a regulatory regime that enforces vertically integrated utilities, or allows competition at one or more vertical stages, then gains from exploiting synergies and, if existent, tacit*

knowledge tend to have a joint effect toward integration, if the knowledge is similar between the stages.

This hypothesis implies a somewhat surprising insight. The existence of similar knowledge across two vertical stages tends to facilitate vertical integration independent of the regulatory regime. In other words, whether a regulatory regime requires a fully integrated organization or liberalizes the market seems to be irrelevant. If there are strong knowledge similarities, a superior governance mode is the coordination of the business activities inside the utility. If, in addition, the knowledge across stages is also tacit, the integration is further facilitated. This situation is indicated in table 3 with yellow boxes.

The institutional implications are that strong similar and tacit knowledge support the intention of a regulatory regime that enforces vertical integration. However, it counteracts the intentions of a regulatory regime that aims to introduce more competition. Even under a regulatory regime that enables competition, there is a trend toward strong monopolistic forces in the industry. This shows that the knowledge characteristics across vertical stages in a sector are not necessarily consist with every regulatory framework. An adequate framework needs to be aligned with the historically emerged knowledge structures. This, in turn, may require addressing different regulatory issues.

Insert table 3 about here

In the following, we analyze the cases if knowledge is dissimilar across two vertical stages. This would predict disintegration processes. We show that strong tacit knowledge changes some of the predicted dynamics depending on the context of the regulatory environment.

First, a fully integrated utility may experience intra-firm partitioning. But there would be no inter-firm co-specialization processes because of the regulatory regime that requires operating an integrated utility as a sole service provider in the defined region. So, even if forces of intra-firm

partitioning are strong, vertical disintegration is not feasible under this regulation regime. Consequently, markets along the value chain would not emerge. While the prior literature predicts that vertical disintegration happens when the knowledge across different vertical levels is dissimilar, we argue that given the specific regulatory environment – which is particularly relevant in infrastructure sectors – vertical disintegration and the emergence of new markets do not occur. This prediction is not very surprising as integration is basically driven by the requirements of the regulatory regime rather than through the pattern of knowledge distribution across stages. However, if there exist strong tacit knowledge between an up- and downstream stage, this would have an integrative effect. The existence of tacit knowledge therefore works in the direction of the regulatory framework and tends to operate opposite to potential forces of intra-firm partitioning due to knowledge dissimilarities.

***Hypothesis 5:** Given a regulatory regime that enforces vertically integrated utilities, tacit knowledge tends to have an integrative effect, even if there are some enfolding processes of intra-firm partitioning, if the knowledge is dissimilar between the stages.*

Dissimilar knowledge across vertical stages in a regulatory environment that enforces vertical integration generates coordination problems at the organizational level. Dissimilar knowledge facilitates disintegrative dynamics. Processes of intra-firm partitioning may become increasingly effective. If regulations does not allow specialization and disintegration, these dividing forces has to be handled inside the firm. As a result, coordination problems may occur. The organizational implication is that companies have to expand their coordinative effort to operate as a consistent organization. Constellations, in which integration is required despite the existence of disintegrative forces, are indicated green in table 3.

Since the regulatory environment enforces vertical integration, tacit knowledge can counteract the predicted vertical disintegration, and may even outweigh the effect. This is because under the given regulatory regime that does not allow organizational separation, there is more time to intensify

learning processes across stages and little effect from enfolding disintegrative processes that could diminish the effect of tacit knowledge.

***Hypothesis 6:** Given a regulatory regime that enforces vertically integrated utilities, tacit knowledge tends to increase the integrative effect over time.*

The organizational implications are that tacit knowledge moderates the disintegrative effect. Therefore, it also mitigates to a certain extent the potential problems of an organizational governance regime to address disintegrative forces. Over time, tacitness is reinforced and may diminish coordinative issues even further.

Second, utilities in a regulatory regime that allows competition at one or more specific stages may experience strong intra-firm partitioning. That is because the potential of other competitors entering the market forces a utility to specifically build and acquire competences and capabilities at these stages. This potentially increases the heterogeneity along the value chain. More importantly, if there are economies of scale to exploit – even if they are only moderate – the introduction of competition at a specific stage may trigger a process in which utilities attempt to grow fast at this stage. Growth tends to drive the specialization of capabilities along the value chain and intra-firm partitioning. Consequently, introducing competition in one vertical stage promotes the intra-firm partitioning and therefore potentially the disintegration of utilities and the emergence of markets at this stage. Economies of scale may further drive this process.

In addition, utilities in this regulatory setting may also see advantages in the potential for co-specialization between firms and profit from gains of trade. If there is competition in at least two stages of the value chain, the prior literature on specialization predicts that the co-specialization is a driving force for vertical disintegration and the emergence of markets. If economies of scale are effective, both processes the intra-firm partitioning and inter-firm co-specialization tend to be even more relevant because it fosters the process of specialization.

Tacit knowledge reduces the effect of intra-firm partitioning and inter-firm co-specialization. Following prediction 1, strong tacit knowledge between stages tends to threaten adequate operations,

when they are disintegrated. If tacit knowledge is effective between one of the vertical stages that is subject to competition and an up- or downstream stage, then it counteracts the disintegrative forces deriving from intra-firm partitioning and inter-firm co-specialization.

***Hypothesis 7:** Given a regulatory regime that allows competition at different vertical stages, tacit knowledge counteracts the forces from intra-firm partitioning and inter-firm co-specialization and tends to have an integrative effect, if knowledge is dissimilar between the stages.*

Following proposition 2, we predict that the moderating effect of tacit knowledge diminish over time. This is because integration is not a regulatory condition in this regime. As integration is not required for organizations, learning processes cannot occur that would reinforce tacit knowledge to emerge.

***Hypothesis 8:** Given a regulatory regime that allows competition at different vertical stages, effects from intra-firm partitioning and interfirm co-specialization dominate effects from tacit knowledge over time resulting in vertical disintegration and the emergence of markets, if the knowledge is dissimilar between the stages.*

The implication of this hypothesis for the organization is that disintegration dynamics tend to operate more forcefully as intra-firm partitioning and inter-firm co-specialization becomes effective in a competitive environment. The conditions, under which we expect disintegrative forces to be dominant, are marked in blue in table 3.

Finally, utilities in a regulatory regime that forces the separation of a specific stage exhibit different dynamics as in the other regulation settings above. If the knowledge between the required-to-be-separated stage and an up- or downward stage is similar, we would expect pure synergies to be effective with integrative forces being substantial. This effect would be amplified if there is strong tacit knowledge between this and the neighboring stages.

Hypothesis 9: *Given a regulatory regime that enforces the separation of one specific stage and if knowledge is similar between this and the up- and downstream level, synergies between the stages counteracts the vertical disintegration with strong tacit knowledge reinforcing this integrative effect further.*

Fundamental issues may occur for organizations in this setting in providing adequate services. If a regulatory regime requires disintegration despite the existence of strong integrative forces due to knowledge similarities and/or tacit knowledge, the adequate operation of the utilities may be threatened (cf. proposition 1). This situation is marked orange in table 3. To ensure service provision in a situation with similar and tacit knowledge, but in which the regulation regime enforces the separation of one specific stage, one important implication is that institutional measures are required to actively manage the disintegration process and lead over to a disintegrated utility.

If the knowledge between this stage and an up- or downward level is dissimilar, separation would be expected to be less problematic. This is because pure synergies from using the same knowledge pool are limited. Consequently, integrative forces are less pronounced. However, if there is substantial tacit knowledge, integrative forces emerge and may substantially work against vertical disintegration as imposed by the regulatory setting.

Hypothesis 10: *Given a regulatory regime that enforces the separation of one specific stage and if knowledge is dissimilar between this and the up- and downstream level, strong tacit knowledge counteracts the regulatory enforced vertical disintegration and tends to have an integrative effect.*

If knowledge is dissimilar, separation would be expected not to be a major issue. The regulatory regime requires the separation of a specific vertical level from other operations along the value chain. In fact, a disintegrative force expected from dissimilar knowledge and separation dynamics tend to have an effect in the same direction as the regulatory regime intends. However, if there is substantial tacit knowledge effective between vertical stages, it counteracts the disintegrative effect. Then, it may even be unfeasible to separate the two stages without threatening the operation

altogether. Whether tacit knowledge have this effect and therefore would be problematic regarding the intended regulatory purpose, depends on whether it is strong enough to outweigh the disintegrative effects deriving from dissimilar knowledge. If tacit knowledge moderates the disintegrative forces, this effect diminishes over time. This is because the regulatory regime requires separation. Therefore, opportunities for learning processes through joint operations to occur are limited.

CONCLUSIONS

The aim of this paper is twofold. First, we extend existing approaches to explain vertical scope by introducing tacit knowledge as an important factor shaping processes of integration and disintegration. Considering the impact of tacit knowledge in interaction with knowledge similarities across vertical stages, we provide a resource-based view argument for the emergence of different governance modes. With this approach, we are able to better understand how conventional organizational forms emerge, i.e. markets and firm hierarchies as predicted in organizational economics. Most importantly, we also explain why firms – under specific conditions – prefer different governance modes such as close cooperation with other companies and the integration in networks and alliances. We identify specific knowledge characteristics across vertical stages as a crucial driver for these governance forms to emerge.

Second, we apply this framework in the context of regulated industries. Distinguishing between three types of regulatory regimes, we assess the impact of knowledge similarities and tacit knowledge on vertical integration and disintegration in regulated sectors. Our findings suggest that knowledge similarities and tacitness generate integrative and disintegrative forces that may be in conflict with the established regulatory framework. The analysis shows that problems occur if the interactions between knowledge characteristics, organizational forms and the regulatory institutions are not taken into account. Then, we examine and derive implications on some managerial and regulatory issues, and how to address them.

More generally, we contribute with this paper to current discussions in the literature on both, explaining the emergence of different governance forms from a resource-based perspective and understanding issues of integration and disintegration in regulated industries. Conceptually, the paper

attempts to make a step forward to the integration of organizational economics and capability approaches. Further research may empirically examine these processes in more detail.

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TABLES

	Transaction cost economics	Resource- and knowledge-based approaches		
		Resource-based view	Knowledge specialization approach	Knowledge interaction approach
Drivers of change	Changing transaction costs if characteristics of transactional relation change (uncertainty, specificity, frequency)	Accessing critical resources, assets, competences outside the firm	Unequal distribution of knowledge and capabilities along the value chain: a) Gains from knowledge specialization within a firm; b) Gains from trade from knowledge specialization across firms	Interaction of knowledge characteristics (similarities and tacitness) across vertical stages: a) Knowledge similarities; b) Knowledge specialization processes c) Tacit knowledge across stages
Process	Adjustment to optimal firm size	Acquiring critical resources	a) Intra-firm partitioning; b) Inter-firm co-specialization	a) Synergies & economies of using a joint knowledge pool; b) Intra-firm partitioning & inter-firm co-specialization; c) Learning builds individual and group level tacit knowledge
Organizational implications	Markets (disintegration) vs. hierarchies (integration) as decision to minimize TC	Integration to access complementary resources	Disintegration through knowledge specialization processes and the emergence of markets	a) Integrative effect; b) Disintegrative effect; c) Integrative effect; may decay over time
Literature	Williamson 1975, 1979, 1985; Klein et al. 1978; Baker and Hubbard 2003; Hubbard 2003	Argyres 1996; Barney 1999; Leiblein and Miller 2003	Jacobides 2005; Jacobides and Hitt 2005	Section 3 of this paper

Extensions toward approaches integrating transaction cost and resource/knowledge-based arguments	Hybrid governance forms between markets and hierarchies	Market uncertainties result in integration to mitigate costs of transferring capabilities	Interactions between transaction costs and capabilities co-evolve	Knowledge-based reasoning to explain the emergence of hybrid governance forms
Literature	Ménard 2004	Langlois 1988, 1992; Langlois and Foss 1999	Jacobides and Winter 2005	Section 3 of this paper

Table 1: Approaches on explaining processes of vertical integration and disintegration

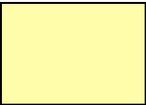
		Tacit knowledge	
		High	Low
Similarities	High	Strong integrative effect (Hypothesis 1a & 1b) Implications for governance: Organization	Integrative effect (Hypothesis 1b) Implications for governance: Organization
	Low	Integrative effect initially with disintegrative effect gaining importance over time (Hypothesis 2b & 3) Implications for governance: 1.) Subsequent outsourcing with market transaction becoming more relevant 2.) Networks, cooperation	Disintegrative effect (Hypothesis 2a) Implications for governance: Market transactions

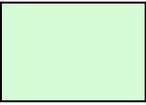
Table 2: Interactions of knowledge characteristics and the implications for emerging governance forms

Intended aim of the regulatory regime	Similar knowledge		Dissimilar knowledge	
	Effect from strong synergies <i>without</i> existence of tacit knowledge	Effect from strong synergies and <i>with</i> existence of tacit knowledge	Effects from specialization <i>without</i> existence of tacit knowledge	Effects from specialization <i>with</i> existence of tacit knowledge
Full integration	Integration	Integration is further facilitated	Disintegrative forces exist (but regulations require integration)	Disintegrative forces exist initially (tacit knowledge moderates these forces and is reinforced over time)
Competition at one or more stages	Integration	Integration is further facilitated	Disintegration	Disintegrative forces are persistent (tacit knowledge moderates disintegrative forces initially but diminishes over time)
Separation of one specific stage	Integrative forces exist (but regulations require disintegration)	Integrative forces further facilitated (but regulations require disintegration)	Disintegration	Disintegrative forces are persistent and tacit knowledge moderates disintegrative forces initially (but regulations require disintegration and therefore tacit knowledge diminishes over time)

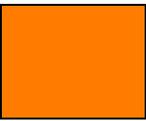
Table 3: The implications of knowledge characteristics in different regulatory environments

Organizational implications:

- 
 Integration:
 - Trend toward strong monopolistic forces in the industry
 - Despite competition & potential for specialization -> Coordination inside the utility

- 
 Disintegrative forces but integration is required:
 - > intra-firm partitioning has to be handled inside the utility
 - > coordination problem

- 
 Disintegration:
 - Institutions that regularly assess the market emerging processes
 - If tacit knowledge dominates -> specialization effects (intra-firm partitioning and co-specialization) remain -> internal coordination problems

- 
 Integrative forces but disintegration required:
 - > may threatening adequate operation
 - > institutional settings require to actively manage the disintegration process and lead over to a disintegrated utility