HARVARD | BUSINESS | SCHOOL

Microeconomics of Competitiveness

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Table of Contents

Executive Summary

Despite being a small, peripheral and costly market, Norway has become one of the most prosperous economies in the world. This story of success can be explained by abundant natural resources (with oil and gas production beginning in 1971), sound and stable macroeconomic policies, strong public institutions, remarkably high productivity and labor utilization, equality across its homogeneous population, and social stability.

However, Norway must not become complacent. The economy is not sufficiently diversified and should be more open; the country has not fully evolved from a natural resource-based to a knowledge-based economy. With declining oil and gas reserves and production, Norway must act to maintain its levels of prosperity.

The oil and gas supplier cluster, analyzed in this paper, is a good example of the way forward. Unlike other oil-producing countries, Norway has been able to develop a supplier cluster that supports oil and gas production. The critical success factors were existing capabilities in the maritime industry, sophisticated demand conditions, and balanced policy intervention. Today, the Norwegian supplier companies are leading players that are strategically positioned in many of the most dynamic oil provinces of the world.

However, the cluster also faces some challenges for the future. The education system and the labor market generate insufficient qualified and skilled human capital. The declining domestic production reduces the opportunities for the companies to develop cutting-edge technologies. Finally, an increasing share of operations abroad gives more location options for headquarters and exposes the companies to geopolitical risks.

This paper digs into the successful stories of Norway's economy and the oil and gas supplier cluster but, most importantly, identifies key challenges and provides recommendations for Norway for the post-oil era.

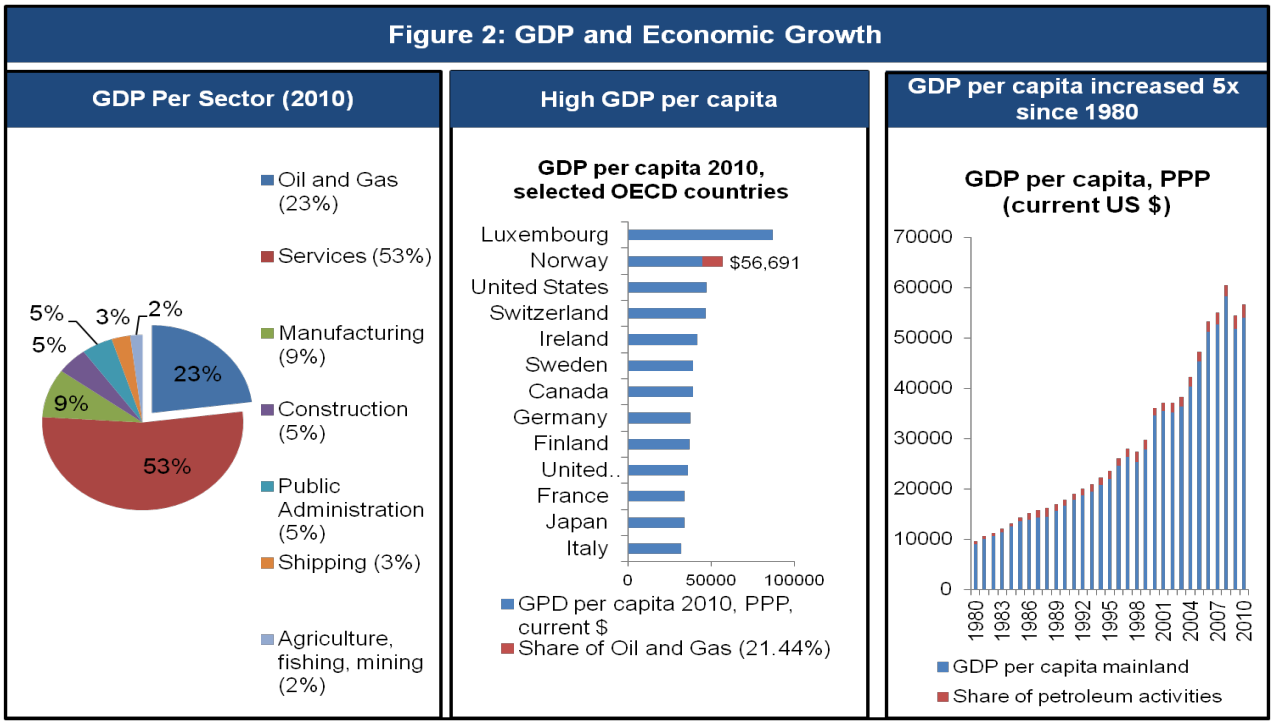
1. Overview of Norway

Norway is a parliamentary democracy and constitutional monarchy in Northern Europe. Having emerged from unions with Denmark (1397-1814) and Sweden (1814-1905), Norway gained independence in 1905. The country rejected EU membership in referenda in 1972 and 1994, but is part of the European Economic Area, which ensures wide market access to the EU. Norway was a founding member of the UN, NATO and WTO. Political power is centralized, with limited authority devolved to 19 counties and 430 municipalities.

The border to the East with Sweden, Finland and Russia is 1,592 miles long, and the 16,000 miles of coastline to the South, East and North face the North Sea, the Norwegian Sea and the Barents Sea. With its vast continental shelf where the petroleum resources are found, its total territory, including the territorial waters, is 810,814 square miles, an area equivalent to the US 1803 Louisiana purchase of the whole of Louisiana, Missouri, Arkansas, Iowa, North Dakota, South Dakota, Nebraska, and Oklahoma, and most of Kansas, Colorado, Wyoming, Montana, and Minnesota (Encyclopedia Britannica, 2012).

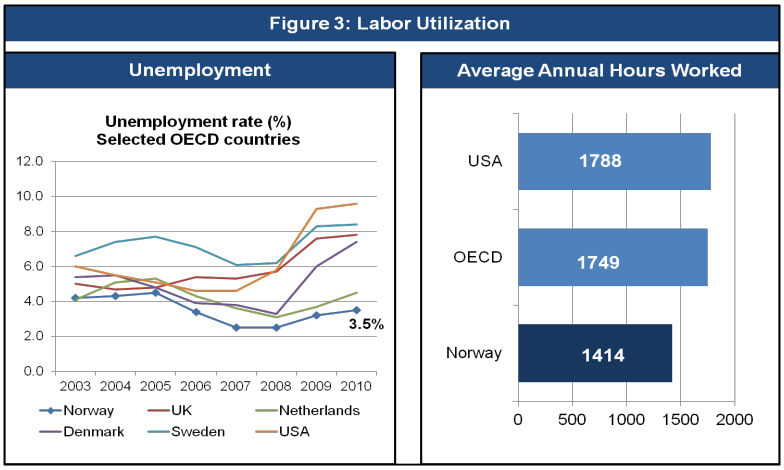
Figure 1: Norway's Geographic Position in Europe

88% of the five million inhabitants are ethnic Norwegians, and they are predominantly Protestant Christians. The population density is only 40 people per square mile (Statistics Norway, 2012). Social equality is high, with a Gini Coefficient of 0.25, below the OECD mean of 0.31, mainly due to centralized wage negotiations and in kind transfers (education, healthcare, social services) from a generous welfare state (OECD, 2012).



2. Norway's economic performance

Fuelled in particular by revenues from petroleum production, which started in the beginning of the 1970s, Norway's GDP per capita increased fivefold in nominal terms from $9,551 in 1980 and to $56,648 in 2010, which is the second highest in OECD (OECD, 2012). As seen in Figure 2, even excluding petroleum, which constitutes 23% of the economy, Norway's GDP per capita would be just behind the United States and Switzerland. The total 2010 GDP of $277 billion—1.75% of the American economy—made Norway the world's 23rd largest economy (World Bank, 2011). Manufacturing only accounts for 9% of the economy, a smaller share than in peer countries (Statistics Norway, 2012). Living costs are high; domestic purchasing power is only 67% of the United States.



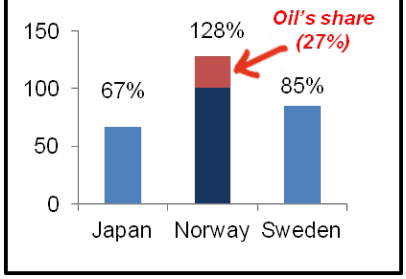
In 2010, labor utilization was 75.3% in the 15-64 age bracket, compared to an EU average of 64.2%. The gap between Norway and the EU is higher for women (73.3% vs. 58.2%) (Eurostat, 2011). However, as seen in Figure 3, the average annual hours worked is 1,414, significantly lower than the OECD average of 1,749 (OECD, 2010). Unemployment has been consistently low for years and is now 3.2% (Statistics Norway, 2012).

Why has Norway done so well over the last twenty years?

A key question is why Norway has experienced sustained growth above the OECD-average over the last twenty years even in the non-petroleum part of the economy.

Norway tops the productivity ranking in the OECD (OECD, 2008). Between 1973 and 2006, Norway was the only OECD country with higher GDP growth per capita than the United States. In 2011, GDP per hour worked was 28% above the US level; discounting the petroleum sector, Norway would be on par with the productivity of the United States, as shown in Figure 4. This might be driven by firms continuously introducing new technology due to the strong incentives to upgrade productivity per worker, since labor is expensive (Norwegian Ministry of Finance, 2009).

Figure 4: Productivity



In addition, Norway's growth can be attributed to the tertiary sector expanding more rapidly than the primary and secondary sectors. Since 2000, education, real estate, financial services, oil and gas services and construction have enjoyed average annual growth rates between 3.5% and 5.5%, whereas manufacturing, fishing and agriculture only grew between 1.5% and 3.5% per year (Statistics Norway, 2012). This shift towards the tertiary sector may have shielded Norway from low-cost manufacturing competition, in particular from China. Furthermore, the structure of the Norwegian economy has helped

Norway sharply improve its terms of trade. Between 1991 and 2011, prices of Norwegian export goods increased 85% more than prices on Norwegian import goods. Excluding petroleum, this figure would be 20% (Statistics Norway, 2012).

3. Competitiveness Analysis of Norway

Endowments

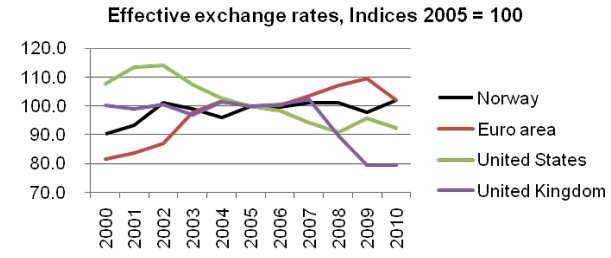
Norway has rich endowments of fish, timber and minerals, in addition to petroleum. Domestic electricity supply is almost 100% hydroelectric power. Winter conditions are harsh, and the terrain is rugged and mountainous. Norway's coastline rarely freezes. The country has easy access to large and rich markets in Europe: Germany, the United Kingdom and the other Scandinavian countries.

The Norwegian oil and gas reserves are the 19th largest in the world. Norway has 1.1% of gas reserves globally (BP, 2011) and provides around one third of the EU's gas imports (Eurostat, 2011). The reserve to production ratio for gas is 19.2 years and for oil 8.5 years (BP, 2011), though Norwegian authorities expect an expansion of known reserves and continued oil production well beyond 2020 (Norwegian Petroleum Directorate, 2012).

Competitiveness Profile and the National Diamond

Norway ranks 9th out of 136 countries on the global competitiveness index. It is 7th on the macroeconomic scorecard and 22nd on the microeconomic ranking (ISC, 2012).

Figure 5: Comparison of Effective Exchange Rate



Macroeconomic Fundamentals: Norway has sound fiscal and monetary policies, low inflation, [1] and a stable currency (the Norwegian Krone), as can be seen in Figure

[1] Inflation was 0.8% from March 2011 to March 2012 (Statistics Norway, 2012).

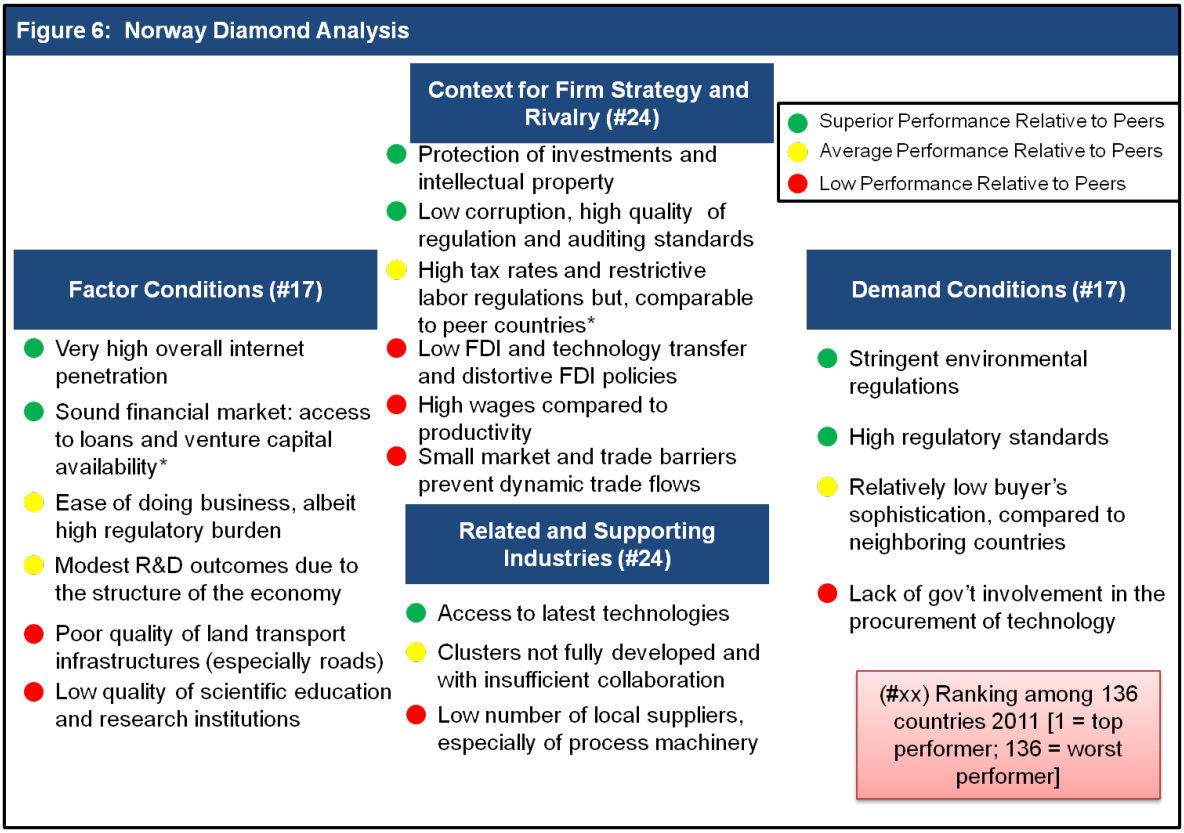
5. The country invests its petroleum revenues abroad in the "Government Pension Fund" and has committed to only harvesting 4% of the fund annually to plug a structural deficit in the state budget. This policy has helped Norway avoid the "Dutch disease," which refers to increased cost and loss of competitiveness in an economy resulting from petroleum revenue inflows. Furthermore, national debt is only 26% of GDP; the average government surplus from 2006 to 2010 was 15%. Despite high tax rates, the impact of taxation on the incentives to work and invest is less negative than in many advanced economies, since the administration of the tax system is less burdensome (HBS ISC, 2012).

Microeconomic Fundamentals: The national business environment has flaws that are surprising for such a wealthy country. The active role of the state in the economy includes a high regulatory burden for businesses. The small domestic market and trade barriers prevent dynamic trade flows, and the domestic value chain is less broad-based than in peer countries. Financial markets are sound and well regulated, and particularly sophisticated in the oil and gas sector. Norway's relative productivity has fallen since 2006, when it was 40% above the US level. Immigration from Eastern Europe, predominantly cheap labor, has increased in this time period, from close to 0 in 2002, to around 5,000 in 2004 and circa 15,000 annually in 2008-2010 (Statistics Norway, 2011).

Social Infrastructure and Political Institutions: Norway is number 1 on the UN's human development index, and comes 6th on the UN's composite index of gender equality. There is universal access to virtually free public health care and education. The judicial system is independent and strong. The press is free, but less diverse than in peer countries. Parliament and government are seen as effective.

Factor Conditions: Roads and railroads are expensive to build, since the population is geographically dispersed and the terrain demanding. Port infrastructure is inferior to peer

countries. However, Norway has a well-developed Internet broadband network. The procedures to start new businesses are relatively burdensome, but Norway ranks close to the top in the global competitiveness index with regards to access to credit, venture capital funds and financing through local equity market.

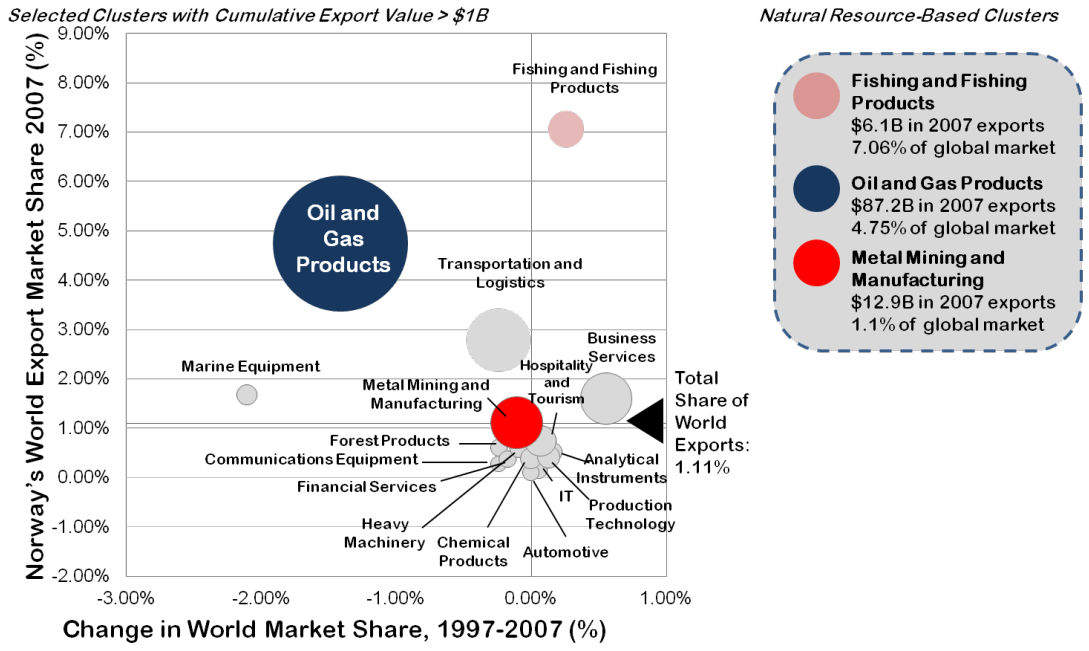


Context for Firm Rivalry and Strategy: Norway enjoys excellent labor-employer relations. The legal framework to settle disputes and enforce contracts is reliable, and there is little corruption. However, transparency in political decision-making is below peer countries. FDI is at a low level, and there are weak incentives for employees to upgrade competence and productivity. As will be explored in greater detail, state ownership is a significant feature of the economy.

Demand Conditions: The harsh winter conditions and mountainous terrain have forced innovation to overcome difficulties posed by nature, for example in the oil and gas industry or in promoting the use of ICT.

Related and Supporting Industries and State of Cluster Development: The economy is less diversified than most developed economies, even those with comparable size. Figure 7 shows this low diversification graphically, along with stagnating export growth. Moreover, 3 natural resource-based clusters are among the 5 largest clusters in terms of exports.

Figure 7: Norway's Export Portfolio by Cluster



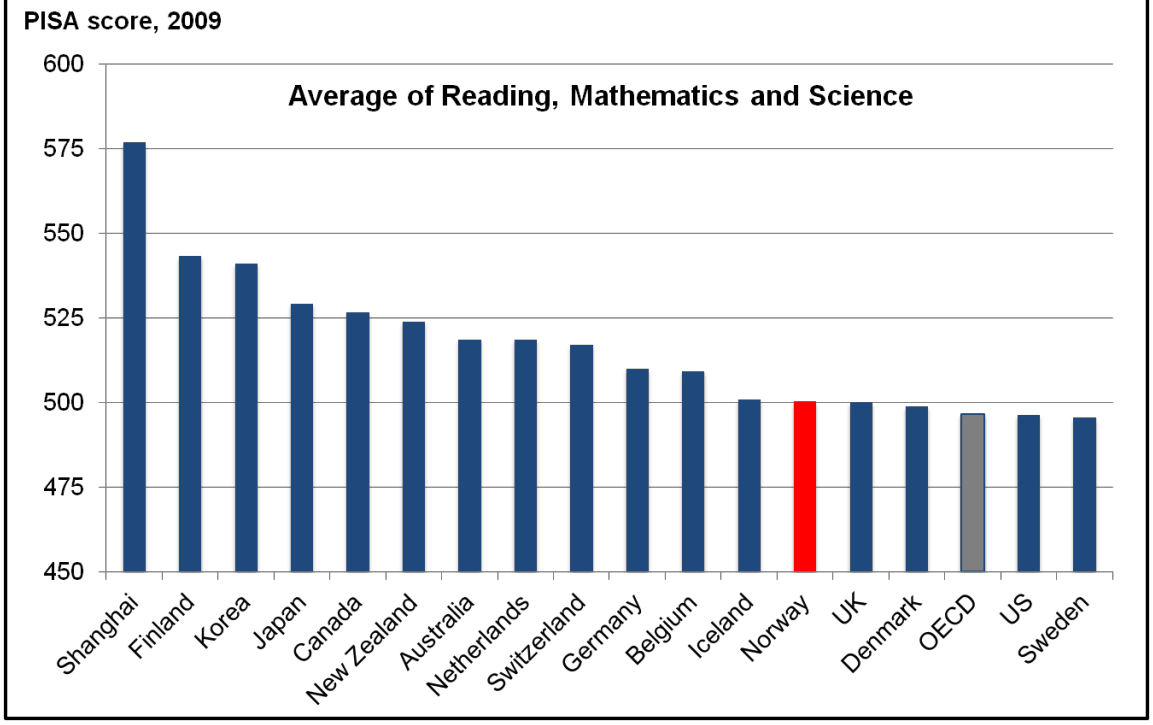
A key tenet of the Norwegian government's industrial policy is to build on existing strengths in developing a more knowledge-based economy, though specific cluster policies do not appear to be sharply prioritized. Norway has some successful cluster programs (ARENA, NCE), led by *Innovation Norway*, the government agency for industrial development (Menon, 2011; Econ Poyri, 2011), and has developed a limited number of clusters that are competitive worldwide.

Factor Conditions: Education

Norway's results in education do not match the level of expenditure, which is the 5th highest in Europe in terms of % of GDP (Eurostat, 2008). As shown in Figure 8, the scores in science, mathematics and reading are only average in the OECD, at 19th, 16th and 10th

place respectively (OECD-PISA, 2009). These data raise concerns about the ability of the country to innovate and increase the technological sophistication of its economy.

Figure 8: Average Scores by Country, OECD PISA Program (max = 600 points)



The tertiary education system mirrors this tendency: although the enrollment in tertiary education is among the highest in the developed world—33% (OECD, 2009)—Norway lacks world-class universities. Indeed, there is only one Norwegian institution among the world's top 200 universities, compared to 6 in Switzerland, 4 in Sweden and 4 in Belgium. Moreover, no Norwegian institutions are included in the ranking of top Schools of Engineering (Shanghai Jiao Tong University Ranking, 2011).

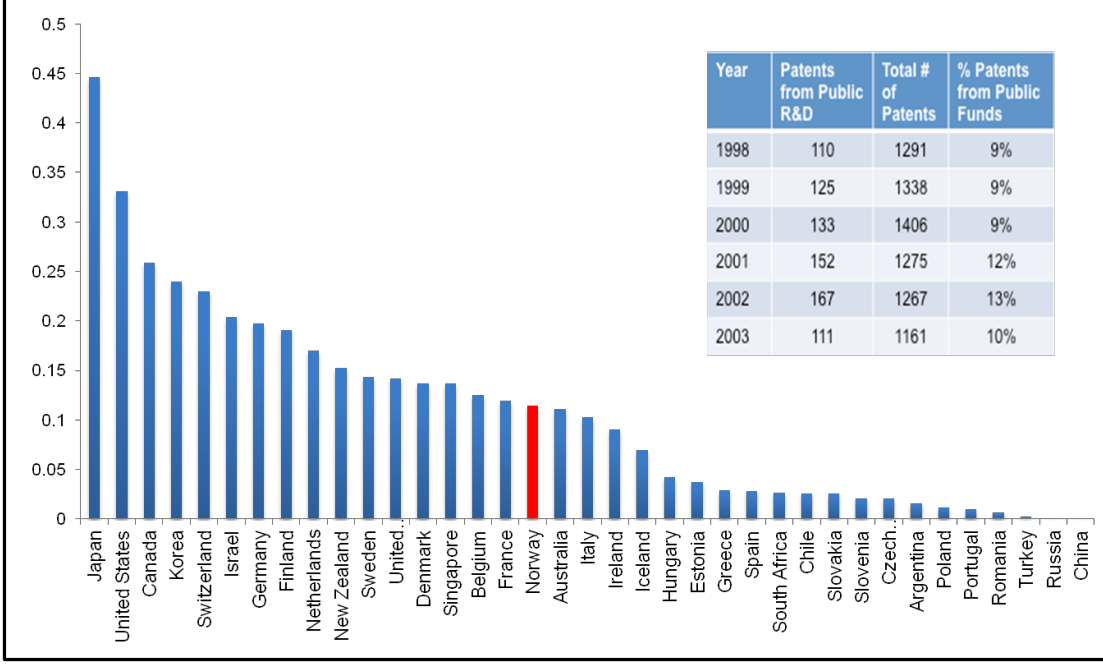
Factor Conditions: Research & Development

The OECD has explored what it refers to as "*the Norwegian Puzzle*": despite weak innovation inputs and even weaker outputs, income per capita in Norway is very high. Norway's expenditures on R&D are much lower than peers (1.61% of GDP vs. 1.92% in the EU), with a lower contribution from the private sector (53% vs. 63%) (Eurostat, 2008).

Norway has increased its patenting output in the last decade, but is significantly less innovative than leading OECD countries (US Patent and Trademark Office, 2010), in particular in the high-tech area. The cause of this apparent contradiction between the performance of the innovation system and the economy has been intensely discussed. For the time being, the most accepted explanation is the structure of the Norwegian economy.

According to the OECD, if Norway had the same industry structure as the average OECD country, it would have the 4th highest R&D intensity in the OECD rather than the 10th (OECD, 2008). Norway does not have large firms in sectors with high R&D intensities since a large part of the economy is based on natural resources; oil and gas accounts for only 6% of all private sector R&D, despite accounting for 23% of GDP. However, even accepting these structural constraints, there is room for improvement.

Figure 9: Effectiveness and Efficiency of R&D Spending



Year	Patents from Public R&D	Total # of Patents	% Patents from Public Funds
1998	110	1291	9%
1999	125	1338	9%
2000	133	1406	9%
2001	152	1275	12%
2002	167	1267	13%
2003	111	1161	10%

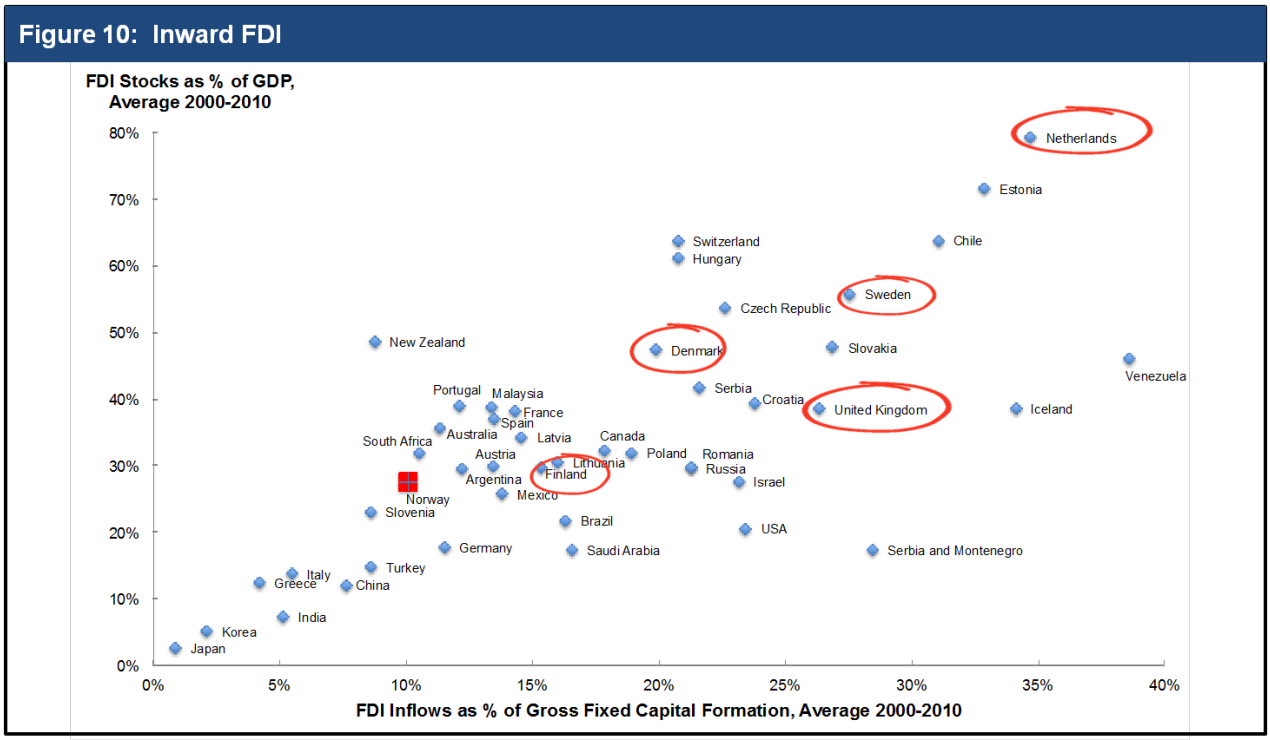
The figure above shows that the United States produces almost 3 times more patents than Norway per $ invested in R&D (US Patent and Trademark Office, OECD,

Eurostat, 2010). Despite public funds accounting for 47% of R&D spending, most innovation occurs in the private sector, suggesting that the public R&D base (Colleges, Research Institutes, Universities) lags behind the private sector in terms of efficiency and effectiveness.

Context for Firm Strategy and Rivalry: Foreign Direct Investment (FDI)

The benefits of FDI would be particularly valuable for a small country like Norway due to the performance of its education and innovation systems. However, inflows and inward stocks of FDI in the last decade are below those of the most dynamic economies (including South Africa, Australia or Brazil) and, what is more worrying, far from neighbor countries like Sweden, Finland, Denmark, UK or the Netherlands (UNCTAD, 2010).

Figure 10: Inward FDI



Norway's position in outward FDI[2] is relatively better, but still worse than peers.

[2] The investments undertaken by *The Government Pension Fund - Global* are not considered as FDI because they never take more than a 10% equity stake in any given company.

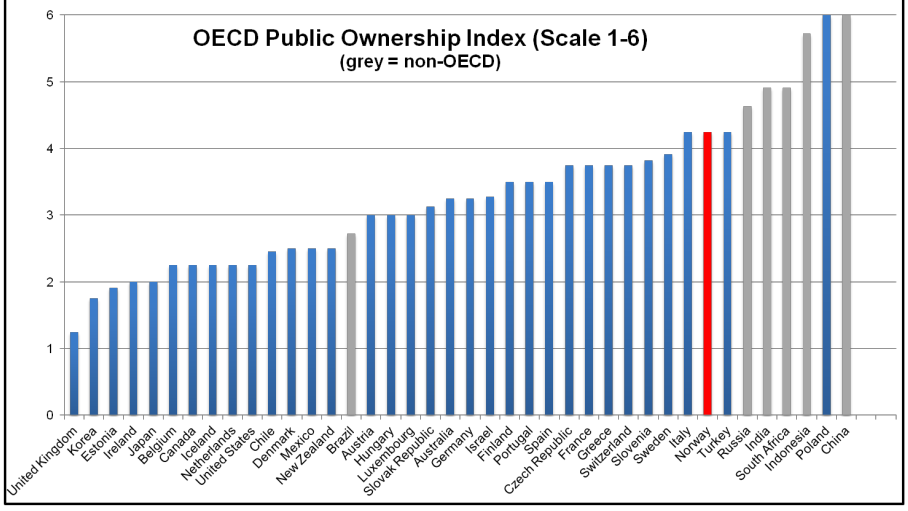
Company Operations and Strategy: The Role of the State in the Economy

The State has historically played a critical role in the economy of Norway. Excluding petroleum, public expenditure is the highest in the OECD as a % of GDP (OECD, 2012). There is extensive state ownership in enterprises (SOEs). The rationale for maintaining SOEs can be grouped in 4 main categories: i) Industrial development and sectorial policies, ii) Control of strategic natural resources, iii) Norwegian ownership, head office location and preservation of strategic national competence and iv) Financial returns.

Norway has undertaken important reforms in its ownership policy over the last 15 years, separating the commercial from the regulatory or public functions and improving management and governance. Some companies have been totally or partially privatized.

However, as can be seen in the Figure 11, Norway is still one of the OECD countries with the highest involvement of the State in the economy, only below Poland and Turkey. Indeed, the Government has an ownership stake in 77 companies, with 52 managed directly by the Government ministries. The size of SOEs varies from large multinationals (the State has significant ownership stakes in 7 of the 10 largest publicly traded companies headquartered in Norway) to SMEs.

Figure 11: Public Ownership Index 2009



Norway has given the Ministry of Trade and Industry the main responsibility for administering state ownership; this partly replicates the centralized model recommended by the OECD, which is used by Singapore, Denmark and Sweden. However, there are important exceptions for companies such as Statoil (Ministry of Petroleum and Energy) and Kommunalbanken (Ministry of Local Government and Regional Development) (Ministry of Trade and Industry, 2011).

Despite the efforts of Parliament and the Government, some inherent risks remain: principal-agent and free-riding problems, lower accountability, the moral hazard derived from a softer budget constraint or less opportunities for innovation and agility in the SOE. The OECD has underscored that there is also a risk for competition: "*to promote a more direct and active state ownership*" (as the Parliament usually demands) could imply a "*move in the direction of an interventionist industrial policy that would undermine the reforms taken the past two decades and exacerbate tensions related to good governance and competitive neutrality*" (OECD, 2003). On the other hand, the policy of preserving headquarters of nationally strategic companies in Norway has succeeded.

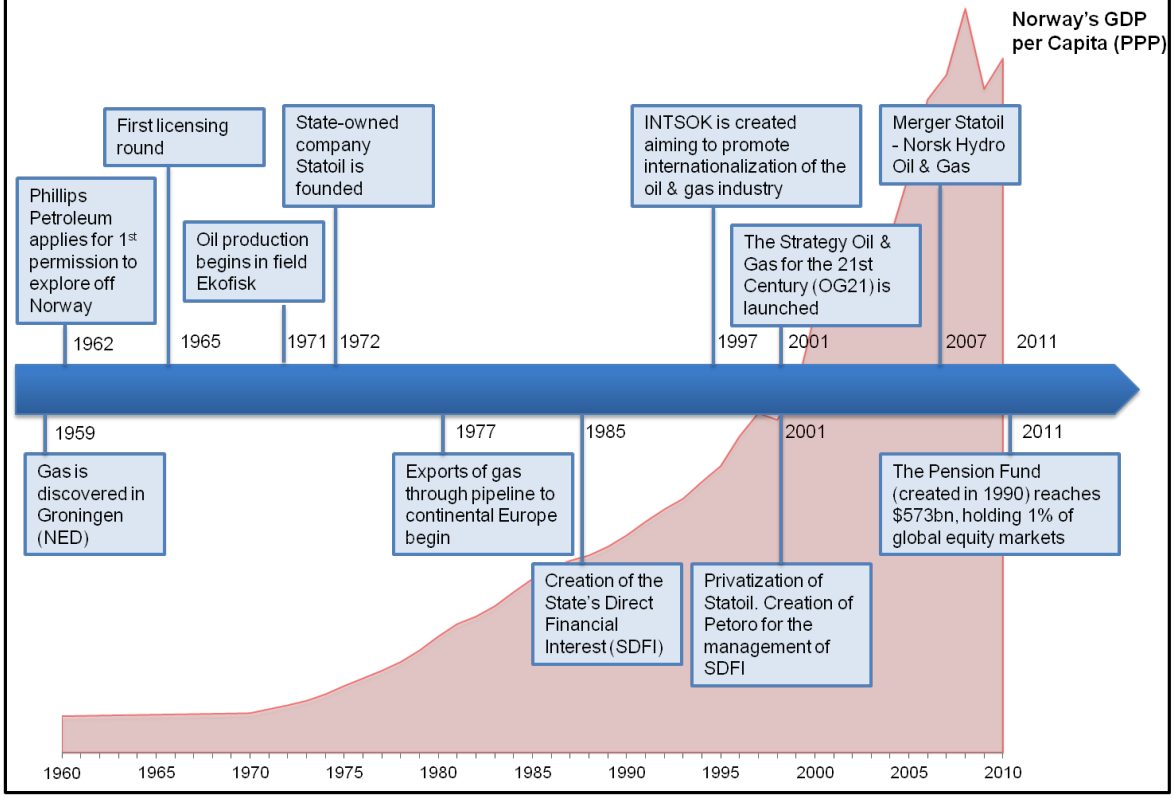
4. The Oil & Gas Supplier Cluster

Unlike most oil and gas producing nations, Norway has developed a significant domestic cluster of suppliers to oil and gas operators. The supplier cluster employs 114,000 people in Norway and achieved sales of $52 billion in 2010, $20 billion of which were sales to customers outside of Norway (Sasson, 2011; Skjellevik, 2011). The cluster succeeded, because the Government put in place effective policies that enhanced pre-existing competences in related industries (shipping, shipbuilding, and mining), and the firms were forced to innovate under harsh demand conditions. The cluster is strategically positioned as a technology-driven innovator.

History of Oil and Gas in Norway

The discovery of gas off the coast of the Netherlands in 1959 prompted Phillips Petroleum to apply for permission to explore off the coast of Norway. The largest field, Ekofisk, was discovered in the North Sea in 1969, and production began in 1971. The oil and gas sector has dramatically transformed the economy in a mere 40 years, as can be seen in Figure 12.

Figure 12: Norwegian Oil and Gas Industry Timeline Vs. Evolution of GDP Per Capita

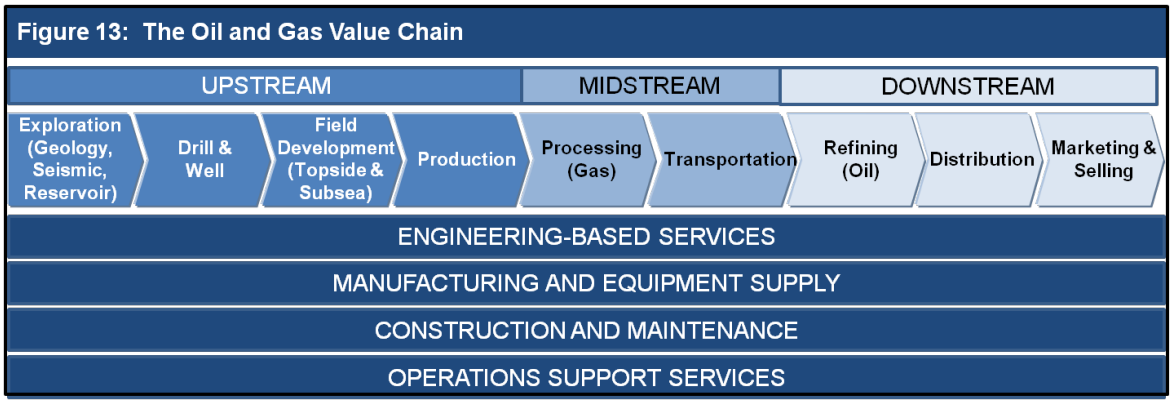


Oil production peaked in Norway in 2001 at 3.4 million barrels per day, while gas production continues to increase, growing on average by 4.6% from 2006-2010. In 2010, Norway produced 2.1 million barrels per day of oil and 106.4 billion cubic meters of natural gas (BP, 2011). This made Norway the 13th largest producer of oil and the 6th largest producer of natural gas.

The dominant industry player is Statoil, headquartered in Stavanger, Norway. Statoil was founded in 1972 as a 100% state-owned oil company, was partially privatized in 2001,

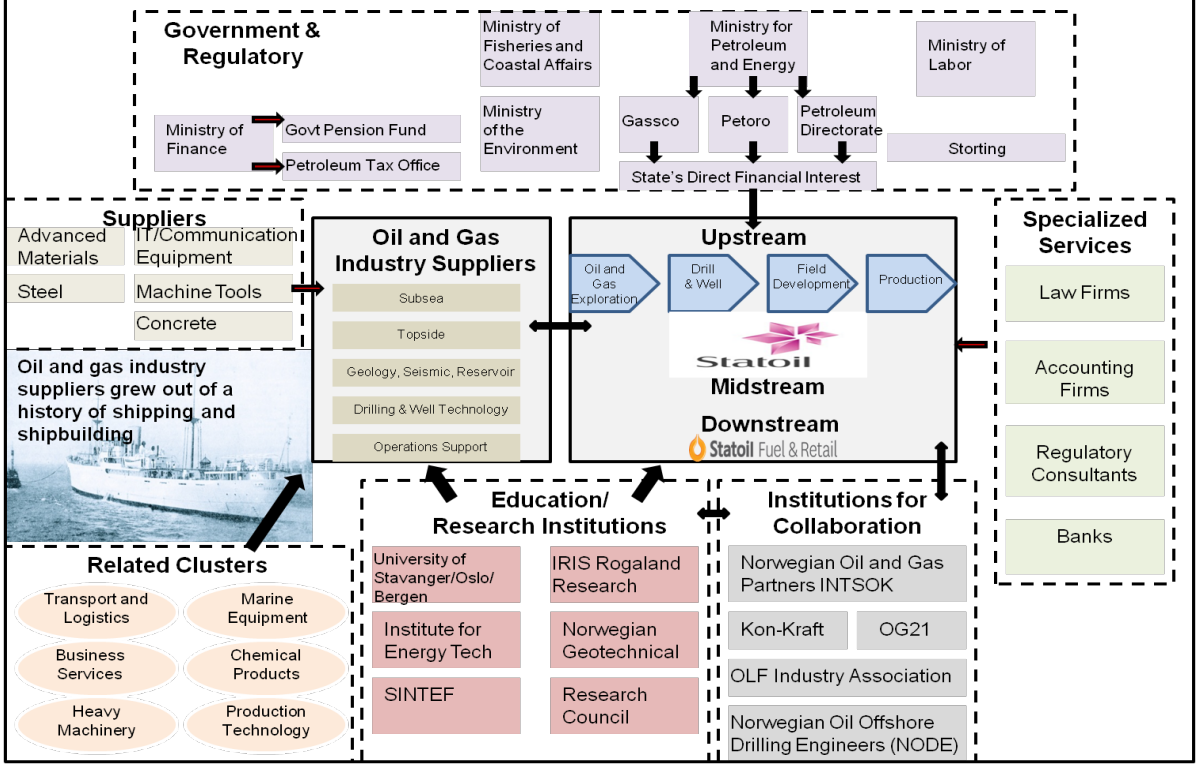
and merged with Norsk Hydro in 2007. Today the Norwegian government owns 67% of Statoil, and the remaining shares are traded on the New York and Oslo stock exchanges. It is the largest company in the Nordic region with $116 billion in 2011 revenues and $85 billion in April 2012 market capitalization (Statoil, 2012). Statoil is internationalizing; 23% of Statoil's proved reserves are outside of Norway, and an equal percentage of revenues came from international markets in 2011.

Oil and Gas Value Chain in Norway



As seen in Figure 13, the oil and gas value chain is divided into 3 phases: Upstream (searching for and getting oil and gas out of the ground), Midstream (gas processing and transportation), and Downstream (refining oil and distributing, selling, and marketing oil and natural gas products). There are companies in all parts of the oil and gas value chain in Norway, with particular intensity in Upstream activities due to the small market size for Downstream products. The companies range in size from the behemoth Statoil to startups. Figure 14 is a cluster map that depicts the interaction between the actors in the oil and gas cluster in Norway.

Figure 14: Norwegian Oil and Gas Cluster Map



The Upstream oil and gas value chain can further be divided into operators and their suppliers. Operators are companies that have production licenses or have operating rights for oil and gas fields. Statoil is the main operator in Norway, accounting for 70% of production (Sasson, 2011). The Norwegian subsidiaries of international operators ExxonMobil, Shell, Marathon, ConocoPhilips, and Eni also make the list of the top ten oil and gas firms in Norway by revenue (Capital IQ, 2012). Exports of the raw materials of oil and gas by operators totaled $83 billion in 2009, 46% of total Norwegian exports (Sasson, 2011).

Operators could not have produced this volume of exports without support from suppliers. Suppliers to these operators accounted for 8% of 2009 Norwegian exports (Sasson, 2011). There are five sub-clusters of oil and gas suppliers: 1) drill and well, 2) operations support, 3) topside, 4) subsea, and 5) geology and seismics. Table 1 describes

the supplier products, important Norwegian companies, number of companies, and number of employees by sub cluster.

Table 1: Description of Upstream Sub Clusters (Operators and 5 Supplier Sub Clusters)

Sub Cluster	Product Description	Norway Leaders	# of Companies	# of Employees
Operators	Hold production licenses or have operating rights for oil and gas fields ; operators employ the suppliers listed below for products and services for Upstream activities	Statoil	223	22,000
Topside	Construction of offshore-related vessels, the construction of surface installations, and the maintenance and modification of onshore and offshore production facilities	Aker, Sevan Marine, Siem Offshore, Beerenberg	404	43,000
Operations Support	Engineering-based services, consisting of firms providing operational support and firms offering personnel for operations support	Scandpower, AGR Group, Kvaerner	1393	34,000
Drill & Well	Running drill and well operations, manufacturing of drill and well equipment, equipment supply, administration of rigs	Seadrill, Fred Olsen Energy, Sevan Drilling, BW Offshore	235	20,000
Subsea	Technology for exploration, drilling and development of oil and gas fields in underwater locations	Aker, Farstad Shipping, DOF, Malm Orstad	96	13,000
Geology, Seismics	Computer-assisted modeling of reservoir data and acquisition and processing of seismic data	TGS, PGS, Electromagnetic Geoservices	149	4000
Total			**2500**	**136,000**

Government Policy Decisions that shaped the Supplier Industry in Norway

Several important policy decisions in the 1970s allowed the Norwegian suppliers to develop competences. The government implemented protectionist procurement policies. In §54 of the Norwegian Petroleum Code, operators, such as Phillips Petroleum, were legally required to inform the Ministry of Petroleum and Energy about supplier bids. The Ministry could then demand that specific Norwegian firms be included on the bidder list. Foreign firms could not be excluded from the list, but the Ministry had the authority to change who was awarded the contract. Informally views were exchanged with the Ministry on which company should be awarded the contract.

As part of the licensing process, foreign operators had to come up with plans to develop the competences of the local suppliers. The Norwegian government subsidized the

local development costs with tax deductions. This is another distinguishing feature of the Norwegian policy model (Heum, 2008).

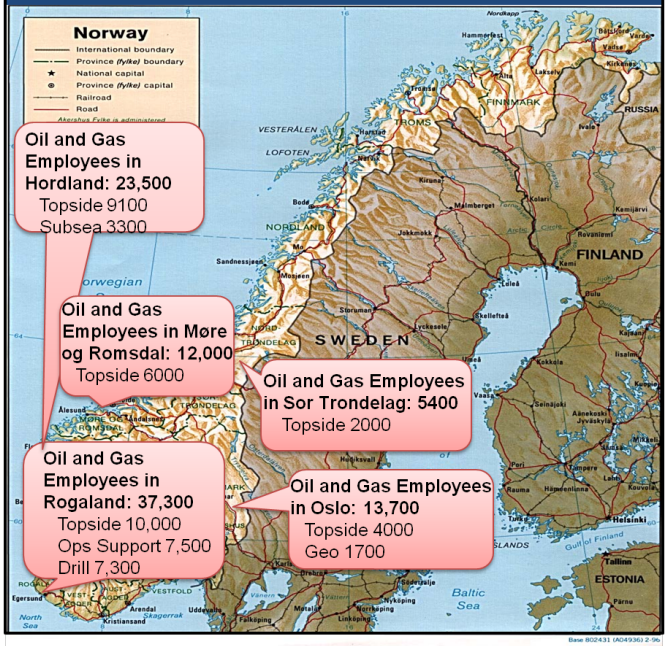
There were location-based directives to keep R&D activities in Norway. In the 4th licensing round in 1978-1979, authorities introduced a requirement that at least 50% of R&D necessary to develop a field had to take place in Norwegian institutions. Later this 50% requirement was replaced with "goodwill agreements" under which foreign operators had to make an effort to conduct as much oil and gas R&D in Norway as possible.

However, these protectionist policies only targeted industries where Norway was already world class (e.g. shipping but not steel) (Heum, 2008). These policies were removed as Norwegian firms developed competences and were phased out in 1994, when Norway entered into a free trade agreement with the EU, which prohibited these practices.

Oil and Gas Supplier Cluster Performance

The oil and gas suppliers in Norway have enjoyed phenomenal growth over the past few years. Employment in the supplier industry has grown from 59,000 in 1990 to 114,000 in 2009, while employment by operators (customers for the suppliers) has stayed relatively flat over the same period at around 20,000 (Sasson, 2011). Most of the employment is concentrated in the South and West, particularly in Rogaland County (see Figure 15). Supplier sales totaled $52 billion in 2010, having grown more than 51% from 2006. The

Figure 15: Geographic Distribution of Employment



employment growth rate (30%) since 2006 has been significantly slower than revenue growth, due to Norwegian labor costs increasing by 51% over the same 5 year period (Skjellevik, 2011).

Suppliers have been able to grow their revenues, because they have been able to internationalize. International sales grew from $8.7 billion in 2000 to more than $20 billion in 2010 (Skjellevik, 2011). For the top 350 suppliers, on average 32% of sales are outside of Norway. Generally the sub clusters with the highest profit margins have the highest percentage of international sales (Geology, Seismic and Drilling), as seen in Figures 16a and 16b.

Figure 16a: Profit Margins by Sub Cluster (Avg. 2005-2009)

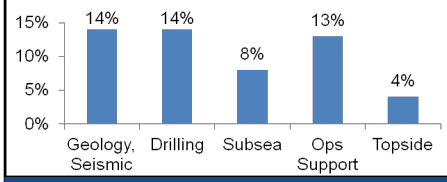


Figure 16b: % International Sales by Sub Cluster (2009)

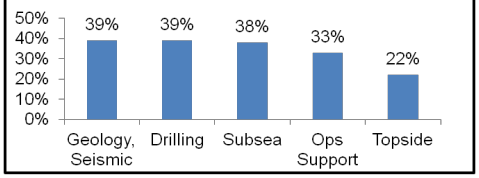


Table 2 shows their global market share by oil and gas producing regions.

The strength and growth potential of the Norwegian supplier base attract foreign capital to Norway. The Oslo Stock Exchange is the 2nd largest market in Europe for energy companies and the 2nd largest worldwide for oil and gas suppliers (Oslo Børs, 2012).

Table 2: Norwegian Oil and Gas Suppliers' Foreign Market Shares in Oil Producing Regions

Oil Producing Region	2009 Global Market Size (US$ Billion)	Market Share of Norwegian-based Suppliers (%)
North Africa	1	28%
North Sea (non-NCS)	8	24%
Southeast Asia, Australia	34	17%
West Africa	19	12%
Brazil, Venezuela, Mexico	14	12%
China	5	11%
US/Canada	24	8%
Russia and CIS	8	8%
Middle East	19	2%

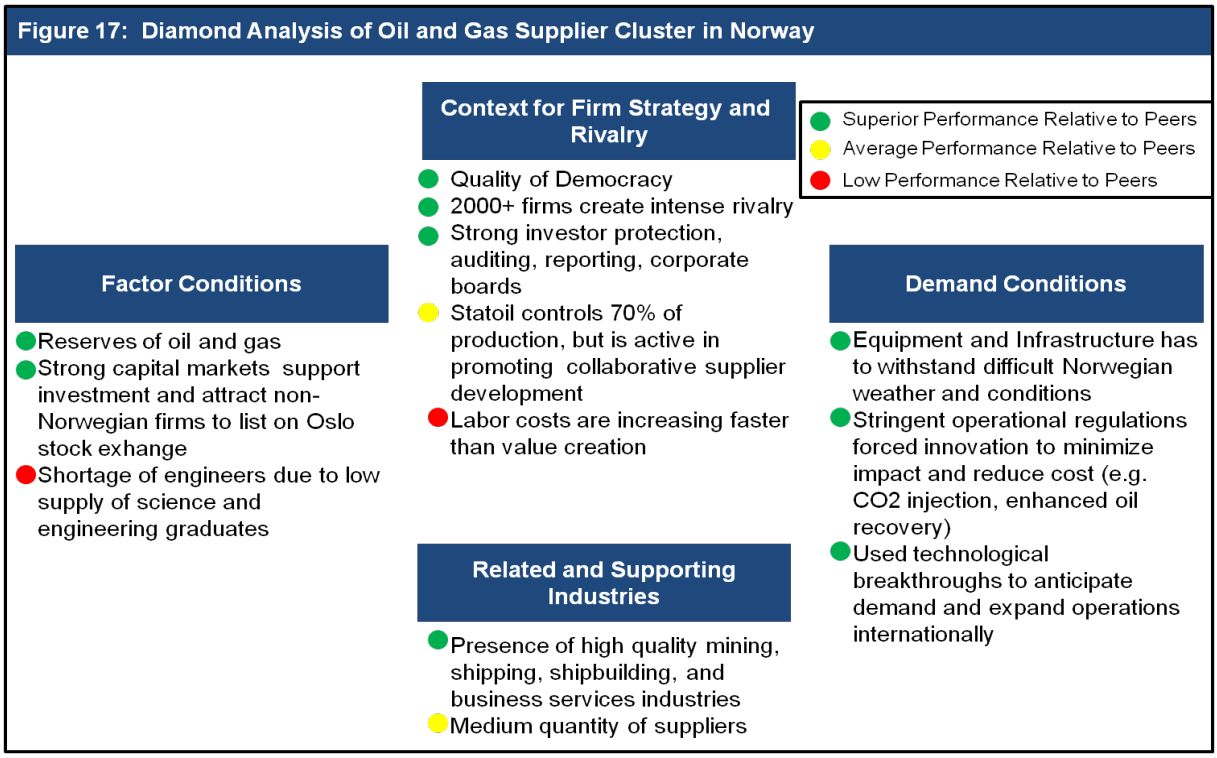
Cluster Diamond Analysis

The diamond for the Norwegian oil and gas supplier cluster highlights many strengths, while also surfacing some concerns for the future (See Figure 17).

Related and Supporting Industries

The oil and gas supplier cluster was built upon existing competences in mining, shipping and shipbuilding. These industries have continued to flourish as the oil and gas supplier industry has grown, with combined 2007 exports totaling nearly $34 billion.

Figure 17: Diamond Analysis of Oil and Gas Supplier Cluster in Norway



The business services cluster has also emerged to support the internationalization of Norway's oil and gas suppliers; 2007 exports totaled $12.5 billion (HBS ISC, 2012).

Demand Conditions

The harsh Norwegian climate combined with stringent regulatory requirements has led to many important innovations in oil and gas technology. The Norwegian Continental Shelf is considered an "advanced laboratory for technology," especially in field development, enhanced recovery, and CO_2 reduction.

The first important innovation by Norwegian shipbuilders in the 1970s was Condeep, the offshore concrete platform. In 1996, a much improved iteration of this technology, the Troll A platform, became the tallest construction that has ever been moved

to another location. Norwegian suppliers also invented hits, such as floating production platforms (1992) and multiphase transport (1996). Enhanced oil recovery innovations, such as water injection (1986), 3D seismic (1979), 4D seismic (1999) and subsea processing (2007), have improved recovery rates from 17% in 1969 to an average of 46% in 2010, an increase of $25 billion in total NPV (Sasson, 2011). In the gas field, Sleipner, the first offshore Carbon Capture and Storage (CCS) was started in 1998 and deposited 1 million tons of CO_2 per year to reduce the CO_2 content from 9% to 2.5% (OG21, 2010). Consequently, Norway has the lowest kilograms of CO_2 equivalent per unit produced in the world (9.2 versus 10.1 and 26 for Europe and North America respectively). According to the Ministry of Petroleum and Energy, "*All of these innovations came about as the result of a close collaboration between Operators and Suppliers*."

Going forward, since the age of "easy oil" is over, oil and gas production globally will take place in areas that are more and more difficult to access, in deeper waters and harsher climates. 5 out of the 8 top oil and gas discoveries in 2011 were offshore, in depths ranging from 300-3,000 meters deep (Kammerzell, 2012). Norwegian suppliers are well positioned to take advantage of this opportunity and provide operators with improved performance that translates into cost savings and more revenues.

Context for Firm Strategy and Rivalry

Statoil's dominance in the Norwegian oil and gas market has put the company in a unique position to develop suppliers and encourage innovation. On its own, Statoil is not recognized as an innovation leader in the industry. As is the case with national R&D outcomes, Statoil's results from R&D spending are mediocre. Statoil spends 0.31% of sales on R&D, while Exxon Mobil spends 0.21%. In their 10-K, ExxonMobil reports more than 11,000 patents, while Statoil's filing with the SEC contains no mention of patents, an

indication that their patenting output is not compelling enough to share with investors. ExxonMobil has 749 patents filed with the Norwegian Industrial Property Website, while Statoil only has 677, even though Statoil's 2010 revenues in Norway were 14 times more ($84 billion vs. $6 billion) (NIPO and Capital IQ, 2012). Statoil recognizes in their 20-F filed with the SEC that "*much of our technology development is carried out in close cooperation with national and international universities, research institutions, and suppliers. Our performance is strongly dependent on our supplier's performance. We work closely with our suppliers*." Statoil is a demanding customer that drives innovation from suppliers.

With $24 billion spent in procurement and 12,000 suppliers, Statoil has created a best in class supplier mentoring program. It uses "Statoil Technology Invest" to take equity stakes in 20 oil and gas technology or renewable companies. It has the LOOP Program, which gives funding, project support, and pilot testing to suppliers for specific technology concepts. More than 260 projects have been funded since 1990. It also hosts an annual Supplier Day, where the CEO of Statoil presents the innovation strategy to all suppliers.

Seadrill is an example of a Norwegian Statoil supplier that has managed to innovate and internationalize. Seadrill has grown net income from $226 million in 2006 to $1.6 billion in 2010. 66% of Seadrill's revenues come from outside of Norway. Its number 1 customer is Petrobras in Brazil, while Statoil is number 2. The case of Seadrill highlights the challenge relating to Norwegian taxes. Although Seadrill's operational headquarters are in Stavanger, Norway, its headquarters for tax purposes are in Bermuda. Out of the 60 companies listed in the Energy Index on the Oslo Stock Exchange, 6 are "Norwegian" oil and gas supplier companies that are headquartered in a tax haven.

Statoil also aims to develop suppliers outside of Norway through "*build[ing] offshore clusters*," with a specific focus on the US Gulf of Mexico, Brazil, Azerbaijan, and Angola.

Statoil works as a classic keystone, a hub that "*motivates the development of new capabilities, processes, and technologies*" (Iansiti, 2004). In its efforts to internationalize its revenue base, Statoil "*invest[s] in the development of sustainable and competitive local companies. We support the development of expertise in local communities and among our suppliers and contractors in order to build up lasting expertise and help them to develop the standards and certification schemes required for work in the oil and gas industry*" (Statoil, 2012). Closer to home and capitalizing on its Arctic operational competences, Statoil has a 35% share in ProBarents, a supplier incubator program aimed at developing a local supplier base in Northern Norway and Murmansk, Russia. As both Statoil and the suppliers continue to internationalize as production shifts to geographies other than Norway, one concern is how connected these firms will remain to their Norwegian locations.

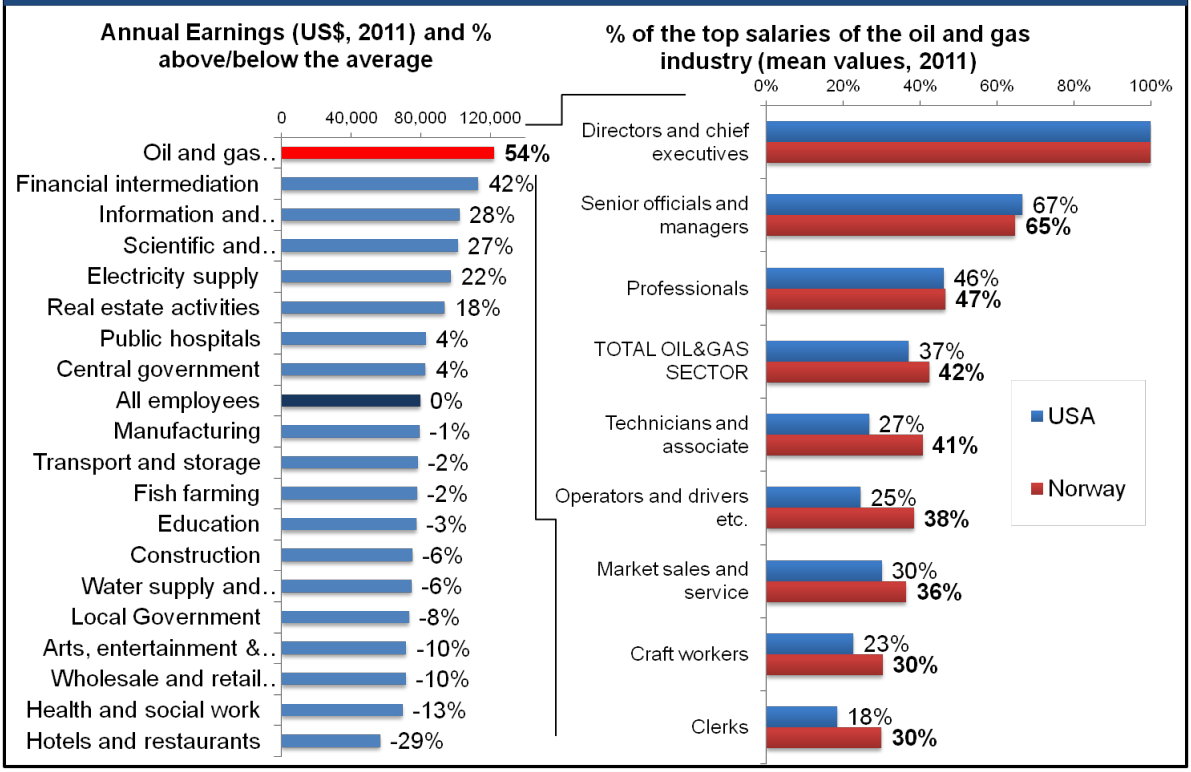
Factor Conditions

The strength of the human capital available is a source of concern. Norway has a lower percentage of science and engineering graduates (12%) than the OECD average (15%) (OECD, 2009); these degrees provide the foundational training for many of the roles in the oil and gas supplier cluster. In addition to the shortage of engineers, oil and gas has a perception issue. An increasing number of Norwegian engineering graduates choose to "*focus on renewable energy and other technologies that are perceived to be environmentally friendly*" (Sasson 2011). The share of engineers is actually declining in some of the supplier sub clusters (Topside, Geology and Seismics, and Operations Support). Firms have plugged this gap with foreign labor. The percentage of foreign labor in the cluster increased from 4% in 2000 to 8% in 2008 (Sasson, 2011).

Although oil and gas is the best paid sector in Norway with an average annual salary of $120,000, the wage compression in the industry does not provide workers with

sufficient incentives to advance their careers or improve their skills with additional training. (See Figure 18.) Amir Sasson identifies an interesting trend: "*The significant increase in the workforce with business and economics degrees and other social science degrees over the last eight years may indicate a shift from the development of new products and services to the commercialization of already developed products and services.*" This may suggest a "*gradual change in workforce composition and strategic positioning within the industry. The three apparent mechanisms—the lack of qualified personnel, an expectation of decreasing returns on investments in engineering based projects, or the offshoring of engineering activities–are likely to negatively affect the sustainability of the Norwegian oil cluster*" (Sasson, 2011).

Figure 18: Earnings Structure for the Oil and Gas Industry in Norway



Competing Clusters

The Norwegian oil and gas supplier cluster faces competition from Houston, US; Rio de Janeiro, Brazil; and Aberdeen, Scotland, which shares the North Sea assets. Although the

Norwegian supplier cluster is enjoying strong growth from internationalization, its strategic position as a technology driven innovator is threatened. Norway does not have the scale of Houston, which has almost 18 times as many firms (Capital IQ, 2012). The cluster size in Aberdeen, Scotland is roughly the same as Stavanger, Norway, but the two clusters have positioned themselves differently, and Aberdeen has better patenting output. Aberdeen is known for process innovations; there were 780 US patents from this cluster up to 2005, compared to only 412 Stavanger-related US patents in the same time period (Hatakenaka, 2006). Rio de Janeiro may pose the biggest threat to the Norwegian supplier cluster. In Brazil, the government has put in place local supplier requirements similar to what Norway had in the 1970s. With these protectionist policies in place, Rio's 64% state-owned Petrobras has managed to increase the percentage of Brazilian suppliers hired to work on the company's oil and gas projects from 53% in 2003 to 77.34% in 2011 (Petrobras, 2011). While Norway's production has peaked, Brazil's production is doubling to 6 million barrels per day by 2020. There is a real danger that Brazil could replace the North Sea as the "advanced laboratory for technology."

Institutions for Collaboration (IFCs)

IFCs play an important role in the Norwegian oil and gas supplier cluster. There are active IFCs at the regional (NCE Subsea, Norwegian Offshore Drilling and Engineering [NODE]), national (Konkraft, Arena, Oil Industry Association [OLF], INSTOK, Norwegian Petroleum Society [NPF], OG21, and the Navitas Network) and European level (European Cluster Alliance). In the Southern part of Norway, the NODE IFC has increased the number of engineers employed and rate of innovation for affiliated supplier firms (Sasson, 2011). The dynamic activity of the IFCs demonstrates the maturity of the cluster.

5. Recommendations

The key challenges and recommendations are provided in order of priority.

Country Level Recommendations

Challenge no. 1: Transformation of the Economy in the Post-oil Era

Norway's vision for its competitive position globally is a knowledge-based, innovation-driven economy, developed from existing strengths. But it has significant work to do to realize this vision, as productivity is declining in relation to peers and the current cluster portfolio has low diversification, with a few successful, natural resource-based clusters.

Recommendations: Formulate and launch a tactical post-oil Road Map that implements the vision and meets the challenges of high labor costs and declining production and revenues from the oil and gas sector. At the center of this road map must be a comprehensive cluster policy, which better links education, training, R&D, regulation, industrial policies, taxation, market and demand sophistication, physical infrastructure, capital markets, and already existing companies. Drawing on its long history of wisely developing its rich natural resources, Norway should further build its strategic position as a reliable, innovative and "clean and green" country. Operationally, the central government should work closely with the private sector, academia and unions in a bottom up approach to create solutions tailored to local and regional strengths. The government should create a broad-based national competitiveness commission with a permanent secretariat in Oslo and with branches at the local level to promote this process and provide accountability.

Challenge no. 2: Openness of the Economy

Norway's economy is closed and insufficiently diversified with limited local competition.

Recommendations: Launch an ambitious "Plan to Attract FDI" that more aggressively pursues FDI through trade missions, reduced regulatory burden, and bilateral trade agreements with distant markets. Norway should establish a government agency to

promote inward FDI,[3] which could be housed in Innovation Norway missions abroad, and which draws upon dedicated talent and a separate budget. The role of the state must be balanced against the need to attract foreign capital and know-how and promote competition. The government should also target increasing the trade flows of the non-oil economy by fostering regional integration (Baltic region, Scandinavia + Russia, etc.).

Challenge no. 3: Innovation System

R&D relies heavily on public spending, leading to lower outcomes than peer countries. R&D is not driving the transformation of the economy, but is serving existing industries.

Recommendations: The system for public expenditure on R&D should be reviewed and reformed with increased focus on efficiency and accountability for outcomes. Public funding should not be a routine source of financing for the private sector but an instrument to correct market failures and hedge technological risks. Innovation and quality of R&D may be improved in three ways: i) using existing capabilities in successful industries with a "Program for Spillovers," ii) fostering international cooperation to increase the sophistication of local capabilities, working at three levels: academia, government and firms, and iii) improving the linkages between R&D and start-ups that commercialize new technologies through IFCs and new and more comprehensive public-private partnerships.

Challenge no. 4: Medium and Higher Education

The quality of high-level training in science and technology lags peers, and the outcomes in science and mathematics do not match the levels of expenditure.

Recommendations: Review and strengthen the science curriculum in primary and secondary education. Norway should find ways to make science and technology more attractive for youth, increase the public recognition of technical careers, and place a special

[3] Norway currently does not have any agency dedicated to attracting inward FDI. The World Bank used the sub-national Oslo Teknopol to assess the country's investment strategy.

focus on women. The government should foster more cooperation between industry and academia both nationally and internationally to promote excellence. The number of co-op opportunities for university students should be increased.

Cluster Level Recommendations

Challenge no. 1: Shortage of Skilled Labor and Insufficient Incentives

The cluster is facing a shortage of engineers and other domestic skilled labor due to lack of supply and misalignment of incentives that threatens the growth of the cluster.

Recommendations: Attract skilled foreign labor. Following the example of the Partnership between Statoil and the University of Texas at Austin, firms should increase cooperation with top foreign universities. They should sponsor science-based competitions with cash prizes at the universities to increase visibility of their firm as a potential employer. Firms should better align results and rewards (career development, recognition, pay) for entry and mid-level managers. They should invest in culture-building programs that make their companies attractive. Firms should position themselves as being on the cutting edge of the sustainability trend and sell the opportunity to innovate around clean technologies.

Challenge no. 2: Declining Oil Production

Declining oil production reduces the home-market size and opportunities for innovation.

Recommendations: Work on a national agreement to open the Barents Sea for exploration and further develop stringent regulation, to force innovation around safety, enhancing recovery rates and environmental protection and sustainability. As part of their talent acquisition and growth strategies, oil and gas suppliers should target specific spillover technologies to related industries, such as renewable and carbon capture and sequestration. Firms should also further develop R&D satellite facilities in export countries in order to stay relevant to technological developments.

Challenge no. 3: Internationalization (Market Opportunities and Geopolitical Risks)

Recommendations: In support of seizing market opportunities for firms, government action should integrate trade and foreign policy interests to mitigate geopolitical risks. Norway should maintain the Norwegian Oil for Development Initiative, which focuses on capacity building around resource management, revenue management, and environmental protection in more than 20 developing countries. In addition to partnering with Statoil's efforts to "maximize shared value,"[4] individual oil and gas supplier firms should develop comprehensive local content strategies in foreign markets, which outline 5-10 year tactics for investing in the skills of local workers and making strategic community investments. They also should sponsor exchange assignments in Norway for local staff.

Challenge no. 4: Low Cost Foreign Competitors

Competing clusters threaten Norway's innovative, but high cost strategic positioning.

Recommendations: Develop partnerships with firms and IFCs in emerging clusters, in particular Brazil. Suppliers should recruit local talent by offering higher salaries than competitors and actively benchmark to stay ahead of poaching efforts.

Challenge no. 5: Loss of Ties to Norway

With internationalization as the core strategy for growth, supplier firms risk losing their Norwegian identities and may shift headquarters due to tax or market incentives.

Recommendations: Initiate a dialogue with business leaders with regard to securing the maintenance of long term roots in Norway. This works to the cluster's strategic advantage. According to Michael Porter, "The strongest international competitors will often be those that can establish deeper roots in important communities. Companies that can embrace this new locational thinking will create shared value" (Porter, 2011).

[4] For example, Statoil has a Management and Technology Transfer Program with the Angolan national oil company.

Disclosures and Disclaimers

One of the authors, Mr. Paul Klouman Bekken, is on leave from the Norwegian Ministry of Foreign Affairs. However, the views in this article should not be attributed to the Norwegian Ministry of Foreign Affairs.

6. Bibliography

Arena Cluster Program. http://ekstranett.innovasjonnorge.no/templates/Page_Meta___57487.aspx Accessed May 2012.

BP Statistical Review of World Energy Excel Download. http://www.bp.com/sectiongenericarticle800.do?categoryId=9037128&contentId=7068555 Accessed April 2012.

Capital IQ, a division of Standard & Poor's Database. Accessed April 2012.

Country Commerce. Norway. Economist Intelligence Unit, New York 2011

The Central Bank of Norway (Norges Bank). http://www.norges-bank.no/en/ Accessed May 2012.

Encyclopedia Britannica Online. "Louisiana Purchase." Accessed May 2012.

Energy Policies of IEA Countries. Norway. 2011 Review. IEA, Paris 2011

Eurostat Database. http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/ Accessed April 2012.

Facts 2012. Norwegian Petroleum Directorate, Oslo, 2012.

Forfas. "The Role of State Owned Enterprises." Dublin. July 2010. http://www.forfas.ie/publication/search.jsp?ft=/publications/2010/title,6603,en.php Accessed April 2012.

Global Investment Promotion Best Practices 2012. World Bank Group. https://www.wbginvestmentclimate.org/advisory-services/investment-generation/investment-policy-and-promotion/gipb/upload/Global-Investment-Promotion-Best-Practices-2012_04-09-2012.pdf Accessed May 2012.

Harvard Business School Institute for Strategy and Competitiveness, International Cluster Competitiveness Project Dataset.

Hatakenaka, S., P., W., Gjelsvik, M., and Lester, R. (2006) "The Regional Dynamics of Innovation". Industrial Performance Center MIT Working Paper.

Heum, P. "Local Content Development - Experiences from Oil and Gas Activities in Norway". SNF. Bergen, 2008.

Innovation Norway. http://www.innovasjonnorge.no/Contact-us/ Accessed May 2012.

Iansiti, M. The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation, and Sustainability. Boston: Harvard Business School Press, 2004.

Internationalisation of the Petroleum Industry. Konkraft and Intsok, Oslo

Jakobsen, E.,W., and Røtnes, R. (2012) "Cluster programs in Norway – Evaluation of the NCE and Arena programs". Menon Business Economics, Oslo.

Kammerzell, J. "10 Significant Discoveries of 2011." Rigzone, 10 January 2012. http://www.rigzone.com/news/article.asp?a_id=114064. Accessed April 2012.

Ketels, Christian. "Norway's role in the global economy of the 21st century – key policy issues." Utenriksdepartementet. http://www.regjeringen.no/nb/dep/ud/kampanjer/refleks/innspill/oekonomi/ketels.html?id=493172 Accessed April 2012.

Ketels, Christian. "Prosperity, Competitiveness, and Clusters: Where Do We Stand?" Presentation at the Norwegian Cluster Manager Forum, Oslo, Norway, 22 March 2012. http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CFMQFjAA&url=http%3A%2F%2Fekstranett.innovasjonnorge.no%2FArena_fs%2FNorwegian%2520Cluster%2520Manager%2520Forum%25202012%2FKetels%2520presentasjon%252003-22-12%2520CK.pptx&ei=sd-jT8mTEMSX6QG9uvWUCQ&usg=AFQjCNFO0BzBm3VqMKTXbvL3YB_n0t_xKA Accessed May 2012.

Lind, R. "Knowledge-based-innovation – are required prerequisites present?" Speech at Oslo Innovation Week, 13 October 2008. http://www.regjeringen.no/en/dep/nhd/Whats-new/Speeches-and-articles/Speeches-and-articles-by-political-staff/statssekretaer_annelene_svingen/2008/knowledge-based-innovation--are-required.html?id=532274 Accessed May 2012.

NCE Cluster Program. http://ekstranett.innovasjonnorge.no/templates/Page_Meta___56536.aspx Accessed May 2012.

Norway: OECD Reviews of Innovation Policy. OECD. Paris, 2008.

Norwegian Industrial Patent Office Database. https://dbsearch2.patentstyret.no/AdvancedSearch.aspx?Category=Patent Accessed April 2012.

Norwegian Ministry of Finance. "Overview." http://www.regjeringen.no/en/dep/fin.html?id=216 Accessed May 2012.

Norwegian Ministry of Finance. "The Government Pension Fund." http://www.regjeringen.no/en/dep/fin/Selected-topics/the-government-pension-fund.html?id=1441 Accessed May 2012.

Norwegian Ministry of Finance. "Long-term perspectives for the Norwegian economy." English summary. Oslo, 2009.

Norwegian Ministry of Petroleum and Energy. "An Industry for the Future—Norway's Petroleum Activities." Report to the Storling White Paper. 24 June 2011. http://www.regjeringen.no/upload/OED/Petroleumsmeldingen_2011/Oversettelse/2011-06_White-paper-on-petro-activities.pdf Accessed May 2012.

Norwegian Ministry of Trade and Energy. http://www.regjeringen.no/en/dep/oed.html?id=750 Accessed May 2012.

Norwegian Ministry of Trade and Industry. "Overview." http://www.regjeringen.no/en/dep/nhd.html?id=709 Accessed May 2012.

Norwegian Ministry of Trade and Industry. "Free Trade Agreements." http://www.regjeringen.no/en/dep/nhd/selected-topics/free-trade.html?id=438741 Accessed May 2012.

Norwegian Ministry of Trade and Industry. "The Norwegian R&D Puzzle." http://www.regjeringen.no/en/dep/nhd/selected-topics/innovation/a-norwegian-puzzle.html?id=582903 Accessed May 2012.

Norwegian Petroleum Directorate. http://www.npd.no/en/ Accessed May 2012.

Norwegian Petroleum Technology. A Success Story. Norwegian Academy of Technological Sciences Offshore Media Group, Trondheim 2005

OECD. "Economic Survey of Norway 2012." http://www.oecd.org/document/3/0,3746,en_2649_33733_49616451_1_1_1_1,00.html Accessed May 2012.

OECD. "Norway." http://www.oecd.org/country/0,3731,en_33873108_33873681_1_1_1_1_1,00.html Accessed May 2012.

OECD. "Regulatory Reform in Norway." Paris. 2003.

OECD. "Statistics." http://stats.oecd.org/ Accessed May 2012.

OG21. "Oil and Gas in the 21st Century." Strategy Document. Oslo. http://www.og21.org/prognett-og21/Documents/1253962785322 Accessed April 2012.

Oil for Development Initiative. Annual Report 2010. NORAD, Oslo http://www.npd.no/Global/Engelsk/3%20-%20Publications/Reports/Oil%20for%20development%202010/OFD_lav_web%20(2).pdf

Olsen, Ø. "The Economic Outlook" Speech by Governor Øystein Olsen to invited foreign embassy representatives, Oslo, 12 April 2012

Oslo Børs. "Energy." http://www.oslobors.no/ob_eng/Oslo-Boers/Listing/Energy-shipping-and-seafood/Energy Accessed May 2012.

Petrobras 2010 Sustainability Report. http://www.petrobras.com.br/rs2010/en/relatorio-de-sustentabilidade/resultados-contribuicoes-sociedade/contribuicoes-sociedade-impactos-indiretos/gestao-de-fornecedores/index.asp Accessed April 2012.

Porter, Michael E, and Kramer, M. "Creating Shared Value." Harvard Business Review. January-February 2011.

Porter, Michael E. "Norwegian Competitiveness: Where Does the Nation Stand?" Institute for Strategy and Competitiveness. Presented to the Oslo Business Summit. 22 October 2004.

The Resource Report 2011. Norwegian Petroleum Directorate, Oslo, 2011 http://www.npd.no/en/Publications/Resource-Reports/2011/

Reve, Torger. "A knowledge-based Norway." Presentation at the Norwegian Cluster Manager Forum, Oslo, Norway, 22 March 2012.

Sasson, Amir, and Atle Blomgren. "Developing NODE: Mediating Strategy for Sustainable Growth." Working Paper. Oslo: Norwegian Business School, December 2011.

Sasson, Amir, and Atle Blomgren. "Knowledge Based Oil and Gas Industry." Knowledge-Based Norway. March 2011. Report No. 4.

Seadrill 2010 20-F. (2011). http://www.seadrill.com/stream_file.asp?iEntityId=1252
Shanghai Jiao Tong University Ranking. "2011 Ranking." http://www.shanghairanking.com/ Accessed April 2012.

Skjellevik, Tor Inge. "The Norwegian Oilfield Service Analysis 2011." Ernst & Young. December 2011. http://www.ey.com/Publication/vwLUAssets/Oljeserviceanalysen_2011/$FILE/oljeserviceanalysen-2011_ny_web.pdf Accessed April 2012.

The State Ownership Report 2010. Norwegian Ministry of Trade and Industry http://eierberetningen.no/2010/index.php?lang=english Accessed April 2012.

Statistics Norway. http://www.ssb.no/en/ Accessed May 2012.

Statoil 2011 20-F. (2012). http://www.statoil.com/AnnualReport2010/en/Download%20Center%20Files/01%20Key%20Downloads/11%20Annual%20report%20on%20Form%2020F/AnnualReportonForm20F.pdf

UNCTAD. "Statistics." http://unctadstat.unctad.org/ReportFolders/reportFolders.aspx?sRF_ActivePath=P,1&sRF_Expanded=,P,1 Accessed April 2012.

United States Department of Labor. "Statistics." http://www.dol.gov/dol/topic/statistics/index.htm Accessed April 2012.

United States Patent and Trademark Office. http://www.uspto.gov/ Accessed April 2012.

World Economic Forum. "The Global Competitiveness Report 2011-2012." Geneva. 2011. http://www.weforum.org/reports Accessed April 2012.

7. Sources for Figures and Tables

Figure 1: Google Maps
Figure 2: Statistics Norway, World Bank Database, OECD
Figure 3: OECD
Figure 4: OECD
Figure 5: World Bank
Figure 6: Team Analysis, Harvard Business School Institute for Strategy and Competitiveness
Figure 7: Harvard Business School Institute for Strategy and Competitiveness
Figure 8: OECD
Figure 9: Eurostat 2010, Norway: OECD Reviews of Innovation Policy
Figure 10: UNCTAD 2010
Figure 11: OECD Indicators of Product Market Regulation 2008
Figure 12: Team Analysis, OECD
Figure 13: Team Analysis
Figure 14: Team Analysis
Figure 15: "Knowledge Based Oil and Gas Industry."
Figure 16: "Knowledge Based Oil and Gas Industry."
Figure 17: Team Analysis
Figure 18: Statistics Norway, US Department of Labor (adapted by Team Analysis)
Table 1: Team Analysis, "Knowledge Based Oil and Gas Industry."
Table 2: "Knowledge Based Oil and Gas Industry."