Nesset, E., Solli-Sæther, H. & Strand, Ø. *Bidrag innen kundeverdi og marked. Festskrift til Øyvind Helgesen.* Oslo: Universitetsforlaget.
DOI: https://doi.org/10.18261/9788215055596-2021-09

9. Onshore-offshore location decision for high-tech shipbuilding projects

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Abstract Innovative shipbuilding projects are relatively complex in design and equipped with advanced on-board systems. Vendors with different nationalities and cultures supply these systems, making the onshore-offshore location decision an important issue for these projects. A unique data set covering information of a Norwegian-owned fleet of 452 vessels is used to estimate and test the effects of the ship-owner's location and project complexity on the probability to choose onshore shipbuilding.

Keywords location decision | complexity | shipbuilding projects | maritime cluster

9.1 INTRODUCTION

Ownership, costs and control connected to the process of producing goods and services are crucial aspects for a firm operating in a global market, making the outsourcing-insourcing – make-or-buy – choice and the onshoring-offshoring (geographical location of production) choice two of the most important decisions a firm makes. The sourcing choice is often linked to the shoring decision (Pereira, Minjal, & Ishizaka, 2019).

Outsourcing is a "buy" decision for which the firm uses a third-party vendor for some of the service/product lines. This is a strategy for cost saving by enabling a stronger focus on the firm's core production processes. Insourcing is a "make" decision whereby the service/product lines are performed within the firm. This make-or-buy decision is thoroughly covered in the large body of transaction-cost literature where the clarification of the role of transaction costs, asset specificity and incomplete contracts has been developed (Grossman & Helpman, 2002; Grossman & Hart, 1986; Williamson, 1985, 2005). The sourcing decision is basically a "trade-off between the costs of running a larger and less specialized organization and costs that arise from search frictions and imperfect contracting" (Grossman & Helpman, 2002, p. 86).

The onshoring-offshoring choice has received much attention in the literature, but mainly in combination with the outsourcing decision (Ishizaka et al., 2019; Pereira et al., 2019). However, relatively few articles on these topics have been published within the fields of international business, management, organization and strategy (Pereira et al., 2019). This analysis contributes to filling this gap in the literature by revealing factors that are important for shipping companies' decisions regarding the use of local/national yards or foreign yards in shipbuilding projects. More specifically, we study the determinants of sourcing decisions in shipbuilding projects of advanced offshore support vessels. *Offshore support vessels*, also known as offshore supply vessels, are specialty ships designed to operate on the ocean, serving multiple purposes such as platform support, anchor handling, construction, maintenance, subsea operations and more. Shipbuilding requires a good relationship between partners in the shipbuilding project. Thus, we focus on the challenges connected to partner relationships (e.g., social capital in business networks) and project characteristics (e.g., complexity), and how these will influence the onshore-offshore location decision in shipbuilding projects. The analysis uses a unique data set containing information from 452 innovative shipbuilding projects from Norwegian-based ship-owners over the last 50 years. The data includes information about the onshore and offshore shipyards chosen, as well as the type of advanced supply vessel (complexity) involved. Our research question is:

How do partner relationship and project complexity influence the shoring decision in shipbuilding projects?

The rest of the chapter is organized as follows: In section 9.2, we briefly describe the contextual background of this study. Section 9.3 outlines the theoretical framework and the proposed empirical model being analyzed. Section 9.4 shows the data, section 9.5 shows the results, and in section 9.6, we discuss the results and conclude.

9.2 CONTEXTUAL BACKGROUND

A cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities (Porter, 2000, p. 254). The regional maritime cluster in Møre and

Romsdal county is a world leader in the design, construction and operation of advanced vessels for global ocean industries. The cluster consists of at least 215 firms, 19 ship-owners, 14 shipyards, 13 design companies and 169 ship technology suppliers. Together these firms employ approximately 20,000 workers within a county that has a population of about 265,000 (Hervik et al., 2012). Møre and Romsdal county enjoys a strategic position close to the North Sea, with rich fishing and oil and gas resources that have contributed to this local maritime industry concentration. Large investments in the oil and gas industry from the early 1970s, which enabled the exploitation of oil in deep waters and harsh weather conditions, made way for expensive and innovative offshore service vessels in the local maritime industry. Sailing officers and crew members have interacted with ship-owners, shipyards and ship technology suppliers to develop experienced-based innovations for high-end offshore vessels, resulting in expansion within the Norwegian maritime industry. Reve and Sasson (2012) describe this maritime cluster as one of the most prosperous in Norway.

According to the Norwegian Ship-owners' Association, the Norwegian offshore fleet is the second largest in the world, as well as being the most modern. It specializes in deep-water operations, which demand that larger vessels be able to operate in harsh weather conditions. However, since mid-2015, ship-owners in the offshore segment of this cluster have found themselves in deep trouble due to overcapacity, and new contracts are rare. Less activity in the oil and gas industry has forced the shipyards and suppliers to focus on other segments of shipbuilding such as fisheries, offshore wind and cruising.

Various actors have taken different roles within the maritime cluster network, and they employ different network structures. Ship technology suppliers may choose to operate within closed communities with shipyards within the cluster or engage in external ties with customers operating all over the world. Shipyards may have both a network of closed ties with suppliers and a more open network with design companies and ship-owners. Design companies can take the role of brokers or boundary spanners between ship-owners, shipyards and ship technology suppliers. Ship-owners supply offshore services in a global market with customer ties spanning the boundaries of the local maritime cluster. Some cluster actors have developed strong relationships from working together in previous projects and may share a common identity. Amdam et al. (2020) shows that cluster identity can play a role in firms' decisions regarding internationalization.

The regional maritime cluster has evolved over decades in an environment with many actors and firms involved in activities at sea and the development of new solutions based on their demands and ideas for improvements and novel solutions.

Today, Møre and Romsdal county has a high concentration of employees using equipment vessels and performing multi-actor operations related to deep-sea oil and gas operations. Firms involved in the development and production of tailored solutions for maritime use have evolved and clustered in the area, providing a concentration of individuals and firms with engineering and production skills related to this industry. Experience from previous projects has contributed to organizational knowledge useful in multi-firm interaction in new projects. From a situation where standardized vessels mainly involved welding hulls and installing components, advanced shipbuilding projects demand other knowledge bases. Ship-owners estimate that complete hull structures constitute only about 20 percent of the value creation in new vessels, and several yards choose to locate this task in lower cost countries. System integration yards have exchanged traditional welding work with more complex tasks related to system integration. Increased complexity in new one-of-a-kind projects tailored for new tasks calls for innovative solutions where sharing of tacit knowledge and social capital such as trust, common codes and established networks may be more important in reaching project goals effectively (Solli-Sæther & Karlsen, 2012).

9.3 THEORETICAL FRAMEWORK AND THE PROPOSED MODEL

Knowledge and knowledge management play a key role in managing businesses and projects successfully (Perez-Araos et al., 2007). Effective knowledge management has the potential to improve the effectiveness of project activities by increased learning ability, providing a major source of competitive advantage for project-based firms (Kivrak et al., 2008). Knowledge management is especially important in innovative shipbuilding projects that are relatively complex in design and equipped with advanced on-board systems. Multiple vendors with different nationalities and cultures often supply these systems. Research has shown that innovative shipbuilding projects involving various knowledge-based activities require different types of knowledge exchange between the actors involved (Solli-Sæther & Karlsen, 2012). However, organizations often face difficulties when trying to encourage knowledge sharing behavior (Wang, 2001). This may be due to the international, organizational and technological challenges faced by innovative shipbuilding projects (Berggren et al., 2011). International challenges may include cross-border projects – such as offshoring – and knowledge integration between companies in high-tech (high-cost) and low-tech (low-cost) countries, as well as cultural differences. Organizational challenges may include project management and control, and alignment of goals and success criteria, as well as social capital in business networks. Technological challenges may include knowledge specialization, complex technologies, issues of intellectual property rights and clock speed competition.

Prior research has come up with different reasons for global sourcing. Cross-border factor-cost advantages through "low-wage country sourcing" is traditionally the primary reason (Steinle & Schiele, 2008). Other goals may be to offset competitive disadvantages by finding foreign suppliers that offer quality or technology superior to what is available at home (global technology sourcing). Purchasing activities in target countries may also be a strategy to pave the way for future sales activities (Steinle & Schiele, 2008).

9.3.1 Onshore-offshore location decision

Offshoring can be defined as a manufacturing location decision, where manufacturing facilities or operations are placed in a different country (Ellram, Tate, & Petersen, 2013). Researchers have identified some of the factors driving offshoring as reduced costs without significantly lower quality (Venkatraman, 2004), market opening, entrepreneurial possibilities, proximity to suppliers in new markets and access to location-specific resources such as human capital (Barbieri et al., 2019). Jensen and Pedersen (2011) studied the economic geography of offshoring and found that offshoring manufacturing flows to low-wage destinations (i.e., Asia and Central and Eastern Europe), and, further, offshoring research and development flows to destinations with a substantial knowledge base (i.e., North America).

Cluster theory (and social capital theory) assumes a knowledge sharing advantage in knowledge-based clusters. In Norway, hourly wages are high compared to most available offshoring locations, so collaboration advantages from social capital within the cluster must outperform cost disadvantages from the higher wage costs of onshoring for this to be preferable. Potential collaboration advantages are likely to increase with the level of complexity or novelty of a shipbuilding project. We therefore assume that a Norwegian shipbuilder located within the maritime cluster has more social capital in relation to the maritime cluster than a ship-owner located elsewhere in Norway.

9.3.2 Social capital in innovative clusters

Positive externalities of firms within clusters and industrial districts are well documented in the literature (Molina-Morales & Martinez-Fernandez, 2006; Porter, 2008). Cluster literature has changed over time and increased its focus on externalities from social and relational resources (Molina-Morales & Martinez-Fernandez, 2006). This calls for studies that target the contribution of social capital in creating positive externalities for cluster firms.

Social capital theory is a label for diverse theories that share a focus on social relations as sources that can provide benefits to individuals or communities/regions. Standard definitions of social capital vary depending on which sources they include. A narrow definition includes only the network structure (Baker, 1990; Burt, 2000). A wider definition also includes social relation factors of the ties or connections (Bourdieu, 1985; Portes, 1998; Putnam, 1995; Woolcock, 1998). The broadest definition additionally includes potential resources related to the actor abilities located in the nodes of a network (Adler & Kwon, 2002; Nahapiet & Ghoshal, 1998). Within the field of organizational theory and management, Nahapiet and Ghoshal (1998) propose a definition of social capital as "the sum of the actual and potential resources embedded within, available through, [and] derived from the network of relationships possessed by an individual or social unit. Social capital thus comprises both the network and the assets that may be mobilized through that network" (p. 243).

The preceding definitions view social capital as a catch-all notion, involving different sorts of social concepts. However, according to Huber (2009) the usefulness of a social capital definition depends on its context or field-specificity, where specific types of resources should be in focus. In advanced clusters, knowledge and knowledge diffusion processes may be regarded as the key resources (Malmberg & Maskell, 2002), and this is the field-specificity for the conceptualization of social capital in our analysis.

Antoniette, Ferrante, & Leoncini (2016) find that social capital, measured as a standardized index following the standard catch-all definitions, has positive effects on the probability of outsourcing *within* the cluster, that is, outsourcing *and* onshoring. Since the catch-all view encompasses the narrower view focusing on key resources such as knowledge and knowledge diffusion processes, we propose the following hypothesis:

Hypothesis H1: *Higher social capital increases the probability of onshoring.*

The relevance of geographical concentration has changed its role due to globalization. Firms open up and interact with distant markets and resources in combination with the exploitation of local factor advantages as stated by Molina-Morales and Martinez-Fernandez (2006): "Previously located factors of production become globally available and, in consequence, they cannot be considered as the base of local competitive advantage. However, the pattern of specialization is remarkably stable" (p. 506). According to Barbieri et al. (2019), firms investing abroad to exploit efficiency-seeking advantages are more likely to undertake an offshoring than an onshoring location decision. However, the efficiency gains of the project must be weighed against the complexity of the project. As stated by Antoniette et al. (2016), the loss of control over the outsourced project (e.g., offshore shipbuilding project) or the costs potentially incurred when suppliers deviate from the contractual requirements make it more important for firms to be able to count on a highly trustworthy environment, where there is little risk of opportunistic behavior. Hence, we state the second hypothesis:

Hypothesis H2: *The more complex the project, the higher the probability of onshoring.*

Proximity as a factor contributing to tacit knowledge exchange, learning and innovation becomes the new explanation for clustered specialization advantages (Maskell, 1998; Maskell & Malmberg, 1999; Molina-Morales & Martinez-Fernandez, 2006). In the high-tech context of building advanced offshore supply vessels, several stakeholders are involved in concept development, sales, basic design, fabrication, outfitting, commissioning and delivery. In this case, social capital may help firms to reduce the uncertainty and the risk of outsourcing while increasing the opportunity to explore and exploit new opportunities and knowledge sources (Antoniette et al., 2016). In their studies of sourcing decisions Di Mauro et al. (2018) argue that onshore sourcing decisions are practically never due to cost, but rather due to a strategic positioning towards higher-end segments and to the consequent need for higher quality, innovation and co-location of manufacturing with research and development and marketing. Hence, we state the third hypothesis:

Hypothesis H3: *Higher project complexity increases the effect of social capital on the probability of onshoring (positive moderation).*

9.3.3 The conceptual model

This chapter builds on the assumption that ship-owners are economizing on core project goals (cost, quality, time and uncertainty) when choosing to build in Norway (onshore location decisions) or abroad (offshore location decisions). Ship-owners' decisions depend on specific offers from shipyards, which again depend on factors such as the macroeconomic environment of shipyards (wage costs, financing opportunities, aggregate supply and demand in segment); cluster environment; social capital from previous partner experience and/or cluster localization; and specific yard qualifications and yard capacity.

Each shipbuilding project constitutes a temporal project network formally regulated by contracts between the ship-owner and the shipyard based on a conceptual design and contract design. Shipyards take the role of system integrator and subcontract both complex coordination intensive tasks and standard purchases. The temporal limitations of contracts contribute to frequent renegotiations of contractual relationships, but collaborating firms tend to continue relationships when entering new projects.

Figure 9.1 illustrates the anticipated causal relations between ship-owner locations (cluster affiliation), complexity and the onshoring decision. Collaboration

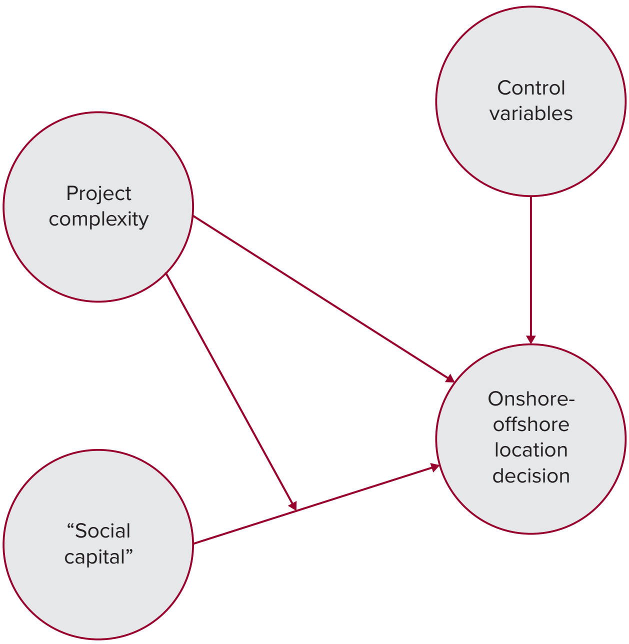

Figure 9.1: The onshore-offshore decision model.

advantages from low distance relationships have probably contributed to the development and survival of a Norwegian shipbuilding industry, where some ship-owners have seen these advantages as outperforming other cost advantages abroad. The onshore location decision is selected when ship-owners try to economize on overall project goals, and we expect the probability of building in Norway to depend on variables such as project complexity, cluster affiliation and previous experience.

9.4 DATA, MEASUREMENTS AND THE EMPIRICAL MODEL

We identified the fleet of Norwegian-owned offshore support vessels and collected information of ship-owner location, shipyard location, building year and vessel design and category by studying documents on the Internet. The sources were articles from naming ceremonies in maritime magazines and web pages from the following stakeholders: Norwegian Shipowners' Association, cluster organizations, ship-owners, shipyards, naval architects and class companies. We then added new constructed variables describing the number of vessels previously built abroad and the number of vessels previously built in Norway based on the collected data. Norwegian ship-owners' locations were coded as either within the maritime cluster at Møre and Romsdal or elsewhere in Norway. A vessel in the Norwegian-owned offshore support fleet in 2015 is the unit of analysis.

A total of 452 vessels in the Norwegian-owned fleet of offshore vessels is registered with information about the owner, design company, shipyard, year of build and vessel categories. This covers more than 90 percent of the total stock of Norwegian-owned offshore vessels. Table 9.1 shows a summary of the data for each ship-owner, the ship-owner's decision to build in Norway or abroad and four vessel categories: anchor handling tug supply (AHTS), platform support vessel (PSV), seismic vessels and subsea vessels.

Table 9.1: Norwegian-owned offshore support vessels in 2015

	AHTS		PSV		Seismic		Subsea		Total
Ship-owner	Abroad	Domestic	Abroad	Domestic	Abroad	Domestic	Abroad	Domestic	
Deep Sea Supply	10	5	23	2	0	0	0	0	40
DOF	13	6	0	25	0	0	5	18	67
Eidesvik Offshore	0	0	0	10	1	9	0	4	24
Farstad	5	27	6	20	0	0	0	4	62
GC Rieber Shipping	0	0	0	0	2	2	2	2	8
Golden Energy	0	0	4	5	0	0	0	0	9
Havila Shipping ASA	4	5	3	12	0	0	0	3	27
Island Offshore	0	3	0	18	0	0	1	10	32
Olympic Shipping	0	4	0	8	0	0	0	9	21
Rem Offshore ASA	0	0	0	10	0	0	0	9	19
Sanco Shipping AS	0	0	0	0	0	7	0	0	7
Siem Offshore	0	0	6	10	0	0	0	8	24
Simon Møkster	0	2	5	13	0	0	0	4	24
Solstad Offshore	5	14	1	8	0	0	2	16	46
Vestland Offshore	0	0	1	4	3	3	0	0	11
Viking Supply Ships	4	4	0	5	0	0	0	0	13
Volstad Maritime	0	0	0	0	0	4	0	6	10
Østensjø	0	0	3	2	0	0	0	3	8
Total	41	70	52	152	6	25	10	96	452

The onshoring location decision was measured as a binary variable. Project complexity and social capital were proxied by dummy variables. Control variables were year of build, number of previous builds at the yard and number of previous builds abroad.

We analyzed the data by estimating the following logistic regression model:

$$\Pr(Y = 1 | X) = F(\beta 0 + \beta X),$$

where Pr is the probability, Y is the binary dependent variable (onshoring decision), F is the cumulative standard normal distribution function, and βX is the vector of independent variables (X) with the attached vector of coefficients (β).

9.5 RESULTS

The estimation results for four different model versions are shown in Table 9.2. Estimation model 1 (the base model) only includes a constant term and the control variables.

Table 9.2: Logistic regression: Effects of project complexity and social capital on the probability of locating shipbuilding in Norway (n= 448)

	Model 1 Odds ratio (p-value#)	Model 2 Odds ratio (p-value#)	Model 3 Odds ratio (p-value#)	Model 4 Odds ratio (p-value#)
Control variables				
Year of build	0.973 (0.308)	0.944 (0,168)	0.966 (0.329)	0.964 (0.300)
Number prev. built at yard	1.734 (0.001)	1.758 (0.001)	1.754 (0.001)	1.740 (0.001)
Number prev. built abroad	0.680 (0.001)	0.692 (0.001)	0.691 (0.001)	0.698 (0.001)
Project complexity				
AHTS (dummy)		0.308 (0.002)		
Seismic (dummy)		1.007 (0.987)		
Subsea (dummy)		3.301 (0.019)		
Complexity (dummy)			3.183 (0.002)	2.660 (0.015)
Social capital				
Cluster (dummy)		2.165 (0.034)	2.022 (0.034)	1.763 (0.134)
Interaction term				
Complexity x Cluster				2.814 (0.181)
# *Robust* p-values based on 1,000 bootstrapping samples.				
Omnibus χ^2(df)	200.182 (3)	228.087 (7)	215.015 (5)	215.987 (6)
$\Delta\chi^2_{\text{model 2 – model 1}}$ (df)		27.905 (4)		
$\Delta\chi^2_{\text{model 4 – model 3}}$ (df)				0.972 (1)
Nagelkerke R^2	0.538	0.595	0.569	0.571
Cox & Snell R^2	0.360	0.399	0.381	0.383

Due to missing values in some of the explanatory variables in the logistic regression models, the number of observations is less in the tables 9.2 and 9.3 (n=448) than in table 9.1 (n=452).

Two of the three control variables affect the probability of onshoring. The number of vessels previously built at the chosen yard shows a significant positive effect on the probability of onshoring, and the number of vessels previously built abroad indicates a significant negative effect on this probability. These are expected results. The year of build has, however, an insignificant effect on the probability.

In estimation model 2, we also include the main predictors, namely, *project complexity* and *social capital*. These two variables are proxied by dummies for type of vessel (from less complex PSV, ATHS, and seismic, to highly complex subsea) and a dummy for belonging to the maritime cluster in Møre and Romsdal, respectively. The estimated odds ratios for the three vessel-type dummies (project complexity) in this model are compared to the results from the omitted dummy for the assumed least complex vessel type PSV. As for model 1, the chi-square (omnibus) test shows a statistically significant model. The chi-square change from model 1 to model 2 (27.905) is highly significant, indicating a significant improvement of fit in model 2 compared to model 1. The good fit is also reflected in the two pseudo R^2 measures (Nagelkerke R^2= 0.595; Cox & Snell R^2= 0.399), as well as by the fact that the percentage of correctly classified observations (84.8%) is well above the classical by-chance-classification-criteria. The most important predictor of the probability of onshoring is the dummy for the most complex vessel type, subsea, with an odds ratio of 3.301. Building the most complex vessel, subsea, instead of the least complex one, PSV, will thus increase the odds ratio of onshoring by as much as 230 percent. This finding thus supports hypothesis H1.

The second most important variable is the cluster belonging (a proxy for social capital). A firm belonging to the Møre and Romsdal maritime cluster will have a 116.5 percent higher odds ratio of onshoring a project compared to a firm outside this cluster, supporting hypothesis H2.

In estimation model 3, the three dummies for vessel type are substituted by a complexity dummy (equal to 1 for seismic and subsea vessels and 0 for the two other types). The odds ratio of this complexity dummy is almost of the same magnitude as the subsea dummy (column 2 in Table 9.2).

In estimation model 4, we also include an interaction term (the product of the complexity dummy and the cluster belonging) to see whether there is also a moderation effect in line with hypothesis H3. The interaction term is not significant, and a test of the improvement in model fit from model 3 to model 4 is not supported. Thus, based on the results from model 4, we can reject hypothesis H3. However, this result may be influenced by the strong restrictions on the estimated coefficients imposed by this model. All the regression coefficients except the coefficient for the interaction term are restricted to be equal for the two categories of project complexity, but these may be unrealistic assumptions. An alternative way of testing moderation effects is to split the sample according to the complexity dummy and estimate the model on both the low complexity sample and the high complexity sample. When the moderator variable is a categorical variable – as in our case – the multi-group analysis is often the preferred method. In this approach, there are no restrictions on the estimated coefficients. Table 9.3 shows the results from these two logistic regression models.

Table 9.3: Logistic regression: Effects of social capital on the probability of locating shipbuilding in Norway for low and high project complexity

	Low production complexity group (n= 311) Odds ratio (p-value#)	High production complexity group (n=137) Odds ratio (p-value#)
Control variables		
Year of build	0.919 (0.008)	1.012 (0.758)
Number previously built at yard	1.741 (0.001)	1.668 (0.002)
Number previously built abroad	0.704 (0.001)	0.724 (0.002)
Social capital		
Cluster	1.818 (0.140)	4.829 (0.055)
# Based on 1,000 bootstrap samples		
Omnibus χ^2(df)	170.120 (4)	32.250 (4)
Nagelkerke R^2	0.598	0.408
Cox & Snell R^2	0.421	0.210

Due to missing values in some of the explanatory variables in the logistic regression models, the number of observations is less in the tables 9.2 and 9.3 (n=448) than in table 9.1 (n=452).

The cluster effect is (weakly) significant (p=0.055) in the high-complexity group and highly insignificant in the low-complexity group. The odds ratio of cluster belonging for the high-complexity group is more than 2.5 times the (insignificant) odds ratio of cluster belonging for the low-complexity group. This result thus weakly supports hypothesis H3.

9.6 DISCUSSION, IMPLICATIONS, AND CONCLUSION

Social capital theory suggests that benefits from social capital may have a positive influence on knowledge sharing and innovation. Norwegian ship-owners' decisions on building location for 452 shipbuilding projects show patterns which can be explained by high levels of social capital in the local maritime cluster. The model shows a significant effect of ship-owners' cluster location and previous experience from building within the cluster on the location of shipbuilding projects. The model also shows a significant effect of project novelty on cluster location, where high novelty projects are systematically located within the regional maritime cluster. This confirms an expected effect whereby an assumed stronger social capital within the local maritime cluster contributes to performance when choosing to build in Norway and an assumed lower social capital when the distance increases between ship-owner and regional maritime cluster, contributing less to performance when building within the cluster. If increased distance between ship-owner and system integration shipyard reduces social capital and performance from partnership between ship-owner and shipyard, it is reasonable to expect an even stronger effect when distance increases from Norwegian shipyards to ship-owners abroad. This would mean that foreign-located ship-owners with even greater distance to the locus of this cluster have a disadvantage compared to local ship-owners if they choose to build in Norway. Non-cluster and foreign-located ship-owners have different options when optimizing their onshore-offshore decisions. If cluster-located ship-owners have the same opportunities and gains from social relations and networks when building abroad than foreign-located ship-owners, and still find local shipbuilding more competitive, this might contribute to competitiveness for cluster-located ship-owners. If cluster-located ship-owners do not have the same opportunities and gains from social relations and networks when building abroad than foreign-located ship-owners, their tendency to build locally may be a sign of lock-in in a less competitive relationship than ship-owners located abroad.

The model also shows a significant effect from previous building experience both in Norway (the same yard as the last vessel) and abroad. Previous building experience from building similar vessels at the same yard in Norway is a measure of relational experience and a possible proxy for measuring social capital between ship-owners and shipyards. The number of vessels previously built abroad is an aggregate of experience from different building locations and does not measure relational experience from a specific yard or cluster. This variable is considered as a proxy for global experience, which we expect to reduce switching costs when considering offshoring later shipbuilding projects.

Variables describing different categories of offshore support vessels have a significant effect on the possibility of building a vessel in Norway. PSVs have less variation in their function than subsea vessels, where the variation in design demands more tailoring of each vessel to specific purposes. The degree of novelty and thus project complexity is higher for subsea vessels than for PSVs, explaining the higher odds ratio for building subsea vessels in Norway compared to PSVs. The odds ratio of building AHTSs at a Norwegian yard is, however, less than the odds ratio of building PSVs in Norway, and the odds ratio of building seismic vessels is not significant. Possible explanations for these unexpected results may be that seismic vessels have their complexity linked to other knowledge bases, which is not core for this maritime cluster, while AHTSs are complex vessels with more standard functional requirements than PSVs. The assumption of subsea vessels being more complex with a higher degree of novelty than PSVs is more certain than the assumptions for AHTSs and seismic vessels. Better data regarding complexity and novelty for each vessel is necessary to further elaborate on these suggestions.

This research gives insight into the onshore-offshore location decision in a high-tech context. Offshore decisions may be more complex than earlier believed, so one should avoid being drawn into the common stream of thought – the belief that Central or Eastern Europe or Asia is the ultimate place for all kinds of shipbuilding projects – as it may not be true when the complexity of the project increases. Our study creates detailed insight into considering the complexity when including advanced and non-advanced activities in shipbuilding projects.

The aggregate demand for Norwegian-built vessels has probably influenced onshore-offshore decisions for Norwegian ship-owners. When Norwegian yards ran at full capacity, ship-owners could either delay their building projects or search new partnerships abroad. Aggregate demand has probably also affected the price level in offers from Norwegian shipyards, which again may have reduced the probability of building in Norway. Norwegian shipyards' order reserves could probably be included in the model to control for these effects.

The available data set only has a limited set of variables. We have used these variables as proxies for vessel complexity, ship-owners' social capital from previous projects and cluster attachment. Other variables that may influence the localization decision in general are missing in this analysis. For variables which did not change much during the period when these vessels where built, this is of little relevance; for example, the assumption of lower wage costs when offshoring than when building in Norway is probably valid and did not dramatically change during this period. Other variables, such as the aggregate demand for vessels in this segment, have probably had a significant effect on ship-owners' onshore-offshore decisions. If there are situations where shipyards are at full capacity with high order reserves in Norway, ship-owners are forced to offshore new projects.

The collected data also provides information of continuation or breaks in relationships between ship-owners and shipyards for successive projects. If complexity increases the value of close relationships, we expect these to be stronger for the most complex vessel categories. Using a continuing relationship (i.e., using the same yard as last time) as a dependent variable is one way to test this assumption in later work.

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