MASTER'S THESIS – MASTER INNOVATION SCIENCES

GLOBAL VALUE CHAINS AND LOCAL INDUSTRIAL DEVELOPMENT: THE CASE OF OFFSHORE WIND

Rowan Langeveld

r.langeveld@students.uu.nl

Supervisors: Prof. dr. Marko Hekkert, Adriaan van der Loos, M.A.

Second evaluator: Dr. Simona O. Negro

Faculty of Geosciences

Utrecht University

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Abstract

The energy transition is essential for climate change mitigation while it provides opportunities for sustainable economic growth. However, many renewable energy sectors have become increasingly globalized with multinational lead firms creating value on a worldwide scale. This raises questions of how individual nations can develop new sources of sustainable industrial growth. The offshore wind industry is used here to assesses the geographic properties of supplier sourcing performed by lead firms for different parts of the value chain. I break down the supply-chain into three governance modes: *market, modular and relational*, depending on the *complexity* and *the ability to codify* the part. Also, the effect of a country's *home market size (measured in MW)* and the presence of *local content push* on the origin of the supplier is tested. The origin of a supplier is operationalized as coming from the global market *(global sourcing)*; from the country where the lead firm is from *(developer sourcing)*; from the windfarm country *(local sourcing)*; or a combination of the latter two *(local-developer sourcing).* This leads to the following propositions: 1) *Global sourcing most likely occurs in the market-based parts of the value chain, followed by the modular and relational parts*; 2) *Developer sourcing and local-developer sourcing most likely occur in the relational parts of the value chain, followed by the modular and market-based parts*; 3) *Local sourcing and local-developer sourcing are positively influenced by greater market diffusion (megawatts of installed capacity)*; 4) *Local sourcing and local-developer sourcing are more likely when local content is encouraged, but will be most effective in the market-based parts of the value chain.* This research runs several logistic regressions based on the '4C Offshore Wind database', in order to test for the propositions. The results indicate that lead firms draw from the global market mostly for the market-based parts of the value chain followed by the modular and relational parts. Also, lead firms are not more or less likely to draw suppliers from their home country in either of the three governance modes, unless the windfarm is located in the lead firm's country. In addition, lead firms are more likely to draw suppliers from the windfarm country when there is a push for local content. Importantly, these local content requirements are the most effective in selecting local suppliers for the market-based parts of the chain and the least effective in the relational parts of the value chain.

Key words: governance, global value chains, value chains, industry formation, local content requirements, offshore wind

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List of Abbreviations

EPCI	Engineering procurement construction and installation
GVC	Global value chain
GW	Gigawatt
LCR	Local content requirement
MW	Megawatt
NIS	National innovation system
RE	Renewable energy
RIS	Regional innovation system
SIS	Sectoral innovation system
TIS	Technological innovation system
TNC	Transnational corporation

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Chapter 1: Introduction

1.1 BACKGROUND

Europe is exploring how to become carbon-neutral by 2050 (European Commission, 2020). This would contribute to limiting global warming to less than 1.5°C by the end of the century in line with the Paris Climate Agreement. Achieving these objectives would require significant technological development across a range of renewable energy (RE) sectors to enhance the competitiveness of immature renewable technologies (IRENA, 2019). In pursuit of the European environmental commitments, opportunities arise for economic value creation on a national scale (IRENA, 2018). Local income generation and job creation in the RE sector can be maximised by building local value chains (Lewis & Wiser, 2007).

However, the RE sector has become increasingly globalized with multinational lead firm corporations creating value on a worldwide scale, raising questions of how regions and nations can build local capacity in global value chains (Lacal-Arántegui, 2019; MacKinnon et al., 2019). Global value chains (GVCs) involve a mode of production that is coordinated and controlled by lead firm corporations, but that is both functionally and geographically fragmented (Mayer et al., 2017). The globalization of value chains is challenging the resilience of many local production systems, where firms are facing new foreign competitors, and losing market share (Elola et al., 2013). Whilst lead firms may desire global sourcing of suppliers, many governments want those lead firms to select local suppliers to support industry building and economic growth (Munson & Rosenblatt, 1997). In order for countries to protect their industries, many countries encourage foreign lead firms to select local suppliers by applying pressure on local content (Kochegura, 2017). So lead firms must decide which components and services to source locally to satisfy local content policies and which components and services to source internationally to garner some of the advantages of global sourcing (Munson & Rosenblatt, 1997).

GVC theory suggests that how lead firms select their suppliers and manage the inter-firm relationships, which is called ‘governance’, matters for the geography of supplier sourcing. In general, five forms of GVC governance have been identified: market, modular, relational, captive, hierarchy (Gereffi et al., 2005). Different types of suppliers maintain diverse relationships, in terms of the mode of governance, with lead firms depending on three parameters: the complexity of the information involved in the transaction, the possibility of codifying that information and the capabilities in the supply-base (Elola et al., 2013; Gereffi et al., 2005). Different combinations of parameter values point towards differential degrees of standardization and technological complexity (Gereffi et al., 2005). Analogous to what Binz & Truffer, (2017) have shown for industries as a whole, this heuristic is used to create propositions on why in some value chain parts a global reach is more likely than in other parts.

1.2 RESEARCH SCOPE

To unravel how lead firm governance and local content policies affect the geography of supply chain selection in the light of globalization I focus on the offshore wind industry in Europe for multiple reasons. First, offshore wind energy is a core renewable that supports Europe's path to a carbon-neutral society (WindEurope, 2019). Second, it provides opportunities for local value creation as technological improvement and supply chain expansion is required to realize the estimated 240 -450 GW of offshore wind power that is needed by 2050 to meet carbon neutrality (WindEurope, 2019). Third, the offshore wind industry is an exemplary case of a renewable energy sector that is nested within a larger global economy (MacKinnon et al., 2019). An extensive value chain is required to build and operate an offshore wind farm, and each project involves hundreds of companies originating from different countries, increasing the geographic fragmentation in the GVC (BVG Associates, 2013; Dedecca et al., 2016). Fourth, wind farms are developed by a few dominant lead firms that organize construction activities and select the appropriate suppliers (van der Loos et al., 2020). Those often times known suppliers follow lead firms to serve new foreign markets (Lacal-Arántegui, 2019). Lastly, national industrial policies are enforced with the aim to push for local content inclusion in the respective GVC in order to increase the value to the local economy (MacKinnon et al., 2019).

This research attempts to broaden our knowledge about the geographical properties of supplier sourcing in offshore wind based on the mode of governance applied by lead firms and the presence of local content requirements (LCRs), drawing from some fundamental insights of GVC literature and the broader field of innovation system studies. More specifically, supplier sourcing is defined based upon the geographical origins of the lead firm and the location of the offshore wind farm. This helps to assess the tendency lead firms might have to draw with them suppliers from their home country in the light of increasingly globally spread value chains and countries' willingness to build up robust local supply chains (Elola et al., 2013; Henderson et al., 2002; Hess, 2004; Mackinnon, 2011).

This leads to the following research question:

Under what conditions do lead firms draw on suppliers from their home country (developer sourcing), from the wind farm country (local sourcing), a combination of both (local-developer sourcing) and the global market (global sourcing) for different parts of the value chain for offshore wind farms in Europe?

A quantitative research strategy based on the 4C Offshore Wind database, a dataset composed of all windfarms including their location and size and the affiliated stakeholders, is used to perform binomial and multinomial logistic regression analyses to investigate any patterns of supplier sourcing, for the different parts of the value chain for all windfarms in European coastal areas.

1.3 RESEARCH SIGNIFICANCE

This thesis contributes to theory, because investigating the extent to which lead firms will draw on suppliers from their home country, as opposed to developing global or local supplier linkages will add to theory on the spatial character of industry building in the light of globalization. As such it fits the modern debate about the spatial complexity of production and innovation systems (Binz & Truffer, 2017). It aims to extend the discussion by arguing that the lead firm – supplier relationships that characterize industrial organization not only differ between industries, but also within industries if one breaks up the value chain. The research is a first step to establish the link between specific value chain parts, modes of governance and the different prospects local suppliers and their countries have for growth and building industries and therefore fits an academic avenue proposed by Pietrobelli & Rabellotti (2011) . More specifically, the research meets the call for further research into the question of how organizations and industries affect the spatial character of sustainability transitions as advocated by (Coenen et al., 2012).

This thesis contributes to society, because specifying the different parts of the offshore wind value chain provides insight in the technical competences related to offshore wind that a country possesses. Different parts of the chain are associated with different technical competences, different lead firm supplier interactions and related to this, different prospects for industrial upgrading (Gereffi & Luo, 2015; Pietrobelli & Rabellotti, 2011). Knowing the technical competences of a country has implications for the potential a country has for upgrading towards more technologically complex parts of the offshore wind value chain where profit margins are usually higher and the risk of being replaced based upon reasons of price is lower (Gereffi, 2011). Based upon these insights, crafting policy interventions, aimed at upgrading the position of local firms and industries within global production systems will likely be more effective (Bair & Sturgeon, 2008). This insight is even more important because if there are parts of the value chain for which lead firms are more likely to source from their home market, it is in these parts then that states tend to have less leverage to demand local content requirements or less scope to stimulate links to local suppliers (Gereffi, 2014).

1.4 THESIS OUTLINE

The remainder of this thesis proposal is structured as follows. Chapter 2 evaluates the literature about innovation systems and argues about what literature on GVCs can potentially add. Also, propositions are constructed throughout this evaluation. Chapter 3 outlines the design and methodology of the research. The results are given in chapter 4, followed by an extensive analysis in chapter 5. In chapter 6, the theoretical and practical contribution of the research are given together with its limitations and some suggestions for further research. Finally, the research is summarized and concluded in chapter 7.

Chapter 2: Literature Review

2.1 THE SPATIAL COMPLEXITY OF INDUSTRIAL DEVELOPMENT

The birth and growth of a new technological field is a complex, multi-faceted process shaped by supporting institutional structures and the innovative behaviour of different types of actors (Musiolik & Markard, 2011). The inauguration of a new technological field is accompanied by the gradual decline observed in another more mature and socially established technological system. This suggests that the emergence of new technologies requires the facilitating capacity of elements that lie beyond technological development alone (Hekkert et al., 2007). Technological growth tends to co-evolve with changes in surrounding factors like markets, user practices, (economic) infrastructures, social contexts, policy environments and cultural discourses (Smith, 2000). The recognition of this systemic character of change has led to the widespread application of the concept of 'innovation systems' (Hekkert et al., 2007; Markard & Truffer, 2008). Innovation systems are defined as "*all important economic, social, political, organizational, institutional, and other factors that influence the development, diffusion, and use of innovations*" (Edquist, 2005). The development of the concept started with national innovation systems (NIS), regional innovation systems (RIS) and sectoral innovation systems (SIS) (Niosi, 2008). A fourth alternative, technological innovation systems (TIS), aims to include the dynamics of the increasingly globalized economy and is seen as the most suitable of all to inform policy (Hekkert et al., 2007). Technological innovation systems are defined as a "*network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure and involved in the generation, diffusion and utilization of technology*" (Carlsson & Stankiewicz, 1991, p. 111). As such a TIS involves a broad delineation around a technology and hence crosses the boundaries of multiple NISs, SISs and RISs (Hekkert et al., 2007). Although TISs have emerged as a response to its spatially delineated predecessors, most TIS studies are still performed within an spatially confined frameworks of analysis and hence provide only limited insights into the spatial dimension of socio-technical change (Coenen et al., 2012). Such TIS approaches implicitly assume that the broader (global) context surrounding a system is represented as an ubiquitous ‘global technological opportunity set’ (Binz et al., 2014; Coenen et al., 2012).

A global technological opportunity set incorrectly assumes that all interactions have become randomly spread across the globe (Binz et al., 2014). Rather, industry growth is nested within both dense local actor networks and transnational production networks (Dicken, 2011). In this view, the emergence and growth of environmental technologies is a complex phenomenon that depends on how processes play out at and between different geographic scales, connecting distant places in technological innovation systems (Binz & Truffer, 2012). How this combination plays out empirically depends on a number of factors, such as the type of industry and the underlying knowledge base of the different activities (Binz et al., 2014; Binz & Truffer, 2017).

Thus, innovative activities aimed at new industrial development in general and sustainability transitions more specifically occur at various geographical scales and in different locations simultaneously (Coenen et al., 2012). Various recent academic improvements in innovation system literature tried to conceptualize these spatial complexities of newly emerging (clean tech) sectors (Binz et al., 2014; Binz & Truffer, 2017; van der Loos et al., 2020; Wieczorek et al., 2015). Those attempts have shown that strengths in terms of system functions that are present in some locations can compensate for weaknesses elsewhere, because the actors in the different national innovation systems are to a great extent internationally oriented (Wieczorek et al., 2015).

Here the global orientation of firms is elaborated on by bringing in the concept of GVCs, that focuses more exclusively on inter-firm linkages, in order to show the crucial impact of international collaboration on the generation and diffusion of new technologies. The precise properties and scales of inter-firm linkages remain black boxed in innovation system literature (Markard & Truffer, 2008), hence bringing in GVCs might prove fruitful. However, it is beyond the scope of this research to extensively elaborate on how GVCs and innovation system studies can be brought under one conceptual umbrella. GVCs provide a different however complementary perspective to meet the challenge that has recently been taken up by innovation scholars to acknowledge the inappropriateness of a homogenous global opportunity set to which all actors have equally access (Binz et al., 2014; Coenen et al., 2012). GVC analysis allows for a fine grained description of a technology and is concerned with how and in what forms different parts of a technology are open to various channels for transfer of foreign knowledge (Fagerberg et al., 2018). As such, it suits the recent acknowledgments made in innovation system studies concerning the interconnectedness of innovation systems across multiple spatial levels. Inclusion in GVCs not only provides a firm with new markets for their products, it also plays a role in access to knowledge and enhanced innovation capabilities which is associated with substantial backward linkages to the domestic economy (Pietrobelli & Rabellotti, 2011).

One last interesting aspect of this debate, one that directly affects the purpose of this research, is the interdependence between innovation and global production patterns. Firms must continually innovate to compete beyond geographic borders in today's new global reality and use innovation as a competitive instrument. Innovation is also a driver of better quality and lower cost which are both needed to turn an infant technological innovation system into an established global production system (Fløysand & Jakobsen, 2011; Lacal-Arántegui, 2019).

2.2 GLOBAL VALUE CHAINS

Global value chains are defined as "*The set of intra-sectoral linkages between firms and other actors through which geographical and organizational reconfiguration of global production is taking place*" (Gibbon et al., 2008, p. 4). The spatial and organizational dispersion of economic activity poses challenges for the coordination of value chains (Amico et al., 2017). These challenges are taken up by lead firms who undertake the functional integration and coordination of internationally sliced-up activities (Humphrey & Schmitz, 2001). Lead firms are defined as "*a dominant party (or sometimes parties) who determine the overall character of the chain, and … becomes responsible for upgrading activities within individual links and coordinating interaction between the links*"(Kaplinsky et al., 2000, p. 8). The 'lead agent' role is often played by large transnational corporations (TNCs) (Christopherson & Clark, 2007).

In deciding how to manage value chains in global innovation systems, lead firms confront a number of choices (Gibbon et al., 2008). First, the lead firm has to decide whether to make the components or deliver the services by itself or to procure it from the market. Secondly, when a decision to buy is made, lead firms must select their suppliers and they must specify the contractual arrangements (Gibbon et al., 2008). Contract forms refer to the agreement between a lead firm and its suppliers concerning the delivery of products or services (Amico et al., 2017). Literature on global value chain governance (GVC governance) refers to the content and the management of these decisions across all suppliers.

Governance involves the ability of the lead firm in the chain to influence or determine the activities of other firms in the chain (Gereffi et al., 2001). More specifically, the symbiotic relationship between a lead firm and its suppliers is rooted in the lead agent role, indicating the presence of power asymmetry between lead firms and suppliers (Christopherson & Clark, 2007; Ponte & Sturgeon, 2014). This power is exercised through the lead firms' governance over key resources needed in the chain, decisions about entry to and exit from the chain, monitoring of suppliers and technical support to suppliers (Gereffi et al., 2001). Firm networks are always constructed around relative power relations, only the size of the relative power differs by value chain configuration (Christopherson & Clark, 2007). Without such heterogeneous distribution of power, value chains are unlikely to be efficiently coordinated and thus associated with high transaction costs (Wilson & Hearnshaw, 2013).

According to Gereffi et al. (2005), governance modes vary according to the values (either high or low) of three independent parameters:

1. the complexity of the information involved in the transaction
2. the possibility to codify that information
3. the capabilities in the supply-base

On the basis of these three factors, the authors identify five modes of governance: (1) market-based chains, characterized by low complexity of transactions, easily codified product specifications and sophisticated competence of suppliers; (2) modular chains, characterized by high complexity of transactions, whilst the ability to codify specifications is easy and when suppliers have the capacity to supply full packages without monitoring and control by lead firms; (3) relational chains, characterized by complex transactions that are not easily codified and highly idiosyncratic relationships with highly competent suppliers, associated with high switching costs to new value chain partners; (4) captive chains, characterized by complex transactions that are easily codified, however the suppliers' competence is low, making the supplier highly transactional dependent upon the lead firm who exerts a high degree of monitoring and intervention; and (5) hierarchical chains, characterized by vertical integration in the case of complex transactions that are not easily codified and when the competence of suppliers is low. The five different global value chain governance modes are listed in Table 1.

Table 1. Key determinants of global value chain governance (source: Gereffi et al., 2005)

Governance type	**Complexity of transactions**	**Ability to codify transactions**	**Capabilities in the supply-base**	**Degree of power asymmetry**
Market	Low	High	High	Low
Modular	High	High	High	↓
Relational	High	Low	High	
Captive	High	High	Low	
Hierarchy	High	Low	Low	High

Different forms of governance may be apparent in a given chain at any point (Ponte & Gibbon, 2005). A GVC may be characterized by different forms of coordination in various parts, implying that the lead firm - supplier interaction differs between a lead firm and different types of suppliers (Gibbon et al., 2008). The relevance of governance to GVC analysis is thus that it highlights the organizational forms through which a specific division of labour between lead firms and other economic agents involved in the conceptualization, production and distribution of goods in global industries is established and managed (Gibbon et al., 2008).

Lead firms are faced with the challenge of finding a balance between global contracting and local sourcing along the length of the value chain, meaning that superior supplier working relations are sometimes established through global contracting with foreign suppliers, sometimes through local sourcing with suppliers from the country where a lead firm has been translocated and sometimes with suppliers from the lead firms' home country (Holweg et al., 2010; Yeniyurt et al., 2013). Ponte & Sturgeon (2014) state that the tolerance of geographic distance between a lead firm and its supplier is described by a continuum ranging from high tolerance in the case of market-based modes to low in the case of relational modes. The 'captive' and 'hierarchy' are modes captured within the lead firm, and hence not relevant for supply-chain selection.

A lead firm will typically forge market-based modes for standardized and technologically mature parts of the chain (Bair & Sturgeon, 2008). Standardized parts of the chain rest on codified forms of knowledge that can be transmitted relatively easily across distance (Dicken, 2011), making a global sourcing strategy more likely in these cases (Elola et al., 2013).

When both the complexity of the activities in a part of the chain and the ability to codify are high, the required transaction-specific investments are low. In case of such modular GVC linkages the potential for tight coordination of distant activities is high, even though activities are highly complex (Bair and Sturgeon, 2008). Like market-based modes, this provides reasons to believe that a global sourcing strategy is likely to be applied. However, the tolerance of geographic distance between a lead firm and its supplier is lower for modular parts of the value chain than for market-based modes, but higher when compared to relational parts of the value chain (Ponte & Sturgeon, 2014). This leads to the following proposition:

Proposition 1: *Global sourcing most likely occurs in the market-based parts of the value chain, followed by the modular and relational parts*.

When activities in a part of the chain are both complex and hard to specify explicitly, the underlying knowledge base is tacit in character and therefore extremely hard to put down on paper (Pietrobelli & Rabellotti, 2011). Activities that rest on tacit knowledge require close cooperation between a lead firm and the supplier base, creating high transaction-specific investments. Lead firms are less likely to adopt a global sourcing model in the case of complex and customized products, processes and services (Amico et al., 2017). Activities that include high transaction-specificity are more likely to occur between firms that have similar national origins. The distinctive cultures, practices and institutions of nation states helps to shape the modes of economic activity (Dicken, 2011). Firms, either lead firms or suppliers, arise from, and continue to be influenced by those cultural and institutional dimensions (Henderson et al., 2002). Similarity in terms of cultural and institutional background tends to facilitate cooperation between business partners, stimulating developer sourcing over global sourcing (Boschma, 2005; Sheth & Sharma, 1997). Indeed, lead firms tend to develop historic ties to their regions of origin (Mackinnon, 2011). Linking with key suppliers and access to domestic labour skills may provide particular advantages in the global economy (Hess, 2004; Mackinnon, 2011). This leads to the following proposition:

Proposition 2: *Developer sourcing and local-developer sourcing most likely occur in the relational parts of the value chain, followed by the modular and market-based parts.*

Whilst the GVC modes may have great influence on the geography of sourcing in different parts of the value chain, the economic geography of entire industries cannot be read from the micro-foundational characteristics of value chain linkages alone (Bair & Sturgeon, 2008). History, institutions, and social contexts all matter for how firms and groups of firms are linked in the global economy (Gereffi et al., 2005). This research takes market diffusion (megawatts of installed capacity) and the presence of local content requirements into account as two examples.

2.3 MARKET DIFFUSION

There are multiple pathways a country can use to pursuit new sources of industrial growth. Basically, a distinction can be made between an approach of demand-pull and an approach in which technology-push is more favoured (Nemet, 2009). Technology-push policy is typically enacted as public R&D subsidy programs, whilst demand-pull policies include market-based instruments such as feed-in tariffs (Peters et al., 2012). The ongoing debate about the effectiveness of both approaches to stimulate the formation of new industries often leads to generalizations about the importance of the combination of technology-push and demand-pull (Nemet, 2009).

Although it is possible to stimulate industry growth without bearing the enormous investments associated with enforcing local demand-pull policies, this is only possible under very specific conditions (van der Loos et al., 2020). Therefore, it is argued that a local market remains an important factor influencing the formation of new local industries (Fagerberg, 2010). By offering subsidies and tax-exemptions, policy makers can seduce foreign suppliers to localise their operations abroad (Bednarz & Broekel, 2020). Moreover, existing local firms might diversify into the new industry as a consequence of the additional demand, especially when their industries are related in terms of competences and knowledge bases (Hansen & Steen, 2015). For example, MacKinnon et al. (2019) highlight the importance of a home market to make oil and gas firms branch into and help create an offshore wind industry. As such demand creation can initiate local supply and is likely to result in more offshore wind farms being constructed, leading to even higher installed capacities (Connor, 2004). Thus, the formation of a domestic market can be crucial for initiating the rise of local suppliers and developing sophisticated local industrial capabilities and experience (Lewis & Wiser, 2007; Steen, 2016). Furthermore, a stable local market is often times related to a firm's success in value chains located elsewhere (Lewis & Wiser, 2007). In summary, countries can use local market formation not only as a means to induce local participation of local firms or as a means to attract foreign direct investment, but also as a means to enhance competitive advantage internationally. In other words, local demand creation provides manifold opportunities for the rise of local industrial base (Kirkegaard et al., 2009). This leads to the following propositions:

Proposition 3a: *For wind farms that are developed by foreign developers, local sourcing becomes more likely at a higher installed capacity.*

Proposition 3b: *For wind farms that are developed by at least one local developer, local-developer sourcing becomes more likely at a higher installed capacity.*

2.4 LOCAL CONTENT REQUIREMENTS

Local content requirements constitute one of the instruments that countries use to shield their local economies from foreign competition. The primary objective for the use of LCRs is to develop local industries, to enhance the value-added by local activities and to increase employment (Kuntze & Moerenhout, 2013; WTI Advisors, 2013). "*Local content requirements are policy measures that require foreign or domestic investors to source a certain percentage of intermediate goods from local manufacturers or producers. These local producers can be either domestic firms or localized foreign owned enterprises"* (Kuntze & Moerenhout, 2013, p. 5). Countries differ in their inclusion of local content requirements in their industrial policies. Countries can use LCRs as an obligation to win RE projects though procurement tenders. In other cases, lead firms will not receive tariff rebates or subsidies, which are very common for RE, if they cannot fulfil the share of local suppliers that they have to include in their value chains (Kuntze & Moerenhout, 2013). This is the 'carrot-and-stick approach', where the carrot size attracts foreign direct investment to the local economy, whilst the stick-side obligates those investors to comply with pre-established local content shares (WTI Advisors, 2013). These policies shape governance at the level of the 'whole chain' (Ponte & Sturgeon, 2014).

From this perspective LCRs seem to stimulate local sourcing and local economic growth, whilst rewarding lead firms for their efforts. However, an extensive debate has formed that questions its effectiveness (see Kuntze & Moerenhout (2013) for an overview). In the context of this research the rise of transaction costs is the most important.

Transaction costs on behalf of the lead firm will rise when faced with LCRs, because from their perspective a cost is associated with local sourcing (Information Technology Industry Council, 2016). Lead firms tend to rely on global networks they have developed with partners across the globe to maximize cost efficiencies and access capable suppliers in order to capitalize fast on new innovation opportunities. If LCRs obligate a lead firm to establish part of its business network in a specific location with costs higher than when they could freely put from their own network, then lead firms must raise its prices to compensate for the additional increase in costs (Information Technology Industry Council, 2016). This might have severe societal consequences. First, in the context of RE, the increase in transaction costs is reflected in higher electricity retail prices which are usually directly passed to the local consumer (Kuntze & Moerenhout, 2013). More generally, the competitiveness of electricity produced by renewables compared to fossil fuel electricity prices might decrease as a consequence of LCRs, hence slowing down the energy transition. Second, from transaction cost theory it is assumed that firm always seek to minimize their transaction costs (Williamson, 1981). If lead firms apply this logic in dealing with LCRs, it is expected that their effect is highly interdependent with the nature of the value chain part. Transaction costs are inherently higher in relational value chain parts, than in market-based value chain parts (Gereffi et al., 2005). Therefore, switching suppliers is very expensive in case of relational tasks whilst it is relatively easy to pick a more cost-competitive supplier for a market-based activity, nonetheless because they are likely to be more widely available as well (Eriksson & Edlund, 2013; Gereffi et al., 2005). This means that LCRs might only increase a country's local participation in the low-value added parts of the value chain where the prospects for economic growth are small. This leads to the following proposition:

Proposition 4a: *For wind farms that are developed by foreign developers, local sourcing is more likely to occur under the presence of local content requirements, but less likely in the relational-based parts of the value chain than in market-based parts or modular parts and less likely for the modular parts than the market-based parts.*

When the windfarm country happens to coincide with the headquarter country of the windfarm developer it is expected that the effect of LCRs does not depend upon the nature of the value chain parts as depicted by the mode of governance. It was expected that local-developer sourcing would be more likely to occur in the relational based parts not taking into account LCRs, following the rationale behind proposition 2. Therefore, when local content becomes required, it is expected that the effectiveness is high in the market-based parts of the value chain but not at the expense of the share of local content in the modular or relational parts of the value chain. This leads to the following proposition:

Proposition 4b: *For wind farms that are developed by at least one local developer, local-developer sourcing is more likely to occur under the presence of local content requirements, across the value chain.*

2.5 THE OFFSHORE WIND VALUE CHAIN

There have been multiple attempts that aimed to capture the diversity of the offshore wind value chain in schematic overviews. However, most studies (see e.g. Elola et al., 2013; Lema et al., 2011; MacKinnon et al., 2019; Yuan et al., 2014) took a slightly adjusted representation of the onshore value chain as a basis for their claims about offshore wind. These representations are considered to be insufficient as a starting point for explaining the lead firm - supplier interaction in the offshore wind industry, because the value chain of offshore wind is distinctive from its onshore counterpart. For example, the set of environmental assessments and site preparations is more extensive, a range of different vessels is required and technological components like sub-sea grid connections are absent for onshore wind (Accenture, 2013; Steen, 2016). Some studies today recognize this drawback and develop representations of the chain that are more specific for offshore wind (Poulsen & Lema, 2017).

Each offshore wind farm only starts to be constructed after it successfully proceeds through a pre-development stage in which feasibility studies and site explorations are performed. In some countries the pre-development work is performed in advance of the tendering process on behalf of the government, meaning that the developer only enters the windfarm project when construction starts, such as in the Netherlands and Denmark (EWEA, 2015; MacKinnon et al., 2019).

During construction, the wind farm is actually built and it includes activities of manufacturing different components, transport, installation and commissioning. Once the construction phase has been finished the wind farm is operated and maintained until the decommissioning phase is entered. However, no large offshore wind farm has reached this stage yet (Poulsen & Lema, 2017). The value chain of offshore wind farm development is illustrated in figure 1.

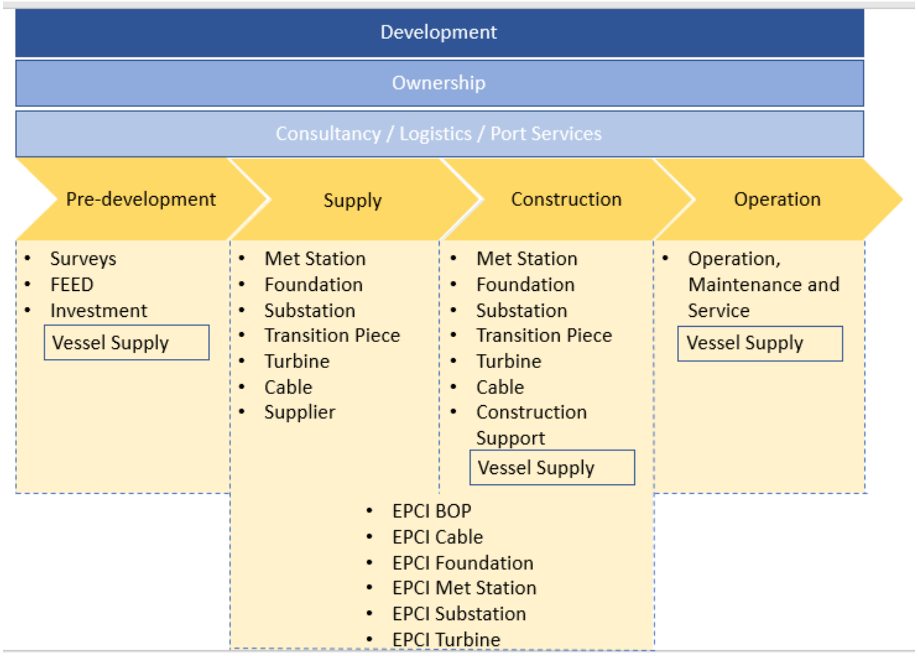

Figure 1. The value chain of offshore wind farm development (source: adapted from Accenture (2013), Amico et al. (2017), BVG (2019a), Lema et al. (2011), Poulsen & Lema (2017) and Weig (2017))

The relationship between a lead firm and the supply base is often characterized as either multi-contracting or engineer, procure, construct and install (EPCI) - contracting (BVG Associates, 2019b; Dinh & McKeogh, 2019). In the multi-contracting strategy, relatively small and distinctively defined contracts are offered for the different key elements of the wind farm (Poulsen & Lema, 2017). Experienced developers using a multi-contract strategy have a better opportunity to optimise a project for cost and use of innovation, but may ultimately be responsible for any costs and delays experienced within each contract, involving an increased exposure to risk on behalf of the lead firm (BVG Associates, 2019b). In the EPCI strategy, very large individual contracts are awarded to EPCI firms and turbine manufacturers (Poulsen & Lema, 2017). Independent developers that are less experienced prefer this approach that allows them to manage a small number of contractors and reduce its risk (Dinh & McKeogh, 2019).

Chapter 3: Research Design

3.1 METHODS

The propositions are tested using quantitative data coming mainly from the '4C Offshore Wind database', as of 2018, which is a dataset of all offshore wind farms across the globe including all stakeholders and the part of the value chain they operate in.

This research aimed to analyse the extent of the empirical differences in supplier sourcing, for the different parts of the value chain for all windfarms in European coastal areas. Besides, the research attempted to understand whether or to which degree local content efforts and bigger local markets succeed in enhancing local industrial capacity. Only those European windfarms that are in either one of the following phases: 'fully commissioned', 'partial generation/under construction', 'pre-construction' and 'under construction', that are positioned in one of the following six countries: Belgium, Denmark, Germany, The Netherlands, Sweden and The United Kingdom, and that have a minimum installed capacity of 30 MW – to exclude most of the demonstration projects – are taken into account. This resulted in a sample of 97 windfarms, 1223 unique firms (including developers) and 13444 awarded contracts. The sample has been cleaned further through the following steps:

- Any remaining demonstration projects were removed by hand.
- Any mis-labelled organizations that represent the different firms in the database that are same, are renamed when needed. Appendix A lists the organizations that were renamed.
- All 'unknown' organizations are removed.
- The original stakeholder types are re-categorized into value chain parts by combining the categorization methods applied by Accenture (2013), Amico et al. (2017), BVG (2019a), Lema et al. (2011), Poulsen & Lema (2017) and Weig (2017), as illustrated in figure 1, to ensure a proper fit with the categories that naturally appear in the data. The lead firm role is assigned to the 'developer' stakeholder role listed in the database, because the developer

usually takes on the leading role during wind farm construction (Poulsen & Lema, 2017). Appendix B lists the full re-categorization that is applied.

- All investors, owners and undefined stakeholders are removed. Investors and owners are removed because they are not contracted by the windfarm developer. Undefined stakeholders are removed from the database as it was impossible to assign them to one of the three modes of governance.
- For all projects with multiple registered developers, only one developer was selected based on data about expired contracts and literature research. There was one wind farm without any registered developer, for this wind farm a developer was assigned based on literature research .

Contracts that could not be awarded locally, because the windfarm country does not have a supply-base for that part of the value chain, are removed. Countries that do not have a supply-base for a certain part of the value chain are by definition not reflected in those parts of the chain. Such scarcities in the pool of suppliers limit a lead firms' choices of sourcing strategies (Amico et al., 2017). This may mean casting the net wider in some places than others (RenewableUK, 2014), hence to investigate the dependence of supplier sourcing on the mode of governance, local content requirements and local market size, supplier scarcities had to be excluded.

After data cleaning the valid N is therefore 12026 awarded contracts, based on 93 windfarms and 968 unique firms.

3.2 DEPENDENT VARIABLE

The dependent variable is the type of sourcing that is applied per part of the value chain. Four categories of sourcing are defined based on the windfarm country and the country of origin of the lead firm. First, in the case lead firms operate on foreign projects and draw with them suppliers from the country where the lead firm is headquartered, the term 'developer sourcing' is used. Second, if a lead firm creates supplier linkages to the market where it develops offshore wind projects, the term 'local sourcing' is used. Third, if the suppliers originate neither from the country where the lead firm is headquartered nor from the country where the windfarm is located, the term 'global sourcing' is used. Fourth, a special case is considered when suppliers are located in the country where the windfarm is located and where the developer is headquartered, the term ‘local-developer sourcing’ is used. The countries of origin of both lead firms and suppliers were already included in the database. For the lead firms, their country of origin was checked and converted into the country where the lead firm is headquartered when needed. In the case of joint venture development teams, the countries of the headquarters of all firms in the development team were listed. If a supplier then originates from one of these countries it got assigned to ‘developer sourcing’ (or local-developer sourcing if the windfarm country equals both the countries of origin of the lead firm and the supplier). For the suppliers, it was believed not to be necessary to convert the countries of origin to the headquarters’ country, because local content rules apply to both local firms and localized foreign owned enterprises (Kuntze & Moerenhout, 2013). Firms without any listed country of origin were given a country of origin based on searching the web.

3.3 INDEPENDENT VARIABLES

In the theory section three independent variables have been introduced. The first independent variable is the mode of governance assigned per part of the value chain. According to GVC theory, three indicators are used to determine which of the ideal modes of governance characterizes a part of the value chain. In this thesis, only two out of those three indicators are used, because the capabilities in the supply-base, and thus automatically the captive and hierarchical modes, are not taken into consideration because these modes are integrated into – or directly controlled by – the lead firm (see section 2.3).

The complexity of transactions and the ability to codify transactions will be used as indicators to establish the mode of governance per value chain part. Both variables will be assigned binary values expressed as ‘high’ or ‘low’ in accordance with theory. Both the amount of individual contracts and the amount of unique firms per stakeholder category will used as a measure for the complexity of the transaction. Thereby, it is assumed that if more firms are contracted and have the competencies to perform a task, the activity relies on a relatively low skill set. If for a stakeholder category, the number of individual contracts or unique firms is smaller than the average number of individual contracts or unique firms for all stakeholder categories, the complexity of that stakeholder role is considered as ‘high’. If for a stakeholder category, the number of individual contracts or unique firms is higher than the average number of individual contracts or unique firms for all stakeholder categories, the complexity of that stakeholder role is considered as 'low'. This data is derived from the database. To identify the effectiveness of the chosen proxies for transactional complexity, anecdotal evidence from literature is used to validate the assigned value, as suggested by Gereffi et al (2005). Hence, in cases where one of the complexity measures matched with anecdotal evidence, this value was chosen as the final complexity value. In cases where anecdotal evidence provided a different story than both the values of the two complexity proxies, it was chosen to go with the anecdotal evidence to assign a value and to provide an explicit explanation. Also, effective proxies for the level of codification are not yet provided by theory (Gereffi et al., 2005), thus anecdotal evidence was used to eventually assign a binary value. Theory stresses the importance of product and process standards, the influence of local conditions and modularity of product architectures as important concepts related to the level of codification. For example, if an activity is highly dependent on specific local conditions, technical standards are not that useful and customization is high. Therefore, I focused on those concepts in order to derive the binary value. Below an example is given for the component supply stage to show how binary values for complexity and level of codification are derived. Appendix C contains a table and explanation involving all value chain activities and the complexity and codification values.

Box 1: Complexity and codifiability in the component supply stage

Value chain part	Complexity (*number of firms*)	Complexity (*number of unique firms*)	Complexity (*literature*)	Codifiability (*literature*)	Mode of Governance
Met Station	1	1	1	1	Modular
Foundation	0	0	0	1	Market
Substation	1	1	1	0	Relational
Transition Piece	1	1	1	1	Modular
Turbine	1	1	1	1	Modular
Cable	1	1	1	1	Modular
Supplier	0	0	0	1	Market

In general supply is considered to be less customized than construction (Steen, 2016). Much of the labour needed to produce the main components involves low to medium skill sets such as foundations for both turbines and substations (IRENA, 2018). On the other hand, production of most of the turbine components requires highly specialised skills not everywhere available (IRENA, 2018). The same applies to designing offshore substations and making them suitable for connection to the onshore grid, which remains a complex and customized process (BVG Associates, 2019a). Cable design characteristics are affected by installation circumstances. As the exact properties of installation differ from wind farm to wind farm, cable design in terms of cable length, cross section, bending range, conductivity etc. is highly variable making it a complex process (IWMA, 2017; Offshore Wind Programme Board, 2015). Indeed, the tendering process for cable suppliers relies on both costs and non-monetary criteria (Offshore Wind Programme Board, 2015).

The second independent variable is the presence of *local content push*. *Local content push* will be measured by a binary variable that represents the presence/absence of LCRs. Data for *local content push* is derived through a process of desk research by analysing industry journals and governmental reports and websites.

The third independent variable is the *current installed capacity* (100 MW) summed over all windfarms that are currently in operation in a country. The data needed to compose this variable were already included in the database.

3.4 CONTROL VARIABLES

One variable will be used to control for other factors, which could influence the dependent variable. This variable is *economic wealth*.

- Economic wealth (€GDP/capita*)*: Countries with deeper pockets are more likely to develop a strong value chain because they can afford to invest in its development (Vachon & Mao, 2008). Data is gathered from the Eurostat database (2019).

Table 2 provides all variable names, indicators and measurements.

Table 2. Operationalization table

Variable name	Variable type	Level of measurement	Measurement
Type of sourcing	Dependent	Nominal	- Developer sourcing = 1, Local sourcing = 2, Global sourcing = 3, Local - developer sourcing = 4
Mode of governance	Independent	Nominal	- The complexity of transactions (low = 0, high = 1) - The ability to codify transactions (low = 0, high = 1)
Local content push	Independent	Nominal	- Presence of local content requirements (no = 0, yes = 1)
Current installed capacity	Independent	Ratio	- Total installed capacity in 100 megawatts summed over all windfarms in either one of the following phases: 'Fully Commissioned', 'Partial Generation/Under construction', 'Pre-Construction' and 'Under Construction'
Economic wealth	Control	Ratio	- Economic wealth in €GDP/capita

3.5 DATA ANALYSIS

The research objective requires to conduct analyses of the 4C Offshore Wind database. The analysis is performed with help of both Excel analysis tools and SPSS statistics. The former will be primarily used for data cleaning, quantification purposes and univariate descriptive statistics whilst the latter will be used for testing the propositions. Three datasets are used to test for the propositions. Propositions one is tested with the full dataset (N = 12026). To account for the fact that local sourcing cannot co-exist with local-developer sourcing and to test for propositions two, three and four the full dataset is separated based on whether a windfarm is developed by a foreign developer (N = 5529) or whether a wind farm is developed by at least one local developer (N = 6497).

Given the nominal character of the dependent variable, logistic regression analyses is used to test the propositions. The dependent variable is converted into dummy variables to utilize the potential that binomial logistic regression has in revealing how each of the three independent variables impacts on the type of sourcing that is applied by a lead firm. Multinomial logistic regressions are used to add nuance to the binomial logistic regressions by comparing all types of sourcing to global sourcing. Global sourcing was set as the reference category to assess the tendency lead firms might have to draw with them suppliers from their home country in the light of increasingly globally spread value chains and countries' willingness to build up robust domestic supply chains, compared to the other types of sourcing. Parsimony and model fit are maximized by adding the predictors hierarchically.

Chapter 4: Results

4.1 DESCRIPTIVE STATISTICS

Table 3 provides an overview of the most important country level variables that characterize the sample. Forty percent of the number of windfarms are located in the United Kingdom followed by Germany, Belgium, Denmark, The Netherlands and Sweden. As a consequence the United Kingdom also has the largest market for offshore wind in terms of installed capacity. Although The Netherlands and Denmark have less windfarms than Belgium, their installed capacity is higher. Half of the contracts are awarded for windfarms in the UK followed by Germany with almost 30 %. Both the complete sample and the data by country shows that most of the contracts are awarded in the market-based parts of the value chain, followed by modular parts and relational parts. In terms of *local content push*, only wind farms in the United Kingdom are considered as being influenced by LCRs (Eriksson & Edlund, 2013; EWEA, 2015; Kern et al., 2014; Kuntze & Moerenhout, 2013; PWC, 2018).

Table 3. Country level variables

		# of windfarms	Contract by mode of governance			Current installed capacity (100MW)	Local content push	Economic wealth (1000€GDP/capita)
			Market	Modular	Relational			
Windfarm country	**Belgium**	11	444	173	163	8,71	No	35,60
	Denmark	8	381	203	190	13,82	No	48,26
	Germany	26	2053	903	567	61,77	No	35,86
	Netherlands	7	482	170	131	11,01	No	41,54
	Sweden	3	54	39	27	1,88	No	43,81
	United Kingdom	38	3732	1388	926	79,01	Yes	32,70

Table 4 provides a breakdown of the dependent variable by windfarm country. Almost half of the contracts are awarded globally, indicating that the offshore wind industry is indeed a global industry. On the contrary, suppliers are rarely drawn from the country where the lead firm is from (developer sourcing), unless the lead firm develops a windfarm in its home country (local-developer sourcing). For each country, the row percentages give the share of contracts awarded per type of sourcing. Although the United Kingdom is the only country in the sample where local content inclusion is stimulated, the share of the sum of local contracts and local-developer contracts is only slightly higher than in Denmark. The difference in local sourcing and local-developer sourcing between those countries shows that the UK offshore wind market is primarily developed by foreign lead firms, whilst the presence of local lead firms is higher in Denmark. The high share of local-developer sourcing in Denmark is observed, because world's largest offshore wind developer, 'Ørsted (formerly DONG Energy)', is headquartered in Denmark and operates on five out of eight local projects. The other countries award fewer local and local-developer contracts as a percentage of the total amount of contracts.

Table 4. The breakdown of the dependent variable by windfarm country

		Type of contract sourcing								Total
		Developer		**Global**		**Local**		**Local-developer**		
		#	%	#	%	#	%	#	%	#
Windfarm Country	**Belgium**	65	8,3	500	64,1	0	0	215	27,6	780
	Denmark	20	2,6	311	40,2	116	15,0	327	42,2	774
	Germany	200	5,7	2409	68,4	136	3,9	778	22,1	3523
	Netherlands	28	3,6	391	50,0	38	4,8	326	41,6	783
	Sweden	0	0,0	73	60,9	13	10,8	34	28,3	120
	United Kingdom	501	8,3	2046	33,8	2462	40,7	1037	17,2	6046
Total		814	6,8	5730	47,6	2765	23,0	2717	22,6	12026

4.2 MODEL BUILDING

Five models are analysed on their ability to answer the propositions. Table 5 provides an overview of the inclusion of different predictors in the five models. The first model includes only the variable that is of main interest here, *mode of governance*. Each subsequent model includes one additional predictor. The final model includes all predictors including the control variable, *economic wealth*.

Table 5. The predictors that are included in the different models

Model 1	Model 2	Model 3	Model 4	Model 5
Mode of governance	Mode of governance	Mode of governance	Mode of governance	Mode of governance
	Local content push	Local content push	Local content push	Local content push
		Mode of governance × Local content push	Mode of governance × Local content push	Mode of governance × Local content push
			Current installed capacity	Current installed capacity
				Economic wealth

The explanatory power as well as model fit of each of the binomial models is given in appendix D. Note that the dependent variable is converted into a dummy variable here. In other words, the models are tested for each type of sourcing. Appendix E provides the overview where the dependent variable is not converted into binary variables, that is the dependent variable is retained nominal. The deviance, or '-2 Log-Likelihood', is used to assess the fit of the model. For each model, the improvement compared to its baseline model, the model when only the constant is included, is provided. The improvement is known as the likelihood ratio and has a Chi-square distribution to assess the significance of the model. In a similar way, the improvement of one model over its predecessor is given.

Each of the models has a Chi-square that is significantly larger than zero, suggesting that each model explains significantly more than its baseline model. However, only looking at the models overall does not provide any insights in the fit of the models compared to each other. Each change in Chi-square between two subsequent models proves to be significant except for two cases. First, the change from the third to the fourth model for *developer sourcing* in case of the binomial logistic regression, is not significant, suggesting that *current installed capacity* does not contribute to enhancing model fit. However, changing the hierarchical addition of variables for this regression, such that *economic wealth* is added before *current installed capacity*, makes the addition of *current installed capacity* significant ($\chi^2(1) = 4{,}310$, $p=0{,}038 < \alpha=0{,}05$). Therefore, the full model is used for this regression as well. Second, the changes in Chi-square from the fourth to the full model for *local sourcing* in case of both the binomial and the multinomial logistic regression, are not significant, suggesting that all variables, except *economic wealth*, significantly contribute to enhancing model fit.

For the multinomial logistic regression models, the predictors were also added automatically through a forward step-wise method based on the likelihood ratio statistic to see if any predictors should have been removed. The results are given in appendix E. As all predictors, except *economic wealth* for *local sourcing*, were eventually retained in the model, all predictors, except *economic wealth* for *local sourcing* are believed to have a significant contribution to enhance the model fit. Below it is shown that multicollinearity is the cause of the exceptionally low likelihood improvements observed after adding *economic wealth* for *local sourcing*.

Another criteria used to assess the fit for a binomial logistic regression is the Hosmer-Lemeshow goodness-of-fit statistic. If the results are significant ($p < \alpha=0.05$), the model is not a good fit of the data. Analogously, in multinomial logistic regression the Chi-square goodness-of-fit statistic and the deviance goodness-of-fit statistic could be used as indicators for model fit. Again, if the results for those statistics are significant ($p < \alpha=0,05$), the model is not a good fit of the data and overdispersion is present. Appendix F provides an overview of the Hosmer-Lemeshow goodness-of-fit statistics for the binomial logistic regressions and an overview of the goodness-of-fit statistic for the multinomial logistic regression.

All the Hosmer-Lemeshow goodness-of-fit statistics turn out to be highly insignificant, approving that model fit of the binomial logistic models is good. For the multinomial logistic regression, both the goodness-of-fit statistics are highly significant for the full dataset and both the subsets, suggesting that neither of the multinomial logistic models is a good fit of the data and that overdispersion is present. In the final analysis, the deviance goodness-of-fit statistic is used to rescale the standard errors and confidence intervals to correct for the effects of overdispersion.

4.3 ASSUMPTIONS TESTING

Logistic regression assumes that the dependent variable is categorical, in this thesis the dependent variable *type of sourcing* and its associated binaries are categorical (Schreiber-Gregory & Karlen, 2018). In addition a minimum of 10 cases per independent variable is suggested to fulfil sample size guidelines and prevent for the issue of complete separation, which in this thesis is covered by sample sizes of N=12026 for the full dataset, n = 5529 for foreign developed windfarms and n = 6497 for windfarms developed by at least one local developer respectively (Schreiber-Gregory & Karlen, 2018). Whilst performing the logistic regressions three additional conditions must be met that can be checked using SPSS Statistics (Field, 2013).

First, logistic regression assumes linearity of any continuous independent variables, in this case *current installed capacity* and *economic wealth* are the only continuous independent variables, and the logit of the outcome variable. This assumption can be tested by including in the model interactions between the continuous predictors and their logs. If such an interaction is significant ($p < \alpha = 0,05$), then the assumption has been violated. The log-linearity diagnostics are displayed in table 6 and table 7 respectively.

Table 6. The log-linearity diagnostics for the binomial logistic regressions

	Interaction terms	Sig.
Developer sourcing[a]	Current installed capacity (100MW) × Ln(Current installed capacity (100MW))	,995
	Economic wealth (1000€GDP/capita) × Ln(Economic wealth (1000€GDP/capita))	,989
Global sourcing[a]	Current installed capacity (100MW) × Ln(Current installed capacity (100MW))	,001
	Economic wealth (1000€GDP/capita) × Ln(Economic wealth (1000€GDP/capita))	,103
Local sourcing[b]	Current installed capacity (100MW) × Ln(Current installed capacity (100MW))	,179
	Economic wealth (1000€GDP/capita) × Ln(Economic wealth (1000€GDP/capita))	*
Local-developer[c] **sourcing**	Current installed capacity (100MW) × Ln(Current installed capacity (100MW))	,012
	Economic wealth (1000€GDP/capita) × Ln(Economic wealth (1000€GDP/capita))	,380

Note: [a] N = 12026, [b] n = 5529, [c] n = 6497, *Economic wealth was excluded from the logistic regression for foreign developed windfarms based on the likelihood ratio statistics.

Table 7. The log-linearity diagnostics for the multinomial logistic regressions

	Interaction terms	Sig.
Developer sourcing[a]	Current installed capacity (100MW) × Ln(Current installed capacity (100MW))	,772
	Economic wealth (1000€GDP/capita) × Ln(Economic wealth (1000€GDP/capita))	,539
Local sourcing[b]	Current installed capacity (100MW) × Ln(Current installed capacity (100MW))	,107
	Economic wealth (1000€GDP/capita) × Ln(Economic wealth (1000€GDP/capita))	*
Local-developer sourcing[c]	Current installed capacity (100MW) × Ln(Current installed capacity (100MW))	,157
	Economic wealth (1000€GDP/capita) × Ln(Economic wealth (1000€GDP/capita))	,654

Note: Global sourcing is used as a reference category, [a] N = 12026, [b] n = 5529, [c] n = 6497, *Economic wealth was excluded from the logistic regression for foreign developed windfarms based on the likelihood ratio statistics.

Sample size affects the significance tests here, implying that significant interactions are more likely to occur (Wuensch, 2020). Therefore, log linearity between the variables is assumed, also for the dependent parameters for which the interaction between a predictor and its logarithm is significant.

Second, logistic regression requires there to be little or no multicollinearity among the independent variables. This means that the independent variables should not be too highly correlated with each other. The categorical predictor, *mode of governance*, is transformed into a set of dummy variables to include it in the collinearity analysis. Tolerance values less than 0.1 and VIF values greater than 10 indicate a problematic amount of collinearity. To further investigate the variables between which there is collinearity, a correlation matrix can be constructed. If there are any correlation values above 0.8 then severe multicollinearity may be present between those variables. Table 8 gives the collinearity diagnostics and table 9 - 11 gives the associated correlation matrices.

Table 8. The collinearity statistics of the independent variables

		Collinearity Statistics	
		Tolerance	**VIF**
Current installed capacity (100MW)	Full dataset[a]	,275	3,643
	Foreign developer[b]	,047	21,317
	At least one local developer[c]	,400	2,500
Economic wealth (1000€GDP/capita)	Full dataset[a]	,328	3,015
	Foreign developer[b]	,054	18,416
	At least one local developer[c]	,451	2,215
Local content push	Full dataset[a]	,324	3,087
	Foreign developer[b]	,384	2,601
	At least one local developer[c]	,583	1,717
Market vs relational	Full dataset[a]	,933	1,072
	Foreign developer[b]	,938	1,066
	At least one local developer[c]	,929	1,077
Market vs modular	Full dataset[a]	,936	1,069
	Foreign developer[b]	,940	1,064
	At least one local developer[c]	,931	1,074

Note: [a] N = 12026, [b] n = 5529, [c] n = 6497

Table 9. The correlation matrix for the full dataset

		Local content push	**Market vs relational**	**Market vs modular**	**Economic wealth (1000€GDP/capita)**	**Current installed capacity (100MW)**
Local content push	**Correlation**	1	-,036**	-,023*	-,673**	,732**
	Sig.		,000	,013	,000	,000
Market vs relational	**Correlation**	-,036**	1	-,251**	,057**	-,056**
	Sig.	,000		,000	,000	,000
Market vs modular	**Correlation**	-,023*	-,251**	1	,018*	-,007
	Sig.	,013	,000		,045	,471
Economic wealth (1000€GDP/capita)	**Correlation**	-,673**	,057**	,018*	1	-,814**
	Sig.	,000	,000	,045		,000
Current installed capacity (100MW)	**Correlation**	,732**	-,056**	-,007	-,814**	1
	Sig.	,000	,000	,471	,000	

Note: **. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). N = 12026

None of the VIF-values is higher than 10. Neither are any of the tolerance values less than 0.1, indicating that there are no issues of collinearity. Between *current installed capacity* and *economic wealth* correlation is high as |-0.814 | > 0.8, however acceptable given the VIF-values and tolerance. The high correlation is explained because the countries with the most wind farms, The UK, Germany and Belgium have relatively low economic wealth. Similarly, correlation between *current installed capacity* and *local content push* is high given the correlation coefficient of 0.732, however not exceeding the threshold of 0.8. The high correlation is explained because The UK has by far the highest installed capacity and it is the only country where local content inclusion is stimulated. Correlation between *economic wealth* and *local content push* is high as |-0.673| approaches the threshold of 0.8. The high correlation is explained because The UK has by far the lowest economic wealth and it is the only country where local content inclusion is stimulated.

Table 10. The correlation matrix for foreign developed windfarms

		Local content push	Market vs relational	Market vs modular	Economic wealth (1000€GDP/capita)	Current installed capacity (100MW)
Local content push	**Correlation**	1	-,002	-,019	-,740**	,780**
	Sig.		,904	,148	,000	,000
Market vs relational	**Correlation**	-,002	1	-,244**	,035**	-,034*
	Sig.	,904		,000	,010	,011
Market vs modular	**Correlation**	-,040*	-,257**	1	,021	-,007
	Sig.	,013	,000		,078	,582
Economic wealth	**Correlation**	-,740**	,035**	,021	1	-,972**
(1000€GDP/capita)	**Sig.**	,000	,000	,115		,000
Current installed	**Correlation**	,780**	-,034**	-,019	-,972**	1
capacity (100MW)	**Sig.**	,000	,011	,164	,000	

Note: **. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed), n = 5529

The VIF-values of both *current installed capacity* and *economic wealth* are higher than 10. Their tolerance values are less than 0.1, indicating that there are severe issues of collinearity. Between *current installed capacity* and *economic wealth* correlation is high as |-0.972| > 0.8. The explanation for the high correlation is the same as for the full dataset. Similarly, correlation between *current installed capacity* and *local content push* is high given the correlation coefficient of 0.780, however not exceeding the threshold of 0.8. The explanation for the high correlation is the same as for the full dataset. Correlation between *economic wealth* and *local content push* is high as |-0.740| approaches the threshold of 0.8. The explanation for the high correlation is the same as for the full dataset. Based on this elaboration and the likelihood ratio statistics that were given in the previous section, *economic wealth* is excluded as a predictor from the analysis for foreign developed windfarms.

Table 11. The correlation matrix for windfarms developed by at least one local developer

		Local content push	Market vs relational	Market vs modular	Economic wealth (1000€GDP/capita)	Current installed capacity (100MW)
Local content push	**Correlation**	1	-,046**	-,040*	-,561**	,627**
	Sig.		,000	,013	,000	,000
Market vs relational	**Correlation**	-,046**	1	-,257**	,063**	-,059**
	Sig.	,000		,000	,000	,000
Market vs modular	**Correlation**	-,040*	-,257**	1	,022	-,007
	Sig.	,013	,000		,078	,582
Economic wealth	**Correlation**	-,561**	,063**	,022	1	-,728**
(1000€GDP/capita)	**Sig.**	,000	,000	,078		,000
Current installed	**Correlation**	,627**	-,059**	-,007	-,728**	1
capacity (100MW)	**Sig.**	,000	,000	,582	,000	

Note: **. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed), n = 6497

None of the VIF-values is higher than 10. Neither are any of the tolerance values less than 0.1, indicating that there are no issues of collinearity. Between *current installed capacity* and *economic wealth* correlation is high as |-0.728| approaches 0.8, however acceptable given the VIF-values and tolerance. Similarly, correlation between *current installed capacity* and *local content push* is high given the correlation coefficient of 0.627, however not exceeding the threshold of 0.8. The explanations for the high correlations are the same as for the full dataset.

Lastly, as in regular regression, there should be no outliers (standardized residuals and DFBetas), or highly influential points (Cooks distance, leverage values). Contrary to goodness of fit tests, individual influential outliers are checked. First of all, there are no Cook’s distances larger than 1. For the binomial logistic regression where *developer sourcing* is the outcome variable, the proportion of standardized residuals does not lie within the 5% range of cases with absolute values above 2, however this is not assumed problematic as the Cook's distance is smaller than 1. Leverage values three times as large as the average leverage value, given by (k+1)/n, could be influential. Although leverage values larger than 3(k+1)/n are observed for some of the models, the cases where those values belong to do not necessarily have a large influence on the regression coefficients, because they are measured on the outcome variables rather than the predictors. Lastly, there are no absolute values for DFBeta larger than 1, indicating that there are no influential outliers.

4.4 BINOMIAL AND MULTINOMIAL LOGISTIC REGRESSIONS

The results of the binomial logistic regressions are given in tables 12 -15. Each table gives the regression results of one of the four binary outcome variables that were created to distinguish between the four different types of sourcing. The regressions give the dependence of the outcome variable on the predictor variables. The value for 'Exp (B)', the odds ratio, represents the odds that the outcome occurs as a function of the predictor variable. If the value is greater than 1 then as the predictor increases or, in case of a categorical predictor, changes into the specified reference category, the odds of the outcome occurring increase. Conversely, a value less than 1 indicates that the odds of the outcome occurring decrease. Each of the regression tables given below is accompanied by a side note to give **examples** on how the odds ratios are interpreted. The statistical significance test, derived from the Wald statistic, provides the degree of confidence that could be applied in correctly interpreting the effect. The multinomial logistic regression results are displayed in table 16. A multinomial logistic regression works essentially the same as binomial logistic regression. The analysis breaks the outcome variable down into a series of comparisons between two possible outcome categories (Field, 2013). The only difference is that multinomial logistic regression compares all types of outcome categories to a chosen reference category. As such, it adds a bit more nuance to the binomial logistic regressions in which all the other residual outcome categories are grouped and together form the reference category.

4.4.1 Binomial logistic regression tables

Table 12. The binomial logistic regression results for developer sourcing

	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Market (reference)			3,997	2	,136			
Modular	,254	,136	3,484	1	,062	1,289	,987	1,682
Relational	,195	,156	1,560	1	,212	**1,215**	,895	1,649
Local content push (1)	,135	,138	,957	1	,328	1,145	,873	1,500
Local content push (0) × market (reference)			6,362	2	,042			
Local content push (1) × modular	-,197	,180	1,195	1	,274	,822	,578	1,169
Local content push (1) × relational	,362	,195	3,429	1	,064	1,436	,979	2,106
Current installed capacity (100MW)	-,006	,003	4,486	1	,034	**,995**	,989	1,000
Economic wealth (1000€GDP/capita)	-,111	,021	28,683	1	,000	,894	,859	,932
Constant	1,443	,840	2,951	1	,086	4,235		

Note: Variable(s) entered on step 1: Mode of governance, Local content push, Mode of governance * Local content push, Current installed capacity (100MW), Economic wealth (1000€GDP/capita), N = 12026.

Odds ratio interpretation

Relational:

The odds of developer sourcing (compared with non-developer sourcing) is not higher or lower in the relational parts of the chain than in the market or modular parts at a 95% confidence interval

Current installed capacity:

The odds of developer sourcing is .995 times higher if current installed capacity increases by 100 MW, holding other variables constant. Put differently, the odds of developer sourcing decreases with 1.005 if current installed capacity increases by 100 MW.

Table 13. The binomial logistic regression results for global sourcing

	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Market (reference)			31,790	2	,000			
Modular	-,220	,047	11,340	1	,001	**,803**	,707	,912
Relational	-,384	,053	27,968	1	,000	**,681**	,591	,785
Local content push(1)	-2,340	,059	1167,647	1	,000	,096	,084	,110
Local content push (0) × market (reference)			313,190	2	,000			
Local content push(1) × modular	1,444	,093	242,441	1	,000	4,236	3,532	5,080
Local content push(1) × relational	1,318	,105	156,581	1	,000	3,734	3,038	4,590
Current installed capacity (100MW)	,004	,001	9,168	1	,002	1,004	1,001	1,007
Economic wealth (1000€GDP/capita)	-,076	,008	92,667	1	,000	,927	,913	,941
Constant	3,354	,343	95,529	1	,000	28,625		

Note: Variable(s) entered on step 1: Mode of governance, Local content push, Mode of governance * Local content push, Current installed capacity (100MW), Economic wealth (1000€GDP/capita), N = 12026.

Changing the reference category

The reference category has to be changed in order to compare modular and relational parts. Changing the reference category to *relational* rather than *market-based* results in an odds ratio of 1.178 for *modular* (Wald(1) = 3.935, p=0.047 < α=0.05). This means that the odds of global sourcing is 1.178 times more likely to occur in the modular parts of the value chain than in the relational parts of the value chain.

Odds ratio interpretation

Modular:

The odds of global sourcing is .803 times higher for modular parts of the value chain compared to market-based parts of the value chain, holding other variables constant. Put differently, the odds of global sourcing is 1.245 times higher in market-based parts of the value chain than in the modular parts of the value chain

Relational:

The odds of global sourcing is .681 times higher for relational parts of the value chain compared to market-based parts of the value chain, holding other variables constant. Put differently, the odds of global sourcing is 1.468 times higher in market-based parts of the value chain than in the relational parts of the value chain.

Table 14. The binomial logistic regression results for local sourcing

	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Market (reference)			1,629	2	,443			
Modular	,003	,166	,000	1	,985	1,003	,724	1,389
Relational	,233	,189	1,515	1	,218	1,262	,871	1,828
Local content push (1)	2,961	,147	406,122	1	,000	**19,309**	14,478	25,752
Local content push (0) × market (reference)			72,956	2	,000			
Local content push (1) × modular	-1,217	,183	44,286	1	,000	,296	,207	,424
Local content push (1) × relational	-1,461	,209	48,754	1	,000	**,232**	,154	,350
Current installed capacity (100MW)	-,029	,003	101,858	1	,000	**,972**	,966	,977
Constant	,082	,150	,299	1	,585	1,086		

Note: Variable(s) entered on step 1: Mode of governance, Local content push, Mode of governance * Local content push, Current installed capacity (100MW), n = 5529.

Odds ratio interpretation

Local content push:

The odds of local sourcing is 19.309 times higher when there is pushed for local content compared to when local content is not stimulated, holding other variables constant.

Local content push (1) × relational:

The odds of local sourcing is .232 times higher in the relational parts of the value chain than in the market parts of the chain when local content is stimulated, holding other variables constant. Put differently, the odds of local sourcing is 4.310 times higher in the market-based parts of the value chain than in the relational parts of the value chain, when there is pushed for local content compared to when local content is not stimulated.

Current installed capacity:

The odds of local sourcing is .972 times higher if current installed capacity increases by 100 MW, holding other variables constant. Put differently, the odds of local sourcing decreases with 1.029 if current installed capacity increases by 100 MW.

Table 15. The binomial logistic regression results for local-developer sourcing

	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Market (reference)			22,932	2	,000			
Modular	,214	,075	8,095	1	,004	1,239	1,069	1,436
Relational	,371	,082	20,330	1	,000	1,449	1,233	1,703
Local content push (1)	2,100	,093	515,000	1	,000	8,167	6,813	9,792
Local content push (0) × market (reference)			94,165	2	,000			
Local content push (1) × modular	-1,280	,145	77,653	1	,000	**,278**	,209	,370
Local content push (1) × relational	-,997	,163	37,327	1	,000	**,369**	,268	,508
Current installed capacity (100MW)	,001	,002	,253	1	,615	1,001	,998	1,004
Economic wealth (1000€GDP/capita)	,121	,009	170,471	1	,000	1,129	1,109	1,150
Constant	-5,405	,396	185,929	1	,000	,004		

Note: Variable(s) entered on step 1: Mode of governance, Local content push, Mode of governance * Local content push, Current installed capacity (100MW), Economic wealth (1000€GDP/capita), n = 6497.

Changing the reference category

The reference category has to be changed in order to compare the behaviour of modular and relational parts under the presence of local content requirements. Changing the reference category to *local content push (0) × relational* rather than *local content push (0) × market* results in an odds ratio of .753 for *local content push (1) × modular*. However, *local content push (1) × modular* is not statistically significant at a 95% confidence interval (Wald(1) = 2.233, p=0.135 > α=0.05). This means that, under the presence of local content requirements, local-developer sourcing is not more or less likely to occur in the modular parts of the value chain than in relational parts of the value chain.

Odds ratio interpretation

Local content push (1) × modular:

The odds of local-developer sourcing is .278 times higher in the modular parts of the value chain than in the market parts of the chain when local content is stimulated, holding other variables constant. Put differently, the odds of local-developer sourcing is 3.597 times higher in the market-based parts of the value chain than in the modular parts of the value chain, when there is pushed for local content compared to when local content is not stimulated.

Local content push (1) × relational:

The odds of local-developer sourcing is .369 times higher in the relational parts of the value chain than in the market parts of the chain when local content is stimulated, holding other variables constant. Put differently, the odds of local-developer sourcing is 2.710 times higher in the market-based parts of the value chain than in the relational parts of the value chain, when there is pushed for local content compared to when local content is not stimulated.

4.4.2 Multinomial logistic regression table

Table 16. The multinomial logistic regression results

		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Developer Sourcing[a c]	**Relational (reference)**	0[b]			0				
	Modular	-,599	,318	3,537	1	,060	,549	,294	1,026
	Market	,113	,272	,173	1	,678	1,120	,657	1,909
	Local content push (1) (reference)	0[b]			0				
	Local content push (0)	-,890	,431	4,264	1	,039	,411	,176	,956
	Local content push (0) × market	-,443	,437	1,027	1	,311	,642	,273	1,512
	Local content push (0) × modular	,587	,496	1,404	1	,236	1,799	,681	4,752
	Current installed capacity (100MW)	-,007	,006	1,337	1	,248	,993	,982	1,005
	Economic wealth (1000€GDP/capita)	-,072	,046	2,431	1	,119	,930	,850	1,019
	Intercept	1,606	1,811	,787	1	,375			
Local Sourcing[a d]	**Relational (reference)**	0[b]			0				
	Modular	-,093	,148	,400	1	,527	,911	,682	1,217
	Market	1,213	,132	84,037	1	,000	3,363	2,595	4,359
	Local content push (1) (reference)	0[b]			0				
	Local content push (0)	-1,342	,319	17,669	1	,000	,261	,140	,489
	Local content push (0) × market	-1,530	,303	25,472	1	,000	,217	,120	,392

Odds ratio interpretation

Market:

The odds that a supplier falls in the category local-developer sourcing rather than global sourcing is 2.118 times higher for market-based parts of the value chain compared to relational parts, holding other variables constant.

Local content push (0):

The odds of local sourcing compared to global sourcing is .261 times more when local content push is absent. Put differently, the odds of local sourcing compared to global sourcing is 3.831 times higher when there is pushed for local content.

Current installed capacity:

When the current installed capacity increases by 100 MW, the change in the odds of local sourcing rather than global sourcing is .975, holding other variables constant. In short, local sourcing is less likely to occur than global sourcing if current installed capacity increases.

	Local content push (0) × modular	-,209	,341	,374	1	,541	,812	,416	1,584
	Current installed capacity (100MW)	-,025	,004	38,829	1	,000	**,975**	,967	,983
	Intercept	1,796	,340	27,892	1	,000			
Local / developer Sourcing[a e]	**Relational (reference)**	0[b]			0				
	Modular	-,525	,355	2,186	1	,139	,592	,295	1,186
	Market	,750	,312	5,801	1	,016	**2,118**	1,150	3,900
	Local content push (1) (reference)	0[b]			0				
	Local content push (0)	-1,314	,330	15,914	1	,000	,269	,141	,512
	Local content push (0) × market	-1,142	,355	10,355	1	,000	**,319**	,159	,640
	Local content push (0) × modular	,376	,403	,863	1	,353	1,457	,659	3,221
	Current installed capacity (100MW)	-,001	,003	,129	1	,719	,999	,993	1,005
	Economic wealth (1000€GDP/capita)	,112	,019	34,193	1	,000	1,119	1,078	1,162
	Intercept	-3,257	,853	14,580	1	,000			

Note: a. The reference category is: Global. b. This parameter is set to zero because it is redundant, c. N = 12026, d. N = 5529, e. N = 6497

Market:

The odds that a supplier falls in the category local-developer sourcing rather than global sourcing is 2.118 times higher for market-based parts of the value chain compared to relational parts, holding other variables constant.

Local content push (0) × market:

The odds that a supplier falls in the category local-developer sourcing rather than global sourcing is .319 times higher for market-based parts of the value chain compared to relational parts, when local content push is absent. Put differently, the odds of local-developer sourcing compared to global sourcing is 3.135 times more for market-based parts of the value chain than for relational based parts of the chain when local content becomes pushed for. In other words, for the market-based parts of the value chain, the presence of local content push is more effective in creating local-developer sourcing over global sourcing than for the relational parts of the chain.

Chapter 5: Analysis[1]

5.1 PROPOSITION 1

Proposition 1: *Global sourcing most likely occurs in the market-based parts of the value chain, followed by the modular and relational parts.*

- confirmed

From the odds ratios that are concerned with *mode of governance* from table 13, the probability of global sourcing (compared to non-global sourcing) is higher in the modular based parts of the chain than in the relational parts, but less likely than in the market-based parts. Note that this effect is superseded by the interaction with local content push. When local content becomes pushed for, global sourcing becomes more likely to occur in both the modular and relational parts of the value chain than in the market-based parts. The reason is that local content requirements are more effective in the market-based parts of the value chain. In other words, modular and relational parts are less affected by local content requirements and therefore remain more likely to be sourced at the global level (see 5.3).

Ponte & Sturgeon (2014) suggest that the tolerance of geographic distance between a lead firm and its supplier is described by a continuum ranging from high tolerance in the case of market-based modes to low in the case of relational modes. In the market-based parts of the value chain transactions are primarily based on price, suggesting that there is no explicit need for spatial proximity to enforce contracts. The relational value chain parts, on the contrary, require the exchange of tacit knowledge, which is favoured by close cooperation based on trust and social ties (see 5.2). In addition, the face-to-face character of knowledge exchange and the importance of learning-by-doing makes relational ties more likely to be spatially nested in historically grown contexts, explaining why the relational parts are relatively under-represented at a global scale (Binz & Truffer, 2017).

[1] The covariate *economic wealth* is included in the analysis for identification purposes. Its marginal effects are therefore not discussed in the results section of this research (Hünermund & Louw, 2020)

5.2 PROPOSITION 2

Proposition 2: *Developer sourcing and local-developer sourcing most likely occur in the relational parts of the value chain, followed by the modular and market-based parts*

- partly confirmed

From the odds ratios that are concerned with the variable *mode of governance* from table 12 and table 16, the probability of developer sourcing (compared with non-developer sourcing and global sourcing) is not higher or lower in the relational parts of the chain than in the market or modular parts at a 95% confidence interval. Thus, proposition 2 is not confirmed for developer sourcing.

From the odds ratios that are concerned with the variable *mode of governance* from table 15, the probability of local-developer sourcing (compared with non-local-developer sourcing) is the highest in the relational modes of governance and the probability of local-developer sourcing is higher in the modular parts than in the market-based parts. Thus, proposition 2 is confirmed for local-developer sourcing. Note that this effect is superseded by the interaction with local content push.

It was expected that activities that are both complex and hard to specify explicitly are more frequently performed by suppliers with the same country of origin as the lead firm (rather than by global suppliers) in comparison with market-based or modular activities. However, the distinctive cultures, practices and institutions of nation states do not necessarily bring firms from the same country of origin more frequently together to perform relational tasks according to the regression results. The result may possibly be due to chance, however it may still be the most likely result because the proposition is not rejected based on a statistical significant outcome for the opposite of the proposition. Nevertheless, an alternative theoretical explanation could be that relational suppliers are chosen by a lead firm because they have worked together before on earlier projects (Pietrobelli & Rabellotti, 2011).

Especially in offshore wind this a likely explanation, because many actors have not only worked together in offshore wind but also in oil and gas or other related industries (Hansen & Steen, 2015). Indeed transactions that involve high levels of asset specificity are often managed through repeated transactions, reputation and social norms (Gereffi et al., 2005). Although a country's distinctive cultural, ethnic, institutional or family-based ties often tend to facilitate reputation and social proximity that are important for effective cooperation in highly asset specific transactions, the regression shows that those factors are not prerequisites (Boschma, 2005; Pietrobelli & Rabellotti, 2011). This means that organizational proximity is not necessarily facilitated by shared national roots.

The odds of local-developer sourcing (compared with non-local-developer sourcing) are higher in the relational value chain parts than in the modular and market-based parts respectively. Thus, the theory underlying proposition 2 is applicable when a developer, or at least one of the developers, originates from the country where the windfarm is built, but the theory may not explain the same phenomenon when the developer does not originate from the country where the windfarm is built. This may suggest that lead firms and suppliers from the same country are more likely to work together within, rather than outside, their geographical borders of origin. This can be explained by the spatial sticky nature of relational knowledge that remains rooted in a specific region's historically grown institutional context over longer periods of time (Binz & Truffer, 2017). At the same time, this might explain why drawing on domestic suppliers on foreign projects is not sufficient for fulfilling relational activities, because the interactions between a lead firm and its supplier are not nested in the same contextual conditions that govern relational interactions in the home country (MacKinnon et al., 2019). It seems to be the combination of geographical proximity and historically grown social ties embedded in certain institutional conditions that governs relational exchange. Indeed, if geographical proximity alone would have been a driver for establishing relational connections, local sourcing would be expected to be more prevalent in the relational based parts and that is not confirmed by the regression results with local sourcing being the outcome variable.

5.3 PROPOSITION 3

Proposition 3a: *For wind farms that are developed by foreign developers, local sourcing becomes more likely at a higher installed capacity*

- rejected

Proposition 3b: *For wind farms that are developed by at least one local developer, local-developer sourcing becomes more likely at a higher installed capacity*.

- not confirmed

From the odds ratio that is concerned with the variable *current installed capacity* from table 14 and table 16, the probability of local sourcing (compared with non-local sourcing and global sourcing) is lower with higher values of installed capacity. Thus, proposition 3a is not confirmed. However, the decreases in the odds are extremely small with odds ratio of .972 and .975 respectively.

From the odds ratio that is concerned with the variable *current installed capacity* from table 15 and table 16, the probability of local-developer sourcing (compared with non-local-developer sourcing and global sourcing) could not be confidently assessed at a 95% confidence interval. Thus, proposition 3b is not confirmed.

The effect of *current installed capacity* on both local and local-developer sourcing gives, unexpected results. Therefore, it makes sense to look at the effect of *current installed capacity* on the other types of sourcing. From the odds ratio that is concerned with the variable *current installed capacity* from table 12, the probability of developer sourcing (compared to non-developer sourcing) is lower with higher values of installed capacity. However, the decrease in the odds is extremely small with an odds ratio of .995. From the odds ratio that is concerned with the variable *current installed capacity* from table 13, the probability of global sourcing (compared to non-global sourcing) is higher with higher values of installed capacity. However, the increase in the odds is extremely small with an odds ratio of 1.004.

The effects of installed capacity on local sourcing and local-developer sourcing (compared with non-local sourcing, respectively non-local-developer sourcing and global sourcing) provides unexpected results. It was expected that market formation fosters the emergence of local industries (Kirkegaard et al., 2009). However, the regression results show that, although the respective effect sizes are small, increasing the installed capacity of offshore wind in a country by stimulating the demand for offshore wind at the expense of fossil fuels does not automatically lead to the formation of a local industry and/or the participation of local players (van der Loos et al., 2020).

Following Bednarz & Broekel (2020), increasing market demand might attract firms to the market, however those firms are neither necessarily originating from that local market, nor do foreign firms necessarily locate their operations in overseas markets. Local industry growth is only likely to be initiated for those parts that require close vicinity to demand for reasons of transaction or transportation costs. In those instances a supplier is more inclined to locate its operation in the country where demand is articulated, for example though founding of a subsidiary firm. An example is given by Siemens who recently opened a turbine manufacturing facility in the largest offshore wind market in Europe, the UK (4C Offshore, 2016). Future research could investigate this more extensively for offshore wind by including an interaction term between mode of governance and installed capacity.

5.4 PROPOSITION 4

Proposition 4a: *For wind farms that are developed by foreign developers, local sourcing is more likely to occur under the presence of local content requirements, but less likely in the relational-based parts of the value chain than in market-based parts or modular parts and less likely for the modular parts than the market-based parts.*

- partly confirmed

Proposition 4b: *For wind farms that are developed by at least one local developer, local-developer sourcing is more likely to occur under the presence of local content requirements, across the value chain.*

- partly confirmed

From the odds ratio that is concerned with the variable *local content push* from table 14 and table 16, the probability of local sourcing (compared with non-local sourcing and global sourcing) is higher when there is a push for local content compared to when local content is not stimulated. Thus the first part of proposition 4a is confirmed. Moreover, the increase in the odds are extremely large with odds ratios of 19.309 and 3.831.

A similar story applies to the probability of local-developer sourcing when there is pushed for local content. From the odds ratio that is concerned with the variable *local content push* from table 15 and table 16, the probability of local-developer sourcing (compared with non-local-developer sourcing and global sourcing) is higher when there is pushed for local content compared to when local content is not stimulated. Thus the first part of proposition 4b is confirmed. Moreover, the increase in the odds are extremely large with odds ratios of 8.167 and 3.717.

The effects of local content push on both local sourcing and local-developer sourcing are, as expected, contradictory to the effect that local content push has on the odds of global sourcing. From the odds ratio that is concerned with the variable *local content push* from table 13, the probability of global sourcing (compared with non-global sourcing) is lower when there is pushed for local content compared to when local content is not stimulated. Moreover, the decrease in the odds is extremely large with a magnitude of 10.417.

The effects found for proposition 1 are superseded by the interaction with local content push because local content requirements are more effective in stimulating local sourcing and local-developer sourcing (compared with non-local sourcing, respectively non-local-developer sourcing and global sourcing) in the market-based parts of the value chain than in the relational parts or the modular parts.

From the odds ratios that are concerned with the variable *mode of governance* × *local content push* from table 14 and table 16, the probability of local sourcing (compared with non-local sourcing, and global sourcing) is higher in the market-based parts of the value chain than in both the modular parts and relational parts of the value chain, when there is pushed for local content compared to when local content is not stimulated. However, the probability of local sourcing (compared with non-local sourcing, and global sourcing) is not higher in the modular parts of the value chain than in the relational parts of the value chain at a 95% confidence interval. Thus, proposition 4a is not completely confirmed, because the probability of local sourcing (compared with non-local sourcing, and global sourcing) is not different between the modular parts of the value chain and the relational parts of the value chain, when local content becomes pushed for.

From the odds ratios that are concerned with the variable *mode of governance* × *local content push* from table 15 and table 16, the probability of local-developer sourcing (compared with non-local-developer sourcing, and global sourcing) is higher in the market-based parts of the value chain than in both the modular parts and relational parts of the value chain, when there is pushed for local content compared to when local content is not stimulated. However, the probability of local-developer sourcing (compared with non-local-developer sourcing, and global sourcing) is not higher in the modular parts of the value chain than in the relational parts of the value chain at a 95% confidence interval. Thus, proposition 4b is not completely confirmed, because the probability of local-developer sourcing is different between both the modular and relational parts of the value chain on the one hand and the market-based parts of the value chain on the other hand, when local content becomes pushed for.

An example is given by the case of foundation supply. In foundation supply, which is a market-based value chain part, contracts became increasingly awarded to local suppliers after local content requirements were enforced in the UK (Kochegura, 2017). An effect of the higher effectiveness of local content push in the market-based parts of the value chain is that it is in those parts that developers constantly have a temptation to switch suppliers in order to reach a better price level (Gereffi et al., 2005). This practice of switching suppliers is not necessarily good for the local suppliers who instead are looking for contracts with repeat orders (Kochegura, 2017). On the contrary, highly technologically complex and therefore capital intense components and services, that are characteristic for relational parts, are less likely to be sourced locally, also because those suppliers are not always present locally (Eriksson & Edlund, 2013). That LCRs are more effective in the market-based parts of the value chain is understandable because it is easier to find local substitutes if the segment does not need experienced based and trustful relationships and the terms can be easily codified. For example, in contrast to supplying substations, the provision of vessels and regular operation and maintenance activities present a lower set of technical barriers to entry for local firms (Kochegura, 2017; MacKinnon et al., 2019).

In addition, Kirkegaard et al. (2009) state that if local content is stimulated, the share of suppliers from the country where the lead firm is headquartered is usually lower than when local content is not mandated. A new regression with developer sourcing being the outcome variable for foreign developed windfarms shows that this claim is confirmed.

Chapter 6: Discussion

6.1 IMPLICATIONS FOR THEORY

The research makes several theoretical contributions to the broader debate about the international dimension of industrial growth in general and clean technologies in particular (Binz et al., 2014; Binz & Truffer, 2017; Pietrobelli & Rabellotti, 2011; Wieczorek et al., 2015).

First of all, this research is an attempt to stress the importance of GVC literature in this debate. It follows the logic applied by Pietrobelli & Rabellotti (2011) and argues that conventional innovation system literature does not allow for a full understanding of how inter-firm networks operate at a global scale. Even though promising improvements in IS literature have emphasized the crucial impact of globalization on innovation system development (see e.g. Binz et al., 2014; Binz & Truffer, 2017; van der Loos et al., 2020; Wieczorek et al., 2015), the specific properties of firm linkages, that affect the scale of knowledge exchange, innovation and production, remain largely unpacked. Indeed, the innovation system approach can benefit from a more explicit incorporation of actor roles and networks (Farla et al., 2012). This research argues that the different modes of governance identified in the GVC literature can function as a promising starting point to operationalize those linkages and unravels the different scales that different type of firms operate in.

Second, this research further extends the application of GVC literature to the offshore wind industry. Previous studies that incorporated a GVC component simply stated that power relationships between lead firms and suppliers are relational because high levels of collaboration, cooperation and knowledge exchange between lead firms and suppliers are required to meet the technological and local challenges associated with offshore wind (see e.g. Binz & Truffer, 2017; Elola et al., 2013; Lema et al., 2011; MacKinnon et al., 2019). Although this might be true when looking at the industry as a whole, this research argues that, by slicing up a value chain into its parts, such statements require more nuance (Bair & Sturgeon, 2008; Gereffi et al., 2005). This argument was used as a starting point for this research to investigate the differences in the spatial distribution and embeddedness of different value chain activities.

Third, although local sourcing is often times put against global sourcing in the literature on outsourcing (see e.g. Amico et al., 2017; Nassimbeni, 2006; Steinle & Schiele, 2008), this research provides reasons for nuancing this dichotomy. For example, the descriptive statistics (table 4) show that contracts are awarded to suppliers that come from the same country as the lead firm on foreign projects. This neither dictates local sourcing nor global souring, but rather introduces a new alternative: developer sourcing. Unfortunately, except for the very minor effect of *current installed capacity*, no significant relationship could have been derived for developer sourcing. At least, the research presented here support the anecdotal evidence provided by other studies that suppliers link up with developers from their home country on international projects (MacKinnon et al., 2019; van der Loos et al., 2020). More research is required to unravel the reasons that lead firms have for drawing on local suppliers under foreign conditions.

Lastly, it has been suggested that the effectiveness of LCRs differs depending on the governance that characterizes the activities in a part of the value chain. This sheds some new light on the discussion that is going on about the effectiveness of local content push vis-à-vis the cost of windfarm development and electricity delivered. On the one hand, efforts to increase the demand of sustainable energy require generation costs to be kept as low as possible. On the other hand, governments have a key interest in local content policies that stimulate local industries while realizing environmental targets (Kuntze & Moerenhout, 2013; van der Loos et al., 2020). The latter can increase transaction costs on behalf of the lead firm, leading to higher generation costs (Kuntze & Moerenhout, 2013). The results indicate that lead firms try to avoid the increase in transactions costs as much as possible by selecting more local suppliers for the market-based parts of the chain than for the other parts under the presence of those requirements. Transactions costs are inherently higher for the relational value chain parts, because respective activities and products are more customized, require more complex transfers of design information and are more time consuming to establish and therefore more heavily rely on repeat transactions, than market-based activities (Gereffi et al., 2005). Therefore, switching suppliers is done at least costs in the market-based parts when in comparison with the modular or relational parts. From the results it can be concluded that states tend to have less leverage to demand local content requirements or less scope to develop links to local suppliers in the relational parts of the value chain (Gereffi, 2014).

6.2 IMPLICATIONS FOR POLICY

This research contributes to practice, by providing insights on the spatial embeddedness of local industrial growth in the increasingly globalized economic domain. Participation in and correctly dealing with the invading effects that GVCs can have, provides a strong indicator of economic growth prospects (Kaplinsky et al., 2000). Although there is not one single strategy to improve a country's international competitiveness in GVCs, the findings of this research allow for several practical implications to be taken into account.

First of all, national political bodies that want to create sustainable economic growth by building cleantech local industries need to find a delicate balance between generation costs and local content requirements. Although mandating the inclusion of local suppliers indeed stimulates local industry formation, it could capitalize on the objective of keeping generation costs as low as possible (Kuntze & Moerenhout, 2013). To compensate, enormous amounts of subsidies and financial support are required to still attract foreign developers in the local market (Kochegura, 2017). In addition, this research has shown that local content requirements are the most effective in the market-based parts of the value chain, but it is in these parts that the value added is relatively low and profit margins are usually lower. Thus, foreign firms are not likely to contribute to any advanced local technology development and manufacturing capacities under these conditions (Choi, 2018). This shows that local content requirements can lock local industries into unprofitable and intellectually narrower parts of the value chain if such regulations do not specify the type of activities that have to be sourced locally (Gereffi, 2014). Alternatively, a 'technology push' strategy, which includes investing in research and development and is aimed at building a supportive innovation system, could potentially improve competitiveness of the local industrial base not only in the lower value added parts of the value chain but also in the higher value added parts and not only in the local economy, but eventually also in the international realm at lower costs (Pietrobelli & Rabellotti, 2011; van der Loos et al., 2020). This argument stresses the importance of the wider policy context for the effectiveness of LCRs (WTI Advisors, 2013). For example, China's success in developing a strong local (offshore) wind industry in a relatively short period of time is the effect of a combination of LCRs and other incentives (Kuntze & Moerenhout, 2013).

The second practical contribution of this research concerns the difference between foreign developed windfarms and windfarms developed by at least one local developer in selecting a supplier with the same origins as the lead firm. A supplier is more likely to be selected by a developer that leads a project located in a country where both lead firm and supplier have their origins than when the project is located in a foreign country. In other words, industry formation is more likely to succeed when suppliers meet up with lead firms within their own geographical borders of origin. This result stresses the importance of a home market for the formation of industries. One should note however, that the presence of a home market is not always a prerequisite to increase participation of local players in the international realm (van der Loos et al., 2020). An example is provided by the internationalization efforts of Norwegian firms to countries where the market conditions were more favourable (Hunstad & Risan, 2014; Steen & Weaver, 2017). One of the major conditions moderating this relationship is the development phase of the industry (Fagerberg, 2010). In the initial stages of industrial development, local markets provide opportunities for technologies to develop in isolation from global dominant technologies and hence to attract local supply. If the technology grows and demand becomes more widely spread, the need for a local market will more likely vanish as markets can be found somewhere else (van der Loos et al., 2020). In addition, some industrial markets, as in early wind power, are inherently more spatially sticky than others, emphasizing the benefits of early market formation as a means for building strong enduring local industries (Binz & Truffer, 2017).

6.3 LIMITATIONS AND FURTHER RESEARCH

There are some possible limitations of the thesis that might have affected the research conducted. Based on this and the insights that were gained, numerous avenues for further research are opened.

First of all, the analysis was based on the Global Offshore Wind Farms Database 4C as of 2018. Unfortunately, access to a more recent version of the database could not be arranged in time. As a consequence, the United Kingdom was the only country in the sample where local content is pushed for. Newer version of the dataset also include France as being another country with local content policies in place. France has 2MW of offshore wind capacity in operation and a handful of projects ready to be built (Offshore WIND, 2019). Future research can run a similar analysis as performed here to see if the effects of local content push will change as a consequence of including France. Similarly, it would be interesting to investigate the change in industry dynamics after including countries that have an impressive population of firms participating in the offshore wind energy supply chain, but that only recently started constructing windfarms, like Poland. (PWEA, 2019). Furthermore, extending the research sample with emerging non-European windfarm countries is potentially fruitful because restrictions in terms of trade might affect a firm's or country's access to global value chains.

Second, as a result it was suggested that repeated relationships might be an important driver for the likelihood of developer sourcing in the offshore wind business. In offshore wind, it is common to initiate relationships with pre-existing partners but less is known about a lead firm's dependence on repeated transactions for the three different modes of governance. Further research can look into this matter by investigation of the degree of repeated transactions by mode of governance and its effect on different types of sourcing. Existing literature suggests that relational relationships tend to be associated with the mutual sharing of financial risk, trust, commitment, mutual pragmatism, reciprocity, and resilience (Hennelly, 2019). Thus an expectation could be that relational value chain parts rely more heavily on repeated transactions than modular of market-based value chain parts.

Third, the cross-sectional nature of the data does not allow for generalizations at the country level, because the impact of possible country-specific factors could influence the conclusions that were drawn. Thus although the conclusions are valid for the sample, they are not necessarily valid for the individual countries that were part of the sample (Robinson, 2009). This has never been a purpose of the research anyway, because it was the purpose to uncover the general patterns for the industry as a whole. Nevertheless, qualitative research methods and case studies have the potential to add a more thorough understanding of social and institutional processes that shape and operate within emerging industries at the country level (Dawley, 2014).

Fourth, one should consider the inherent nature of logistic regressions in which both the predictors and the outcome variable are always compared to a reference case. For the binomial logistic regressions, the reference category is constituted by grouping all the other residual outcome categories together. For the multinomial regressions global sourcing was set as the reference category to assess the tendency lead firms might have to draw with them suppliers from their home country in the light of increasingly globally spread value chains and countries' willingness to build up robust local supply chains. A good example of the additional nuance that a multinomial logistic regression has to add is given by the odds ratios for the different modes of governance for local-developer sourcing. The comparison with global sourcing from the multinomial model in table 16 shows that the odds that a supplier falls in the category local-developer sourcing rather than global sourcing is higher for market-based parts of the value chain compared to relational parts and that the odds that a supplier falls in the category local-developer sourcing rather than global sourcing is not statistically different between modular and relational modes. This means that the relational value chain parts, compared with market-based parts, are the best represented in *local-developer sourcing (compared with non-local-developer sourcing)* according to the binomial regression, but that relational suppliers are still more likely to be sourced on a global scale rather than being chosen through *local-developer sourcing*, when compared to market transactions. In other words, the underlying comparisons are crucial for the interpretation. Table 17 shows the difference in frequencies of mode of governance per type of sourcing for the illustrated case.

Table 17. The underlying comparisons between different outcome categories used in binomial and multinomial logistic regression

		Type of Sourcing			
		Developer	**Global**	**Local-developer (0)**	**Local-developer (1)**
Mode of Governance	market	164	2033	2197	1625
	modular	69	879	948	587
	relational	51	584	635	505

Future studies could investigate the globalization of supplier sourcing on a global scale more thoroughly by performing a time-sensitive analysis on the different types of sourcing per mode of governance.

Fifth, in some instances, the windfarm developer is also a supplier on the same windfarm project. In this case, the lead firm had chosen to internalize a value chain activity, indicating a hierarchical mode of governance rather than either one of the three forms that were represented by this research. This was not being accounted for, because value chain parts were categorized into one of the three modes of governance based on the *complexity* and *codifiability* of the activities belonging to the value chain parts.

Lastly, in the light of the obtained results it is good to discuss the quality of the research. Especially with respect to generalizability and the development of accurate measurements for *the mode of governance*.

The six countries involved in the research sample do not constitute the whole package of global value chains underlying the offshore wind industry. However, as they represent 85% of the global offshore wind market (van der Loos et al., 2020), I expect that the conclusions have general validity for offshore wind operations located elsewhere. In addition, the research acknowledges that, although increasingly globally established, the precise properties of offshore wind operations remain spatially sticky at least for longer periods of time (see above). The relative high degree of spatial stickiness in offshore wind is explained by the importance of interactive and collaborative learning (Elola et al., 2013). As such, it is believed that the results are applicable to other industries that are characterized by a similar spatial stickiness.

Although GVCs constitute one potential way to operationalize actor roles and inter-firm linkages in innovation systems, theory calls for more conceptual work on the proxies for *complexity* and *codifiability* that feed into the different modes of governance (Gereffi et al., 2005). This thesis can be seen as an attempt in doing so. Here, the number of firms and the number of contracts are taken as proxies for the complexity of a value chain part under the assumption that if more firms are able to perform a certain task or if more individual contracts get awarded, complexity is lower. This is expected to be fairly valid, because current theory confirms that more firms are able to engage in activities that are lower value-added (MacKinnon et al., 2019). In addition, the proxies are triangulated with literature to add to the internal validity. For codifiability, however, the assessment here is primarily based upon personal interpretations of industry reports. Further research can increase the validity in this part by including both the number of industry standards and their global applicability as quantitative measurements for the degree of codification. However, in the context of the data collection that was applied in this research such data turned out to be very sporadically available.

Chapter 7: Conclusions

An extensive value chain is required to build and operate offshore wind farms, with each project involving hundreds of companies originating from different countries under the guidance of a lead firm. Moreover, complexity in the value chain has increased with the increasing size of offshore wind farms and their rise across the globe. This has implications for where and how a lead firm selects its suppliers. This research made use of the global value chain (GVC) concept to assess the geography of value creation in the offshore wind industry in the light of globalization and the effectiveness of local content requirements. More specifically, supplier selection was investigated based upon the origin of the lead firm, the location of the offshore wind farm, the effectiveness of local content requirements, and a country's market size, while taking into account that different parts of the value chain are characterized by three different modes of governance: market-based, modular and relational. The aim was to provide an answer to the following research question: "*Under what conditions do lead firms draw on suppliers from their home country (developer sourcing), from the wind farm country (local sourcing), both (local-developer sourcing) and the global market (global sourcing) for different parts of the value chain for offshore wind farms in Europe*".

From the logistic regressions analyses that were performed it has been found that lead firms draw from the global market mostly for the market-based parts of the value chain followed by the modular and relational parts. Lead firms are not more or less likely to draw suppliers from their home country in either of the three governance modes, unless the windfarm is located in the lead firm's country. Lead firms are more likely to draw suppliers from the windfarm country when there is a push for local content. These local content requirements are the most effective in selecting local suppliers for the market-based parts of the chain and the least effective in the relational parts of the value chain.

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Appendices

Appendix A

Re-categorization analysis name

Analysis Name	Re-named
BAM Infra	BAM
BAM Nuttall	BAM
c	NHV
CG Global	CG
CG Power Systems	CG
Cofely Fabricom	Engie
Cofely Fabricom GDF Suez	Engie
COWI-IMS	COWI
EDP - Energias de Portugal	EDP
EDS HV Management	EDS
Fabricom	Engie
GDF SUEZ	Engie
GEO	GeoTeknisk, Geo Plus and Geo MHB
Global Marine Systems	Global Marine
Greater Gabbard OFTO	Greater Gabbard Offshore Winds
GTU I	GTU GmbH
GTU II	GTU GmbH
J. Murphy & Sons	J Murphy and Sons
Kersten Europe	Kersten
Kersten Middle East	Kersten
Lamprell Energy	Lamprell
Mitsubishi UFJ Lease & Finance	Mitsubishi
Navantia y Windar Renovables	Navantia
Noreq Acta	NOREQ,
Siemens Bank	Siemens
Swire	Swire Pacific
Swire Blue Ocean	Swire Pacific
Technip	TechnipFMC
Technip Norge	TechnipFMC
Trianel Windkraftwerk Borkum	Trianel
Volker Staal en Funderingen	VolkerWessels
Volker Wessels	VolkerWessels
Volkerwessels	VolkerWessels
Wood Group Kenny	Wood Group

Appendix B

Re-categorization value chain parts

Stakeholder Type	Re-categorization
Consultant-Certification	Consultancy
Consultant-EIA	Consultancy
Consultant-Financial	Consultancy
Consultant-Health & Safety	Consultancy
Consultant-Legal	Consultancy
Consultant-Other	Consultancy
Consultant-Project Management	Consultancy
Consultant-Shipping and Navigation	Consultancy
Consultant-Weather Forecasting	Consultancy
Contractor-Array Cable Removal	Cable Installation
Contractor-Diving	Operation, Maintenance and Service
Contractor-Export Cable Removal	Cable Installation
Contractor-Fisheries Liaison	Surveys
Contractor-Grid Connection	Cable Installation
Contractor-Grouting(metmast)	Construction Support
Contractor-Grouting(substation)	Construction Support
Contractor-Grouting(turbines)	Construction Support
Contractor-Heavy Load Logistics(Foundation)	Logistics
Contractor-Heavy Load Logistics(Substation)	Logistics
Contractor-Heavy Load Logistics(Turbine)	Logistics
Contractor-Marine Coordinator	Operation, Maintenance and Service
Contractor-Met Mast Removal	Met Station Installation
Contractor-Other	Other
Contractor-Pre Assembly	FEED
Contractor-Route Clearance(ordnance)	Construction Support
Contractor-Route Clearance(PLGR)	Construction Support
Contractor-Seabed Preparation	Construction Support
Designer(Detailed)-Foundation(Substation)	Foundation Supply
Designer(Detailed)-Foundation(Turbine)	Foundation Supply
Designer-FEED	FEED
Designer-Foundation	Foundation Supply
Designer-Foundation(metmast)	Foundation Supply
Designer-Foundation(substation)	Foundation Supply
Designer-Foundation(template)	Foundation Supply
Designer-Foundation(turbine)	Foundation Supply
Designer-Met Mast	Met Station Supply
Designer-Other	Supplier
Designer-Substation	Substation Supply
Designer-Substation-Electrical	Substation Supply

Stakeholder Type	Re-categorization
Designer-Substation-Topside	Substation Supply
Designer-Transition Piece	Transition Piece Supply
Developer	Development
Engineer-Geotechnical	FEED
EPCI-Balance of Plant	EPCI-BoP
EPCI-Array Cabling	EPCI-Cable
EPCI-Export Cabling	EPCI-Cable
EPCI-Foundation(substation)	EPCI-Foundation
EPCI-Foundation(turbine)	EPCI-Foundation
EPCI-Met Mast	EPCI-Met Station
EPCI-Offshore Substation	EPCI-Substation
EPCI-Onshore Cabling	EPCI-Cable
EPCI-Onshore Substation	EPCI-Substation
EPCI-Turbine (supply and installation)	EPCI-Turbine
Installer(LEAD)-Array Cabling	Cable Installation
Installer(LEAD)-Export Cabling	Cable Installation
Installer(LEAD)-Foundation(substation)	Foundation Installation
Installer(LEAD)-Foundation(turbine)	Foundation Installation
Installer(LEAD)-Met Mast	Met Station Installation
Installer(LEAD)-Substation	Substation Installation
Installer(LEAD)-Transition Piece(Substation)	Transition Piece Installation
Installer(LEAD)-Transition Piece(turbine)	Transition Piece Installation
Installer(LEAD)-Turbine	Turbine Installation
Installer-Array Cable (Jointing/Termination)	Cable Installation
Installer-Array Cable(cable lay and burial)	Cable Installation
Installer-Array Cabling	Cable Installation
Installer-Array Cabling(burial)	Cable Installation
Installer-Array Cabling(cable lay)	Cable Installation
Installer-Array Cabling(components)	Cable Installation
Installer-Array Cabling(trench excavation)	Cable Installation
Installer-Cabling	Cable Installation
Installer-Cabling(pull-in)	Cable Installation
Installer-Export Cable(cable lay and burial)	Cable Installation
Installer-Export Cabling	Cable Installation
Installer-Export Cabling (Jointing/Termination)	Cable Installation
Installer-Export Cabling(burial)	Cable Installation
Installer-Export Cabling(cable lay)	Cable Installation
Installer-Export Cabling(components)	Cable Installation
Installer-Export Cabling(Horizontal Directional Drill)	Cable Installation
Installer-Export Cabling(Joint)	Cable Installation
Installer-Export Cabling(trench excavation)	Cable Installation
Installer-Foundation(Dredging)	Foundation Installation
Installer-Foundation(met mast)	Foundation Installation
Installer-Foundation(post-piling)	Foundation Installation

Stakeholder Type	Re-categorization
Installer-Foundation(pre-piling)	Foundation Installation
Installer-Foundation(Seabed levelling)	Foundation Installation
Installer-Foundation(substation)	Foundation Installation
Installer-Foundation(turbine)	Foundation Installation
Installer-J-tube	Cable Installation
Installer-Met Mast(Equipment install)	Met Station Installation
Installer-Onshore Cabling	Cable Installation
Installer-Other	Other
Installer-Protection(Mattressing)	Construction Support
Installer-Scour Protection	Construction Support
Installer-Substation	Substation Installation
Installer-Substation-Topside	Substation Installation
Installer-Tower(met mast)	Met Station Installation
Installer-Transition Piece(met mast)	Transition Piece Installation
Installer-Transition Piece(substation)	Transition Piece Installation
Installer-Transition Piece(turbine)	Transition Piece Installation
Installer-Turbine	Turbine Installation
Insurer	Operation, Maintenance and Service
Investor	Investment
Maintenance-Array Cable	Operation, Maintenance and Service
Maintenance-Cabling	Operation, Maintenance and Service
Maintenance-Export Cable	Operation, Maintenance and Service
Maintenance-Foundations	Operation, Maintenance and Service
Maintenance-Met Mast	Operation, Maintenance and Service
Maintenance-Other	Operation, Maintenance and Service
Maintenance-Substation	Operation, Maintenance and Service
Maintenance-Turbine	Operation, Maintenance and Service
Manufacturer-Array Cabling	Cable Supply
Manufacturer-Cabling	Cable Supply
Manufacturer-Export Cabling	Cable Supply
Manufacturer-Foundation(anchor)	Foundation Supply
Manufacturer-Foundation(metmast)	Foundation Supply
Manufacturer-Foundation(PinPiles)	Foundation Supply
Manufacturer-Foundation(pre-fabricated pipes)	Foundation Supply
Manufacturer-Foundation(substation)	Foundation Supply
Manufacturer-Foundation(suction bucket)	Foundation Supply
Manufacturer-Foundation(Template)	Foundation Supply
Manufacturer-Foundation(turbine)	Foundation Supply
Manufacturer-Foundation-Gravity Based(metmast)	Foundation Supply
Manufacturer-Foundation-Gravity Based(substation)	Foundation Supply
Manufacturer-Foundation-Gravity Based(turbine)	Foundation Supply
Manufacturer-Foundation-Primary Steel(metmast)	Foundation Supply
Manufacturer-Foundation-Primary Steel(substation)	Foundation Supply
Manufacturer-Foundation-Primary Steel(turbine)	Foundation Supply

Stakeholder Type	Re-categorization
Manufacturer-Foundation-Secondary Steel(substation)	Foundation Supply
Manufacturer-Foundation-Secondary Steel(turbine)	Foundation Supply
Manufacturer-Met Mast(Tower)	Met Station Supply
Manufacturer-Onshore Cabling	Cable Supply
Manufacturer-Onshore Substation	Substation Supply
Manufacturer-Other	Supplier
Manufacturer-Secondary Steel-Boat Landing(substation)	Supplier
Manufacturer-Secondary steel-Boat Landing(turbine)	Supplier
Manufacturer-Substation	Substation Supply
Manufacturer-Substation-Electrical	Substation Supply
Manufacturer-Substation-Topside	Substation Supply
Manufacturer-Substation-Transformer	Substation Supply
Manufacturer-Transition Piece(substation)	Transition Piece Supply
Manufacturer-Transition Piece(turbine)	Transition Piece Supply
Manufacturer-Transition Piece-Met Mast	Transition Piece Supply
Manufacturer-Transition Piece-Primary Steel(substation)	Transition Piece Supply
Manufacturer-Transition Piece-Primary Steel(turbine)	Transition Piece Supply
Manufacturer-Transition Piece-Secondary Steel(substation)	Transition Piece Supply
Manufacturer-Transition Piece-Secondary Steel(turbine)	Transition Piece Supply
Manufacturer-Turbine	Turbine Supply
Manufacturer-Turbine(Blades)	Turbine Supply
Manufacturer-Turbine(Tower)	Turbine Supply
Operator	Operation, Maintenance and Service
Operator-Offshore Transmission	Operation, Maintenance and Service
Owner	Ownership
Owner-Offshore Transmission	Ownership
Port	Port Services
Port Services	Port Services
Project Management-EPC	Operation, Maintenance and Service
Project Management-Other	Operation, Maintenance and Service
Supplier-Cable Protection Systems	Cable Supply
Supplier-Coatings(Foundation)	Supplier
Supplier-Coatings(MetMast)	Supplier
Supplier-Coatings(Substation)	Supplier
Supplier-Coatings(Transition Piece)	Supplier
Supplier-Coatings(Turbine)	Supplier
Supplier-Crane(Substation)	Supplier
Supplier-Crane(Transition Piece)	Supplier
Supplier-Crane(Turbine)	Supplier
Supplier-Flanges	Supplier
Supplier-Helicopter	Supplier
Supplier-Hydraulic Hammer	Supplier
Supplier-Installation Equipment (Array Cable)	Supplier

Stakeholder Type	Re-categorization
Supplier-Installation Equipment (Export Cable)	Supplier
Supplier-Installation Technicians	Supplier
Supplier-LiDAR	Supplier
Supplier-MetOcean Equipment	Supplier
Supplier-Navigation Aids	Supplier
Supplier-Other	Supplier
Supplier-Plate Steel(Foundation)	Supplier
Supplier-Plate Steel(Tower)	Supplier
Supplier-Temporary Power	Supplier
Surveyor-Geophysical	Surveys
Surveyor-Geotechnical	Surveys
Surveyor-Maritime Traffic and Navigation Risk	Surveys
Surveyor-Metocean	Surveys
Surveyor-Other	Surveys
Surveyor-UXO	Surveys
Surveyor-Warranty end-Handover Survey	Surveys
Surveyor-Wildlife	Surveys
Transport-Foundation	Logistics
Transport-Other	Logistics
Unknown	Other
Vessel-Accommodation	Crew Vessels
Vessel-Accommodation (W2W)	Crew Vessels
Vessel-Array Cable Installation	Cable Installation Vessels
Vessel-Array Cable Installation(burial)	Cable Installation Vessels
Vessel-Array Cable Installation(cable lay and burial)	Cable Installation Vessels
Vessel-Array Cable Installation(cable lay)	Cable Installation Vessels
Vessel-Array Cable Installation(components)	Cable Installation Vessels
Vessel-Array Cable Installation(trench excavation)	Cable Installation Vessels
Vessel-Array Cable Maintenance	Operation, Maintenance and Service Vessels
Vessel-Array Cable(removal)	Cable Installation Vessels
Vessel-Boulder Removal(seabed clearance)	Construction Support Vessels
Vessel-Cable Installation	Cable Installation Vessels
Vessel-Construction Support (W2W)	Construction Support Vessels
Vessel-Crew Transfer	Crew Vessels
Vessel-Decommissioning	Construction Support Vessels
Vessel-Engineering	Construction Support Vessels
Vessel-Export Cable Installation	Cable Installation Vessels
Vessel-Export Cable Installation(burial)	Cable Installation Vessels
Vessel-Export Cable Installation(cable lay and burial)	Cable Installation Vessels
Vessel-Export Cable Installation(cable lay)	Cable Installation Vessels
Vessel-Export Cable Installation(components)	Cable Installation Vessels
Vessel-Export Cable Installation(dive support)	Cable Installation Vessels
Vessel-Export Cable Installation(trench excavation)	Cable Installation Vessels

Stakeholder Type	Re-categorization
Vessel-Export Cable Maintenance	Operation, Maintenance and Service Vessels
Vessel-Export Cable(joint)	Cable Installation Vessels
Vessel-Export Cable(removal)	Cable Installation Vessels
Vessel-Foundation Installation(met mast)	Foundation Installation Vessels
Vessel-Foundation Installation(post-piling)	Foundation Installation Vessels
Vessel-Foundation Installation(pre-piling)	Foundation Installation Vessels
Vessel-Foundation Installation(substation)	Foundation Installation Vessels
Vessel-Foundation Installation(turbine)	Foundation Installation Vessels
Vessel-Grouting	Construction Support Vessels
Vessel-Heavy Maintenance	Operation, Maintenance and Service Vessels
Vessel-J-tube installation	Cable Installation Vessels
Vessel-Met Mast Installation	Construction Support Vessels
Vessel-Met Mast(removal)	Construction Support Vessels
Vessel-O&M-Array Cable	Operation, Maintenance and Service Vessels
Vessel-O&M-Blades	Operation, Maintenance and Service Vessels
Vessel-O&M-Component Exchange	Operation, Maintenance and Service Vessels
Vessel-O&M-Gearbox	Operation, Maintenance and Service Vessels
Vessel-O&M-Heavy Maintenance	Operation, Maintenance and Service Vessels
Vessel-O&M-Met Mast	Operation, Maintenance and Service Vessels
Vessel-O&M-Support (W2W)	Operation, Maintenance and Service Vessels
Vessel-Operations and Maintenance	Operation, Maintenance and Service Vessels
Vessel-Protection(Mattressing etc)	Construction Support Vessels
Vessel-Route Clearance(ordnance)	Construction Support Vessels
Vessel-Route Clearance(PLGR)	Construction Support Vessels
Vessel-Scour Protection Installation	Construction Support Vessels
Vessel-Substation Installation	Substation Installation Vessels
Vessel-Substation(cable connection)	Substation Installation Vessels
Vessel-Support	Construction Support Vessels
Vessel-Survey	Surveying Vessels
Vessel-Survey(Geophysical)	Surveying Vessels
Vessel-Survey(Geotechnical)	Surveying Vessels
Vessel-Survey(UXO)	Surveying Vessels
Vessel-Transition Piece Installation(met mast)	Foundation Installation Vessels[2]
Vessel-Transition Piece Installation(substation)	Foundation Installation Vessels[3]

[2] The transition piece is usually lifted and grouted or bolted in place from Foundation Installation Vessels

[3] The transition piece is usually lifted and grouted or bolted in place from Foundation Installation Vessels

Stakeholder Type	Re-categorization
Vessel-Transition Piece Installation(turbine)	Foundation Installation Vessels[4]
Vessel-Transportation	Operation, Maintenance and Service Vessels
Vessel-Transportation(Foundation)	Operation, Maintenance and Service Vessels
Vessel-Trenching	Cable Installation Vessels
Vessel-Turbine Installation	Turbine Installation Vessels
Vessel-Unknown	Other

[4] The transition piece is usually lifted and grouted or bolted in place from Foundation Installation Vessels

Appendix C

Allocation of complexity values per value chain parts

Value chain part	Number of firms	Unique number of firms	Complexity (based upon number of firms)	Complexity (based upon unique number of firms)	Complexity (validation with literature)	Codifiability	Mode of governance
Cable Installation	462	66	**0**	**0**	**1**[5]	0	Relational
Cable Installation Vessels	513	79	**0**	**0**	**1**[6]	1	Modular
Cable Supply	210	18	1	1	1	1	Modular
Construction Support	133	21	1	1	1	0	Relational
Construction Support Vessels	770	152	**0**	**0**	**1**[7]	1	Modular
Consultancy	746	195	0	0	0	1	Market
Crew Vessels	3144	113	0	0	0	1	Market
EPCI-BoP	27	13	1	1	1	0	Relational
EPCI-Cable	101	20	1	1	1	0	Relational
EPCI-Foundation	67	22	1	1	1	0	Relational
EPCI-Met Station	16	15	1	1	1	0	Relational
EPCI-Substation	89	34	1	1	1	0	Relational

[5] For cable installation the database suggests otherwise, however the number of unique firms is very close to the mean average value
[6] For cable installation vessels the database suggests otherwise, however the number of unique firms is very close to the mean average value
[7] For construction support vessels the database suggests otherwise, however construction support vessels perform all kinds of smaller however tailored activities, suggesting complexity (BVG Associates, 2019a)

Value chain part	Number of firms	Unique number of firms	Complexity (based upon number of firms)	Complexity (based upon unique number of firms)	Complexity (validation with literature)	Codifiability	Mode of governance
EPCI-Turbine	26	4	1	1	1	0	Relational
FEED	40	22	1	1	1	0	Relational
Foundation Installation	239	44	1	1	1	0	Relational
Foundation Installation Vessels	361	41	0	1	1	1	Modular
Foundation Supply	586	102	0	0	0	1	Market
Logistics	80	33	1	1	1	1	Modular
Met Station Installation	49	21	1	1	1	0	Relational
Met Station Supply	34	11	1	1	1	1	Modular
Operation, Maintenance and Service	556	169	**0**	**0**	**1**[8]	1	Modular
Operation, Maintenance and Service Vessels	597	87	0	0	0	1	Market
Port Services	141	46	**1**	**1**	**0**[9]	1	Market
Substation Installation	90	26	1	1	1	0	Relational

[8] For operation, maintenance and service the database suggests otherwise, however the high tech skills required and the similarities with installation indicate high complexity
[9] For port services the database suggests otherwise, however port facilities are simply available in limited amounts independently from any complexity measures (Scholz-Reiter et al., 2010)

Value chain part	Number of firms	Unique number of firms	Complexity (based upon number of firms)	Complexity (based upon unique number of firms)	Complexity (validation with literature)	Codifiability	Mode of governance
Substation Installation Vessels	80	19	1	1	1	1	Modular
Substation Supply	303	52	1	1	1	0	Relational
Supplier	839	188	0	0	0	1	Market
Surveying Vessels	660	100	0	0	0	1	Market
Surveys	435	80	0	0	0	1	Modular
Transition Piece Installation	123	30	1	1	1	0	Relational
Transition Piece Supply	242	38	1	1	1	1	Modular
Turbine Installation	145	30	1	1	1	0	Relational
Turbine Installation Vessels	138	22	1	1	1	0	Relational
Turbine Supply	146	19	1	1	1	1	Modular
Mean	**353,1944444**	**60,19444444**					

Pre-development stage

Surveying work is relatively simple. Surveyors take full responsibility for their work with little input from the lead firm (BVG Associates, 2019a). In addition, they use their skills across a wide customer base as other marine industries rely on similar activities, suggesting low asset specificity and limited transaction specific investments. Moreover, knowledge about geotechnical surveys is relatively easily transferable by means of education and training (IRENA, 2018). For FEED the situation is different: FEED is a multi-disciplinary process that requires extensive communication and coordination, often across multiple teams and organisations, suggesting high complexity and low codifiability (BVG Associates, 2019a).

Supply stage

In general supply is considered to be less customized than construction (Steen, 2016). Much of the labour needed to produce the main components involves low to medium skill sets such as foundations for both turbines and substations (IRENA, 2018). On the other hand, production of most of the turbine components requires highly specialised skills not everywhere available (IRENA, 2018). The same applies to designing offshore substations and making them suitable for connection to the onshore grid, which remains a complex and customized process (BVG Associates, 2019a). Cable design characteristics are affected by installation circumstances. As the exact properties of installation differ from wind farm to wind farm, cable design in terms of cable length, cross section, bending range, conductivity etc. is highly variable making it a complex process (IWMA, 2017; Offshore Wind Programme Board, 2015). Indeed, the tendering process for cable suppliers relies on both costs and non-monetary criteria (Offshore Wind Programme Board, 2015).

Construction stage

Offshore wind farm construction is complex and hard to codify because it is faced with severe weather conditions and challenges associated with increasingly larger installations and developments further from shore (Barlow et al., 2015). The uncertainties faced during installation can extend construction schedules and increase capital expenditures (Paterson et al., 2018). The specifications for installation cannot be codified, because they differ by wind farm location and the product architecture of technologies that is chosen (Sovacool & Enevoldsen, 2015; Steen, 2016). Offshore wind farm projects require the integration of foundations, vessels, cables, blades, towers etc. (Sovacool & Enevoldsen, 2015). Integral product architectures are more likely to require non-standard inputs, making installation requirements subject to close coordination among suppliers and between suppliers and the lead firm (Gereffi et al., 2005).

EPCI stage

EPCI contractors take full responsibility for a wide scope of supply- and construction activities and delivers via own and subcontract resources (BVG Associates, 2019a). Those contracts go beyond installation by doing the whole thing, therefore they are more complex and even harder to codify. As the EPCI-contractor has to deliver a complete package, the degree of risk in operation is much higher. This means that only large, experienced contractors are awarded with EPCI-contracts (BVG Associates, 2020).

Operation stage

Operating a wind farm is a very diverse and complicated process (Triepels, 2017). Operations, maintenance and service covers all activities from completion of installation to the start of decommissioning and all activities that were needed to support any main activities from previous stages. A highly skilled workforce with solid knowledge of mechanical, ICT and electrical engineering is required for both operations and maintenance tasks (IRENA, 2018). Moreover, some operation and maintenance tasks are akin to installation, that is a very complex process (Dewan & Asgarpour, 2016). Synergies in terms of planned maintenance, defect detection, and asset repair are very strong between offshore wind and other offshore sectors. Moreover, the skills required to carry out underwater inspection, maintenance and repair could potentially be transferred after minimal re-training. The synergies, the ability to enforce service contracts and the comprehensive training infrastructure available, suggest that information can be codified easily (IRENA, 2018).

Cross-cutting stage

Consultancy activities are similar to surveys in a sense that they are independent and fully responsible for supplying their packages of work throughout multiple development stages in the value chain (BVG Associates, 2019a).

Through logistics all components and services are brought together at the windfarm location. Between production and offshore installation, the supply chain consists of shore-based transport, handling at the port and the sea-based transport. Due to the high customization of some components and because they are mostly very bulky and heavy and because appropriate vessels are often limited in supply, it is a challenge to formulate appropriate logistic strategies and schedules (Scholz-Reiter et al., 2010).

Each wind farm requires a port to get constructed. Ports play a fundamental role in windfarm construction and the rapid industry growth imposes significant requirements on the ports (Ade Irawan et al., 2017). For ports to be selected, the main requirement is the port-to-farm site distance to keep transportation and installation cost at a minimum (Sarker & Faiz, 2017). Developers will typically competitively tender the contract for the provision of port services (BVG Associates, 2019a). Moreover, a developer may stay for the duration of installation only and move on to the next project at a different location (WindEurope, 2017). Thus, developers contact ports mainly based on market factors.

Vessels

Vessels are required throughout the process of constructing offshore wind farms. Operating vessels for the installation stage is characterized by high complexity, because vessel supply in general is constrained and because technological maturity of bespoke installation vessels is low (Steen, 2016). Installation vessels intended for use in other marine sectors are able to perform offshore wind farm installation, however they are not ideal for such conditions making operating those vessels a complex process (EWEA, 2009). Often vessels from other marine industries are used because the competencies associated with those operations are at least close to what is required for installing offshore wind farms (MacKinnon et al., 2019). For example, laying electrical cables is done in many applications in many industries and is still primarily done by specialized cable laying vessels not unique to any particular industry (Hunstad & Risan, 2014). The same reasoning applies to substation installation vessels: despite the complexity of operating the vessel, the choice of vessel is likely to be driven by costs and, in many cases, the vessels serve other markets (BVG Associates, 2019a). Also construction support vessels and foundation installation vessels are used in sectors like oil and gas, bridge building and near-shore construction (BVG Associates, 2019a; EWEA, 2009). The use of vessels for the similar purposes in other industries suggests that asset specificity is low because knowledge is not transaction specific. Rather vessel suppliers are introduced to a common language that is shared across a spectrum of industries, reducing the need for transaction specific investments. This phenomenon is also observed within the offshore wind industry itself. For example, operation, maintenance and service vessels are often shared between more offshore wind farms (Halvorsen-Weare et al., 2013).

On the other hand, some vessel types are designed primarily to serve an offshore wind value chain part. For example, turbine installation vessels are designed primarily for the purpose (BVG Associates, 2019a). In these cases asset specificity is higher, thus the reliance on tacit know-how and skills is greater (Gereffi et al., 2005). The specialist nature of these vessels is reflected in the limited number of turbine-installation vessels available for installation (Barlow et al., 2015)

Vessels for site assessments and geotechnical surveys are also used in other offshore industries, making operation of those vessels less specific than the operation of purpose-built installation vessels specifically developed for operations in offshore wind (Musial et al., 2006). Finally, transporting personnel to the wind farm with help of crew vessels is inherently less complex than installing wind farm components with installation vessels. Indeed, crew vessels are the most commonly used way of accessing offshore wind farms (Dewan & Asgarpour, 2016).

Appendix D

Model fit tests for the binomial logistic regressions

D1. Model fit and explanatory power of the binomial logistic model for the full dataset with developer sourcing being the outcome variable

		Model 1	Model 2	Model 3	Model 4	Model 5
Developer sourcing	**-2 Log-Likelihood (intercept)**	5955,602	5955,602	5955,602	5955,602	5955,602
	-2 Log-Likelihood (model)	5940,839	5893,474	5886,387	5883,375	5850,837
	Chi-square	14,763*	62,128*	69,215*	72,227*	104,765*
	Change in Chi-square	-	47,366*	7,087*	3.012	32,538*
	Change in degrees of freedom	-	1	2	1	1
	Cox and Snell's pseudo R2	0,001	0,005	0,006	0,006	0,009
	Nagelkerke's pseudo R2	0,003	0,013	0,015	0,015	0.022

Note: N = 12026, *model (improvement) is significant for α=0,05

D2. Model fit and explanatory power of the binomial logistic model for the full dataset with global sourcing being the outcome variable

		Model 1	Model 2	Model 3	Model 4	Model 5
Global sourcing	**-2 Log-Likelihood (intercept)**	16644,927	16644,927	16644,927	16644,927	16644,927
	-2 Log-Likelihood (model)	16515,632	15590,459	15255,276	15111,520	15016,256
	Chi-square	129,295*	1054,469*	1389,651*	1533,408*	1628,671*
	Change in Chi-square	-	925,174*	335,183*	143,756*	95,264*

		Model 1	Model 2	Model 3	Model 4	Model 5
	Change in degrees of freedom	-	1	2	1	1
	Cox and Snell's pseudo R2	0,011	0,084	,109	0,120	0,127
	Nagelkerke's pseudo R2	0,014	0,112	,146	0,160	0.169

Note: N = 12026, *model (improvement) is significant for α=0,05

D3. Model fit and explanatory power of the binomial logistic model for foreign developed windfarms with local sourcing being the outcome variable

		Model 1	Model 2	Model 3	Model 4	Model 5
Local sourcing n = 5529	**-2 Log-Likelihood (intercept)**	7664,822	7664,822	7664,822	7664,822	7664,822
	-2 Log-Likelihood (model)	7396,095	6976,492	6882,989	6779,503	6779,390
	Chi-square	268,727*	688,329*	781,833*	885,318*	885,431*
	Change in Chi-square	-	419,603*	93,503*	103,485*	,113
	Change in degrees of freedom	-	1	2	1	1
	Cox and Snell's pseudo R2	,047	,117	,132	,148	,148
	Nagelkerke's pseudo R2	,063	,156	,176	,197	,197

Note: n = 5529, *model (improvement) is significant for α=0,05

D4. Model fit and explanatory power of the binomial logistic model for windfarms developed by at least one local developer with local-developer sourcing being the outcome variable

		Model 1	Model 2	Model 3	Model 4	Model 5
Local-developer sourcing n = 6497	**-2 Log-Likelihood (intercept)**	8832,049	8832,049	8832,049	8832,049	8832,049

	Model 1	Model 2	Model 3	Model 4	Model 5
-2 Log-Likelihood (model)	8820,270	8511,531	8411,166	8325,267	8142,924
Chi-square	11,779*	320,517*	420,882*	506,781*	689,125*
Change in Chi-square	-	308,739*	100,365*	85,899*	182,343*
Change in degrees of freedom	-	1	2	1	1
Cox and Snell's pseudo R2	,002	,048	,063	0,075	0,101
Nagelkerke's pseudo R2	,002	,065	,084	0,101	0.135

Note: n = 6497, *model (improvement) is significant for α=0,05

Appendix E

Model fit tests for the multinomial logistic regressions

E1. Model fit and explanatory power of the multinomial logistic models

		Model 1	Model 2	Model 3	Model 4	Model 5
-2 Log-Likelihood (intercept)	Full dataset[a]	318,676	3240,342	3240,342	3937,081	3937,081
	Foreign developer[b]	327,879	882,558	882,558	1079,581	1079,581
	At least one local developer[c]	54,539	768,001	768,001	1305,070	1305,070
-2 Log-Likelihood (model)	Full dataset[a]	70,512	423,764	125,334	648,300	395,128
	Foreign developer[b]	43,416	175,577	76,366	150,271	148,260
	At least one local developer[c]	42,436	205,120	74,940	452,111	238,260
Chi-square	Full dataset[a]	248,164*	2816,596*	3115,008*	3288,781*	3541,953*
	Foreign developer[b]	284,463*	706,981*	806,193*	929,309*	931,321*
	At least one local developer[c]	12,103*	562,881*	693,061*	852,959*	1066,809*
Change in Chi-square	Full dataset[a]	-	2568,432*	298,412*	173,773*	253,172*
	Foreign developer[b]	-	422,518*	99,212*	123,116*	2,012
	At least one local developer[c]	-	550,778*	130,180*	159,898*	213,850*
Change in degrees of freedom	Full dataset[a]	-	3	6	3	3
	Foreign developer[b]	-	2	4	2	2
	At least one local developer[c]	-	2	4	2	2
Cox and Snell's pseudo R2	Full dataset[a]	0,020	0,209	0,228	0,239	0,255
	Foreign developer[b]	0,050	0,120	0,136	0,155	0,155
	At least one local developer[c]	0,002	0,083	0,101	0,123	0,151
Nagelkerke's pseudo R2	Full dataset[a]	0,022	0,229	0,250	0,263	0,280
	Foreign developer[b]	0,059	0,142	0,160	0,183	0,183
	At least one local developer[c]	0,002	0,102	0,125	0,152	0,187

Note: [a] N = 12026, [b] n = 5529, [c] n = 6497, *model (improvement) is significant for α=0,05

E2. The likelihood ratio statistics of the full multinomial logistic models

Effect		Model Fitting Criteria	Likelihood Ratio Tests		
		-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	Full dataset[a]	395,128[a]	,000	0	.
	Foreign developer[b]	150,271[a]	,000	0	.
	At least one local developer[c]	238,260[a]	,000	0	.
Mode of governance	Full dataset[a]	395,128[a]	,000	0	.
	Foreign developer[b]	150,271[a]	,000	0	.
	At least one local developer[c]	238,260[a]	,000	0	.
Local content push	Full dataset[a]	395,128[a]	,000	0	.
	Foreign developer[b]	150,271[a]	,000	0	.
	At least one local developer[c]	238,260[a]	,000	0	.
Local content push × Mode of governance	Full dataset[a]	668,295	273,167	6	,000
	Foreign developer[b]	227,338	77,067	4	,000
	At least one local developer[c]	365,318	127,057	4	,000
Current Installed Capacity (100MW)	Full dataset[a]	453,091	57,964	3	,000
	Foreign developer[b]	273,388	123,117	2	,000
	At least one local developer[c]	341,251	213,851	2	,000
Economic wealth (1000€GDP/capita)	Full dataset[a]	648,300	253,172	3	,000
	Foreign developer[b]	removed	removed	removed	removed
	At least one local developer[c]	452,111	213,851	2	,000

Note: [a] N = 12026, [b] n = 5529, [c] n = 6497, The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0

[a] This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom

Appendix F

Goodness-of-fit statistics

F1. The Hosmer-Lemeshow goodness-of-fit statistic of the binomial logistic models

		Chi-Square	df	Sig.
Developer sourcing	Full dataset[a]	4,972	6	,547
Global sourcing	Full dataset[a]	6.525	5	,258
Local sourcing	Foreign developer[b]	,224	4	,994
Local-developer sourcing	At least one local developer[c]	7,730	6	,259

Note: [a] N = 12026, [b] n = 5529, [c] n = 6497

F2. The goodness-of-fit statistics of the multinomial logistic models

		Chi-Square	df	Sig.
Pearson	Full dataset[a]	132,261	30	,000
	Foreign developer[b]	29,696	16	,020
	At least one local developer[c]	79,458	20	,000
Deviance	Full dataset[a]	140,019	30	,000
	Foreign developer[b]	31,035	16	,013
	At least one local developer[c]	83,828	20	,000

Note: [a] N = 12026, [b] n = 5529, [c] n = 6497