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The Dynamics of the Regional Innovation around the Oil and Gas Industries: Cases of Stavanger and Aberdeen*

La dinámica de la innovación regional alrededor de las industrias del petróleo y el gas natural: Casos de Stavanger y Aberdeen

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Palabras Claves
Innovación, Stavanger, Aberdeen, petróleo, gas, *cluster*, tecnología, investigación.

Abstract
This paper presents the IRIS and MIT comparative study of the two oil capitals in Europe: Aberdeen and Stavanger, in order to analyze two successful oil and gas clusters. The Norwegian innovation system would be presented in detail. The article also examines the intrinsic role between the universities and the industrial context in the regional innovation system.

Resumen
Este artículo presenta el estudio comparativo entre las dos capitales petroleras de Europa, Aberdeen y Stavanger, realizado por IRIS y MIT, con el objetivo de analizar dos *clusters* exitosos de gas y petróleo. Se exhibe en detalle el sistema noruego de innovación. Asimismo, este artículo examina la relación intrínseca entre las universidades y el contexto industrial en el sistema regional de innovación.

Introduction

My presentation is divided in two parts; the first is a comparative study of the two oil capitals in Europe Aberdeen in United Kingdom and Stavanger in Norway. The second part is dedicated to explain how the oil and gas business is organized in Norway.

First of all is important to explain the Norwegian context. About 40 years ago Norway did not have oil or gas, so in 1969, when it was discovered in the Norwegian territory, nobody had an idea of what to do with it. Nevertheless, today it is the biggest industry in Norway and comprises:

- 21% of GNP
- 50% of exports
- 250 000 employees, a great number for a 5 million population country
- 2,1 million barrels per year
- 70 fields in production
- The 7th largest oil exporter and the 2nd largest gas exporter
- Government Pension Fund ($ 600 bill), We believe in a strong state ownership of the oil and that the industry should benefit the people of Norway, therefore that pension is going to pay for me as well when that time comes.

The Different Stories Of The Development Of The Oil And Gas Industry In Aberdeen, Uk, And Stavanger, Norway

We did the study of Aberdeen and Stavanger in collaboration of the Industrial Performance Center in MIT. This was part of the study where we examined regional development and, in particular, how regions can survive in a more globalized economy.

In geographical terms, Stavanger is located on the west coast of Norway and Aberdeen on the east coast of the U.K (Figure 1). The oil was first found in this area between Aberdeen and Stavanger and, at least when it comes to Norway, the exploration of oil is now moving north. Norway has a common border with Russia and recently we made an agreement with Russia, on the borderline. Establishing that agreement has been the problem for about 20 or 25 years.

Industrial Development Process In Oil And Gas Producing Regions

In this study we look upon the establishment of the oil and gas industry as an evolution. The first step is what we call localization, in this case is when the

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Americans move in with their oils companies, their rigs, their partners Baker Hughes, Halliburton and so forth.

The next step is the upgrading and deepening of the local competences, knowledge and technology development. When the Americans first came in with their competences and their technology, we very soon found out that their rigs did not fit in to the North Sea. The way they work did not fit in with the Norwegian way to work and so on. In consequence the rigs that they brought needed to be modified and it happens that in Norway there is a long coast full of shipyards. In the 70's the shipping industry declined and all of a sudden they had ample capacity. So they transform their shipping business into the business of modifying and making platforms, so that is one of the upgrading mechanisms.

The other one have to do with the hydropower in Norway, because for this purpose we have lots of knowledge of how concrete works with water. When we started to build the platforms they have huge concrete legs to temporarily store the oil before they could be exported. So, the upgrading and deepening of Norwegian technology and competence happened very quickly since most of the oil companies choose concrete platforms and that choice implied that only the Norwegian shipyard could make that.

Is a fact that we are now in the process of declining oil and the big problem is whether or not the whole industry will decline with the oil? This leads to two issues; one is if the possibility of internationalize the technology to other countries, because this is independent of the presence of oil. The other issue is potential of business to diversify into other businesses; in our case renewables and in particular offshore wind mills.

From this point of view we find two scenarios, one decline scenario, in the case that we do not succeed with internationalization and diversification, thus the whole business collapses with the end of the oil and leads to the delocalization of the firms. The other scenario is positive and obviously is what we want to achieve.

Similar Characteristics Of The Oil And Gas Clusters In Aberdeen And Stavanger

We a match peer comparative analysis between the two clusters, because Stavanger and Aberdeen are very similar. For that reason the differences between the two innovation systems were caused by the oil and gas business and no other factors.

As you can see, in the Figure 2, the population and the total employment in the oil and gas cluster are very similar. But there is a difference in the number of companies because on the UK they have much smaller fields than the Norwegian continental shelf. So we have bigger companies but fewer. On the Norwegian continental shelf there are about 40 operators and licensees while on UK are 116. It is very important for the innovation system that there are a large number of operators because they compete on the technology, solutions, and for the licensees given to them. Both places have global integrated service providers, companies like Baker Hughes, Halliburton, Schlumberger and Weatherford. The reason of its importance is that the global companies do research all over the world and bring in to Norway and the UK all the best technology they have, and they can use it thanks to their absorptive capacity. In view of that they create important global pipe lines for technology. Since Norwegians enjoy a high standard of education, they are able to use it..

Equally important for the innovation system is the main contractors, being

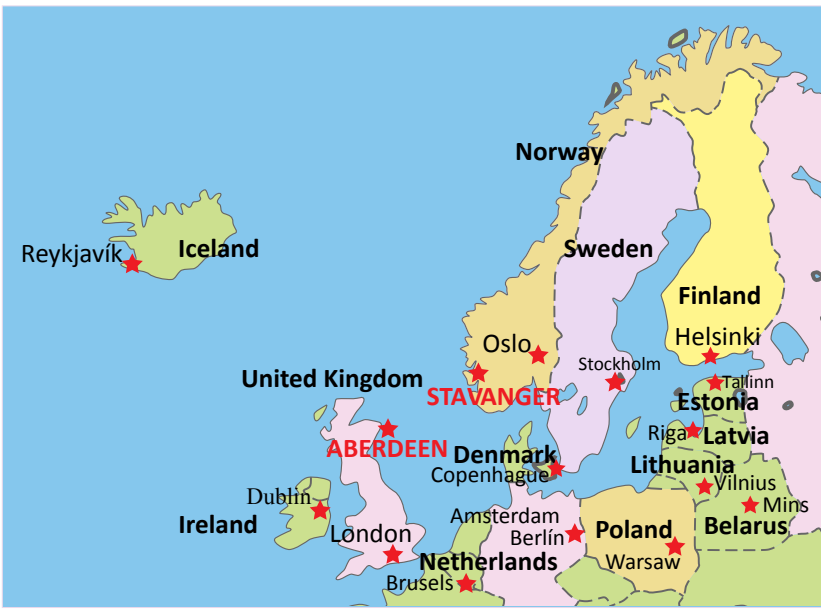


Figure 1. Geographic context

	Pupulation (city / region)	Employment in O&G cluster´s core	Total employment in O&G- cluster	Number of companies in O&G-cluster
Aberdeen	210 000/440 000	27 000	39 000	900-1000
Stavanger	200 000/390 000	26 000	37 000	500-600

Figure 2. Similar Characteristics of the Oil and Gas Clusters in Aberdeen and Stavanger

part of the main contractors means that you can develop a very good competence in project management of large contracts EPCI (Engineering, Procurement, Construction and Installation). In Stavanger we are lucky to have two or three of these huge companies because they provide a lot of jobs, they are very innovative and some of them are also global in their presence. Another reason for their significance is that they know how to execute big projects.

As well we have developed lots of local services suppliers, usually smaller businesses SMEs. In Aberdeen they have a greater number than Stavanger and again that is related to the different size of the fields.

To conclude the study, first of all is vital to say that Stavanger and Aberdeen are two very successful oil and gas clusters but for different reasons. They have very different innovation systems, which means that there is not one single best practice, in fact there are several successful practices, but all of them need to have a coherent policy, which might be different from context to context.

It is significant to see this closer. When they found oil in the UK they already had two large oil companies; BP and Shell. Both were located in London and not in Aberdeen and when a firm is located in one place it often is not too interested in moving. In addition, at that time the UK economy was rather poor; they needed the money and the jobs, so they wanted to go ahead very quickly.

On the Norwegian side there were a gradual exploration, since we did not needed the income, the government budget was on balance. On the contrary we were actually afraid of spending too much money which could trigger an inflation in Norway. Our policy included the establishment of Statoil, a national oil company, the state made licensing terms for technology transfer from the American companies to Norwegian companies, there was a very conscious localization policy and stimulation of higher education and research capabilities.

In Aberdeen the local capability-building was a secondary consideration. We see it today that even if Aberdeen is the oil capital of the UK, many of the institutions are located in other places, either in Scotland or in London, where they have the big oil companies and universities.

When we found oil we did not have a university in Stavanger, actually it was build up in parallel with the oil gas industry. There was a conscious policy in Norway to build local capabilities and attract key industrial players. After a while the UK followed the same schema but is important to bring up the reactions of the two universities in Aberdeen when they first found oil. The first reaction was that oil is dirty, that it is going to last a short time and there is no reason why academians should try to help oil companies in the first place. Now that has changed, for one thing, the oil & gas industry in the UK came to stay for a long time so they are much more engaged now than they used to be.

Martin Gjelsvik. Foto. Roger Triana

In the UK the industry is more spread around, while in Stavanger we are proud to say that we are the undisputed oil capital of Norway , the region employs about every other person engaged in that industry in Norway. In addition the university in Stavanger was built to serve the oil & gas industry. Statoil is also located in Stavanger, while even if the BP has a large activity in Aberdeen, the main office in not located there.

There has always been a high collaboration between key private and public institutions and also a very strong support from both local and national governments.

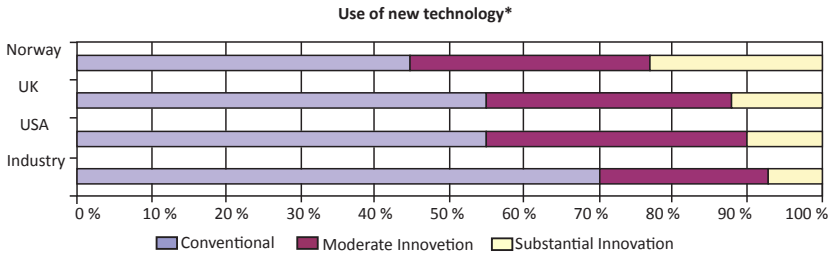
According to our studies, a technology driven innovation emerged in Stavanger and a business driven innovation system grew up in Aberdeen.

Innovation Performance Indicators

Measuring innovation is a pretty tough task. However we found an international source (Figure 3), which measures how the new technology is implemented and used. The Norwegians use more new technology than the UK and the US. The oil companies grow their income by implementing technology; they are not too interested in owning technology or in patents, while the suppliers industries live from selling the technology because they do not have oil. Notwithstanding, another very common method of measuring innovation is the number of patents. In Aberdeen doubled the number of patents of the Norwegian side. So when it comes to innovation is 1 to 1.

Similar Performance Outcomes?

Being competitive means that you have to compete also on the costs, on the Norwegian side the cost level is higher than the UK side, given that the Norwegian oil business is more unionized than on



SOURCE IPA

Distribution of patents by invertor (all US patents through June 2005)

	No. of Patents
With at least one Aberdeen-based inventor	756
With at least one Stavanger-based inventor	307

Source: US patentdatabase

Figure 3. Innovation performance

the UK side. When the Norwegian workers work offshore, on the platforms, they work two weeks on the platform and then they stay home on land for two weeks, and that is very different from the UK side.

In Norway there is a greater propensity to introduce new technology, but the number of patents indicates are larger in Aberdeen. In the internationalization both sectors have a very steep development, they export all over the world.

In diversification, there is not that much diversification into renewables in Stavanger, this is caused by the importance of the hydropower in Norway, in fact all our electricity comes from the hydropower, so there are very few incentives in Norway in going to other renewables. On the Aberdeen and Scotland side, they have invested lots of money in offshore wind and that is because they need the power and the jobs. In the UK, especially in Scotland, they have an unemployment rate of about 10% and Norway is down to 3 %.

Policy Instruments Important to Norway for Developing Regional Innovation Capabilities

It is important to stress that the two innovation systems are successful, in the meaning that they have created lots of jobs, made a lots of money of course and also help to finance the welfare systems in both countries. I am saying this because in many other oil rich countries the oil is not a blessing, it is more a curse.

In detail the oil and gas industry in Norway works in a particular way. When the oil was found the state decided that they wanted to have control of the resources and also to norwegianize the industry; to transform the industry from American based industry, to a Norwegian based industry.

I will also describe the Petroleum Tax System that stimulates innovation. When the oil companies applied for licenses in the North Sea the government approved that plan for drilling and production. Then I will explain the technology agreement and how the Norwegian institutions are built up, and how the industry and research industry work to develop a common I & D programs.

State Control – Norwegianisation

The Petroleum Act proclaims Norwegian ownership of petroleum resources. We developed licensing system and a gradual opening of the continental shelf. Now, after 40 years, lots of fields are gradually moving to the Norwegian Sea and recently appear to the Barents Sea.

Oil is always also politics, so when it comes to Norwegian policies the border with Russia did not have oil and gas development, but since we agreed with Russians on the border there are going to be lots of more fields in the Barents Sea. In addition we might take advantage of the climate changes because in this area there is ice oil around, which may be accessible if the snow is melting.

In Norwegian politics there was a clear preference to Norwegian oil companies from 1974. Statoil was established in 1972, and Statoil very soon became an integrated oil company. Now the oil companies collaborate in the licenses and the idea was of course transfer knowledge and technology from the global companies to the Norwegian companies. Similarly there has been the policy to transport the oil and gas to onshore plants in Norway, in order to expand the industry into refineries for example, petrochemicals and so forth. Additionally there are several pipelines to transport the oil and gas directly from Norway to the UK to Germany and now by boat to the US.

Build Up of National Institutions

We established a dedicated Ministry of Petroleum and Energy, in the 80's and Norwegian Petroleum Directorate. The Directorate works with the Ministry, is located in Stavanger, and has a very important role because they have a large data center, so when the oil companies want to know the status of the fields to apply for licenses they need this kind of information. The Petroleum Directorate has trustworthy information and all the oil companies have access to the same information. Of course it is up to each oil company to interpret that information, but from the start they have very similar access.

There is also a safety authority (Petroleum Safety Authority Norway) and they secure that everything is in its place; they are very tough in health, safety and environmental issues.

Statoil used to be a 100% state own company but, now that is become a public company, the state owns 67% and is listed on the Norwegian Stock Exchange and New York Stock Exchange. So they think like a private company, the state chooses the board but they do not interfere in daily business.

Petoro is a Norwegian oil company but they do not operate fields. When Statoil was partly privatize the state says well you're not allow to privatize all you're cash, so they establish another company, Petoro, to take care of what is called the state direct investments, so they take part of licenses, try to influence the group licenses to get most oil out of the fields.

Gassco runs the pipelines.
The GPFG (Government Pension Fund Global) invest all the money outside of Norway, and the politicians only can use 4% of the annual income from that fund. A rule that is very important to underline, because if the politicians really can do what they want to do they would probably spend much more money than they are able to do today.

The research institutions (SINTEF, IRIS, CMR, IFE) are found in parallel with the oil and gas industry. IRIS in Stavanger was, at first, to study the social impact of the oil and gas industry in the country, but these days they are very heavily engaged in developing technology for the oil and gas business.

Tax Regime

The oil companies have an operating income, and they can deduct the operating expenses, the linear depreciation for investments of 6 years, the exploration expenses, all R&D, and eventually decommissioning. For environmental reasons, the oil companies have to pay tax on their CO_2 and Nox emissions and they also have to pay and area fee. The last fee is an incentive for start the exploration and the production as soon as reasonably possible. Added to the precedents fees the net financial cost of deduction makes the corporation tax base which in Norway is 28% for all business. Since this is a natural resource which eventually will be depleted, there is a special tax base and special tax rate on the oil companies of another 50%. Tis adds up to78%.

Why in the world would the international oil companies come to a country that grabs your profit? Even so, the companies do lots of profit in Norway because of the huge fields. However when we talk about innovation and R&D, this actually a very good proceed because whatever the oil companies use in R&D the state actually pay 78% of the costs.

Norway has developed an infant industry policy, the state helped, very consciously, the industry to develop. That was thanks to three related propositions; the global oil companies had to make their research in Norwegian research institutions. That really helped the research institutions to get in to the business and prosper.

Technology agreements 1979 - 1994

Figure 4. Iris Ullrig

The rig in the photograph (Figure 4) is located in IRIS and is one of the two rigs in the world that is not supposed to find oil. This rig tests out the technologies of the oil companies and the global service companies.

One example of the organization of R&D development in Norway, the Ministry of Petroleum and Energy Department created a common platform called OG21, oil and gas in the XXI century. The whole industry agreed on what are the most pressing priorities when it comes to oil and gas for the future. They came up to 8 different priorities, which were later lifted into two different research programs, partly financed by the Research Council of Norway, and partly by the industry itself, so is a typical 50-50 deal. In the program PETROMAX, the aim is to maximize the recovery rate of the oil fields, so they do basic research and sponsor about 30 or 40 PhDs related to the industries. And again this is a joint partnership between the research council and the lead industry parties. The demonstration and piloting of technology have become very popular and are aligned with the agreed upon strategy.

Collaboration between the authorities and the petroleum industry

There was another initiative in the 90's when we saw that the Norwegian continental shelf had become too expensive and not competitive anymore. This was an initiative to standardize the technology, lower the costs of technology development, lower the time from the find of the oil and to the production. For that we introduced the EPCI contracts; the main contractors should enter into collaborative long terms contracts with the oil companies, if the main contractors came up with innovations to drove down the costs or drove up the income of the oil companies they have to share that added value creation.

The Norwegian recipe for developing and sustaining an oil and gas industry

I have described some of the national framework and the national institutions; we have many operators, global suppliers, strong global competition, but there is also collaboration. The combination of strong competition and collaboration has served Norway very well and also the support of R&D, with the tax regime and the Norwegian Resource Council.

A model for innovation in the oil and gas cluster

In the universities we like to think that all ideas grow from universities, later the ideas are taken into the labs, where they develop prototypes and then the commercialization of technology starts. But that is not the way it works in practice. The technology development is motivated from a problem and solution demand. In the oil sector, that demand arises from the nature resources themselves. For example, on the Norwegian coast there are deep waters, high pressure, moving up north is extremely cold, and in the winter it is completely dark so is a necessity to develop new technology. That is how it starts, the oil companies find the problems when they start to study the fields and they tell the suppliers the problem and expect them to find solutions and commercialize the oil.

The rivalry and competition have created a diversity of solutions. This is one of the problematic things in Norway right now, the fact that Statoil merged with another Norwegian oil company so there was competition, but right now Statoil runs 80 % of the production in the Norwegian continental shelf and that may stifle the innovative capacity in Norway. That is good for Statoil but is not that good for the innovation system in Norway.

The cooperation has resulted in cost-effective solutions and faster diffusion of technology. We do much of the technology development in joint industry projects, where several oil companies, research institutes and suppliers industries are involved in the same research. That implies that the results are also common, they are open to all the participants, consequently it is impossible to take out patents. Normally an innovation system works with a lot of patents, but in this case the joint industry projects help for a fast diffusion of technology, a vital point because it is the implementation of technology what really makes the difference of research.

The oil price and the gas market have provided profitability on most technology investments. The huge projects on the Norwegian shelf may be seen as very huge R&D projects, since they develop new technologies tailored to that particular field. The drawback is that tailor made solutions often get very expensive solutions, remembering that the state pay almost all the R&D. This situation brings another important dilemma; which is whether the technology can be standardized because we are talking about the technology made to be tailored to one specific field.

The roles of universities in the regional innovation system depend on the industrial context

Before I finish it is important to explain the issue of how a university may help a region to grow and to do business. To explain that, I will use the study that we made with MIT in Boston, where we arrived to a conceptual way of thinking. Another speaker told us that Colombia does not have angel business, but I think that maybe is not a necessity, because a Colombian oil region will not create a totally new oil industry.

If we talk about the new industries it is impossible not to think in Silicon Valley, the most famous example of all. In fact the establishment and development of their whole IT industry was new to the world, and to the US, for that many of the ideas came from the universities. In that order, seeing that the professors are usually poor, they realized that they needed business angels and venture capitalists. It is important to keep in mind that this is a case of completely new industry, while the oil and gas industry is old, even if is new to the region.

Equally we may talk about the diversification of an old industry into a related new. For example, go from oil and gas into renewables. The study identified four pathways to regional development.

1. Creating new industries

Talking about creating new industries the university has to:

- Be on the forefront scientifically and do engineering research.
- Be aggressive technology licensing policies to get a new technology out.
- Promote and assist entrepreneurial businesses.
- Cultivate ties between academic researchers and local entrepreneurs
- Create an industry identity.
- Convene conferences, workshops, entrepreneurs' forums, etc.

I guess that the efforts to copy Silicon Valley are in vain, because that schema works when it comes to a completely new industry but it does not work very well when is for a already existing industry.

2. Industry transplantation

In Norway we educate people from the oil industry because we want them to take part of the industry. In broad terms make industry transplantation needs:

- Education/manpower development.
- Responsive curricula towards to the industry.
- Technical assistance for sub-contractors, suppliers.
- Bridges between disconnected actors like the universities local business
- Fill structural holes.

3. Diversification of old industry into related new

For the third role of the universities in the regional innovation system we have three important points:

- Bridges between disconnected actors
- Fill 'structural holes.
- Create an industry identity.

4. Upgrading of mature industry

The fourth role is upgrading of mature industry, which depends on six central areas:

- Problem-solving for industry through contract research, faculty consulting, etc.
- Education/manpower development
- Global best practice scanning.
- Fill holes.
- Convene foresight exercises.
- Convene user-supplier forums.

To sum up: my intention was to give a conceptual frame work to think strongly about how university can help Bogotá, or in a larger way Colombia, to expand that business and industries. These four categories are ideal categories in practice there are a different combinations of them.