Inter-Organizational Trust as a Shift Parameter in the Extended Transaction Cost Framework – A first Application to the LNG Industry

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Abstract
This paper provides an empirical analysis that examines the effect of both, transaction characteristics and the institutional environment on the choice of governance. Using a dataset of 237 corporate-specific value chains in the global LNG industry, we introduce inter-organizational trust as a shift parameter. First, following transaction cost economics (TCE), it is hypothesized that specific investments under uncertainty provide incentives to integrate vertically. Second, it is argued that inter-organizational trust changes the relative costs of vertical integration and non-integration and supports less hierarchical governance modes. These economic relationships are tested based on probit and ordered probit models. Estimation results provide broad support for TCE by showing that relationship-specific investments in an uncertain environment drive LNG companies to invest in successive stages along the value chain. The presence of inter-organizational trust increases the likelihood of less hierarchical governance modes. The consideration of a shift parameter further enhances the explanatory power of the model supporting the need for empirical studies accounting for both, transaction cost variables as well as variables capturing dynamics in the institutional environment.

JEL-Codes: L22, D23, C35, L95

Keywords: transaction cost economics, shift parameter, inter-organizational trust, vertical integration, liquefied natural gas

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Acknowledgements: The author thanks participants of the ESNIE 2009 and Christian von Hirschhausen for helpful comments and suggestions. The usual disclaimer applies.
1 Introduction

Even though the huge body of empirical literature testing transaction cost economics’ (TCE) predictions has increased the understanding of post-contractual hold-up, TCE in its basic form is a static concept taking the institutional environment as given. This has been a major point of criticism in the New Institutional Economics (NIE) literature. Oliver Williamson himself introduced in 1991 an extension of the TCE model investigating how the optimal choice of governance changes in response to dynamics in the institutional environment; changes in exogenous parameters will shift the relative costs of alternative governance structures; hence, the influence of both, transaction characteristics and the institutional environment on governance choice should be analyzed (Williamson, 1991b).

TCE discusses post-contractual hazards under the assumption that the investing party faces an opportunistic counterpart with formal contractual arrangements and internal organization being the only possible safeguards against ex-post expropriation of quasi-rents. However, inter-organizational trust, a concept intensively studied in social sciences and psychology, can attenuate the incentives to behave opportunistically; immediate gains from opportunism must be traded off against future costs since unreliable behavior would be punished with respect to future exchange relationships. The presence of inter-organizational trust should enhance information exchange, support conflict resolution, and decrease transaction costs. Hence, trust reduces the need for hierarchical controls and should favor the choice of less hierarchical (i.e., more relational) governance modes.

The evolution of the institutional framework of downstream natural gas (and electricity) markets from monopolistic structures to competition has required fundamental changes in the organizational behavior of market participants. Functioning spot markets, contract flexibility, and increasing international trade place traditional players under intense pressure. Global mergers and acquisitions, vertical and horizontal integration, and strategic partnerships have become common practices. Many oil and natural gas producers and distributors are involved in all stages of the LNG value chain; thus, the global industry is now characterized by a small number of very large firms. In fact Jensen argued in 2004 that “super majors” would soon dominate the developing global LNG market. Nonetheless new players utilizing innovative strategies (downstream investment in a single stage of the value chain, merchant investment in liquefaction and regasification terminals, etc.), continue to enter the picture.

Empirical work testing Williamson’s shift parameter framework is rather scarce. Our contribution, therefore, is an empirical analysis that examines the effect of both, transaction characteristics and the institutional environment on the choice of governance. Using a dataset of 237 corporate-specific value chains in the global LNG industry, we introduce inter-organizational trust as a shift parameter. First, following TCE, it is hypothesized that specific investments under uncertainty provide incentives to integrate vertically. Second, it is argued that inter-organizational trust changes the relative costs of vertical integration and non-integration and supports less hierarchical governance modes.
These economic relationships are tested i) based on a probit model to explain the binary choice between vertical integration into midstream shipping and non-integration and ii) based on an ordered probit model to explain the degree of vertical integration (i.e., non-integration versus integration from upstream or downstream into midstream shipping versus integration along the whole value chain). Estimation results provide broad support for TCE by showing that relationship-specific investments in an uncertain environment drive LNG companies to invest in successive stages along the value chain. The presence of inter-organizational trust increases the likelihood of less hierarchical governance modes. The consideration of a shift parameter further enhances the explanatory power of the model supporting the need for empirical studies accounting for both, transaction cost variables as well as variables capturing dynamics in the institutional environment.

2 Literature review

Economic literature provides a number of theories explaining corporate behavior. Most empirical studies investigating motivations of internal organization use the TCE framework based on Coase (1937) and further developments thereof (Williamson, e.g. 1971, 1983; Klein et al., 1978). The main hypothesis is the importance of “align[ing] transactions, which differ in their attributes, with governance structures, which differ in their costs and competencies, in a discriminating (mainly, transaction cost economizing) way” (Williamson, 1991a, p. 79). TCE identifies asset specificity, uncertainty, and frequency of transactions as the most significant factors influencing transaction costs with the first being the strongest determinant of vertical integration. Relationship-specific investments result in bilateral dependency and in an uncertain environment with economic agents characterized by bounded rationality and opportunism in costly ex-post bargaining, ex-ante under-investment, and decreasing efficiency. Organizing transactions within a corporation’s own hierarchy by internalizing the appropriable quasi-rent avoids these problems. TCE came into prominence during the 1980s when early empirical work generally focused on manufacturing and the impact of investments in specific physical assets on corporate behavior. Subsequent research has emphasized the importance of human assets and applied the new findings to numerous industries.

However, even though the large body of empirical literature has increased our understanding of post-contractual hold-up, TCE in its basic form is a static concept that takes the institutional environment as given. This has been widely criticized in the NIE literature. Williamson (1991b) responded by introducing an extension of the TCE model to investigate how the optimal choice of governance changes in response to dynamics in the institutional environment. He treats the institutional environment as a set of parameters; changes in these parameters will shift the relative costs of alternative governance structures. The influence of both, transaction characteristics and the

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2 Davis and North (1971, pp. 6-7) define the institutional environment as “the set of fundamental political, social and legal ground rules that establishes the basis for production, exchange and distribution.”
institutional environment on governance choice are analyzed. As potential shift parameters Williamson discusses the stability of property rights, improvements in contract law, reputational effects in networks, and varying levels of uncertainty.

There is only a small number of empirical papers testing the shift parameter framework. The first application is Oxley (1999) who investigates the impact of intellectual property protection on the structure of inter-firm technology transfer alliances linking US and non-US firms. Finding support for TCE’s hypotheses she also shows that more hierarchical alliances (i.e., equity joint venture instead of a contractual alliance) are more likely in the presence of weak intellectual property protection. A strong protection of intellectual property is achieved only when property rights are easy to establish, interpreted broadly and strictly enforced (p. 287). Weak protection will result in an increased appropriability hazard and support the choice of more hierarchical governance modes. Oxley concludes that a “complete understanding of the structure of inter-firm alliances thus requires a combined focus on the institutional environment and mechanisms of governance” (p. 285).

Henisz and Williamson (1999) discuss the concept of shift parameters for national and multinational firms focusing on the impact of weak (respectively strong) property rights and on the stability of contract law on governance choice (e.g., partnership between the foreign and a host-country firm). They argue that within a single country, the choice is mainly determined by the attributes of the transaction. Comparing corporate behavior over time or across countries, a higher credibility of the institutional environment (i.e., secure property rights, stable contract law) will support complex transactions and governance forms. High political hazards should support partnering of multinational firms with host-country entities.

Gulati and Nickerson (2008) analyze the impact of inter-organizational trust as a shift parameter on governance choice and the performance of exchange relationships in the US auto industry using a survey of component buyers at Ford Motor Company and Chrysler Corporation. Estimation results of a three-stage switching regression model support transaction cost theory’s predictions. Further, the authors’ hypotheses of exogenous trust enhancing performance both directly and indirectly are confirmed. On the one hand, an increase in inter-organizational trust directly enhances firm performance; on the other hand, it shifts the likelihood of organizational choice from hierarchy to the market (i.e., a less expensive mode of governance is substituted for a more expensive one) and hence indirectly enhances firm performance.

We place ourselves in the continuation of this literature by analyzing corporate strategies in the global LNG industry, introducing inter-organizational trust as a shift parameter. Following TCE, it is hypothesized that specific investments under uncertainty provide incentives to integrate vertically. Furthermore, it is argued that inter-organizational trust changes the relative costs of vertical integration and non-integration and substitutes less hierarchical governance modes.
3 Theoretical background

3.1 Inter-personal and inter-organizational trust

The past decade has shown increased interest in investigating the sources and consequences of trust in economic exchanges. Recent literature encompasses research in the fields of social psychology, organizational theory, strategic management, business history, and economics. Traditional TCE argues that exchange relationships involving non-redeployable investments create ex-post bilateral dependency and vulnerability to opportunistic behavior, trust does not yield a reliable safeguard unlike formal modes of governance. On the contrary, trust is understood as an important mean to mitigate relational risks in the social science literature which argues that economic players may not always behave opportunistically. There is an emerging view that in the governance of exchange relationships noneconomic factors complement economic ones (see e.g., Zaheer and Venkatraman, 1995; Woolthuis et al. 2005, p. 816) argue that “…the assumption that actors have an intrinsic tendency to keep promises is as true as their likelihood to behave opportunistically.”

A narrow definition is called for when delineating the concept of trust from traditional economic terms. Zaheer et al. (1998, p. 143) define trust as “the expectation that an actor (1) can be relied on to fulfill obligations, (2) will behave in a predictable manner, and (3) will act and negotiate fairly when the possibility for opportunism is present.” In other words, trust is based on reliability, predictability, and fairness. Similar definitions appear in Woolthuis et al. (2005, p. 816), Gulati and Sytch (2008, p. 167), and Gulati and Nickerson (2008, p. 689). Dispositional trust reflecting expectations about the trustworthiness of others in general is distinguished from relational trust which is based on experience and interaction with a particular exchange partner (e.g., Zaheer et al., 1998; Gulati and Sytch, 2008). The focus of the following discussion is on the latter. Williamson (1993) distinguishes i) calculative trust (i.e., refers to a rational form of trust built upon reputation and can be understood in terms of risk); ii) personal trust (i.e., altruistic behavior not depending on calculations of self-interest but being motivated by benevolence); and iii) institutional trust (i.e., derives from social and organizational embeddedness). Partly in line with this last classification, Gulati and Nickerson (2005) discuss exogenous trust (i.e., arising out of past interactions) as opposed to endogenous trust (i.e., intrinsic to the governance mode).

Trust in its relational, or benevolent, form can be understood as an endogenous variable that is determined by the history of prior interactions between trading partners. For example, potential partners can jointly adjust the incentives to make trustworthy behavior an economically preferable option, select firms which engage in non-opportunist behavior, etc. Trust increases due to learning

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3 See Gulati and Sytch (2008) for a more detailed discussion of the recent contributions to theoretical and empirical literature. Gulati and Nickerson (2008, p. 690) provide a survey of empirical studies showing that trust in fact is an important element of market exchanges in various industries.
about the partner and his likely behavior as well as due to improved coordination processes among firms.

A trust relationship becomes particularly valuable in situations characterized by risk and uncertainty (mainly behavioral uncertainty). Higher levels of trust are related to reduced negotiation costs, lower levels of conflict and easier problem solving, superior information sharing, and high levels of cooperation. Negotiations are less costly in the presence of trust because agreements are reached more quickly and easily; trust mitigates information asymmetries by allowing more open sharing of information. When unforeseen contingencies arise, high levels of trust facilitate the development of a common understanding about the contingencies and how they might be resolved. The presence of trust reduces transaction costs by reducing or eliminating both ex-ante and ex-post opportunism. Indeed, a number of papers find that trust in inter-firm exchanges can even be a source of competitive advantage. Gulati and Nickerson (2005) discuss the central role of exogenous inter-organizational trust in both directly enhancing exchange performance and indirectly enhancing performance by supporting the use of less hierarchical (i.e., less costly) governance.

Whereas the early literature focused on inter-personal trust (relationships between individuals such as boundary spanners who handle and manage inter-organizational exchange), later studies explicitly delineate inter-organizational trust (relationships between entities). Zaheer et al. (1998, p. 141) point out that “a fundamental challenge in conceptualizing the role of trust in economic exchange is extending an inherently individual-level phenomenon to the organizational level of analysis. Not clearly specifying how trust translates from the individual to the organizational level leads to theoretical confusion about who is trusting whom.”

Gulati and Sytch (2008, p. 171) argue that there are at least two mechanisms that contribute to the development of inter-organizational trust from the history of interaction between individuals representing their entities (i.e., organizational boundary spanners): (1) emerging interpersonal trust between boundary spanners is likely to transform with time into organizational trust as the initially informal inter-personal commitments between individuals become routinized and institutionalized at the organizational level; and (2) the history of interaction between organizational boundary spanners can foster inter-organizational trust directly as those individuals are viewed first and foremost as occupants of constrained organizational roles; interaction between boundary spanners will reflect not just an inter-personal connection, but also an institutionalized role relationship. Zaheer et al. (1998, p. 144) argue similarly that the connection between inter-personal and inter-organizational trust is based on institutionalizing processes. Over time, repeated ties between two firms evolve into deeper, more stable cooperative arrangements; informal commitments made by individual boundary spanners become established as organizational structures and routines. Using data on exchange relationships between electrical equipment manufacturers and their component suppliers the authors confirm empirically the high correlation between inter-personal and inter-organizational trust as well as the negative impact of inter-organizational trust on the transaction costs of inter-firm exchange.
3.2 Trust versus formal contracts – complements or substitutes?

Empirical evidence about the relationship between trust and formal contracts is mixed (see e.g., Poppo and Zenger, 2002, pp. 711 ff.; Woolthuis et al., 2005, pp. 813 ff.). Gulati and Nickerson (2008) argue that trust and formal governance modes (i.e., hybrid modes as well as vertical integration) act simultaneously as both substitutes and complements. These and other researchers agree that trust can be understood as a substitute for formal contracts. If trust exists when firms enter an exchange relationship, it mitigates some of the contracting hazards associated with the exchange relationship which in turn results in a higher exchange performance since formal governance is substituted by less formal (i.e., less expensive) organizational forms. On the other hand, trust can also be understood as a complement for formal contracts. Trust reduces transaction costs and facilitates joint problem solving in cases where unexpected contingencies arise; hence, exchange performance will be superior when trust operates with formal contracts regardless of the chosen governance structure. The complementarity view in some cases is also interpreted as trust being a precondition for negotiating a complex contract; pre-existing trust may be necessary for the parties to be willing to invest in the relationship.\(^4\)

Poppo and Zenger (2002) find empirical evidence for the complementarity of formal contracts and relational governance in the outsourcing of information services; both also had a positive impact on exchange performance. Woolthuis et al. (2005) investigate the relationship of trust and formal contracts based on case study analyses. Trust can successfully substitute for contracts (i.e., a very incomplete contract is accompanied by high inter-organizational trust which results in a successful relationship), or trust and formal contracts may be complements in the sense that trust is understood as a precondition for contract negotiations. Gulati and Nickerson (2008) confirm empirically the simultaneity of trust inducing a substitution effect on the optimal choice of governance mode and the complementarity effect of trust lowering the governance costs of all modes of organization whenever exchange hazards are present. They furthermore find that exchange relationships involving inter-organizational trust are more successful than those strongly exposed to opportunistic behavior.

3.3 Formalization of the shift parameter framework

Classical TCE studies economic organizations from a comparative point of view; the choice of the optimal governance mode is determined based on transaction cost economizing. Williamson (1991b) introduced an extension of the basic TCE model investigating how the optimal choice of governance changes in response to dynamics in the institutional environment; changes in exogenous parameters will shift the relative costs of alternative governance structures.

Governance costs for market organization \((M)\) or internal organization \((H)\) increase with the level of investments in specific assets \((s)\). Internal organization involves higher bureaucratic costs as well as

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\(^4\) An alternative view comes from social science. Contracts may also signal distrust and the active use of a contract may evoke conflict.
lower internal incentives; hence \( M(0) < H(0) \). Whereas the market supports autonomous adaptation to unpredictable events, internal organization supports coordinated adaptation which becomes relevant in the presence of bilateral dependency (i.e., relationship-specific investments); hence \( \delta M(s)/\delta s > \delta H(s)/\delta s > 0 \). Hybrid governance modes \((L)\) are located between market and hierarchy with respect to incentives, adaptability, and bureaucratic costs; hence \( M(0) < L(0) < H(0) \) and \( \delta M(s)/\delta s > \delta L(s)/\delta s > \delta H(s)/\delta s > 0 \).

The purpose of this paper is to consider how the equilibrium of optimal governance choice will change in response to disturbances in the institutional environment. Changes in exogenous parameters, or shift parameters, will have a disproportional impact on the costs of different modes of organization. They may shift the cost curves via changes in the intercepts and/or slopes and may be relevant for one or more of the alternative modes of governance.

In analyzing the optimal governance of technology transfer alliances linking US and non-US firms, Oxley (1999) hypothesizes that weaker intellectual property protection increases the costs of contracting relative to the costs of equity joint ventures; the intercept of the contracting cost curve increases which results in a shift of the critical level of appropriability hazards to the left-hand side, i.e., more hierarchical governance becomes more likely. Henisz and Williamson (1999) discuss the impact of property rights and contract law on governance choice; since vertical integration supports internal conflict settlement, changes in contract law will influence only market exchange and hybrid governance modes. A change in contract law that improves the quality of enforcement will therefore reduce the governance costs of market and hybrid contracting as compared to hierarchy; the intercepts of their governance cost curves decrease; less hierarchical governance modes become more likely. Williamson (1991b) discusses property rights protection as a possible shift parameter; the fear of expropriation by the government and/or expropriation by rivals, suppliers, or customers distorts ex-ante incentives to invest and motivates ex-post safeguards via protective (hierarchical) governance structures. The governance cost curves for market exchange and hybrid modes will shift upwards with decreasing stability of property rights. Further, he argues that improved reputation in a network will attenuate incentives to behave opportunistically since the immediate gains from opportunistic behavior must be traded-off against future costs. The governance cost curves for market and hybrid governance forms will decrease favoring less hierarchical governance modes. See the Appendix for graphical illustrations of these applications of the shift parameter framework.

The following discussion focuses on inter-organizational trust as a shift parameter, in particular, trust engendered by past interactions between the same trading partners. Prior empirical work finds that the presence of inter-organizational trust reduces transaction costs in the sense of lowering (re-) negotiation costs, facilitating adaptation, information exchange and joint problem-. In the presence of relationship-specific investments, inter-organizational trust will decrease the probability and/or extent of post-contractual opportunistic behavior by the non-investing party; exchange partners are more
likely to avoid disputes or to resolve them quickly. Looking at market exchange, trust will have no
effect on the governance cost curve when exchange hazards are absent, but otherwise will shift the
curve downward. The impact of trust on the governance costs of hybrid modes of organization is very
similar. However, the decrease will be less significant than for market exchange since complex
contracting may limit the effectiveness of trust and may even dissipate it. Finally, we argue, as do
Gulati and Nickerson (2008), that trust is important in hierarchical exchanges as well. Internal
disputes between divisions should arise less frequently, and should they occur they will more often be
resolved by the partners themselves without recourse to other authorities. The decrease in governance
costs will be lower than for hybrid modes since high levels of bureaucracy and administrative controls
limit the ability of exchange partners to make adaptations and agreements independently. In summary,
pre-existing inter-organizational trust should enhance exchange performance independent of the
chosen organizational structure (with this effect being the higher the less hierarchical the respective
governance mode) and result in the substitution of less formal governance modes. As the level of
specific investments deepens, the cost of opportunistic behavior as well as the benefits from
mechanisms that reduce the likelihood of such behavior will increase.

Figure 1: Inter-organizational trust as a shift parameter

![Diagram](image)

Source: Own depiction

Figure 1 illustrates Williamson’s shift parameter framework applied to the binary decision about
whether to integrate vertically (VI), or to use less hierarchical governance modes (non-integration, or
NI). In the absence of pre-existing trust, the choice of the optimal (transaction cost economizing)
governance form implies using non-integration for $s < s^*$ and internal organization otherwise. The
presence of inter-organizational trust ($t$) will decrease the probability and extent of post-contractual
opportunistic behavior and reduce governance costs in the presence of asset specific investments:
\( NI(0,t) = NI(0) \) and \( VI(0,t) = VI(0) \) and the slope of the governance cost curves flatten with \( \delta NI(s,t)/\delta t < \delta VI(s,t)/\delta t < 0 \) for all \( s > 0 \) if \( t > 0 \). The critical value of asset specificity shifts from \( s^* \) to \( s^{*'} \) with \( s^* < s^{*'} \); the likelihood of organizing a transaction within one’s own hierarchy therefore should decrease with an increase in the level of inter-organizational trust.

### 3.4 Industry-specific propositions

To investigate the LNG industry from an economic as well as from a strategic perspective, the five stages of the value chain should be considered together. In general, the structure of export or import projects is largely predetermined by exogenous factors and therefore lies beyond the control of individual players. Exploration and production of natural gas is directly linked to the liquefaction projects whose ownership structures in many cases are determined by national oil and gas companies. On the downstream end, national infrastructure, marketing, and distribution systems are often in place before import terminal construction. Therefore, this analysis concentrates on the three successive stages, upstream, midstream, and downstream, as shown in Figure 2.

**Figure 2: LNG value chain**

Firms may specialize in one, two, or all three of these segments. First, a number of players integrate along several stages of the value chain (e.g., British Gas will control the whole value chain for deliveries from Idku/Egypt to Brindisi/Italy which is expected to start operation in 2010; GdF Suez owns a fleet of LNG vessels used to transport natural gas amongst other from Algeria to France). Second, there are companies investing in a portfolio of export and import positions, thereby focusing a strategy of both vertical and horizontal integration (e.g., ExxonMobil has interests in liquefaction facilities in Qatar [10% in Qatargas I, 30% in Qatargas II, 26.5% in RasGas I and II] as well as in Indonesia [30% in Arun]; at the same time the company holds import capacities in South Hook/UK and Rovigo/Italy and recently started investments in Golden Pass/US). Strategic partnerships and joint ventures here play an important role. Third, a number of new non-integrated players have entered the LNG market during the last decade (e.g., Cheniere Energy has invested in two regasification terminals on the US Gulf coast and has two additional projects on the drawing board; Excelerate Energy operates offshore on-board regasification facilities in the US and the UK). However, we also observe varying strategies of different companies which are active in similar stages of the value chain, and one and the same company choosing different positions along alternative value
chains. Several authors have provided perspectives on the emerging corporate strategies employed in the LNG sector. Cornot-Gandolphe (2005) and Iniss (2004) indicate that long-term contracts are increasingly accompanied by flexible short-term agreements as well as vertical integration and strategic partnerships. Nissen (2006) identifies a new business model, the so-called ‘commercial LNG’ which is characterized by unbundling of transportation assets to enable flexible trade.

The definition of asset specificity in the LNG industry is not straightforward. According to Nissen (2007, p. 5), asset specificity is “a property of the transportation links, created by the terms of physical and commercial access [to shipping capacities].” In particular, the midstream element of the value chain is of crucial importance in an industry with a relatively illiquid shipping market. Post-contractual opportunism by the counterparty may be hazardous for parties without shipping control, in other words, ex-ship/cif buyers and free-on-board sellers. However, the natural gas market is a sellers’ market; the accompanying restructuring and liberalization of downstream natural gas (and electricity) markets results in downstream physical asset specificity. A player investing in regasification capacity without having secured supplies and access to midstream shipping can be caught in a lock-in situation. LNG sellers profit from significant bargaining power since importers compete globally for natural gas supplies; furthermore, competitive downstream markets facilitate their access to numerous buyers.

According to Williamson’s transaction cost approach, idiosyncratic assets in uncertain environments lead to the hazard of post-contractual opportunistic behavior by the counterparty which in turn results in ex-ante under-investment, and decreasing overall efficiency. Organizing transactions within a firm’s own hierarchy will avoid ex-post appropriation of quasi-rents. Based on TCE’ discriminating alignment hypothesis, we can derive the first proposition:

**Proposition 1:** The higher the share of idiosyncratic (downstream) assets in the portfolio of an LNG firm in an uncertain environment, the higher the probability of vertical integration along the entire LNG value chain.

As discussed above, prior empirical work has found that the presence of inter-organizational trust reduces transaction costs in the sense of lowering (re-) negotiation costs, facilitating adaptation, supporting information exchange, etc. In the presence of relationship-specific investments inter-organizational trust will decrease the probability and/or extent of post-contractual opportunistic behavior by the non-investing party; governance costs (i.e., transaction costs) are reduced and overall exchange performance increases. Since governance costs change disproportionally between governance modes, less hierarchical modes become more attractive, leading to the second proposition:

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5 Free-on-board [fob]: title transfer at the loading port with the buyer being responsible for shipping; cost-insurance-freight [cif]: title transfer during voyage with the seller being responsible for shipping; delivered ex-ship [des]: title transfer at the unloading port with the seller responsible for shipping.
Proposition 2: An increase in the level of trust between upstream and downstream players in the LNG industry should favor less hierarchical modes of governance.

For this study, it is assumed that the observed governance modes represent efficient choices and that potential misalignment will result in a re-positioning or in the company ceasing its activities in the industry due to entrepreneurial failure. It is noted, however, that since transaction-specific performance data (i.e., performance related to activities along the LNG value chain) are not publicly available, a possible third proposition hypothesizing that the presence of trust will increase exchange performance independent of the chosen organizational structure cannot be tested.

4 Data and Methodology

4.1 Data
The global dataset used in this paper encompasses corporate investment behavior along LNG value chains from the beginning of the industry until today. It was compiled from publicly available sources such as company websites, reports, newsletters, industry journals, etc., and complemented with interviews with industry experts. The dataset includes export and import capacities, ownership structures, investment costs, financing structures, and expansion plans for liquefaction and regasification projects, data on the global tanker fleet, including vessels currently listed in shipyard order books, and analyses of contracting partners, contracted volumes, and contractual durations.

Using the dataset’s 67 import and 22 export projects, existing value chains (historical, actual, and planned for the mid-term) are identified, followed by an analysis of individual companies’ activities throughout the chains. Omitting observations with missing data, the final sample consists of 237 corporate-specific value chains, 131 of which are situated in the Atlantic Basin and 106 of which correspond to Asia-Pacific trade.

The unit of analysis for studying the determinants of vertical integration is a corporate-specific value chain. Two alternative measures for integration are specified: First, a binary variable indicating vertical integration from upstream or downstream (depending on the observed firm’s origin) into midstream shipping is defined. Both, equity relationships and long-term charter contracts are classified as vertical integration. Even though New Institutional Economics considers long-term contracts as a hybrid form of governance, it is appropriate to classify long-term charter agreements for LNG vessels as vertical integration since the ships traditionally have been dedicated to specific companies and transport routes. The dependent variable $VI_1$ is a discrete measure taking the value of one if we observe vertical integration of the player, and zero otherwise:

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6 These include all of the existing regasification and liquefaction plants worldwide and projects under construction and expected to be operational up to 2012.
In 134 of the 237 observations we observe vertical integration of the respective player into midstream shipping. Second, the degree of vertical integration (i.e., no vertical integration versus vertical integration from upstream or downstream into midstream shipping versus vertical integration along the entire value chain) with $\text{VI}_2$ defined as:

$$
\text{VI}_2^i = \begin{cases} 
0 & \text{if no vertical integration} \\
1 & \text{if vertical integration into midstream shipping} \\
2 & \text{if vertical integration from upstream or downstream into midstream shipping} \\
3 & \text{if vertical integration along upstream, midstream and downstream}
\end{cases}
$$

In 103 of the observations there is no integration, in 85 cases integration takes place in midstream shipping, and in 49 cases companies control the entire value chain.

### 4.2 Explanatory variables

**Transaction cost variables.** Proposition 1 refers to the impact of idiosyncratic assets and uncertainty on the likelihood of vertical integration. TCE predicts that asset specificity is the strongest determinant of vertical integration. Theory shows that the most efficient solution is trade on a short-term market for exchange relationships not involving any investment in specific assets. Markets become inefficient as bilateral dependencies – resulting from investments in specialized assets – arise. Specific investments in environments without uncertainty can be secured through long-term contracts. In contrast, the existence of uncertainty results in vertical integration being more efficient. The extent of idiosyncratic assets of a player ($\text{SPEC}$) is defined as the ratio of regasification capacity ($r_{i,\text{year}}$) over the sum of regasification and liquefaction capacity the player controls in the start-up year of the value chain ($r_{i,\text{year}} + l_{i,\text{year}}$). The variable increases with the share of regasification capacities in a firm’s LNG portfolio, mirroring the lock-in situation of a player investing downstream in a sellers’ market. It is continuously distributed between zero and one, including these threshold values:

$$
\text{SPEC}_i = \frac{r_{i,\text{year}}}{r_{i,\text{year}} + l_{i,\text{year}}}.
$$

Due to the high capital intensity of infrastructure investments, and uncertainties about the scope of natural gas fields or price developments, investors generally face different risks. In addition, natural gas fields are often located in politically unstable regions. Several risks can be hedged via diversification or other measures; therefore, the political risk associated with upstream investments is evaluated as the main driver of uncertainty. The variable for political uncertainty ($\text{UNC}$) is based on the so-called POLCON-index developed by Henisz (2000). This index measures the degree of
constraints on policy change in a country averaged for five-year periods since 1960. Various studies have shown that it is suitable for testing TCE’s hypotheses. We adjust the POLCON-index so that a high (low) value expresses high (low) uncertainty; UNC is defined as \((1 - POLCON)\) with \(UNC, \in [0...1]\). To account for TCE’s proposition that relationship-specific investments in the presence of uncertainty drive companies to the internalization of quasi-rents, an interaction term \((SPEC*UNC)\) is included.

**Shift parameters:** Williamson (1991b) proposes as one potential shift parameter reputational effects discussed in the context of networks, and Gulati and Nickerson (2005) employ a measure of exogenous trust based on an assessment of the opinion of the buyer about its supplier compared to the best alternative partner. TCE discusses post-contractual hazards under the assumption that the investing party faces an opportunistic counterparty. Inter-organizational trust, however, can attenuate the incentives to behave opportunistically as discussed above. Gulati and Sytch (2008) point out that the history of prior interaction is the most important factor determining inter-organization trust. To explain the level of trust, Gulati and Nickerson (2008) employ variables measuring the length of historical exchange. Oxley (1999) quantifies the number of prior alliances between the trading partners.

Therefore, we define three variables to measure inter-organizational trust: \(TRUST_1\) is a count index of the years of inter-country LNG trade before the initiation of the respective value chain. On a country level we very often observe the same players active in LNG exportation and/or importation (e.g., Sonatrach is the only exporter in Algeria; Gaz de France is the main importer in France), which justifies the choice of this variable as a measure of trust resulting from past inter-country (and respectively inter-company) trading experiences. Faithful partners may be rewarded and opportunistic behaviors punished in such long-term relationships; furthermore, there may be a decrease in transaction costs due to learning processes, established routines, and reputational effects. The second variable \(TRUST_2\) indicates whether the value chain is an expansion project covering a pre-existing value chain; the third variable \(TRUST_3\) indicates whether trading partners already operate along value chains between the same countries.

**Control variables.** To account for changes in corporate strategies over time a dummy variable indicating value chains that came into operation after 1999 \((D2000)\) is included. It is expected that players will encounter a changing environment given the industry’s rapid expansion and maturation since the end of the 1990s and that they must select or adapt strategies to maintain or gain competitive advantages as discussed above.

Several dummy variables are used to control for differences in corporate strategies resulting from regional factors that vary between the Atlantic Basin market (deliveries to Europe and North America)

---

\(^{7}\) Henisz (2000) reports the POLCON-index until the period 1990-1994. For observations after 1994 we use the most recently reported value which is an appropriate assumption, since the index is very stable over the reported period.
where LNG trading hubs already exist or are developing, and Asia-Pacific trade where buyers depend
strongly on LNG imports. EXPAB indicates exporters situated in the Atlantic Basin, EXPPB indicates
exporters situated in the Pacific Basin; suppliers delivering LNG from the Middle East to either
Europe, North America, or Asia (EXPME) are the default category.
CAPOWN accounts for a company’s participation in the industry, calculated as the ratio of the
accumulated liquefaction and regasification capacities controlled (owned or contracted) by a global
player over the sum of worldwide liquefaction and regasification capacities in operation at the end of
the respective year \( \left( \frac{r_{i,\text{year}} + l_{i,\text{year}}}{r_{\text{total,year}} + l_{\text{total,year}}} \right) \). Companies controlling significant LNG
capacities may be able to benefit from arbitrage possibilities which in turn may increase the
motivation to integrate into midstream shipping, especially when downstream regasification assets
account for a significant share in the portfolio.
Empirical research on the make-or-buy decision building on TCE often includes the size of the
transaction or of the exchange partners as a control variable (e.g., Zaheer and Venkatraman, 1995;
Gulati and Nickerson, 2008). The player’s assets value \( \text{ASSETS} \) is a proxy variable for firm size and
financial strength. A positive relation between vertical integration and \( \text{ASSETS} \) is expected since
companies endowed with a strong capital basis face lower barriers to entry in terms of funding capital-
intensive LNG projects. Finally, \( \text{STATE} \) identifies state-owned entities, thus allowing for differences
in corporate strategies due to a different ownership structure.
For a survey of all explanatory variables as well as their descriptive statistics see Table 1. Slightly
more than half (53%) of the analyzed corporate-specific value chains began operations after 1999,
mirroring this decade’s expanding international LNG trade. Asset specificity of the respective
company’s LNG portfolio ranges between zero (portfolio is dominated by upstream capacities; e.g.,
National Gas Company Trinidad and Tobago) and one (portfolio is dominated by downstream
positions; e.g., Korea Gas Corporation) with a mean of 0.48. The political uncertainty index of the
exporting country lies between 0.13 and one. The history of LNG trade between two countries differs
widely, whereas some value chains represent the first exchange relationships and other value chains
cover bilateral trading experience of up to 38 years. In 37% of all observations the value chains
represent expansion projects; 22% represent trading partners already operating along value chains
between the same countries. Broken out by region, 44% of the observations represent value chains
originating from Atlantic Basin exporters, 40% represent Pacific Basin exporters’ deliveries and 16%
involve Middle Eastern suppliers. Players control between 0.1% (Union Fenosa in 2000) and 30.3%
(Osaka Gas in 1972) of worldwide liquefaction and regasification capacities. Corporate size ranges
from USD 358mn (Italian Enel) to USD 279bn (Japanese Nippon Oil).\(^8\) Finally, 33% of the observed
value chains include state-owned entities.

---

\(^8\) We assume a firm’s assets value of USD 10 bn if no data was available (e.g., Pertamina, National Libyan Oil
Company, and EGPC).
### Table 1: Explanatory variables and summary statistics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Proxy</th>
<th>Unit</th>
<th>Denotation</th>
<th>Exp. Sign</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proposition 1 (transaction cost variables)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset specificity</td>
<td>Share of downstream capacities in the player’s LNG portfolio</td>
<td>%</td>
<td>SPEC</td>
<td>+</td>
<td>0.479</td>
<td>0.446</td>
<td>0</td>
<td>1</td>
<td>237</td>
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<tr>
<td>External uncertainty</td>
<td>Political instability in the supplying country</td>
<td>UNC</td>
<td></td>
<td></td>
<td>0.616</td>
<td>0.379</td>
<td>0.13</td>
<td>1</td>
<td>237</td>
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<tr>
<td><strong>Proposition 2 (shift parameters)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inter-organizational trust</td>
<td>Years of previous inter-country LNG trade +1</td>
<td>Count</td>
<td>TRUST1</td>
<td>-</td>
<td>6.283</td>
<td>8.583</td>
<td>1</td>
<td>38</td>
<td>237</td>
</tr>
<tr>
<td></td>
<td>Value chain covering an expansion project of an already existing value chain</td>
<td>Dummy</td>
<td>TRUST2</td>
<td>-</td>
<td>0.367</td>
<td>0.483</td>
<td>0</td>
<td>1</td>
<td>237</td>
</tr>
<tr>
<td></td>
<td>Firm already active along a value chain between the same export and import countries</td>
<td>Dummy</td>
<td>TRUST3</td>
<td>-</td>
<td>0.219</td>
<td>0.415</td>
<td>0</td>
<td>1</td>
<td>237</td>
</tr>
<tr>
<td><strong>Control variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in industry structure</td>
<td>Start-up of the value chain after 1999</td>
<td>Dummy</td>
<td>D2000</td>
<td></td>
<td>0.527</td>
<td>0.500</td>
<td>0</td>
<td>1</td>
<td>237</td>
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<tr>
<td>Export region</td>
<td>Exporter in the Atlantic Basin</td>
<td>Dummy</td>
<td>EXPAB</td>
<td></td>
<td>0.439</td>
<td>0.497</td>
<td>0</td>
<td>1</td>
<td>237</td>
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<tr>
<td></td>
<td>Exporter in the Pacific Basin</td>
<td>Dummy</td>
<td>EXPPB</td>
<td></td>
<td>0.405</td>
<td>0.492</td>
<td>0</td>
<td>1</td>
<td>237</td>
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<tr>
<td></td>
<td>Exporter in the Middle East</td>
<td>Dummy</td>
<td>EXPME</td>
<td></td>
<td>0.156</td>
<td>0.364</td>
<td>0</td>
<td>1</td>
<td>237</td>
</tr>
<tr>
<td>Company’s participation in the LNG industry</td>
<td>Capacity controlled by the player (% of total existing export and import capacity)</td>
<td>%</td>
<td>CAPOWN</td>
<td></td>
<td>0.040</td>
<td>0.052</td>
<td>0</td>
<td>1</td>
<td>237</td>
</tr>
<tr>
<td>Financial resources</td>
<td>Company size measured by the assets value</td>
<td>mn USD</td>
<td>ASSETS</td>
<td></td>
<td>63,476</td>
<td>63,628</td>
<td>358</td>
<td>195,265</td>
<td>237</td>
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<tr>
<td>Company type</td>
<td>Company being state-owned</td>
<td>Dummy</td>
<td>STATE</td>
<td></td>
<td>0.380</td>
<td>0.486</td>
<td>0</td>
<td>1</td>
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<td></td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
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<td>-------</td>
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<td>-------</td>
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<td>-------</td>
</tr>
<tr>
<td>VI1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VI2</td>
<td>2</td>
<td>0.882</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SPEC</td>
<td>3</td>
<td>0.159</td>
<td>0.103</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>UNC</td>
<td>4</td>
<td>-0.205</td>
<td>-0.151</td>
<td>-0.224</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>TRUST1</td>
<td>5</td>
<td>-0.140</td>
<td>-0.185</td>
<td>0.042</td>
<td>0.104</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>TRUST2</td>
<td>6</td>
<td>-0.092</td>
<td>-0.105</td>
<td>0.040</td>
<td>0.053</td>
<td>0.634</td>
<td>1</td>
<td></td>
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<tr>
<td>TRUST2</td>
<td>7</td>
<td>-0.008</td>
<td>0.011</td>
<td>-0.141</td>
<td>0.055</td>
<td>0.467</td>
<td>0.654</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>D2000</td>
<td>8</td>
<td>0.176</td>
<td>0.336</td>
<td>0.011</td>
<td>-0.068</td>
<td>0.011</td>
<td>-0.033</td>
<td>-0.029</td>
<td>1</td>
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<tr>
<td>EXPAB</td>
<td>9</td>
<td>-0.065</td>
<td>0.067</td>
<td>-0.059</td>
<td>0.330</td>
<td>-0.142</td>
<td>-0.038</td>
<td>0.024</td>
<td>0.173</td>
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<tr>
<td>EXPPB</td>
<td>10</td>
<td>0.030</td>
<td>-0.113</td>
<td>0.202</td>
<td>-0.230</td>
<td>0.288</td>
<td>0.138</td>
<td>0.103</td>
<td>-0.286</td>
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<tr>
<td>EXPME</td>
<td>11</td>
<td>0.049</td>
<td>0.067</td>
<td>-0.192</td>
<td>-0.140</td>
<td>-0.195</td>
<td>-0.135</td>
<td>-0.172</td>
<td>0.151</td>
</tr>
<tr>
<td>CAPOWN</td>
<td>12</td>
<td>0.120</td>
<td>-0.001</td>
<td>0.222</td>
<td>0.004</td>
<td>0.014</td>
<td>0.053</td>
<td>0.090</td>
<td>-0.329</td>
</tr>
<tr>
<td>STATE</td>
<td>13</td>
<td>-0.051</td>
<td>-0.119</td>
<td>-0.180</td>
<td>0.242</td>
<td>-0.103</td>
<td>-0.001</td>
<td>0.152</td>
<td>-0.148</td>
</tr>
<tr>
<td>ASSETS</td>
<td>14</td>
<td>0.197</td>
<td>0.225</td>
<td>-0.365</td>
<td>-0.115</td>
<td>-0.041</td>
<td>-0.066</td>
<td>0.006</td>
<td>0.063</td>
</tr>
</tbody>
</table>
4.3 Methodology

In a first step, a probit model explaining vertical integration versus non-integration under the assumption that the dependent variable can be specified as an unobserved latent variable \( VT_i^{*} \) is estimated. It is assumed that \( VT_i^{*} = \alpha X_i + \varepsilon_i \) where \( X_i \) is a vector of exogenous variables representing asset specificity, uncertainty and further independent and heterogeneous factors; \( \alpha \) is a vector of coefficients; and \( \varepsilon_i \) is an error term with the cumulative density function \( F(\varepsilon) \). We will observe \( VT_i^1 = 1 \) if \( VT_i^{*} > 0 \) and \( VT_i^1 = 0 \) otherwise. Thus, the probability of observing vertical integration \( \Pr(VT_i^1 = 1) \) equals \( \Pr(\varepsilon_i > -\alpha X_i) = 1 - F(-\alpha X_i) = F(\alpha X_i) \) for a symmetric distribution. The probit model assumes \( F(\cdot) \) to be standard normal; hence, \( \Pr(VT_i^1 = 1) = \int_{-\infty}^{\alpha X_i} \phi(t) dt = \Phi(\alpha X_i) \). The level of specific investments is treated as an exogenous variable; an interaction term combining specificity and uncertainty is included to account for the impact of specific investments under uncertainty on optimal governance choice. Based on a first regression including ASSETS in linear as well as quadratic form a nonlinear relationship between this variable and \( VT^1 \) was found; therefore, the logged value is included into the estimation model:

\[
VT^1_i = \alpha_0 + \alpha_1 \text{SPEC}_i + \alpha_2 \text{UNC}_i + \alpha_3 (\text{SPEC}_i \cdot \text{UNC}_i) + \alpha_4 \text{EXPAB}_i + \alpha_5 \text{EXPPB}_i \\
+ \alpha_6 D2000_i + \alpha_7 \text{CAPOWN}_i + \alpha_8 \text{STATE}_i + \alpha_9 \ln(\text{ASSETS}_i) + \varepsilon_i
\] (4-1)

where \( i \) indexes a corporate-specific value chain and the error term \( \varepsilon_i \) is expected to follow a normal distribution.

In the second step, inter-organizational trust as a shift parameter is added. Three models – each including only one of the alternative measures of trust to avoid multicollinearity problems with: i) \( \ln(\text{TRUST1}) \), ii) \( \text{TRUST2} \), and iii) \( \text{TRUST3} \) – are estimated. Based on a first regression including TRUST1 in linear as well as quadratic form a nonlinear relationship between this variable and \( VT^1 \) was found; therefore, the logged value is included into the estimation model:

\[
VT^1_i = \beta_0 + \beta_1 \text{SPEC}_i + \beta_2 \text{UNC}_i + \beta_3 (\text{SPEC}_i \cdot \text{UNC}_i) + \beta_4 \text{EXPAB}_i + \beta_5 \text{EXPPB}_i \\
+ \beta_6 D2000_i + \beta_7 \text{CAPOWN}_i + \beta_8 \text{STATE}_i + \beta_9 \ln(\text{ASSETS}_i) + \beta_{10} \text{TRUST}_i + \nu_i
\] (4-2)

with the error term again expected to follow a normal distribution.
In order to differentiate between different degrees of vertical integration, a second class of models – following the same specification as described above and employing an ordered probit model – is estimated:

\[
VI_i^{2} = \alpha_0 + \alpha_1 SPEC_i + \alpha_2 UNC_i + \alpha_3 (SPEC_i \cdot UNC_i) + \alpha_4 EXPAB_i + \alpha_5 EXPPB_i + \alpha_6 D2000_i + \alpha_7 CAPOWN_i + \alpha_8 STATE_i + \alpha_9 \ln(ASSETS_i) + \varepsilon_i
\]  

(4-3)

\[
VI_i^{2} = \beta_0 + \beta_1 SPEC_i + \beta_2 UNC_i + \beta_3 (SPEC_i \cdot UNC_i) + \beta_4 EXPAB_i + \beta_5 EXPPB_i + \beta_6 D2000_i + \beta_7 CAPOWN_i + \beta_8 STATE_i + \beta_9 \ln(ASSETS_i) + \beta_{10} TRUST_i + \nu_i
\]  

(4-4)

The ordered probit model is, similarly to the probit model, based on a latent regression with \(VI_i^{2*} = \alpha X_i + \varepsilon_i\). With respect to actual governance mode choice, we observe

\[
\begin{align*}
VI_i^2 &= 0 \quad \text{if } VI_i^{2*} \leq \mu_1 \quad \text{with } \Pr(VI_i^2 = 0) = \Phi(\mu_1 - \alpha X_i) \\
VI_i^2 &= 1 \quad \text{if } \mu_1 < VI_i^{2*} \leq \mu_2 \quad \text{with } \Pr(VI_i^2 = 1) = \Phi(\mu_2 - \alpha X_i) - \Phi(\mu_1 - \alpha X_i) \\
VI_i^2 &= 2 \quad \text{if } \mu_2 < VI_i^{2*} \quad \text{with } \Pr(VI_i^2 = 2) = 1 - \Phi(\mu_2 - \alpha X_i)
\end{align*}
\]

where \(\mu_1\) and \(\mu_2\) are referred to as break points (i.e., unknown parameters to be estimated with the vector of coefficients).

5 Estimation results and interpretation

5.1 Probit model

Table 3 displays estimation results of nested models explaining governance choice based on a probit model with i) Model 1 including only transaction cost variables; ii) Model 2 including furthermore variables controlling for differences between exporting regions as well as changes in corporate behavior over time; iii) Model 3 including additionally company characteristics; and finally, iv) Models 4 to 6 accounting for alternative shift parameters.\(^9\)

Both industry-specific propositions can be confirmed empirically; estimation results are robust with respect to alternative model specifications. The log-likelihood values as well as different information criteria (i.e., Akaike and Bayesian information criteria) indicate that Model 4 which includes

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\(^9\) Probit estimation is preferred to the logit model (assuming a logistic instead of a normal distribution of the error term) since the first shows slightly better goodness-of-fit indicators (i.e., Pseudo R\(^2\), log-likelihood values, AIC, BIC). Estimation results are similar for both estimation procedures.
transaction cost variables, all above defined control variables, and ln(TRUST1) as a shift parameter has the best explanatory power.

Contrary to TCE’s predictions, specific investments (SPEC) appear to decrease the likelihood of vertical integration into midstream transportation for Models 1 and 2; the coefficient for the remaining four models is not significant. Uncertainty (UNC) is negatively related to the integration decision which goes in line with Williamson (1971). However, as theory hypothesizes, investments in relationship-specific assets in the presence of uncertainty result in a strong motivation to avoid the appropriability hazards under market organization and to internalize the transaction instead; the coefficients of the interaction term are positive and highly statistically significant for all specifications. This finding reflects the recent developments by traditional buyers that are increasingly integrating upstream.

Model 2 including additionally control variables for the export region provides only a slight improvement in explanatory power compared to Model 1. The variables EXPAB and EXPPB have no significant impact on the decision to integrate vertically and there appears to be no difference in corporate strategies between value chains in the Atlantic Basin which are dedicated to more or less competitive downstream markets, value chains in the Pacific Basin market where countries typically strongly rely upon natural gas imports in the form of LNG, and value chains from the swing producer region of the Middle East. An alternative regression accounting for the importing region (deliveries dedicated to Atlantic Basin customers instead of to Pacific Basin customers) does not reveal any regional differences, too.

D2000, the variable controlling for the start-up date of the value chain, indicates that vertical integration is becoming more common, which reflects global players’ efforts to establish a portfolio of export and import positions to exploit arbitrage potentials. Access to flexible transport capacities (e.g., via integration into midstream shipping) is the key to successful employment of this strategy. Rapid industrial expansion when accompanied by a restructuring process prompts firms to internalize risks inherent in the capital-intensive industry via strategic repositioning and reshaping.

Model 3 which adds variables accounting for corporate specific characteristics shows an improvement of the Pseudo R² to 0.213. Players controlling a larger share of world LNG regasification and liquefaction capacities (CAPOWN) show a higher likelihood of vertical integration. This can be explained by a higher motivation to integrate into midstream shipping to benefit from the portfolio of upstream and downstream positions. The value of assets positively relates to the likelihood of vertical integration, an indication that larger firms have the financial capabilities necessary to invest in numerous capital-intensive export and/or import and shipping facilities. Finally, the variable STATE is significant, too. In contrast to private firms, state-owned entities tend to prefer vertical integration as opposed to less hierarchical governance modes.

The type and scope of the transaction explain much of the variation in mode of governance. Dynamics in the institutional environment, however, also play an important role. The last three model
specifications include shift parameters indicating inter-organizational trust. Estimated coefficients of the three variables, ln(TRUST1) TRUST2, and TRUST3, show the expected negative sign, although only ln(TRUST1) is statistically significant. As expected, the presence of trust supports less hierarchical governance.\textsuperscript{10}

\textsuperscript{10} To avoid multicollinearity problems due to the high correlation between the three variables measuring trust (also confirmed by a calculation of Variance Inflation Factors), they have been included into alternative model specifications. However, a regression including all three variables at the same time confirms the results above but does not significantly improve the overall explanatory power of the model.
## Table 3: Estimation results probit model

<table>
<thead>
<tr>
<th>Specification</th>
<th>Proposition 1</th>
<th>Proposition 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>0.986*** (0.269)</td>
<td>0.730** (0.328)</td>
</tr>
<tr>
<td>SPEC</td>
<td>-0.779** (0.368)</td>
<td>-0.802** (0.375)</td>
</tr>
<tr>
<td>UNC</td>
<td>-1.492*** (0.341)</td>
<td>-1.474*** (0.359)</td>
</tr>
<tr>
<td>(SPEC*UNC)</td>
<td>1.847*** (0.521)</td>
<td>1.906*** (0.524)</td>
</tr>
<tr>
<td>EXPAB</td>
<td>-0.058 (0.263)</td>
<td>-0.034 (0.271)</td>
</tr>
<tr>
<td>EXPPB</td>
<td>0.017 (0.270)</td>
<td>0.088 (0.291)</td>
</tr>
<tr>
<td>D2000</td>
<td>0.482*** (0.181)</td>
<td>0.692*** (0.204)</td>
</tr>
<tr>
<td>CAPOWN</td>
<td>5.337** (2.263)</td>
<td>5.919** (2.488)</td>
</tr>
<tr>
<td>STATE</td>
<td>0.569** (0.232)</td>
<td>0.537** (0.238)</td>
</tr>
<tr>
<td>ln(ASSETS)</td>
<td>0.361*** (0.081)</td>
<td>0.344*** (0.083)</td>
</tr>
<tr>
<td>ln(TRUST1)</td>
<td>-0.217*** (0.080)</td>
<td></td>
</tr>
<tr>
<td>TRUST2</td>
<td></td>
<td>-0.211 (0.195)</td>
</tr>
<tr>
<td>TRUST3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pseudo R²</td>
<td>0.080</td>
<td>0.104</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>-149.23</td>
<td>-145.46</td>
</tr>
<tr>
<td>AIC</td>
<td>306.47</td>
<td>304.91</td>
</tr>
<tr>
<td>BIC</td>
<td>320.34</td>
<td>329.19</td>
</tr>
<tr>
<td>N</td>
<td>237</td>
<td>237</td>
</tr>
</tbody>
</table>

*** Statistically significant at a 1%-level; ** statistically significant at a 5%-level; * statistically significant at a 10%-level; standard errors in parentheses. All levels of statistical significance are based on two-sided test statistics.
5.2 Ordered probit model

Table 4 displays estimation results of nested models explaining the degree of vertical integration based on an ordered probit model with again i) Model 1 including only transaction cost variables; ii) Model 2 including furthermore variables controlling for differences between exporting regions as well as changes in corporate behavior over time; iii) Model 3 including additionally company characteristics; and finally, iv) Models 4 to 6 accounting for alternative shift parameters.

The log-likelihood values and different information criteria indicate that Model 4, which includes transaction cost variables, the control variables defined above, and ln(TRUST1) as a shift parameter, has the best explanatory power.

Both industry-specific propositions can be confirmed empirically; estimation results are robust with respect to alternative model specifications and are consistent with those found in the probit model. Specific investments in the presence of uncertainty lead to a strong motivation to integrate vertically; the presence of inter-organizational trust reduces the need for hierarchical controls and supports the choice of a lower degree of vertical integration. Significant control variables also provide some interesting findings which are qualitatively consistent with those of the probit model; for a detailed discussion see above.
### Table 4: Estimation results ordered probit model

<table>
<thead>
<tr>
<th>Specification</th>
<th>Proposition 1: Transaction cost and control variables</th>
<th>Proposition 2: Trust as a shift parameter included</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
</tr>
<tr>
<td>SPEC</td>
<td>-0.624 **</td>
<td>-0.722 **</td>
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<tr>
<td></td>
<td>(0.316)</td>
<td>(0.324)</td>
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<tr>
<td>UNC</td>
<td>-1.122 ***</td>
<td>-1.317 ***</td>
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<tr>
<td></td>
<td>(0.301)</td>
<td>(0.323)</td>
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<tr>
<td>(SPEC*UNC)</td>
<td>1.408 ***</td>
<td>1.676 ***</td>
</tr>
<tr>
<td></td>
<td>(0.453)</td>
<td>(0.464)</td>
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<tr>
<td>EXPAB</td>
<td>0.078</td>
<td>0.088</td>
</tr>
<tr>
<td></td>
<td>(0.232)</td>
<td>(0.236)</td>
</tr>
<tr>
<td>EXPPB</td>
<td>-0.141</td>
<td>-0.170</td>
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<tr>
<td></td>
<td>(0.234)</td>
<td>(0.243)</td>
</tr>
<tr>
<td>D2000</td>
<td>0.781 ***</td>
<td>0.886 ***</td>
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<tr>
<td></td>
<td>(0.162)</td>
<td>(0.177)</td>
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<tr>
<td>CAPOWN</td>
<td>3.050</td>
<td>3.088 *</td>
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<tr>
<td></td>
<td>(1.676)</td>
<td>(1.702)</td>
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<tr>
<td>STATE</td>
<td>0.313 *</td>
<td>0.286</td>
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<td></td>
<td>(0.189)</td>
<td>(0.191)</td>
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<tr>
<td>ln(ASSETS)</td>
<td>0.341 ***</td>
<td>0.324 ***</td>
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<tr>
<td></td>
<td>(0.074)</td>
<td>(0.075)</td>
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<tr>
<td>ln(TRUST1)</td>
<td>-0.207 ***</td>
<td>-0.220</td>
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<tr>
<td></td>
<td>(0.068)</td>
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<tr>
<td>TRUST2</td>
<td>-0.787</td>
<td>-0.518</td>
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<tr>
<td></td>
<td>(0.232)</td>
<td>(0.289)</td>
</tr>
<tr>
<td>TRUST3</td>
<td>0.235</td>
<td>0.598</td>
</tr>
<tr>
<td></td>
<td>(0.229)</td>
<td>(0.293)</td>
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<tr>
<td>Pseudo R²</td>
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<td>0.095</td>
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<tr>
<td>AIC</td>
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<td>BIC</td>
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<td>496.51</td>
</tr>
<tr>
<td>N</td>
<td>237</td>
<td>237</td>
</tr>
</tbody>
</table>

*** Statistically significant at a 1%-level; ** statistically significant at a 5%-level; * statistically significant at a 10%-level; standard errors in parentheses. All levels of statistical significance are based on two-sided test statistics.
Summary and Conclusions

This study provides empirical evidence for Williamson’s (1991b) shift parameter framework. The presence of inter-organizational trust shifts the governance cost curves for alternative modes of organization disproportionally; it can be shown that pre-existing trust increases the likelihood of less hierarchical governance forms. Hence, the discussion of an optimal alignment of transactions, differing in their attributes, with appropriate governance structures should take into account both, parameters on the transaction level (e.g., specificity of investments, uncertainty) and parameters accounting for dynamics in the institutional environment (i.e., shift parameters).

The ‘LNG rush’ forecasted during the early years of this decade has increased regasification capacity to almost 45% since 2000. Increasing worldwide demand (even though recent projections are less enthusiastic due to the economic recession that began in 2007) and the ongoing process of deregulation in downstream markets have brought fundamental changes in corporate behavior. Many firms are already investing in regionally diversified LNG portfolios and integrating vertically to internalize risk factors resulting from investments in capital-intensive infrastructures. Control of transport capacities is a key factor in order to benefit from cross-trade opportunities.

Using probit and ordered probit models, the determinants of vertical integration (and the degree of vertical integration respectively) are analyzed. Empirical results confirm the industry-specific propositions and support classical TCE as well as the relevance of shift parameters. The models show that relationship-specific investments in the presence of uncertainty favor hierarchical modes of governance to safeguard quasi-rents and avoid the hazard of post-contractual opportunism. However, pre-existing inter-organizational trust as determined by the historical relationship between the exchange partners mitigates the need for formal controls and favors less hierarchical structures. Trust can also provide a strong, relational safeguard against opportunism: as Williamson (1993, p. 482) highlights, “breach of contract is sometimes efficient, even in a commercial contract that is supported by perfect safeguards. By contrast, betrayal of a personal trust can never be efficient. Betrayal is demoralizing.” Summarizing, a complete understanding of governance choice requires that both, transaction characteristics as well as the institutional environment are considered. The current scarcity of empirical literature testing the shift parameter framework suggests fruitful avenues of research into alternative shift parameters.

This study has some limitations. First, in reality pre-existing inter-organizational trust is an endogenous variable being determined by prior experiences between the exchange partners. Gulati and Sytch (2008, p. 166) point out that empirical studies “have focused primarily on the consequences and not the antecedents of trust.” Therefore, two-stage regression models that explain the level of trust in a first step would improve the analysis. However, it is difficult to measure inter-organizational trust; all studies explaining trust rely on survey data in which the measure of trust derives from indirect questions to be answered by key informants. Second, this study tests only reduced form equations.
since transaction costs cannot be measured. Should performance data on transaction levels become publicly available, researchers could investigate the direct impact of trust on the performance of alternative governance costs. Third, the ability to distinguish between pre-existing trust and emerging trust, that is, the relationship that develops during an exchange and/or over time is critical. Panel data would greatly enhance our understanding of the relationship between inter-organizational trust and choice of governance.

References


Appendix

Figure 3: Shift parameter framework as discussed in Oxley (1999)\(^ {11}\)

![Figure 3: Shift parameter framework as discussed in Oxley (1999)\(^ {11}\)](image)

Source: Own depiction following Oxley (1999)

Figure 4: Shift parameter framework as discussed in Henisz and Williamson (1999)\(^ {12}\)

![Figure 4: Shift parameter framework as discussed in Henisz and Williamson (1999)\(^ {12}\)](image)

Source: Own depiction following Henisz and Williamson (1999)

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\(^{11}\) Even though the governance costs associated with equity joint ventures are also likely to rise, they will do so at a lower extent. The change in relative governance costs is the relevant factor.

\(^{12}\) This downward shift of the governance cost curves of market and hybrid organization can also be interpreted as an improvement in the intellectual property rights, thereby supporting greater inter-firm contracting.
Figure 5: Shift parameter framework (stability of property rights) as discussed in Williamson (1991b)

An increase in the importance of reputation in networks will reduce the GC of market [M(s)] and hybrid [L(s)] governance modes. Decreasing stability of property rights will raise the GC of market [M(s)] and hybrid [L(s)] governance modes. More hierarchical governance modes become more likely.

Source: Own depiction

Figure 6: Shift parameter framework (increased reputation) as discussed in Williamson (1991b)

An increase in the importance of reputation in networks will reduce the GC of market [M(s)] and hybrid [L(s)] governance modes. Less hierarchical governance modes become more likely.

Source: Own depiction