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## **Indexing terms**

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Firm  
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# 1. Introduction<sup>1</sup>

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A supply chain consists of all activities and information associated with the transformation flow of goods and services from the raw material stage till the final product reaches the consumer. Since the transformation of individual products and services normally involve the interactions of independent firms, several organisations are typically involved in the supply chain. A key variable in the organisation of the chain is therefore the level of financial integration and the contractual obligations between the participating firms. Pending on the external business environment, the organisation of the supply chain varies across sectors and between firms in a given sector.

This paper focuses on the organisation of the supply chain in the offshore oil industry, primarily the relationships between upstream oil-companies and their main contractors. Upstream oil activities represent one part of a broader supply chain of fluids, but we will only look at the extraction and production phases in this chain. The oil company is thus our final consumer. From studies of the North Sea offshore industry, we know that there are close ties between the upstream oil industry and its suppliers. The Norwegian state owned oil company Statoil, for instance, tends to outsource goods and services to numerous independent suppliers. At the same time, Statoil provides several incentives and makes alliances with its suppliers in order to reduce life cycle costs. In new and promising markets in developing countries where technology and trust may differ from those of the North Sea, the organisation of the supply chain may differ from the above pattern. If so, we may expect the internationalisation strategies of these firm to differ from those applied in the North Sea.

Along the transaction costs traditions, we are particularly interested in how the organisation of the supply chain depends on the complexity of the technology applied (Williamson 1985, Coase 1960). In this analysis, we will bring in one new dimension by analysing how cultural aspects such as trust may influence the organisation of the supply chain (Sako 1992, Baker 1997).

Angola is currently considered the most promising market in the world, and the increased production will be from deepwater wells. While subsea and deepwater constitute approximately one third of the global market for offshore engineering and construction services in 2000, they will increase to nearly 50 per cent or approximately USD 30 billion in 2004.<sup>2 3</sup>

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<sup>1</sup> I would like to thank Hildegunn Nordaas, Line Tøndel, Inge Tvedten, Øystein Kristiansen and Henri de Groot for helpful comments on this draft. Financial support from the Norwegian Research Council, 'Petropol' is gratefully appreciated.

<sup>2</sup> Estimate by Coflexip Stena Offshore. A smaller estimate of USD 20 billions is provided by *The World Deepwater Report 2000–2004* by Douglas-Westwood Limited (adapted from Alexander's Gas & Oil Connections Online; <http://www.gasandoil.com/goc/company/>). According to *The World Subsea Report 1999–2003* by Douglas-Westwood Limited, subsea expenditure will constitute around 50 per cent of deepwater expenditure.

The Angolan case is important for several reasons. First, it gives information on the organisation of the supply chain in a new technologically advanced segment of the oil market, namely deepwater exploration. Second, it sheds lights on how differences in cultural factors such as trust influences the structure of the supply chain. Finally, from a more strategic point of view, Angola represents a growth potential for the Norwegian supply industry and others. In subsea markets such as the Angolan, the growth potential for the supply industry is highest.<sup>4</sup>

In the following section, we give a brief overview of the oil industry in Angola and supply chain management in the Norwegian part of the North Sea. While the structure of the supply chain in the North Sea is presented in several publications (Heum 1999; Greve H, Haugland, and Walderhaug 1996; Nordaas 2000ab), one hardly finds any comprehensive analysis of supply chains in Angola. Based on transaction costs-inspired theories of supply chain management, section three generates some hypotheses regarding the organisation of the supply chain in Angola. By presenting two case studies, section four analyses this supply chain, particularly in terms of contracts awarded, ownership structure and informal network between the parties. The two case studies chosen, Kuito and Girassol, have either recently started the production or are in the process of doing so. The main question addressed is whether technological and cultural differences may explain how and why these supply chains differ from the present North Sea structures. The concluding section emphasises the way in which the organisation of the supply chain influences main strategies for penetrating this type of market.

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<sup>3</sup> West Africa is the most promising area in this field, and the expenditure on subsea drilling and completion will exceed that in North America (including Gulf of Mexico) in 2002. Cf. *The World Deepwater Report 2000–2004*. Douglas-Westwood Limited (adapted from Alexander's Gas & Oil Connections). According to Dick Matzke, vice chairman of Chevron, Angola is "one of the world's best areas for frontier oil exploration and production, especially in deep water areas." Press release from Chevron January 5 2000.

<sup>4</sup> Moreover, since deepwater activities are extremely skill-intensive, one should expect a high profit margin.

## 2. Supply chains in the oil industry

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This section gives a general overview of the types of agents involved in the supply chain in the oil industry, their core activities and market segments. It starts with an overview of the oil industry in Angola and its growth potential. Supply chain management in the oil industry is then described with an emphasis on the role played by human and physical assets. As a benchmark for the subsequent analysis, an overview of supply chain management in the Norwegian part of the North Sea is presented. Section 2.3 demonstrates how creating partnerships plays a significant role in this market.

### 2.1. The oil industry in Angola

Angola started oil production already in 1957. Oil plays a significant role in the Angolan economy. Oil production constitutes 50 per cent of GDP and revenue from oil production constitutes half of Angolan tax income. In 1999, a Chevron-led consortium produced 420,000 bpd oil, or 58 per cent of the Angolan production of 720,000 bpd. Other companies, Elf, Texaco, Fina, Ranger, and the Angolan state oil company Sonangol, produced the rest. With the start-up of the Kuito Field, Chevron's total production per day has increased to 550,000 bpd.<sup>5</sup>

Since 1995, oil majors have started to encounter huge oil reservoirs in Angola's deep water, from depths of 300 meters to beyond 1200 meters. Reserves have been in proportions far exceeding anything onshore. In half a decade, some eight bn barrels have been discovered. If three-quarters of these are proven, Angola's reserves will more than double.<sup>6</sup> Since Girassol was discovered, ten other fields have been found in Elf's successful Block 17. Esso has made huge discoveries in various fields (nine found) in block 15 and Chevron has made a number of significant discoveries in block 14.<sup>7</sup> All new fields are based on production sharing agreements (PSA) with Sonangol.

Angolan authorities expect yearly investments in the oil sector to be approximately four billions USD ([www.angola.com](http://www.angola.com)). Chevron and its partners alone plan to invest some six billion dollars in Angola over the next five years. In fact, Norwegian oil companies are poised to spend three billion dollars on offshore oil exploration in Angola during the next decade.<sup>8</sup> Angola therefore represents a growth potential for the supply industry.

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<sup>5</sup> Press release from Chevron Oct. 4, 2000.

<sup>6</sup> *Alexander's Gas & Oil*.

<sup>7</sup> One of the reasons why these new discoveries have yet not been developed is that while the operators are seeking to develop different fields in concert Sonangol has put its foot down. For instance, as of November 2000 a dispute is ongoing between ExxonMobile and Sonangol regarding tenders for Kizomba field where Sonangol is seeking to reduce the speed of the process.

<sup>8</sup> Information from the Norwegian Ambassador Bjørg Leite (quoted in *Alexander's Gas and Oil*).

About 200 firms are registered in Angola, providing services and goods to the oil industry. There is no available information about the number of employees and turnover of these firms. Less than 20 per cent are Angolan companies and most of these has some relationship to Sonangol. The rest are local offshoots of multinationals put in place to service the Angolan market. Angola is not being used as a stepping stone to service other markets in Nigeria, Chad etc. Sonangol plays the leading role in the oil industry both as a concessionaire, a licence partner, a partner in the supply of goods and services and as a regulator and implementing agency of Angolan oil policy.

Several Norwegian companies are already established in Angola (e.g., Statoil, Norsk Hydro, Kvaerner, Stolt Offshore and Kongsberg Offshore), but as indicated above, the growth prospects makes Angola an even more interesting market in the future.

## 2.2. Market segment and supply chain

A firm which seeks to penetrate a new market needs first of all to clarify its core activities and which market it wants to compete in. Regarding upstream oil production, there are a number of different tasks or segments. Firms can be classified according to the task or market segments they work in.<sup>9</sup> Some firms specialise in a single task while others provide all or a combination. Firms specialising in more than one task are integrating or *bundling* its activities. Bundling means that the firm seeks to be an integrated provider of fluids (oil or gas). Table 1 classifies tasks or markets in the upstream oil sector. Halliburton is an example of a vertical multinational which has integrated all of the tasks listed in Table 1 (and is involved in downstream activities also). Halliburton can therefore serve as an example of a integrated oil service firm. The other extreme is a firm specialising in a single task (for instance in drilling). Normally the supply industry (the oil service firms) is dealing with tasks 1-5 in Table 1, while the core activity of the oil company is the production of oil (task 6 in table 1).

As with the oil majors, the supply industry consists of multinationals and we see a rising trend in acquisitions, particularly in terms of vertical activities.

### Table 1: Key Tasks in the Upstream Oil Sector

1. Exploration (including seismic) and drilling (which in deepwater is undertaken by ships or SPAR platforms),
2. Engineering and project management,
3. Construction of production facilities e.g., platform,
4. Subsea construction, pipelay and fabrication of subsea equipment,
5. Installation (platform and subsea),
6. Operations (production of oil).<sup>10</sup>

<sup>9</sup> One may also classify markets geographically.

<sup>10</sup> There is also a separate market of well maintenance. The importance of this market increases during the on stream phase.

The key determining factor in the choice of market, is the *assets of the firm*, particularly its knowledge and capabilities. We distinguish between human and physical assets. There are two types of human assets, individual and firm-specific knowledge. A firm may acquire physical assets and firm-specific knowledge; individual knowledge, however, belongs to the individuals.

A particular aspect of the supply chain in the oil industry is the role played by producer services. Producer services such as research and development (R&D) and engineering act as intermediate goods at every step in the supply chain and play a significant role in the co-ordination of the whole process from field exploration to shipment of crude oil. In the deepwater sector, there are three types of know-how (engineering competence) of particular relevance: the engineering of a platform, the engineering of flowlines and sub-sea equipment and reservoir management and well design.

Efficient information flows between the agents involved in the different tasks are particularly important in the oil industry. The integration of tasks can increase the information flow between firms and thereby reduce the transaction costs in the supply chain. Oil companies prefer increasingly to deal with a limited number of suppliers, a factor which give additional supports to the integration of tasks. The other side of the coin is that integration may lead to inefficiencies. Normally, there is a *trade off between specialisation and integration*; *integration* reduces the transaction costs of using the market at the costs of scale economies and specialisation. *Supply chain management* deals with mechanisms for solving this trade-off.

The supply chain is mainly characterised by two *physical* assets: the production facilities (e.g., platform) and the fluid and reservoir characteristics (e.g., the oil); and one *human* asset, namely knowledge (producing engineering services). All assets are essential in order to produce oil.

In addition to the assets of the firm, the market potential in the different segments is also an important factor in the choice of market. In addition to engineering, *platforms* (3, 3 refers to phase 3 in table 1), *subsea equipment*, *drilling* and *well completion* (1), (4) and (5) are the three markets which dominate deepwater expenditure.

The supply industry not only needs to decide which market segment in the supply chain it will penetrate, firms also need to assess how they will serve the market: through exports or investments? In order for multinationals to undertake FDI, three conditions need to be met (Dunning 1981): ownership advantage; internalisation advantage; and locational advantage.

The firm's *ownership advantage* refers to a situation where it has a product, technology or intangible assets (human capital) of such a nature that the firm enjoys some advantage in foreign markets to compensate for the disadvantages of entering new markets. *Internalisation advantage* relates to the fact that the firm must have a reason to exploit its ownership advantage internally, rather



than licence or sell its product/process to a foreign firm. Firms transfer knowledge internally in order to maintain the value of assets and prevent asset dissipation. When products are new, complex and have no prior commercial application, and are produced by R&D intensive firms, transfers tend to be internal (see (Markusen, Rutherford, and Hunter 1995) for an overview of the literature). As far as *locational advantage* is concerned, the firm must have a reason to locate production abroad rather than concentrate it in the home country, especially when there are scale economies at the plant level.

In Angola, local infrastructure is missing and the fact that oil companies make most of their important logistic decisions from their headquarters in Paris or Houston (confer section four), indicate that it is a locational disadvantage for the supply industry of locating in Angola. However, saying this, to the extent that local investments have been undertaken by the multinationals, they have played an important role in terms of being awarded contracts.

From the operator's point of view, there are different ways of organising the supply chain. Two extremes are the vertical integrated supply chain, in which all tasks are undertaken by one firm, and market transactions based on arm's length trade. There are also hybrid institutions (see the following section).

### **2.3. Forming partnerships - a hybrid example of integrated supply chain management**

Since downstream competition is fierce, an oil company may increase its profits either by increasing the scale of its downstream production (to achieve economics of scale), differentiating its downstream products (through branding) or undertaking lifecycling cost savings in its upstream activities. Regarding the last option, the most important criteria are the success rate in exploration and the reduction in development or on-stream costs.

Since the oil companies tend to outsource or procure a substantial part of its goods and service from independent firms specialising in one or more of the tasks described in Table 1, they therefore need to provide the supply industry with incentives towards cost-reduction.

Procurement of goods and services constitutes more than 50 per cent of an oil company's cost.<sup>11</sup> For the oil company, this means that a considerable part of its gross output is created outside the company. Since even a small change in the organisation of the supply chain may lead to a significant change in profits for the oil company, providing the supply industry with incentives for cost reduction is important. Forming partnerships with *prequalified* suppliers is one mechanism for improving these incentives that is commonly applied in the Norwegian part of the North Sea. Forming partnerships based on interaction and mutuality with suppliers is a central Statoil strategy, and indicates that

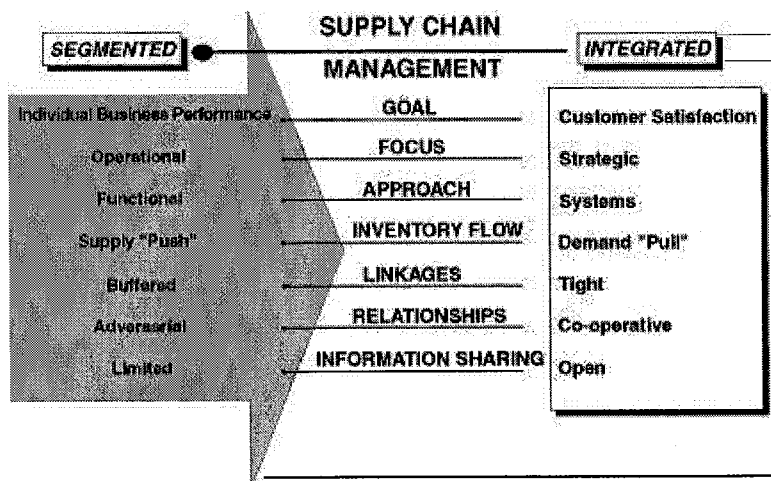
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<sup>11</sup> . Procurement of goods and services in 1996 constituted nearly three times as much as Statoil's profit before tax ([www.statoil.com](http://www.statoil.com)).

Statoil plays an important role in the organisation of the supply chain in the North Sea.<sup>12</sup>

According to Statoil's Director Trondslie (www.statoil.com), supply chain development in the oil industry is characterised by a focus on maximising the *chain's joint profit*. He is also conceptualising the competition arena as *between 'integrated chains'* (where a company is only one of many links in a supply chain) – not between disintegrated chains consisting of individual firms. It is no surprise that a downstream firm tries to give the impression that all firms in the chain have similar interests, although it has been difficult to find other oil companies emphasising this as clearly as Statoil, at least in Angola.<sup>13</sup> As we will return to in section 4, competition rather seem to be between *integrated oil service firms (excluding the oil company)*.

**Figure 1: Development trends through integrated supply chain management**



Source: Adapted from Trondslie, P. The Importance of the Procurement Process to Statoil, and the Development within Statoil's Supply Chain. www. Statoil.com.

The importance of creating partnerships (or relationships) is also underscored by other characteristics of procurement:

- The need for adjustment and bargaining. Parties need to bargain during the contract process because contracts are incomplete. Ex ante uncertainty related to technical specification leads the oil company in many cases to specify functional requirements to a product or technology. This gives the

<sup>12</sup> (Anna Duboi, statoil.com) distinguishes between a unilateral perspective and a bilateral perspective on partnerships.

<sup>13</sup> When deciding on contract partners, Shell seeks mutually beneficial relationships with their contractors. BP Amoco published a new "Supply Chain Management" philosophy in 1999 placing more emphasis on the supply chain management process in order to reduce costs and improve access to technology. We have not found similar explicit references to the importance of creation of relationships in the chain on the homepages of the other majors.

contractor some degree of flexibility in order to develop a particular piece of goods or services. At the same time, unforeseen contingencies frequently arise. Each parties' appraisal of such contingencies may differ, and, since contracts are incomplete, bargaining represents one way of solving such disputes.

- Technical solutions are specific to particular fields (depth and size) and may be tailored towards specific oil companies. Intermediate goods and services are therefore differentiated, and innovations are important in order to satisfy specific demands from the oil companies.
- Limited numbers of pre-qualified suppliers for the main contracts. At the same time, numerous contracts are awarded, implying that the oil company cannot create a relationship to all its suppliers (e.g., in the Gullfaks field in the North Sea more than 1,700 contracts were awarded (Nordaas 2000a).

Trondslieen does not assess the supply chain in upstream oil market from the perspective of financial integration. By this measure, the chain, at least in the North Sea, is rather *fragmented*. The most common way of organising the supply chain in the North Sea is that of the independent and integrated supplier (contractor) that undertakes engineering (designing the platform), procurement, construction (build the platform), and installation (EPCI contract), and delivers the platform to the oil company. However, as the Gullfaks example showed there are a number of additional suppliers involved and the oil company plays an important co-ordination role towards these. Trondslieen tends to look at the supply chain as a business group where the players create informal partnerships, networks and alliances. In such networks, long-term relationships, *trust and mutual dependence substitute for financial integration* and lead to an integrated supply chain where the oil company largely controls the value added outside the company.

### 2.3.1. NorSok - illustrating the role of trust

There are hybrid institutions in-between markets and hierarchies. *Business groups* vary not only by degree of *ownership*, but also according to *authority structure, trust and solidarity* (Granovetter 1995; Feenstra, Huang, and Hamilton 1996).

Trust is of particular importance when contracts are incomplete, and the environment is uncertain and under rapid technological change. Trust is therefore of particular importance in the oil industry, and a keyword in both the NorSok and the CRINE initiatives in the Norwegian and British parts of the North Sea respectively. Both initiatives were initiated by the oil industry and the governments in the respective countries in order to increase *co-operation* between contractors and operators. They focus on how the stakeholders in a supply chain through *informal* mechanisms and institutional *relationships* may enhance common goals of long-term cost minimisation.

Both initiatives try to build up new business groups independent of how the individual actors perceive ownership integration.<sup>14</sup>

According to (NorSok 1996:6) close co-operation between the customer and the contractors

is a precondition if projects are to be completed in a faster and a less costly way.... Mutual trust between the parties is imperative to succeed. The need for formalities is replaced by a culture of work where the contractor and the customer are expected to implicitly know what is right and what is wrong based on agreed attitudes and objectives.

According to (Crabtree, Bower, and Keogh 1997), the outcome of the Crine initiative for the oil companies, are savings of 30 per cent on capital expenditure. The use of partnership and teamwork has played a significant role in this process. Similar reductions of costs have been achieved in Norway, even though this has led many suppliers into financial distress.<sup>15</sup>

Having said this, trust can vary across locations for a given sector. We know, for instance, that the sub-contracting system of parts to Japanese car manufacturers is based more on trust and long-term relationships than the corresponding American system, although the technology is the same (Helper 1991; Sako and Helper 1998).

NorSok does not address mechanisms that can create trust and how trust can influence the way agents deal with each other. It rather appeals to the moral obligations of the parties. Sako and Helper (1998) analysed such mechanisms in the automobile industry and found that trust increases with the *information flow* between the parties and by the level of *technical assistance* provided by the customer. The building of trust can be regarded as an investment. Trust between an oil company and the main supplier (or between the first and second-tier suppliers) represents a sort of 'relation-specific skill' (Asanuma 1989). This means that changing partners has switching costs, which ultimately strengthens the glue in the chain.

Except for the integration of suppliers in the decision-making process for technical solutions, Statoil is not explicit regarding what is meant by the creation of relationships and what partnerships mean for the (independent)

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<sup>14</sup> One additional reason for the upbeat Norwegian attitude towards NORSOK is that it stimulates the development of a national supply industry (at least in its home market). Trusts between independent actors are probably easier to establish between firms from the same country since they share common cultural conceptions, at least a common language. The idea of an integrated supply chain based on trust, as described by Trondslie and based on the NorSok (and Crine) initiatives, represents a way of promoting a *national supplier industry in a legal context where national discrimination is not allowed*. Similar initiatives are not taken in Angola, partly because there are other available instruments which can be applied for the same objective.

<sup>15</sup> In Njord in the Norwegian part of the North Sea, a 40 per cent cost reduction was achieved due to changes in project organisation.

parties. A business partner can, for instance, be a buyer in one relationship and become a seller or a competitor in other relationships. So what is the 'glue' in the chain? This is the topic of the next section.

### 3. Theories of the firm

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Our knowledge of the 'glue', both in terms of the type of factors holding the different firms in the chain together and the degree of integration in the chain are limited. In section 2.2 we discussed the trade-off between integration and specialisation, represented by an oil company undertaking most activities in-house, and a company basing its operations on arm's length trade with independent firms specialising in a particular task respectively. In section 2.3, the creation of relationships and trust between independent partners were pinpointed as a factor increasing the costs of switching partners in the chain, and thereby cementing the existing trading practice.

This section seeks to present hypotheses concerning the organisation of supply chains in Angola based on the property right perspective of the firm. The underlying question is: When will a firm choose a particular strategy regarding i) choice of market segment and ii) supply chain management (cf. section 2.2)? In section four, we present our results and discuss these in light of alternative theories.

The degree of vertical integration is one indicator of the strength of the glue in the supply chain. A measure of this is external procurement as a share of value added (or value added as a share of sales). If this share is low for a particular task (compared to other firms in the sector), it indicates that production is undertaken in-house. If it is low for all the tasks, the supply chain degenerates to a fully vertically integrated multinational energy provider (such as Halliburton or an oil company which undertakes all activities in-house). If the share is high, the supply chain consists of independent firms. Independent ownership structure, however, does not mean that transactions are based on arms' length trade:

- The contract partners are integrated oil service units. A contract partner may be involved in more than one task (cf. Table 1) at the same time, either through acquisition or through long-term relationships.
- There are close relationships between the contract partners and the oil company (as discussed in section 2.3).

#### 3.1. Transaction costs

The property right approach is inspired by transaction costs analysis, and we will start by presenting some of that theory's main hypotheses. According to transaction cost analysis, governance structure is treated as a dependent variable (Klein, Crawford, and Alchian 1978; Williamson 1985). Between the polar extreme of arm's length trade and vertical integration, the degree of integration is assumed to be increasing with *asset specificity*, *uncertainty* and *the frequency* of transactions (the fixed costs of internal governance are spread

on more transactions).<sup>16</sup> *The degree of integration between companies in a supply chain can be analysed by a similar approach.*

When transactions are characterised by asset specificity, the value of the transactions has a higher value between the parties than outside the relationship. The extreme case is a transaction with no value outside the relationship, e.g., a technology development undertaken by an upstream firm which can only be applied by a particular oil company. Although such cases are rarely found in any industry, it is nonetheless a fact that different oil companies apply different types of technologies or standards. This implies that upstream firms may undertake relation-specific investments with a resulting risk of hold-ups, since it is costly to switch to a different buyer. The outcome is that the firm risks to underinvest in technology improvements.

There are three types of transaction-specific assets:<sup>17</sup>

- When assets are immobile once in place, we have *site specificity*. Site specificity is most relevant during the production phase. The extreme cases are pipelines, fixed installations or platforms and yards. The theory predicts that:
  - An increasing degree of site specificity increases the tendency of vertical integration. Since floating platforms are more mobile than fixed platforms, the tendency for oil companies to own them consequently is lower.<sup>18</sup>
  - The lower the number of suppliers of particular goods and services, the greater the frequency of internal production. If, for instance, goods and services have to be provided locally and few service providers are available, the oil company is unable to switch to other suppliers and it will tend to integrate production (catering and transport facilities are good examples).
- *Human asset specificity* describes transaction-specific knowledge or human capital achieved through specialised training or learning by doing (e.g. engineering competence). Transaction costs theory predicts accordingly that increasing engineering intensity of a task tends to favour integration. Engineering competence of particular relevance for an oil field or a particular operator (e.g. reservoir knowledge and the engineering of a platform) should accordingly be owned by the oil company. Nevertheless,

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<sup>16</sup> Uncertainty by itself does not lead to integration without asset specificity. If there is no asset specificity and thus many potential suppliers of a component for which future demand is uncertain, it may be cheaper to buy it in the market than produce it yourself.

<sup>17</sup> There is a fourth type termed *dedicated assets* which refers to cases in which substantial general purpose investments would not have been made outside a particular transaction serving a large customer. Strategic delays or temporal asset specificity are used by (Masten 1986) as a fifth type of asset specificity. Particularly in the oil industry, delays can be used strategically by the upstream firms.

<sup>18</sup> At least in the Angolan case, most deepwater platforms are more or less mobile although ownership structure varies. Yards are mainly owned by the main contractors (jointly with Sonangol).

oil companies tend to employ engineers with reservoir competence and frequently hire in other type of engineers from independent contractors.

- When equipment and machinery are relation-specific, we have *physical asset specificity*. Masten (1984) uses component 'complexity' as a measure of asset specificity, but since most of the technology in the oil sector is complex, this measure does help explain the difference in the degree of vertical integration between different phases. For instance, refining technology is a general-purpose technology and similar across firms, while upstream technology is more complex. Despite this, one sees more integration downstream than upstream. What distinguishes the different upstream technologies is that they are tailored toward specific fields (the technology and complexity of the conditions (such as pressure) in deepwater fields differs from shallow water or onshore), contractors or oil companies. This means input is *differentiated* and the supplier may risk a hold-up. The theory gives similar predictions as above.

In sum: the transaction cost of using the intermediate product market is lower the more suppliers locate close to the oil companies in a given offshore province; the less consequential the oil company's costs of switching between suppliers; the more standardised the inputs; the more effectively technical change can be organised through the market; the stronger the long-term relationships between contractors; and the higher the internal relocation costs (Hallwood 1992). *According to this theory, we would therefore expect the supply chain in Angola to be more integrated than in the North Sea.*

One of the weaknesses with transaction cost analysis is that it mainly focuses on the costs (transaction costs) and benefits (economies of scale) of market transactions, not on the costs of vertical integration. One of the costs of vertical integration is that it may give *lower* incentives for an upstream firm to undertake product development and *innovation* since the downstream firm (as an owner) can refuse the upstream firm to apply the technology other places.<sup>19</sup> Such incentives are of particular importance when the upstream firm, by its actions, has a great influence on the downstream agent's value of the product, as was discussed in section 2.3 above.

### 3.2. A property right perspective

The central question, addressed by Grossman and Hart (1986), is *why do we have firms?* In a world of complete contracts (which can be verified by a third party), firms are to some extent unnecessary. Transactions can be handled by independent actors based on arm's length trade. However, when contracts are incomplete, ownership (firms) are necessary in order to give proper investment incentives. Based on the same approach, we might ask why we have a *group of firms* organised as a supply chain. *Similar to the tradition in transaction costs*

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<sup>19</sup> But integration represents one way of acquiring firm-specific knowledge. The recent merger of Coflexip and Aker represents one example of this. One problem with such a strategy is that it gives few incentives for Aker for further improvement of its deepwater technology. Confer section 4.2.



*analysis, the degree of integration of the supply chain is the endogenous variable and the key issue is what type of hierarchical (governance) structure will most efficiently facilitate product innovation or quality improvement by the upstream firm.*

In Grossman and Hart's modelling approach, each agent owns his own human capital, but a firm is a set of non-human assets under common ownership. Ownership of assets is important because it gives the owner bargaining power under unforeseen contingencies (which require bargaining) and it confers ownership of goods. The ownership of *non-human assets* affects the ex ante incentives to invest in human capital and the boundary of the firm is determined by the agents needs to protect their *investments*. According to this theory, firms are only needed in order to deal with incomplete contracts and the focus in the analysis is therefore on the incomplete part of contracts.

As regards the oil industry, it is reasonable to assume that contracts are incomplete in the sense that not all contingencies are covered. Complex technologies and uncertainties require extensive applications of functional contracts and change orders. The property right perspective is therefore an interesting point of departure for analysing the structure of the supply chain (see (Kvaløy 2000) for a discussion).

Grossman and Hart focus on formal structures (ownership) *between* firms, but do not analyse self-enforcing informal structures such as the parties' concern for their reputation. Baker, Gibbons and Murphy (1997) extend Grossman and Hart's model by analysing the interplay between formal structures and informal relationships (relational contracts), particularly how the former facilitates the feasibility of the latter. Trust and partnership, discussed in section 2.3, is one example of a relational contract. This interplay can be analysed both between firms and within a firm (for instance between different departments). In contrast to the transaction cost approach where 'relational contracts' are placed in a continuum along one dimension (degree of ownership), Baker and Gibbons distinguish between two dimensions and four prototypes of ownership/governance regimes (see Table 2).

**Table 2: Outsourcing versus integration**

Governance Environment	Ownership Environment	
	Non Integrated (Upstream owns)	Integrated (Downstream owns)
Spot ('arm's length')	Spot Outsourcing (1)	Spot Employment (2)
Relational	Relational Outsourcing (3)	Relational Employment (4)

There are two agents, an upstream firm and a downstream firm. The upstream party produces an item that can be used in a downstream party's production process. The upstream firm may undertake observable but unverifiable investments in the good such as technology improvement. Let us assume that

no investments are made by the downstream firm.<sup>20</sup> Downstream firms (oil companies or main contractors) want upstream firms to invest in order to improve quality or technology and thereby reduce costs. After observing the value of the good to the buyer and the seller, the parties negotiate the price and split the gain according to a Nash bargaining solution. Ownership matters because it determines the stakeholders' threatpoints under the negotiations and thereby the way in which the gain is split between the players. This split in turn influences the parties' incentives to invest. The theory can be applied to analyse the relationship between an oil company (downstream firm) and its contract partner (upstream firm). But it can also be used to analyse the relationship between the main contractor (this time interpreted as a downstream firm) and its sub-contractors (upstream firm). According to the theory, there are two ways of doing this: asset ownership and relational contracts. For spot transactions, ownership is the main incentive mechanism. Let us start by analysing such a case.

If the upstream firm owns the asset, the transaction is non-integrated and the upstream producer is an independent contractor using his own assets. We can term this outsourcing. This reflects the segmented supply chain as depicted in the left-hand part of Figure 1, and one would expect it to characterise not only the supply chain of standardised products but also upstream differentiated products with *general (non-relation-specific)* technology.

When the downstream firm owns the asset, asset ownership is integrated and we can call it 'employment'. Under employment the downstream firm can renege and refuse to pay a potential bonus for technology improvement. Knowing this, without any reputation mechanism in place hindering the downstream firm from reneging, an upstream firm will not invest.<sup>21</sup>

If the upstream agent owns the assets, he can negotiate with the downstream agent about the sale price (a possibility that is unavailable if a downstream agent owns the asset). Should the downstream party declare the promised bonus too high the upstream party will obtain more resources. Under spot employment, the upstream firm has no incentives for cost reduction while under spot outsourcing an upstream firm does have such incentives. *In cases where it is important for a (oil) company to provide incentives for investments in cost reductions and technology improvements (and explicit contracts are not attainable), it is therefore important to outsource (1 in Table 2) part of their activities.* However, outsourcing creates a temptation ex post for the upstream party (the main contractors) to renege by declaring the bonus too low. Asset specificity is a mechanism that can prevent the upstream firm from reneging since its outside option is weaker (see Kvaløy 2000 for an elaboration).

<sup>20</sup> See Wiig 1995 for an example where the downstream firm undertakes investment.

<sup>21</sup> The importance of ownership reduces as the frequency with which the parties deal with each other rises.

When the parties have more frequent interactions, as assumed in the case of the oil market, the sales price or bonus can form the basis of a *relational contract* (cf. (3) or (4) in Table 2) enforced by the parties' concerns about their reputation. In contrast to spot transactions, a downstream firm, say a main contractor, can provide incentives for technology improvements to an upstream firm even as an owner.

Relational contracts between integrated parties ('relational employment') differ from those between non-integrated ('outsourcing') parties in the ways the parties attempt to renege.<sup>22</sup> Under relational outsourcing the upstream firm may undertake investments which improve its best alternative (threatpoint) and thereby its bargaining position. However, in the integrated case, the upstream firm has no resources if the downstream firm declares poor performance and is unwilling to pay the bonus.<sup>23</sup> In a relational contract, the downstream party promises a bonus (say  $B$ , where  $B > 0$  if performance is good). In the non-integrated case, the upstream firm can extract some of the value of the good through bargaining (say  $S$ , where  $S < B$ ). Reneging under integration saves  $B$ , but reneging under non-integration saves the difference ( $B - S$ ), and the temptation not to renege is therefore less under non-integration. This reduced temptation makes it credible to promise a larger bonus to an independent contractor.

### 3.2.1. *Predictions derived from the property right approach*

- As in transaction cost analysis, one would expect assets to be more relation-specific and complex in Angola than in Norway, with a subsequent tendency towards integration ((2) or (4)).
- The importance of outsourcing (ownership) increases (decreases) by the importance of providing incentives for cost reduction or technological improvement. One should accordingly expect (1) or (3) in Table 2 to be more common in Angola than in Norway, particularly between the oil company and the main contractors.
- Higher discount rates make relational contracts less likely. While the operation risk is quite similar between Norway and Angola, the country risk (the oil companies face a severe political risk in terms of civil war, corruption<sup>24</sup> and human development) is higher in Angola. Increasing risk

<sup>22</sup> A key difference between outsourcing and employment with relational contracts is that the good's value in its alternative use affects the reneging decision under relational outsourcing, but not under relational employment.

<sup>23</sup> Under relational outsourcing changes in market factors influence the parties' incentives to renege. When prices are low, downstream may require reneging and conversely, when prices are high, upstream firms may require to renege. From such a perspective one would expect the degree of integration to increase by the variance of prices. To the extent that oil prices are more variable than the prices of goods and services procured by the oil companies, one would expect that oil companies are more integrated downstream than upstream. Hence, this theory is in accordance with observed phenomena in the oil industry.

<sup>24</sup> Cf. Global Witness report on Angola where Elf in particular is blamed for its non-transparent actions (Global 1999).

has the same effect as an increasing discount rate. An additional factor making relational contracts more difficult to sustain is that deepwater fields in Angola represent markets where many of the agents have no prior experiences with each other and therefore have not been able to create a reputation. Cultural and political differences may also impede the development of trust, and is pinpointed as an explanation why automobile industry supply chains differ in Japan and the US. Angola is a 'new' oil-producing country, and local Angolan companies have yet not established brands for quality as has happened in Norway. Accordingly, one should expect spot transactions, particularly with domestic firms, to be more common in Angola than in Norway ((1) or (2)).

- Acquisition and mergers represent a way of getting access to new technology (for instance, pipes in deepwater), new customers (oil companies) and a greater market (by providing integrated solutions). Although this is a general phenomenon in the supply industry, it is particularly important in new markets characterised by a high degree of uncertainty.

## 4. Supply chain management in Angola

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Guided by the discussion in Section 2, we can identify some essential variables to help us analyse the structure of the supply chain in Angola. We will emphasise the following factors:

- Characteristics of the *contracts* awarded in terms of: i) number of contracts and their size; ii) incentives provided.
- The complexity of *technology* and asset specificity, including the location of production.
- *Ownership* structures between the contract partners;
- The *informal* network between the contract partners.

The *number* of contracts awarded and their size represent a measure of the degree of integration in the chain. They also provide information about the relationships between the contract partners. If *one* contract is awarded only, for instance, the contractor is likely either to be an *integrated* oil service firm providing all services from drilling to production or subcontracts some of these tasks to independent firms. In both cases, the contractor represents the guarantor of the obligations of the upstream firms to the oil company, and the contractor either has to be an integrated oil service firm providing all services from drilling to operation or subcontract some of them to independent firms. The other extreme is a situation where there are numerous contracts between the oil company and its suppliers. In the first place, it is a bilateral relationship between the contract partner and the oil company, but in the second place, these relations are fragmented.

The incentives provided also give a measure of the degree of integration. Providing high-powered incentives to contractors indicates that the transactions between the partners are characterised by market transactions. We will focus on the incentives provided by the oil company towards their contractors.

Ownership is a direct measure of integration, and we will emphasise how contract partners through acquisitions and JVs have integrated different tasks or market segments (cf. Table 1).

While the indicators above refer to the governance structure of the chain, or how the supply chain is organised, the last two refer to some variables that influence this organisation.

The informal network between the contract partners indicates how difficult it is to sustain relational contracts. We discuss the agents previous experience and common culture.

Regarding technology, we are particularly concerned about the parties' fear of imitation.

We structure the following analysis along the four factors mentioned above, and restrict the analysis to two deepwater fields, namely Girassol and Kuito which were analysed in section 4.1 and 4.2 respectively.<sup>25</sup> Girassol was discovered by Elf in 1996, while Chevron encountered the Kuito only a year after. The entire field development bill for Girassol is USD 2.5 bn, which is far more than Chevron's cost of developing the Kuito Field. In the following, we therefore put more emphasis on the Girassol field

## 4.1. Girassol

Girassol is located in Block 17, and both Statoil and Hydro are partners. Nearly all wells that Elf has drilled in Block 17 have been positive and there are more than ten individual discoveries.

### 4.1.1. *Few, but sizeable contracts awarded*

Let us start with the conclusion of this sub-section and present the details afterwards. With regard to the characteristics of the contract, our main conclusion is that since fewer, but larger contracts are awarded at Girassol, *the contractors in the chain are more integrated* than in Norway. Main contractors are providing a bundle of goods and services and are characterised by integrated ownership ((2) or (4) in Table 2). Nevertheless, in terms of incentives, the chain is more *fragmented, at least between the oil company and the main contractors* ((1) or (3)). Since strong incentives are provided to the main contractors, this indicates that the relationship between the main contractors and the operator is based on market transactions. One important explanation is that the oil company seeks to reduce uncertainty.<sup>26</sup>

Based on a *sealed bid* procedure (bidders were unable to match each others' offers), the three largest contracts awarded for the development of Girassol were the i) FPSO ((2) and (3) in Table 1); ii) the FUR ((4) and part of (5)) and iii) the contract for subsea equipment (part of 5).<sup>27</sup> The total values of these contracts amount to USD 1,5 billion (or 60 per cent of total development costs). In addition, two main contracts were awarded for drilling (1).

Bouygues offshore (BOS) plays a leading role in the FPSO contract through its 50 per cent stake in Mar Profundo Girassol (MAR).<sup>28</sup> Mar will handle the design, engineering, procurement, construction and installation of the FSOP.

<sup>25</sup> Fieldwork was undertaken in Luanda March 2000, where we made interviews with the main contract partners in the two fields. All main contract partners in the two fields have offices in Luanda. Alexander's Gas and Oil Online (<http://www.gasandoil.com/goc/company/>) and the homepages of the firms involved, have been used to collect additional information.

<sup>26</sup> Given high degree of uncertainty in Angola and strong incentives provided, the main contractors operating in Angola need significant financial strength.

<sup>27</sup> FPSO refers to floating production storage and offloading barge and offloading buoy. FUR refers to flowlines, umbicals and risers.

<sup>28</sup> MAR is a 50/50 joint venture between BOS and ETPM for the supply of the FSOP. ETPM has just recently been bought by the Norwegian company Stolt Comex. After the acquisition, the new name of the company is Stolt Offshore.

MAR has commissioned the construction of the FSOP to a yard in South Korea.

BOS also plays a significant role in the FUR contract through its 33 per cent stake in Alto Mar Girassol.<sup>29</sup> Alto Mar will handle the design, engineering, fabrication, and installation of FUR (including the installation of production manifolds and the tie-in of the subsea wells).

**Table 3: Main contracts awarded at Girassol**

Product	Company in charge	USD Million	Time frame	Production
i) FPSO	Mar Profundo Girassol (Equal shares BOS and ETPM)	700	Last part of 2000	Mostly from South Korea
ii) FUR	Alto Mar Girassol (Equal shares BOS, ETPM and Stolt Comex Seaway)	450	Phases starting in 2000.	Prefabrication in Angola. FDS ship from South Korea.
iii) Subsea equipment	Kongsberg Offshore	220		Delivered ELF in Norway

FMC Corporation's subsidiary Kongsberg Offshore has been awarded a contract by Elf Exploration Angola to supply subsea equipment for the Girassol project. All goods are delivered to ELF in Norway. A project team consisting of staff from ELF is responsible for organising the Girassol project from Paris.

Elf takes all risks above a particular downside amount for the FSOP while there is no downside amount for the FUR contract. The reason for this is that the suppliers have more time for the FUR contract. The subsea equipment contract is a fixed-price contract. A fixed-price contract gives the supplier high incentives to achieve cost reductions. At the same time, the oil company does not achieve any rewards from it. In the EPCI contracts applied in the North Sea, the gain is split between the contractor and the operator and there is a downside amount for the contractor's potential loss.

#### 4.1.2. *Technology and outsourcing*

As in the previous section, we will start with the conclusion and elaborate details afterwards. None of the main contractors was afraid of hold-ups by the oil company or that their technology might be imitated by competitors, either indicating a *low degree of physical asset specificity or that those asset-specific assets were already integrated*. In any case, the contractors *merged with upstream firms to get hold of new technologies and know-how and thereby cover a larger part of the value chain ((2) or (4) in Table 1.)* The production, but not the engineering of the FSOP and FDE, are outsourced. Both results fit

<sup>29</sup> Alto Mar is a joint venture between BOS, ETPM and Stolt Comex Seaway (with equal 1/3 stakes).

the theories discussed in the previous section: more advanced technology is produced in-house while general-purpose technology is outsourced.

Girassol will involve the largest infrastructure for such depths ever installed, as well as innovative technology.<sup>30</sup> The FSOP will be the largest to date and have a storage capacity of 2,000,000 barrels and a production capacity of 200,000 barrels per day (bpd).<sup>31</sup> Hyundai Heavy Industries Co Ltd has already built the steel hull in Korea, and the plan is to build the topsides at the BOS yard in France.<sup>32</sup>

In the choice of contract partners for the sub-sea and FUR contracts, a primary concern was the choice of technological solution. According to Stolt Offshore (one of the partners in Alto Mar), a key to the success of the FUR bid was the novel concept of three towers housing all the risers.<sup>33</sup> The technology for these riser towers is the property of Stolt Comex and Doris Engineering.<sup>34</sup> The riser tower concept has already been in use in the US Gulf of Mexico and is less costly than that of conventional flexible flowlines and risers applied in Kuito.

The subsea contract provides FMC/Kongsberg to install and operate its HOST 2500 technology at a record depth. HOST 2500 is a modular, remote-controlled subsea production system. Hydrocarbons will be produced through subsea production systems connected to a FPSO. Subsea systems integration includes wellheads, Christmas trees, manifolds, flowline connection systems, controls, and well intervention equipment. All products are delivered to Elf in Norway, but are produced by different FMC subsidiaries all over the world.

The wells will be *drilled* from one semisubmersible rig (Sedco Express) and one dynamically positioned drillship (Pride Africa). Both are new ships rented by Elf, but owned by the contractors, Transocean Sedco Forex Inc. and Pride International Inc respectively.<sup>35</sup>

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<sup>30</sup> There will be 40 subsea wells, of which 23 will be producing; 14 water injection and three gas injection wells. Production per well will range as high as 40,000 bpd; Girassol is 18 km long and 10 km wide. Girassol base case reserves are estimated around 700 million bbls. The high reservoir quality allows for the drilling of few wells for efficient drainage.

<sup>31</sup> The deck is 180m long by 60m wide. It weighs approximately 20 000t. It contains living quarters, oil treatment, storage, metering and offloading, gas treatment and reinjection facilities. The process deck is located 7m above the deck of the hull. It contains facilities for produced water treatment as well as facilities for gas lift, gas compression and gas dehydration.

<sup>32</sup> The plan was to build the topsides as an innovative 'integrated deck' in France and load the deck onto the hull. However, the contract for the topsides was re-awarded to Hyundai Heavy Industries. The cost is approximately USD 300 million.

<sup>33</sup> The Girassol Riser Tower can house 6 flowlines and a number of service lines. The flowlines are totally interchangeable. The base of these riser towers will be connected to the subsea production system, which includes 23 subsea production wells and 14 water injectors, using flowline bundles connected to the FSOP by conventional flexible risers.

<sup>34</sup> <http://www.stoltcomexseaway.com>

<sup>35</sup> Transocean Offshore Inc., a successor to Transocean ASA and Sonat Offshore, completed a merger with Sedco Forex in December 1999, which was spun-off from Schlumberger Limited. The resulting company, Transocean Sedco Forex Inc., is now the world's largest offshore



As discussed in greater detail in the following section, it is noticeable that BOS has bought Doris Engineering while Stolt Offshore has bought ETPM and NKT Flexibles, a manufacturer of flexible pipes and risers. Two of the main contract partners have thereby integrated important technology providers (as would be expected according to transaction cost analysis).

This contrasts to the fragmentation of construction activities. In the FSOP contract, Hyundai is the main sub-contractor, while the field development ship (FDE) is bought from Samsung. Both are new ships (due to the long duration of the field). The FDE ship is owned by Saibos, a joint venture between BOS and the Italian firm Saipem and it will be used at Girassol (the FUR contract) and in Brazil.<sup>36</sup> This contract alone is worth approximately USD 150 million.

Except for the local content of the FUR contract (see below), most construction activities are currently procured externally, particularly at shipyards in South Korea. This fragmentation also contrasts with the structure of the supply chain in Norway where, for instance, the Norwegian firm Aker constructs platforms at their own yards.

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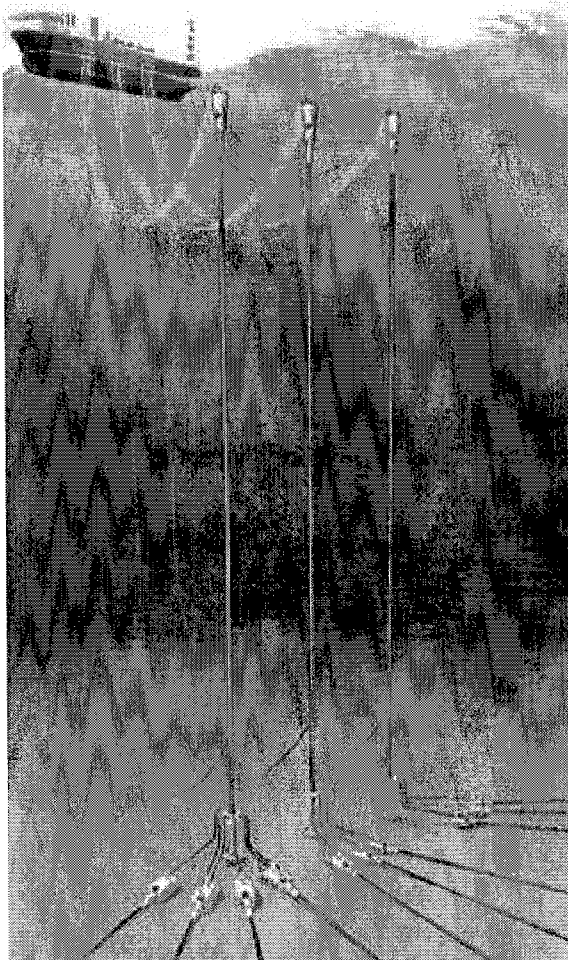
drilling contractor and third-largest oilfield services company in terms of equity market capitalization. Schlumberger stockholders hold about 52 per cent of the outstanding shares of Transocean Sedco Forex. Transocean Sedco Forex owns Sedco Express and has constructed approximately 70 per cent of all wells in water depths greater than 5,000 feet. The company designed and built the first jackup in the North Sea including the first jackup operating in more than 250 feet. These jackups played a vital industrial role, drilling the first exploration and development wells for oil and gas in the North Sea. Currently, the is company launching the first fifth-generation semisubmersible rigs with three *Sedco Express* units in 2000. These next-generation semisubmersibles are estimated to be able to reduce total well construction time by 25 per cent and total well construction costs by 30 per cent. One of these will operate in Angola. Aker Gulf Marine's fabrication yard is producing a second one which will be used in Mexico.

<sup>36</sup>Saipem provides drilling and construction services to oil and gas companies worldwide.

Saipem is 43 per cent-owned by ENI, an oil company controlled by the Italian government.

**The Riser Towers and Flowline Bundles as they will be installed.**

Source: <http://www.offshore-technology.com/projects/girassol/index.html#girassol6>



*4.1.3. Ownership, investments and joint ventures for complementing energy activities*

Two main conclusions can be drawn from this section:

- The contracting firms are integrated oil service firms providing a bundle of goods. Acquisition is an important way to achieve integration.
- They have established joint ventures with the national oil company Sonangol.<sup>37</sup>

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<sup>37</sup> Similar arguments have been made elsewhere. BOS recently won two big contracts in the Caspian pipeline projects, partly because of their ability to form a strong partnership with their Russian partners.

Before the acquisition of ETPM by Stolt Offshore, Bouygues was the main contract partner at Girassol. It was established in 1975 as part of the French Bouygues Group. BOS specialises in providing *integrated solutions* for the design, construction, installation and management of offshore and onshore oil and gas production-related turnkey projects.

BOS has strengthened its position in the market for energy services. With the recent acquisition of *Doris Engineering*, BOS covers the *entire value chain* from basic engineering to maintenance, including detail engineering, procurement, construction and installation (but not operation and subsea equipment). Net sales in 1999 were approximately Euro 1 billion.<sup>38</sup> The group has approximately 100,000 employees and a turnover of Euro 15 billion. BOS formed the *construction firm* Petromar Uem Angola in 1984, a 70/30 joint venture between BOS and Sonangol. Petromar owns the Soyo Kwanda Base and has built jackets both for Chevron and Elf. BOS created a firm, DHL (a joint venture company where Sonangol and BOS are partners), undertaking all the *logistics* (catering and accommodation)).

The other contract partner, the French firm ETPM, was established in the 1960s and has 2,000 employees. It specialises in turnkey projects and deepsea work covering design, procurement, installation and commissioning of offshore platforms and specialised structures.

ETPM not only provides goods and services to ELF, but also goods to Chevron in block 0. Until recently ETPM was owned by Groupe GTM (with a turnover of USD 8.4 billion and 61,000 employees), but has recently been sold to Stolt Comex Seaway. GTM has kept an 8 per cent stake. The new company's name is Stolt Offshore.

With more than 25 years' experience, Stolt Offshore is now one of the largest offshore contractors in the international offshore oil and gas industry. After Coflexip it is the most important player in the world-wide subsea market (see section 4.2.2). Stolt-Nielsen S.A., one of the world's leading providers of integrated transportation services for bulk liquid chemicals, owns 53 per cent of Stolt Offshore S.A. Stolt Offshore operates the world's largest fleet of specialist subsea construction ships. The Company offers customers *total field development solutions* and its capabilities include design, supply and installation of all of the subsea architecture from the subsea wellheads to fixed or floating process platforms (primary (2), (3), (4) and (5) in Table 1). With the acquisition of ETPM, Stolt complements its activities and competence with i) competence in *engineering* of all types of platforms; ii) *fabrication* through ETPM's yards in Nigeria and in Angola;<sup>39</sup> iii) *pipelay* (ETPM has broad competence to lay pipes of all sizes and in all water depths).

<sup>38</sup>BOS has recently bought Kvaerner, France.

<sup>39</sup>Stolt Offshore owns 55 per cent of Sonamet (Sonangol holds 40 per cent). Sonamet fabricates metallic platforms and pipes and has 500 persons working at its yard in Lobito.

On their side, Stolt complements ETPM's activities by their ability to provide services which ETPM previously bought externally, such as diving, service activities and the production of flexible flowlines and dynamic flexible risers (through NKT Flexibles where Stolt Offshore holds 49 per cent stake). Stolt also undertakes activities previously assumed by subcontractors., and covers a wider geographical area than ETPM (by undertaking work in the Gulf of Mexico, Asia Pacific and Brazil in addition to North Sea, West Africa and the Middle East where ETPM operates). The combined group had a turnover in 1999 of about USD 1.3 billion.

NKT Flexibels is one of three worldwide firms providing flexible pipes, and, with its acquisition in December 1999, Stolt Offshore has access to one of these manufacturers. NKT is providing 17 flexible risers for Girassol.

The same pattern as described above, that of an integrated energy provider, is not applicable to the final contract partner, Kongsberg Offshore, except that it belongs to a bigger group of firms. FMC Corporation is one of the world's leading producers of chemicals and machinery for industry and agriculture and has 16,000 employees. Kongsberg specialises in subsea equipment with sales of USD 300 million last year.<sup>40</sup>

For the FUR contract, a factor supporting the choice of Alto Mar was that all pre-fabrication work will be carried out in Angola. Since all sizeable contracts need approval from Sonangol, they support solutions where local suppliers are involved. BOS uses local firms (e.g., DHL) to deal with the logistics. The towers are to be produced at ETPM's Lobito yard and the flowlines at Bouygues' Soyo yard.<sup>41</sup> In both cases, Sonangol is a partner in the managing firm. A similar pattern can be seen in the drilling contract.

Pride International and 51 per cent joint owner Sonangol have just completed the construction of the Pride Africa and the Pride Angola, two ultra-deepwater drillships. The drillships are contracted to work offshore Angola for initial terms of five and three years, respectively.<sup>42</sup>

#### 4.1.4. *The informal network between the contract partners and ELF*

The main conclusion to be derived from this section is that close ties prevailing between the operator and some of the contract partners can partly be explained by a (French) common cultural background, but more important is

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<sup>40</sup> Kongsberg employs 600 people at its headquarters in Kongsberg, Norway, and 200 people at its Offshore Service Department in Bergen, Norway.

<sup>41</sup> Source: *Alexander's Gas and Oil*. Volume 3, issue #22, Monday, September 14 1998 and various press releases from Bouygues offshore.

<sup>42</sup> Pride International, Inc. is one of the world's largest drilling contractors, operating a diverse fleet of rigs on a global basis. The Company provides offshore and onshore drilling, workover and related services in more than 20 countries with a fleet of almost 300 rigs. In 1999, Pride had revenues of \$620 million and 5,900 employees.

the long-lasting previous association between the operator and the contract partners.

BOS has a long-term experience from West Africa, and has its own yard (Boscongo) in Congo where it produced jackets for Elf in the beginning of the 1980s. From the same yard, BOS constructed several platforms for Chevron in Angola and Elf in Cameroon and Angola. The Pal P1 platform for Elf Angola was also produced in Congo in the beginning of the 1980s. Jackets for Elf were produced in Angola (Soyo).

BOS has therefore considerable experience of Western Africa, including Angola. It has been dealing with a number of oil companies, but Elf predominates. In fact, in 1981, Elf acquired a 34 per cent stake in the equity capital of BOS,<sup>43</sup> which it sold back in 1990. ETPM has a similar record. It is originally French, and has long experience in West Africa. It has worked in Nigeria, Cameroon, Gabon and Congo. With BOS, it was responsible for the Nkosa field in Congo for Elf. Neither BOS nor ETPM has any frame agreements with any oil companies (but BOS provides maintenance to block 0 (operated by Chevron) and block 3 (operated by Elf)).

As regards Kongsberg Offshore, it is a subsidiary of FMC, which has much experience with ELF all over the world. The Swiss branch of FMC International has a contract with ELF, Angola for service and installation operating from its supply base in Luanda. Kongsberg will provide assistance throughout the installation phase. Kongsberg Offshore also has a long-term contract with the two Norwegian partners in block 17, Statoil and Norsk Hydro.

Since none of the contract partners was afraid of technology imitations or potential hold-ups, we can infer that that other mechanisms than technology link them to ELF. They have known each other for a long time. ETPM and BOS are French of origin and share the same cultural and linguistic background as ELF. Nevertheless, this can hardly be the most important reason for the choice of contract partners, because if that been the case, Coflexip rather than Stolt offshore would be awarded the subsea contract.

We have no information on the internal informal relationships within the integrated contract partner. However, one must presume that Stolt Offshore and ETPM have enjoy long-term relationships, which may stimulate product innovation by the upstream firm (ETPM).

The following table summarises the relationship between the main contract partners at Girasoll according to the typologies applied in Table 2 (where (3) indicates non-integration, but relational contract, and (3-) indicates that the contract is relationally biased but also include elements of spot transactions).

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<sup>43</sup> This is one of the few examples where a constructor is owned by the oil company (Saipem is another).

**Table 4: Typologies of contracts at Girassol: A wrapping up**

	Operator/Contractor	Contractor/sub-contractors
FSOP	(3-)	(1)
FUR	(3)	(4)
Subsea	(3-)	(4)

## 4.2. Kuito

Kuito is located in Block 14, which is operated by Chevron (holding of 31 per cent).<sup>44</sup> Up to October 2000, six discoveries had been made in block 14. Kuito is the first field to be developed.

While Elf has been criticised for slowness in putting Girassol on stream, Chevron has made a speedy start-up at Kuito. However, this comparison misses the important differences between the fields in terms of location, size and deepwater level. Kuito is merely a step out of Chevron's Block 0 operations offshore Angola. It was easy to develop a facility and tie it to the inshore production. Chevron was, however, unsure about the real size of the field, and its connections to other sites nearby. They therefore wanted to speed up the process to gain production experience and gather reservoir data. Moreover, Kuito is located in 350 meters of water, which makes it a considerable lot easier to develop than Girassol. In spite of these differences, the structure of Chevron and Elf's supply chains is quite similar as set out in the following.

### 4.2.1. *Contracts awarded and technology applied*

Chevron opted for a fast but phased development of Kuito. The first phase brought together ABB and Coflexip Stena Offshore (CSO) in a consortium headed by the Monaco-registered firm SBM (Single Buoy Mooring Inc). SBM was responsible for the FSOP, the mooring system and export facilities and for the management of the consortium. As in the Girassol development, a small number of contract partners cover most of the procurement, indicating an *integrated chain*. The contract partners play a more important role in Kuito than Girassol, since they are in charge of production. Chevron therefore plays a less dominant role in supply chain management in Kuito than ELF at Girassol.

In the case of Kuito, the contract partners were *involved at an early stage* of development. SBM was brought on board already at discovery in April 1997, and was directly involved from November the same year. Initially 14 suppliers were asked to show their interest, and the final choice was between SBM and the American firm Oceaneering International. SBM was chosen because it was perceived to be technologically capable (only a few energy servicing firms are

<sup>44</sup> The remaining interests are held by Sonangol (20 per cent), Agip, a subsidiary of the Italian state owned oil company ENI (20 per cent), Total (20 per cent) and Petrogal (9 per cent).

able to undertake operations [cf. stage 6] and SBM already owned a vessel which could be used).

The initial development included the drilling and completion of 12 subsea production wells producing through horizontal trees, jumpers, and a subsea production manifold connected to the FPSO, plus the completion of a gas re-injection well. The contract value for the first phase was USD 400 million. This includes the installation of the FSOP along with a calm buoy, subsea trees and manifolds, flowlines, risers and mooring systems.

The FPSO has a production capacity of 100,000 barrels per day and a storage capacity of 1.4 million barrels. The ship, previously a turbine tanker of 228,000 tons dw, was converted at a shipyard in Singapore. The topsides were engineered by SBM's sister company Gusto Engineering. This FPSO is a zero flare facility. Associated gas, not used for fuel for the FSOP, is injected into the reservoir. Wells were drilled and completed by the Sedco Forex.

The second phase was awarded to the same consortium in May 1999. It consists of one subsea water injection centre with eight water injection wells.

CSO designed, engineered and supplied approximately 20 km of flexible flowlines and risers and 15 km of umbilicals (produced at DUCO, a Coflexip company) and carried out the offshore installation work. CSO also installed a range of subsea equipment.<sup>45</sup>

ABB has supplied production trees (ABB Vetco-Gray horizontal trees), production manifold (the heart of the subsea production centre), water injection trees and manifold, surface and subsea controls system, gas lift distribution unit, subsea distribution unit and associated jumpers along with all necessary installation tooling. Components, controls and engineering systems for the Kuito project were built and provided from facilities in Angola, USA, UK, Norway and Italy.

In October 2000, the same consortium was awarded the contract for the third phase. This phase consists of an additional subsea production centre with seven producing wells.<sup>46</sup>

As in Girassol, the contract partners were not afraid of imitation of their technology.

## Leasing

In contrast to Girassol, the oil company leases the platform. The FSOP is *leased* from Sonasing, a joint venture *between SBM and Sonangol*. The leasing

<sup>45</sup> Press release Coflexip Stena Offshore Jan. 5. 2000.

<sup>46</sup> CSO's workscope includes design, fabrication and installation of all flowlines, risers, umbilicals and associated jumpers required for the manifold and subsea tree hook-up; transport and installation of manifold and umbilical termination units supplied by ABB; and hook-up of 3 subsea trees to the manifold and associated umbilicals. Press release Coflexip Stena Offshore Oct 11. 5. 2000.

period is five years, with the possibility of an extension of five additional years. The daily rate is fixed, but it is a small variable element based on an operating agreement giving penalties and bonuses based on a complex set of formula. The consortium takes all risks of misspecification of costs and there is no bottom line of losses. Therefore, *incentives are provided to reduce the fixed cost of the FPSO, but no incentives to reduce variable costs (for some reason, no incentives are provided to increase the production of oil).* According to the property right theory presented above, leasing gives fewer incentives for increasing the oil production when the FSOP and the oil are owned by different players. Chevron seems to have pressed for a leasing solution because of uncertainty related to the size of the reservoir. The PSA agreement makes it possible to deduct a certain amount of capital investments. When an oil company owns the FSOP, and the field is smaller than expected ('nature is bad'), an oil company risks not recovering all of its capital costs. In contrast, by leasing, all leasing costs are recovered independently of nature's whims. When nature is bad (good), the host government therefore receives more (less) income compared to a leasing situation.<sup>47</sup> However, when nature is good (huge reservoir), Chevron has the *flexibility* to get a bigger ship.

There are no reasons to believe that SBM had more information about the reservoir than Chevron has. However, SBM has the advantage of dealing with *asymmetric asset specificity* as regards the FSOP. Even though the technology of the FSOP is general, and SBM is not afraid of imitation, its alternative value is higher for a firm specialising in providing FSOPs for a number of firms than for an oil company with the primary objective of exploring oil. Partly for this reason, SBM takes the risk of high residual value and relocation risk.

#### 4.2.2 Ownership and acquisitions

In this section we discuss the main contract partners involved in our discussion so far in more detail.

##### SBM - Floating terminals

SBM is specialised in stages 2, 3, 6 (confer Table 1). SBM is a wholly owned subsidiary of the Dutch public company IHC Caland.<sup>48</sup> SBM is a turnkey

<sup>47</sup> If prospects are good, it therefore makes sense for a government like the Angolan to require a more common use of leasing contracts. In fact, this is also what happens. Foreign operators are now under pressure to lease, not buy, FPSO vessels in order to reduce initial investment costs and increase early revenue flow for Angola. *Financial Times* Nov. 15 2000. "Angola to firm grip on foreign oil companies."

<sup>48</sup> The Dutch public company IHC Caland N.V. is the holding company of a group of international, marine technology-orientated companies. Its business is to serve on a global basis the offshore oilfield service industry and the dredging, shipping and mining industries by supplying engineered products, vessels, systems and contracting services. It has four shipyards in the Netherlands. The products comprise mainly floating crude oil (un)loading systems, storage systems and production systems based on the single point mooring principle, hydraulic pilehammers, custom-built and standard dredging and mining equipment, and custom-built ships and FPSOs/FSOs which are chartered on a long-term basis to oil companies. In addition, specialised engineering services are provided. Adapted from <http://www.singlebuoy.com>



supplier or key element supplier in more than 50 per cent of the installed floating terminals world-wide (based on the Single Point Moorings or SPM principle). SBM has been involved in more than fifty FSO or FPSO projects. In addition to being a major supplier of SPMs, the company has gained substantial experience in the conversion of trading tankers and the construction of new-built units for FSO and FPSO projects. Most recently, ten units of FSO and FPSO were scheduled to be in operation before year 2000 on a leasing basis of which four are based in West Africa (for Elf in Congo and Nigeria and for Chevron in Angola).

SBM has no world-wide alliance or frame agreement with Chevron or other contract partners, but has an agreement with the Italian contractor Saipem to cooperate on deepwater FPSO projects. Eni, a partner in the licence of block 14 holds 45 per cent of the shares in Saipem. Saipem provides subsea construction (4) while SBM undertakes the operations. The two parties therefore *complement each other* and it gives the 'group' a position to be a global offshore service provider (covering nearly the whole value chain except for drilling).

Since the Angolan authorities prefer leasing contracts for the FPSOs, firms that are able to handle the production phase will be stimulated. This by itself can have an impact on an oil service firm's incentives to integrate or create alliances for given operations. In any case, the success in the Kuito field, the importance of being involved early on in the development of new fields (SBM with Brown and Root have undertaken a front end engineering and design study in Exxon's block 15) and the experience from co-operation with Chevron, indicate that SBM will play an increasingly more important role in the future. To underline this, it has already been requested to bid for a FSOP at Kizambo field, which is located in block 15 (ABB, Aker and Bouygues and Mustang have also been asked to bid).

#### ABB - A global engineering and technology company

In upstream oil production, ABB is specialised in subsea equipment (5), but is also involved in engineering (2). ABB provides power generation, transmission, and distribution; automation; oil, gas, and petrochemicals; industrial products and contracting; and financial services. The Group reported orders in 1998 of USD 31 billion and employed about 200,000 people in more than 100 countries.

ABB has a three-year world-wide alliance with ESSO and Chevron providing subsea drilling equipment, but no frame agreements with the other contract partners.

#### *CSO - Acquisitions for complementing activities*

CSO provides a wide range of services (project management, engineering design, procurement, subsea pipeline and umbilical laying, construction and maintenance work) and products (design and manufacture of flexible pipes, control umbilicals and remotely operated vehicles). CSO is the biggest world-

wide subsea-contracting firm with a market share of 30 per cent as against Stolt Offshore's 20 per cent and Halliburton's 15 per cent.

Coflexip is probably best known for the creation of high-pressure flexible pipes, and CSO has an extremely dominant market position in the market for flexible pipes and umbilicals (75 per cent). As a comparison, Stolt Offshore has a market position of 5 per cent and Halliburton of 20 per cent.<sup>49</sup>

Net operating revenue in 1999 was approximately EUR 1 billion. Although the share is declining, nearly one half of CSO's revenue stems from the North Sea and their primary client base is made up of US majors.<sup>50</sup> CSO has a world-wide frame agreement with Chevron for flexible flowlines. Its headquarter is in Paris.

Coflexip acquired Stena in 1994 and formed Coflexip Stena Offshore, a French company with headquarters in Paris. COS employs approximately 4,000 people spread over five continents, with subsidiaries in Angola, Australia, Brazil, Canada, France, India, Norway, Singapore, the United Kingdom and the United States.

After a sale of a 30 per cent stake in CSO by Stena to the French group Technip, a world-wide strategic alliance in offshore activities was established in April 2000 between Technip and CSO. By this acquisition, Technip became the largest shareowner in CSO. A joint bidding strategy for integrated projects was formed. The reason for this was given to be the *demands from clients* seeking a broader array of services from a limited number of suppliers.

Whereas CSO has a leading position in the deep offshore market ((4) and (5) in Table 1), Technip brings additional competence in engineering and project management capability (2); a broad geographic presence; and a more diversified client base (national oil companies in particular). Technip is primarily involved in downstream activities (oil refining and gas processing) and has established an Angolan subsidiary seeking to establish a refinery in Angola.

In their marketing, CSO therefore emphasises that the company is a world leader and the *most integrated contractor in the subsea oilfield service* industry. CSO has also recently entered into an agreement to acquire Aker Maritime's deepwater division. Through the strategic alliance with Technip and the planned acquisition of the Deepwater Division, CSO has complemented its activities downstream and also covers all stages in the upstream value chain. CSO is thereby able to tender for significantly higher contracts.

The strategic objective behind the acquisition of Aker is explained as "increasing the Group's front-end and full field engineering capabilities; expanding and strengthening its geographic presence in deep water markets,

<sup>49</sup> Figures are from a press release from Technip April 2000

<sup>50</sup> Among other contracts, it manufactures all flexible risers in the Asgard field.

particularly the Gulf of Mexico; and enlarging the scope of technologies, services and products offered by the Group. The two groups have an excellent fit as they complement one another strategically, technologically, and geographically and have similar cultures." (CSO, Press Release, 29 Oct. 2000.)

Looking at the technology, CSO is particularly interested in Akers' Deepwater Division's advanced technologies in offshore production support, including dry well-head concepts. The Deepwater Division is one of the two companies holding exclusive rights to the SPAR technology for drilling and production in deepwater. SPAR has become the leading concept for dry completion deepwater field developments. The Deepwater Division has been involved in all the three existent SPAR production platforms installed to date (in Mexico) and CSO is seeking to tender the concept in other parts of the world as well. The Deepwater Division also holds a strong market position in the area of engineering and construction of FPSOs, Tension Leg Platforms (TLPs) and semi-submersible platforms.

### 4.3. Informal partnerships

Both ABB and CSO have a frame agreement with Chevron. Apart from this, we do not find indications of any informal relationship between the parties.

Chevron has been operating in Angola since the 1950s and is the country's largest oil producer. Half of Angola's oil is shipped to the US market. Chevron hopes that a lot of their future spending in Angola will go to US suppliers. The US has even created financial guarantees for this purpose.<sup>51</sup> According to Kenneth Derr, Chevron's chairman and CEO, "I would hope a lot of that would go to U.S. suppliers. This Ex-Im bank loan will certainly help and I think it's a great step forward ... in order to make US businesses more competitive" (*Alexander's Gas and Oil*, December 24 1998).

In this context, we find it remarkable that contracts for suppliers are not biased towards American companies. *Neither financial incentives towards American suppliers, nor preferences for American suppliers by Chevron as the principle stakeholder, were enough to win contracts at the Kuito development in block 14 for US companies.*<sup>52</sup> Only ABB and Sedco Forex are headquartered in the US.

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<sup>51</sup> The Ex-Im Bank provides guarantees of working capital loans for US exporters, guarantees the repayment of loans, or makes loans to foreign purchasers of US goods and services. The bank also provides credit insurance against non-payment by foreign buyers for political or commercial risk. In the last year it financed approximately USD 40 million in SSA, but it can give guarantees for USD 400 million year i SSA.

<sup>52</sup>

#### 4.4 Similar findings and alternative explanations

Based on a transaction costs analysis of the organisation of the supply chain in the British part of the North Sea, Hallwood found little support for the transaction costs analysis (Hallwood, 1992).

In a study of Statoil's procurement by Dir. Trondslien (www.statoil.com), the degree of integration was found to vary between different phases of production and between different tasks in each phase. The suppliers' contribution to total inputs amounted up to 95 per cent within drilling/well technology and the development projects (cf. stages 1:5 in Table 1), 50–70 per cent within the operation (stage 6) of on- and offshore installations, up to 70 per cent within distribution/sales and approximately 50 per cent within innovation (stage 2 in particular). It therefore seems that the oil companies are vertically linked downstream, but not upstream. Several studies confirm this results (Al Moneef 1998; Al Obaidan and Scully 1993; Bindemann 1999). Our findings supports the hypothesis derived from the property right perspective that contractors tend to be integrated oil service firms (see the concluding section).

However, there are two main problems with empirical analyses based on transaction costs (Shelanski and Klein 1999). First, there is the *measurement* problem of comparing the value of the investments inside and outside a relationship. Normally, survey methods where respondents are requested to state their opinions on a Likert scale are applied for this purpose. Our approach was to ask whether the supplier was afraid of imitation and hold-ups. Second, and more importantly *alternative hypotheses* could in many cases equally well confirm the data.

Two such alternative hypotheses giving the same predictions as the property right approach are:

- *Market power.* Neo-classical approaches are based on market power explanations or economics of scope between successive stages in order to explain vertical integration (Stigler 1951). The market power explanation of (vertical) integration says that gains will increase by degree of supplier market concentration (Spiller 1985). When upstream firms have market power, vertical integration eliminates the divergence between the value of the marginal product of the input and the marginal cost. On the other hand, the downstream firm also has market power and this reduces the gains from mergers. Assuming the downstream market power is the same in Norway and Angola (most of the multinational oil companies are located in both destinations), and that the supply industry is 'thinner' in Angola than in Norway, *a more integrated supply chain is likelier in Angola than in Norway. If upstream market power stems from access to a superior technology or other physical assets, e.g., a yard, one should accordingly expect i) the tendency of acquisition to increase, and ii) that the main contractors tend to integrate with upstream firms.*

- *Domestic political reasons.* The pressure for integration can come from the state in order to create a geographically segmented chain.

We do not find much evidence to confirm the latter theory. The integrated solution concept chosen was requested by the oil companies and adapted to their needs. This falsifies the demand-driven explanation. Angola has no preferences for a particular organisation of the supply chain although it has preferences for the use of local firms. The market power explanation represents an alternative explanation, which has not been falsified by our data.

## Conclusion

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Our findings support the hypothesis derived from the property right perspective (confer section 3.2.1):

- As measured by the number of awarded contracts, the supply chain is more integrated in technically advanced markets such as Angola compared to the North Sea. Few, but sizeable contract partners are involved in our case studies. Tailor-made solutions in deepwater are generally more technically advanced or complex and require integrated solutions. The oil companies achieve such integration by using integrated oil service firms.
- As measured by the informal networks between the contract partners, the importance of relational contracts based on mutual trust are less than in the North Sea. Contracts are mainly based on market transactions between the supply industry and the oil companies. For instance, we find no close relationship between the oil company and the constructing firm. However, Girasoll and Kuito display slightly different patterns. At Girasoll, main contracts are awarded to firms sharing the nationalities of the majority interests in the licence (French and Norwegian). We do not find similar preferences for American firms in the Chevron case (at Kuito). Since oil service firms are integrated units and relational contracts are harder to sustain in Angola, the competition arena is biased more towards a competition between integrated oil service firms rather than between integrated supply chains (as in the North Sea).
- As measured by knowledge intensity, technically advanced tasks are undertaken in-house while low-skill intensive tasks are fragmented (i.e., construction activities and the building of ships are done by independent companies).

The 'glue' in the chain determines a firm's penetrating strategies regarding its choice of market segment and types of relationships to the main actors in the supply chain. When most transactions in the chain were based on arm's length trade, upstream firms compete with regard to costs. To the extent that the establishment of relationships to customers is important, one would expect the supplier to get in touch with the oil companies, and especially the *operator*, since they are the ultimate customer and organiser of the chain (as in the North Sea). The flip side of the coin are projects in which the oil company prefers an integrated approach (as the Angolan cases presented). There are several reasons for this choice, but in essence, the oil company prefers to deal with a limited number of suppliers in order to reduce transaction costs, spread the risk, and concentrate on core activities. In an integrated project, the main contractors are thereby more involved in the organisation and design of the project. To serve as a main contractor, one therefore needs to provide integrated solutions. Although first-tier suppliers (e.g., big turnkey contractors) will never succeed without a proven record or

reputation *vis-à-vis* the oil company, second-tier suppliers and sub-suppliers need to create relationships to first-tier suppliers (*main contractors*), not primarily the oil companies.<sup>53</sup> Without previous experience with multinational contractors, this may create problems for the sub-suppliers (Crabtree, Bower, and Keogh 1997). In both cases, a supplier not only needs to be competitive in price but also needs a good business reputation. When the host government, for instance the Angolan Government, requires or prefers that foreign suppliers link up to local suppliers or oil companies, suppliers also have to establish working relationships with *local* companies in the host country.

Information about the glue in the chain is also interesting for other reasons than its impact on penetrating strategies. It determines whether liberalisation of energy services will have any effect on supply chain management. Liberalisation may lead to standardisation and reduce the role of relationships, particularly to the national oil company (confer (Wiig 2001)). The oil sector is going through a rapid technological revolution, particularly in *deepwater* technology and in B2B (Business to Business E-commerce) which may change supply chain management. Previous business practices may therefore change with the arrival of new players on the scene, either as providers of new technology or as intermediates. These are questions to be addressed in subsequent papers.

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<sup>53</sup> There are also some opportunities for bypassing the contractors by taking direct contact with the operator.

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# Summary

This paper focuses on the organisation of the supply chain in the offshore oil industry, primarily the relationships between upstream oil-companies and their main contractors. From studies of the North Sea offshore industry, we know that there are close ties between the upstream oil industry and its suppliers. From a transaction cost perspective, we analyse how the supply chains are organised in new and promising markets such as Angola where technology and trust differ from those of the North Sea. Tailor-made solutions in deepwater are generally more technically advanced and complex and require integrated solutions. The oil companies in Angola achieve such integration by using integrated oil service firms. We also observe that contracts are mainly based on market transactions between the supply industry and the oil companies.