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INTER-ORGANIZATIONAL TRUST AS A SHIFT PARAMETER IN THE EXTENDED TRANSACTION COST FRAMEWORK: A FIRST APPLICATION TO THE LNG INDUSTRY

Sophia Ruester

EUROPEAN UNIVERSITY INSTITUTE, FLORENCE
ROBERT SCHUMAN CENTRE FOR ADVANCED STUDIES
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For further information
Loyola de Palacio Energy Policy Chair
Email contact: yannick.perez@eui.eu
Robert Schuman Centre for Advanced Studies
European University Institute
Via delle Fontanelle, 19
I-50016 San Domenico di Fiesole (FI)
Fax: +39055 4685755

http://www.eui.eu/RSCAS/Research/Loyola/Index.shtml

Abstract

This paper provides an empirical analysis examining the effect of both transaction characteristics and the institutional environment on governance choice. Using a dataset of 237 corporate-specific value chains in the global LNG industry, we introduce inter-organizational trust as a shift parameter. Following transaction cost economics, 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 organizational structures. These economic relationships are tested based on probit and ordered probit models. Estimation results provide broad support for both propositions

Keywords

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

JEL-Codes: L22, D23, L95

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 and motivated Oliver Williamson in 1991 to introduce 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 thereby will shift the relative costs of alternative governance structures (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 natural gas producers and distributors are involved in all stages of the liquefied natural gas (LNG) value chain. At the same time, some new entrants invested in non-integrated LNG import terminals operating them as so called tolling facilities or speculating for short-term deliveries.

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 organizational structure. 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. As expected, the presence of inter-organizational trust increases the likelihood of less hierarchical governance modes.

[*] The author thanks participants of the ESNIE 2009 and Christian von Hirschhausen for helpful comments and suggestions. The usual disclaimer applies.

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. 1975; 1985; 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. 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 and ex-ante under-investment. Organizing transactions within a corporation's own hierarchy by internalizing the appropriable quasi-rent avoids these problems.

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, "the set of fundamental political, social and legal ground rules that establishes the basis for production, exchange and distribution" (Davis and North, 1971, pp. 6 f.), as given. This has been widely criticized in the NIE literature. Williamson (1991b) therefore introduced 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.

There is only a small number of empirical papers testing the shift parameter framework. Oxley (1999) provides the first application investigating 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 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. Weak protection will result in an increased appropriability hazard and support the choice of more hierarchical governance modes.

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. 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 supports 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 and reputation in economic exchanges. Recent literature encompasses research in the fields of social psychology, organizational theory, strategic management, business history, and economics.[1] 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 non-economic 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 (Zaheer et al., 1998; Gulati and Sytch, 2008). Williamson (1993) distinguishes calculative trust (i.e., refers to a rational form of trust built upon reputation and can be understood in terms of risk), personal trust (i.e., altruistic behavior not depending on calculations of self-interest but being motivated by benevolence), and 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). Organizational arrangements may reduce the likelihood of opportunistic behavior since they provide a basis for trust by creating incentives, providing administrative controls and a means for solving disputes.

Trust in its relational form can be understood as an endogenous variable being determined by the history of prior interactions between trading partners as well as by their evaluation of the future value of the relationship. For example, potential partners can jointly adjust the incentives to make trustworthy behavior an economically preferable option, select firms which engage in non-opportunistic behavior, etc. Trust increases due to learning about the partner and his likely behavior as well as due to improved coordination processes among firms. Contracts are self-enforcing if the present value of continuing the relationship exceeds the value of deviating from the implicit contractual terms. Fehr (2009) provides a literature review on recent research addressing the presence of inter-personal trust and its formation.

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.

[1] See Gulati and Sytch (2008) for a more detailed discussion of the recent contributions to theoretical and empirical literature.

The presence of trust reduces transaction costs by reducing or eliminating both ex-ante and ex-post opportunism.

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). 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.

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.

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.

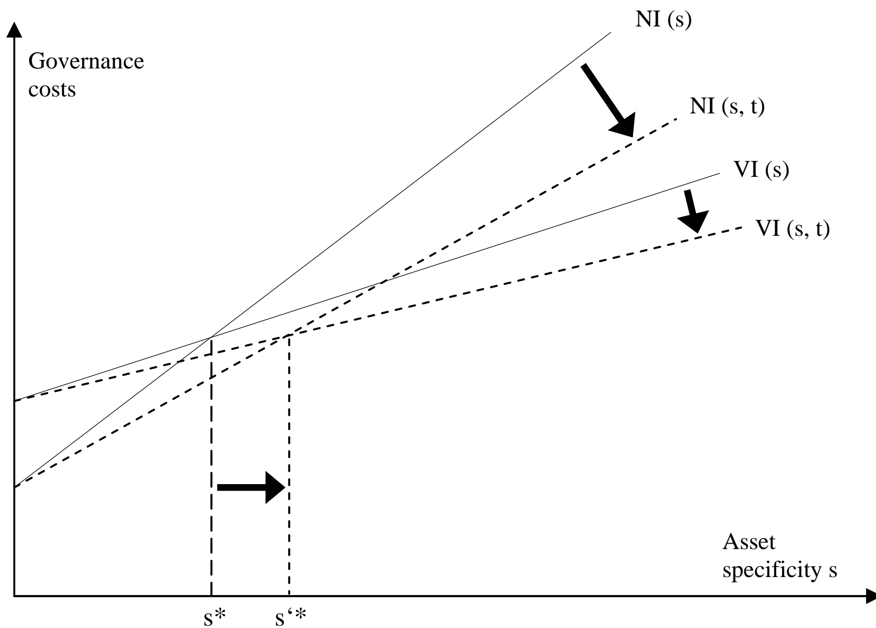
3.3 Formalization of the shift parameter framework

The following discussion focuses on inter-organizational trust as a shift parameter, in particular, trust engendered by past interactions between the same trading partners. As discussed above, 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-solving. 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. 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 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 result in the substitution of formal governance modes for less formal ones.

Figure 1 illustrates the 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 $\partial NI(s, t)/\partial t < \partial VI(s, t)/\partial t < 0$ 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 the own hierarchy therefore should decrease with an increase in the level of inter-organizational trust.

Figure 1: Inter-organizational trust as a shift parameter



Source: Own depiction

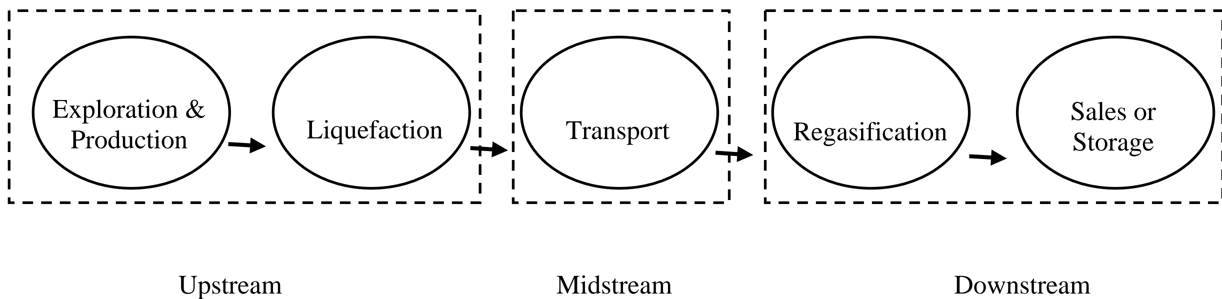
3.4 Industry-specific propositions

Figure 2 depicts the five stages of the LNG value chain. Following exploration and production (stage 1), the raw feed gas is transported via pipeline to liquefaction facilities. After removing impurities and separating heavier hydrocarbons, it is cooled to minus 160°C under atmospheric

pressure and shrinks to about 1/600 of its volume (stage 2). The liquefied gas is transported to the destination country using tankers (stage 3). Upon arrival, tankers are off-loaded to terminals that reconvert the LNG to its original state of aggregation (stage 4). Finally, the gas is fed into the destination country's pipeline grid, traded and sold to marketers, distributors, or power producers, or stored for future demand (stage 5).

To investigate the LNG industry from an economic 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.

Figure 2: LNG value chain



Upstream Midstream Downstream

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., the BG Group will control the whole value chain for deliveries from Egypt to Italy which is expected to start operation in 2010). 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 as well as in Indonesia; at the same time the company holds import capacities in the UK and Italy and recently started investments in the 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, Excelerate Energy).

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.[2] However, the natural gas market a long time has been 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 risks to 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 the transaction cost approach, idiosyncratic assets in uncertain environments lead to the hazard of post-contractual opportunistic behavior by the counterparty. Organizing transactions within a firm's own hierarchy will avoid ex-post appropriation of quasi-rents. Based on the discriminating alignment hypothesis, we 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 will be the probability of vertical integration along the 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. Since governance costs change disproportionally between governance modes, less hierarchical modes become more attractive, leading to the second proposition:

> *Proposition 2: An increase in the level of trust between upstream and downstream players in the LNG industry will favor less hierarchical modes of governance.*

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. 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 unfortunately cannot be tested.

4. Data and Methodology

4.1 Data

Our global dataset 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 66 import and 23 export projects,[3] existing value chains (historical, actual, and planned for the near-term) are identified, followed by an analysis of individual companies' activities throughout the chains. The 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.

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[2] 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.

[3] These include all of the existing regasification and liquefaction plants worldwide and projects under construction and expected to be operational up to 2012.

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 long-term contracts typically are considered 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 $\underline{VI^1}$ is a discrete measure taking the value of one if we observe vertical integration of the player, and zero otherwise:

$$VI_i^1 = \begin{cases} 1 & \text{if vertical integration} \\ 0 & \text{otherwise} \end{cases}$$

In 134 of the 237 observations vertical integration of the respective player into midstream shipping is observed. 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) is defined as $\underline{VI^2}$:

$$VI_i^2 = \begin{cases} 2 & \text{if vertical integration along upstream, midstream and downstream} \\ 1 & \text{if vertical integration from upstream or downstream into midstream shipping} \\ 0 & \text{otherwise} \end{cases}$$

In 103 of the observations there is no integration, in 85 cases integration into midstream shipping takes place, 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. Transaction cost economics predicts that asset specificity is the strongest determinant of integrating successive stages of the value chain into the corporation's own hierarchy. 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 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 relative extent of idiosyncratic assets of a player (SPEC) is defined as the ratio of regasification capacity over the sum of regasification and liquefaction capacity the player controls in the start-up year of value chain *i* with $SPEC_i = r_{i,\, year} / (r_{i,\, year} + l_{i,\, year})$. 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 boundaries.

Due to the high capital-intensity of infrastructure investments and uncertainties about the scope of natural gas fields and 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 (e.g., upstream exploration success), price adaptation and renegotiation clauses or other measures (price and quantity risks). Therefore, the political risk associated with upstream investments is evaluated as the main driver of uncertainty. The variable for political uncertainty (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.[4] Various studies

[4] Henisz (2000) reports the POLCON-index until the period 1990-1994. For observations after 1994 I use the most recently reported value which is an appropriate assumption, since the index is very stable over the reported period.

have shown that this measure is a suitable index for political uncertainty testing transaction cost economics' hypotheses. I adjust the POLCON-index so that a high (low) value expresses high (low) uncertainty. UNC is defined as (1 – POLCON) with $UNC_i \in [0, 1]$.

To account for transaction cost economics' 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: As discussed above, Williamson (1991b) proposes as one potential shift parameter reputational effects discussed in the context of social networks; 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. Gulati and Sytch (2008) point out that the history of prior interaction is the most important factor determining inter-organization 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. For this study, three proxy variables indicating inter-organizational trust are defined.

Prior interactions between the same trading partners thereby are expected to improve exchange productivity via diminishing coordination and contracting costs. Furthermore, the potential of future interactions deters exchange partners from engaging in opportunistic behavior; short-term gains from a deviation of implicit contractual terms have to be traded-off against long-term disadvantages. Investments in inter-organizational trust (or reputation) represent relationship-specific investments being sunk in nature. The termination of an existing trade relationship will imply an increase in exchange costs (i.e., additional costs for searching a new exchange partner and higher contracting costs due to a lack in historical bilateral trading experience).

TRUST1 is a count index of the years of inter-country LNG trade before the initiation of the respective value chain indicating the stock of prior interactions between two trading partners. 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. TRUST2 indicates whether the value chain is an expansion project of an already pre-existing value chain. For example, ENI is vertically integrated along the value chain for LNG deliveries from Nigeria's Bonny Island facility train 3 to the Sines import terminal in Portugal where deliveries started in 2003. Three years later, the company entered a value chain representing an expansion of this existing value chain including Bonny Island's trains 4 and 5. TRUST3 indicates whether trading partners already operate along value chains between the same countries since one might argue that due to the limited number of firms active in the industry, the same trading partners with a high probability will meet again.

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.

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) 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 Europe, North America, or Asia (EXPME) are the default category.

CAPOWN accounts for a company's market share 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 start-up year of the value chain: $(r_{i,\ year} + l_{i,\ year}) \ / \ (r_{total,\ year} + l_{total,\ year})$. Companies

controlling significant LNG capacities may be able to benefit from arbitrage possibilities which in turn increases the motivation to integrate into midstream shipping, especially when downstream regasification assets account for a significant share in the portfolio.

The player's assets value (ASSETS) is a proxy variable for firm size and financial strength. A positive relation between vertical integration and ASSETS is expected since companies endued with a strong capital basis face lower barriers to entry in terms of funding capital-intensive LNG projects. Finally, the dummy variable 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 in the dataset began operations after 1999, mirroring this decade's expanding international LNG trade. Asset specificity of the respective company's LNG portfolio ranges between zero (no specificity of the investments since the portfolio is dominated by upstream capacities; e.g., National Gas Company Trinidad and Tobago) and one (very high specificity since the 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 with a mean of 0.62. 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 37 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 during the observation period. Corporate size ranges from USD 358mn (Italian Enel) to USD 279bn (Japanese Nippon Oil Corporation).[5] Finally, 33% of the observed value chains include state-owned entities.

[5] If no data was available the firm's assets value was set to USD 10 bn (i.e., Pertamina, National Libyan Oil Company, and EGPC).

Table 1: Explanatory variables and summary statistics

Characteristic	**Proxy**	**Unit**	**Denotation**	**Exp. sign**	**Mean**	**Std. dev.**	**Min**	**Max**	**N**
Proposition 1 (transaction cost variables)									
Asset specificity	Share of downstream capacities in the player's LNG portfolio	%	SPEC	+	0.479	0.446	0	1	237
External uncertainty	Political instability in the supplying country		UNC		0.616	0.379	0.13	1	237
Proposition 2 (shift parameters)									
Inter-organizational trust	Years of previous inter-country LNG trade +1	Count	TRUST1	-	6.283	8.583	1	38	237
	Value chain covering an expansion project of an already existing value chain	Dummy	TRUST2	-	0.367	0.483	0	1	237
	Firm already active along a value chain between the same export and import countries	Dummy	TRUST3	-	0.219	0.415	0	1	237
Control variables									
Change in industry structure	Start-up of the value chain after 1999	Dummy	D2000		0.527	0.500	0	1	237
Export region	Exporter in the Atlantic Basin	Dummy	EXPAB		0.439	0.497	0	1	237
	Exporter in the Pacific Basin	Dummy	EXPPB		0.405	0.492	0	1	237
	Exporter in the Middle East	Dummy	EXPME		0.156	0.364	0	1	237
Market share in the LNG industry	Capacity controlled by the player (% of total existing export and import capacity)	%	CAPOWN		0.040	0.052	0	1	237
Financial resources	Company size measured by the assets value	mn USD	ASSETS		63,476	63,628	358	195,265	237
Company type	Company being state-owned	Dummy	STATE		0.380	0.486	0	1	237

Table 2: Correlation matrix

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
VI1	1	1													
VI2	2	0.882	1												
SPEC	3	0.159	0.103	1											
UNC	4	-0.205	-0.151	-0.224	1										
TRUST1	5	-0.140	-0.185	0.042	0.104	1									
TRUST2	6	-0.092	-0.105	0.040	0.053	0.634	1								
TRUST2	7	-0.008	0.011	-0.141	0.055	0.467	0.654	1							
D2000	8	0.176	0.336	0.011	-0.068	0.011	-0.033	-0.029	1						
EXPAB	9	-0.065	0.067	-0.059	0.330	-0.142	-0.038	0.024	0.173	1					
EXPPB	10	0.030	-0.113	0.202	-0.230	0.288	0.138	0.103	-0.286	-0.730	1				
EXPME	11	0.049	0.067	-0.192	-0.140	-0.195	-0.135	-0.172	0.151	-0.380	-0.355	1			
CAPOWN	12	0.120	-0.001	0.222	0.004	0.014	0.053	0.090	-0.329	-0.100	0.237	-0.184	1		
STATE	13	-0.051	-0.119	-0.180	0.242	-0.103	-0.001	0.152	-0.148	0.097	-0.150	0.071	0.115	1	
ASSETS	14	0.197	0.225	-0.365	-0.115	-0.041	-0.066	0.006	0.063	-0.141	0.033	0.148	-0.098	-0.491	1

4.3 Methodology

In a first step, a probit model explaining vertical integration under the assumption that the dependent variable can be specified as an unobserved latent variable VI_i^{1*} is estimated. It is assumed that $VI_i^{1*} = \alpha X_i + \varepsilon_i$ where X_i is a vector of exogenous variables representing asset specificity, uncertainty and further independent and heterogeneous factors; α is a vector of coefficients; and ε_i is an error term with the cumulative density function $F(\varepsilon)$. We will observe $VI_i^1 = 1$ if $VI_i^{1*} > 0$ and $VI_i^1 = 0$ otherwise. Thus, the probability of observing vertical integration $\Pr(VI_i^1 = 1)$ 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, $\Pr(VI_i^1 = 1) = \int_{-\infty}^{\alpha X_i} \phi(t)dt = \Phi(\alpha X_i)$. Based on a first regression including ASSETS in linear as well as quadratic form a nonlinear relationship between this variable and VI^1 was found. Therefore, the logged value is included into the estimation model:

$$\begin{aligned} VI_i^1 &= \alpha_0 + \alpha_1 SPEC_i + \alpha_2 UNC_i + \alpha_3 (SPEC_i \cdot UNC_i) + \alpha_4 EXPAB_i + \alpha_5 EXPPB_i \\ &+ \alpha_6 D2000_i + \alpha_7 CAPOWN_i + \alpha_8 STATE_i + \alpha_9 \ln(ASSETS_i) + \varepsilon_i \end{aligned} \tag{1}$$

where i indexes a corporate-specific value chain and the error term ε_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(TRUST1), ii) TRUST2, and iii) TRUST3 – are estimated. Based on a first regression including TRUST1 in linear as well as quadratic form a nonlinear relationship between this variable and VI^1 was found; therefore, the logged value is included into the estimation model:

$$\begin{aligned} VI_i^1 &= \beta_0 + \beta_1 SPEC_i + \beta_2 UNC_i + \beta_3 (SPEC_i \cdot UNC_i) + \beta_4 EXPAB_i + \beta_5 EXPPB_i \\ &+ \beta_6 D2000_i + \beta_7 CAPOWN_i + \beta_8 STATE_i + \beta_9 \ln(ASSETS_i) + \beta_{10} TRUST_i + v_i \end{aligned} \tag{2}$$

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 (i.e., VI^2 as endogenous variable) – is estimated.

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.

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 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.

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 R^2 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.[6]

Table 3: Estimation results probit model

Specification	Proposition 1 Transaction cost and control variables			Proposition 2 Trust as a shift parameter included		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
CONSTANT	0.986 *** (0.269)	0.730 ** (0.328)	-3.628 *** (1.016)	-3.366 *** (1.042)	-3.500 *** (1.030)	-3.635 *** (1.019)
SPEC	-0.779 ** (0.368)	-0.802 ** (0.375)	-0.582 (0.438)	-0.686 (0.446)	-0.604 (0.439)	-0.583 (0.438)
UNC	-1.492 *** (0.341)	-1.474 *** (0.359)	-1.661 *** (0.390)	-1.654 *** (0.398)	-1.662 *** (0.391)	-1.660 *** (0.390)
(SPEC*UNC)	1.847 *** (0.521)	1.906 *** (0.524)	2.240 *** (0.581)	2.350 *** (0.592)	2.267 *** (0.584)	2.236 *** (0.582)
EXPAB		-0.058 (0.263)	-0.034 (0.271)	0.005 (0.272)	-0.021 (0.271)	-0.029 (0.275)
EXPPB		0.017 (0.270)	0.088 (0.291)	0.309 (0.307)	0.118 (0.293)	0.094 (0.297)
D2000		0.482 *** (0.181)	0.692 *** (0.204)	0.749 *** (0.207)	0.704 *** (0.204)	0.693 *** (0.204)
CAPOWN			5.337 ** (2.263)	5.919 ** (2.488)	5.667 ** (2.361)	5.361 ** (2.280)
STATE			0.569 ** (0.232)	0.537 ** (0.238)	0.560 ** (0.233)	0.573 ** (0.234)
ln(ASSETS)			0.361 *** (0.081)	0.344 *** (0.083)	0.353 *** (0.082)	0.361 *** (0.081)
ln(TRUST1)				-0.217 *** (0.080)		
TRUST2					-0.211 (0.195)	
TRUST3						-0.026 (0.242)

[6] To avoid multicollinearity problems due to the high correlation between the three variables measuring trust, 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.

Pseudo R²	0.080	0.104	0.213	0.236	0.217	0.213
Log-likelihood	-149.23	-145.46	-127.65	-123.93	-127.06	-127.64
AIC	306.47	304.91	275.29	269.86	276.12	277.28
BIC	320.34	329.19	309.97	308.01	314.27	315.43
N	237	237	237	237	237	237

*** 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 again 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

Specification	Proposition 1 Transaction cost and control variables			Proposition 2 Trust as a shift parameter included		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
SPEC	-0.624 ** (0.316)	-0.722 ** (0.324)	-0.409 (0.372)	-0.510 (0.375)	-0.448 (0.373)	-0.408 (0.373)
UNC	-1.122 *** (0.301)	-1.317 *** (0.323)	-1.315 *** (0.345)	-1.319 *** (0.350)	-1.332 *** (0.346)	-1.315 *** (0.345)
(SPEC*UNC)	1.408 *** (0.453)	1.676 *** (0.464)	1.761 *** (0.491)	1.899 *** (0.499)	1.819 *** (0.495)	1.761 *** (0.491)
EXPAB		0.078 (0.232)	0.088 (0.236)	0.128 (0.237)	0.106 (0.236)	0.086 (0.239)
EXPPB		-0.141 (0.234)	-0.170 (0.243)	0.032 (0.254)	-0.134 (0.245)	-0.173 (0.249)
D2000		0.781 *** (0.162)	0.886 *** (0.177)	0.967 *** (0.181)	0.910 *** (0.178)	0.885 *** (0.178)
CAPOWN			3.050 * (1.676)	3.088 * (1.702)	3.172 * (1.688)	3.045 * (1.679)

STATE			0.313 * (0.189)	0.286 (0.191)	0.311 (0.190)	0.311 (0.192)
ln(ASSETS)			0.341 *** (0.074)	0.324 *** (0.075)	0.333 *** (0.074)	0.341 *** (0.074)
ln(TRUST1)				-0.207 *** (0.068)		
TRUST2					-0.220 (0.167)	
TRUST3						0.009 (0.201)
Cut 1	-0.787 (0.232)	-0.518 (0.289)	3.470 (0.914)	3.204 (0.926)	3.332 (0.924)	3.468 (0.916)
Cut 2	0.235 (0.229)	0.598 (0.293)	4.687 (0.931)	4.449 (0.943)	4.552 (0.940)	4.685 (0.932)
Pseudo R^2	0.034	0.095	0.157	0.176	0.161	0.157
Log-likelihood	-241.72	-226.38	-210.87	-206.14	-210.00	-210.87
AIC	493.44	468.76	443.74	436.28	444.00	445.73
BIC	510.78	496.51	481.89	477.89	485.62	487.35
N	237	237	237	237	237	237

*** 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.

6. 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 export capacities by more than 100% from 1999 to 2009 (see also Ruester, 2010). 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, pre-existing inter-organizational trust should be treated as 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.

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Author contacts:

Sophia Ruester

Florence School of Regulation

Robert Schuman Centre for Advanced Studies, EUI

Via Boccacio 151

I-50133 Florence

Phone: +39 055 4685 752

Fax: +39 055 4685 755

Email: sophia.ruester@eui.eu