# The development of the Brazilian offshore oil sector, seen with a Norwegian view

Helge Ryggvik, aug. 2016*

When large amount of oil was discovered in the ultra-deep pre-salt geological layers outside the coast of Brazil late in 2006, it was a moment of joy in a country that was struggling to take final steps away form poverty to become a part of the modern developed world. At the same time the discoveries for many created a feeling of relief. Since the establishment of the state oil company Petrobras in 1953, self-sufficiency of oil was considered to be a main priority in Brazilian politics. With a landmass covering 49 per cent of South America, containing several large sedimentary basins, there had for long been reasons to expect that Brazil might have large oil resources. But even though Brazil was producing oil, the proven resources could not be compared to that of the much smaller neighboring country Venezuela. Now, suddenly, the hope was that Brazil not only could reduce its import of oil, but instead become a major exporter. Brazils political approach to its new situation has been linked to what in the oil and business literature at the time was described with terms as *oil nationalism* or *resource nationalism.*[1] This trend was symbolized with Hugo Chavez who came to power in Venezuela with a political platform where renationalization of the country's former state oil company PDVSA and stricter conditions for foreign oil companies operating in the country were central. Indeed, there were element in Brazil's approach to oil that could be linked to oil the kind of nationalistic opposition to foreign oil companies that was defined as part of the term resource nationalism. This was the case both before and after the pre-salt finds.

However, in order to really understand the essence of the Brazilian oil experience, the comparison with Venezuela is of limited help. Unlike Venezuela, the Brazilian upstream oil sector has since the 1970s predominantly been based on offshore activities. Internationally, the offshore part of the oil industry has differed from the onshore part in the sense that it has always been dependent on much greater investment in advanced technology. This was particularly the case when the industry, as in Brazil in the 1990s, gradually moved into much deeper waters. This in turn made the service firms and supply companies that delivered a large part of that technology much more important in the industry's development. And importantly, the main reference point for the change of policies that took place in the decade before and

* Researcher, Centre for Technology, Innovation, and Culture, University of Oslo. E-mail: helge.ryggvik@tik.uio.no

[1] David R. Mares, "Resource Nationalism and Energy Security in Latin America: Implications for Global Oil Supplies", Working Paper, James Baker III Institute for Public Policy, Rice University, 2010. Mark Clarke & Tom Cummins, "Resource Nationalism: A Gathering Storm?" *International Energy Law Review*.

after the first pre-salt find was neither Venezuela nor other Latin American countries with petroleum reserves. Brazil had become much more connected to the dominant centers of offshore oil technologies: the U.S. Gulf of Mexico and the North Sea. Increasingly, many of those with a stake in the development of the Brazilian oil sector were looking to Norway as an example to follow. Norway started to develop its oil sector at more or less the exact same time as Brazil. How was it that Norway during a rather short period had developed such advanced skills, while Brazil, at least according to some measurements, had failed?

In their "Natural Resources and Economic Development in Brazil", Sara M. Brooks and Marcus J. Kurtz argue that "…While there is surely some natural limit to the quantity of oil underground, proven reserves of oil and the amount produced may be more constrained by the locally-available technology than by underlying natural endowments."[2] This conclusion is interesting in the sense that it opposes the two dominant, politically influenced views which for years have dominated the debate on oil policy in Brazil.

On the one side, both on the political left and in nationalist oriented currents on the center and the right, there has been a strong support for the state oil company Petrobras dominating position. For this position the Brazilian oil sector's main problem has been pressure from outside, not at least the debt crises followed by a strong pressure to privatize Petrobras and open up the sector to foreign oil companies, giving these companies the possibility to extract oil rent which otherwise should have belonged to the Brazilian state and therefore the Brazilian people. On the other side, not at least among some of Brazils elites, the term resource nationalism fits well to summarize what tends to be described as the Brazilian oil sector's historical problem. A similar line of argument, typical for a neoliberal approach, would emphasize that the oil sector would have been larger and more efficient if governments had been willing to open up to foreign investment, instead of being over reliant on a state oil company.

Instead of discussing which of the two positions above makes best sense, this paper agrees with Brooks and Kurtz in that both the "natural limit to the quantity of oil underground" and "available technology" are indeed very important to understand the development of the Brazilian oil sector. However, the emphasis on how these factors influenced the development of the oil sector is different. Local capability can indeed important when it comes to making sure that the oil activities has general positive effect on a country's industry and economic ripple effects on the general society. But, as we will show, when it comes to Petrobras' actual capacity to produce oil the most important relationship has been the symbiosis between the dominating state oil company Petrobras and an increasingly more technologically advanced

[2] Sara M. Brooks and Marcus J. Kurtz, "Natural Resources and Economic Development in Brazil", in Ben Ross Schneider (ed.) *New Order and Progress, Development and Democracy in Brazil*, Oxford University Press, 2016.

international offshore supply industry. This becomes particular clear when we compare the development of the Brazilian offshore oil sector with the parallel development of offshore oil activities on other continental shelves and with the benefit of hindsight know where it from a geological point of view have been possible to find oil.

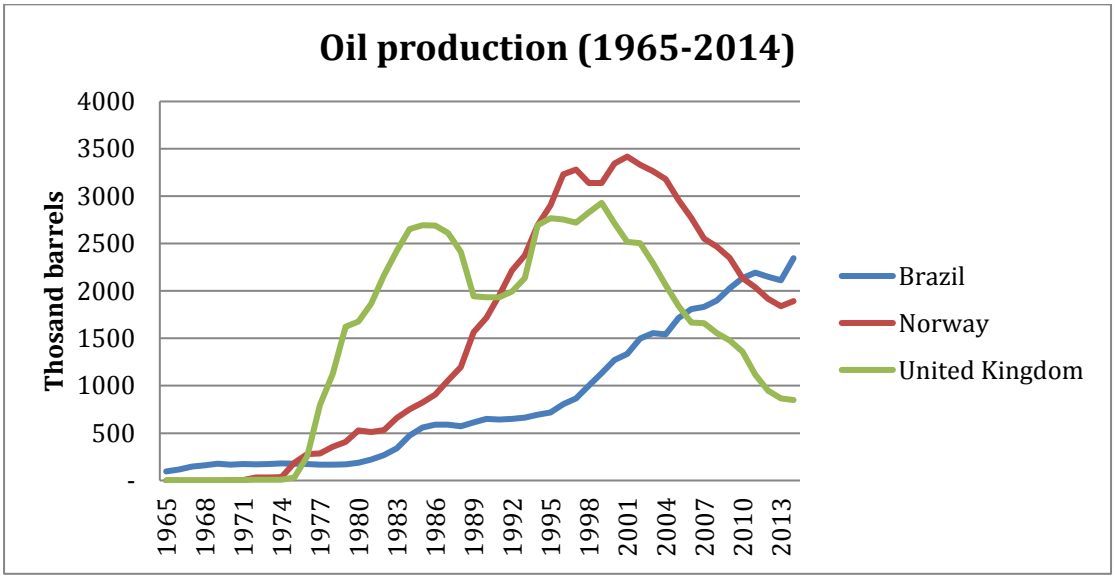
**Starting at the same time as in the North Sea**

When Petrobras was established as a state oil company under the president and former General Vargas in 1953, Brazil had a radical, nationalistic approach to oil that fitted well with the term resource nationalism that became popular in the early 2000s.[3] With Petrobras' monopolistic role both on the upstream and downstream sides of the industry, Brazil had a more statist oil policy than its neighboring country Venezuela. This remained so first under democratic governments and then from 1964 under a new period of military dictatorship.[4] Lack of significant finds in Brazils large onshore sedimentary basins contributed to an increased interest in areas outside Brazil's coast. The fact that all discoveries of oil onshore were made near to the coast had the same impact. However, when Petrobras actual started to plan for drilling operation offshore it was because international drilling companies had developed the technological capacity to do so. It was therefore no accident that the first oil drilling offshore began more or less simultaneously in the middle of the 1960s in Norway, the United Kingdom and Brazil. The breakthrough in Brazil was the discovery of the Guaricema field in 1968.[5] The oil field was located at approximately 30 meters deep, 10 kilometers from shore, in an area just north of the city Salvador. Only one year later, the large Ekofisk field was found on the Norwegian continental shelf. One year after that again, in 1970, the first major oil field was discovered in the British North Sea sector. Guaricema was a small field, but since hydrocarbons were detected and given the size of the Brazilian continental shelf, there was no reason to be less optimistic about the future discoveries in Brazil than the optimism that prevailed in Norway and the UK.

From the establishment of Petrobras, when the focus was on onshore drilling, the main political target for Brazilian oil policy was to become self-sufficient. However, those who initially hoped that offshore discoveries meant that Brazil now would reach that goal were soon disappointed. First, Brazil had to wait some years before substantial fields was found offshore. New discoveries from the mid-1970s were large enough to make the offshore dimension dominate oil activities in Brazil (Garopa, Enchova, Prago, Badejo, Namorado, Bagre, Cherne, Bonito and Pampos). The largest

[3] Boris Fausto, *A Concise History of Brazil. Cambridge University Press*, New York 1999,
[4] Laura Randall, *The Political Economy of Brazilian Oil*, Praeger, London 1993
[5] Monteiri, M. R. *Development and operation of Guaricema Field Offshore Brazil*, Petrobras 1988.

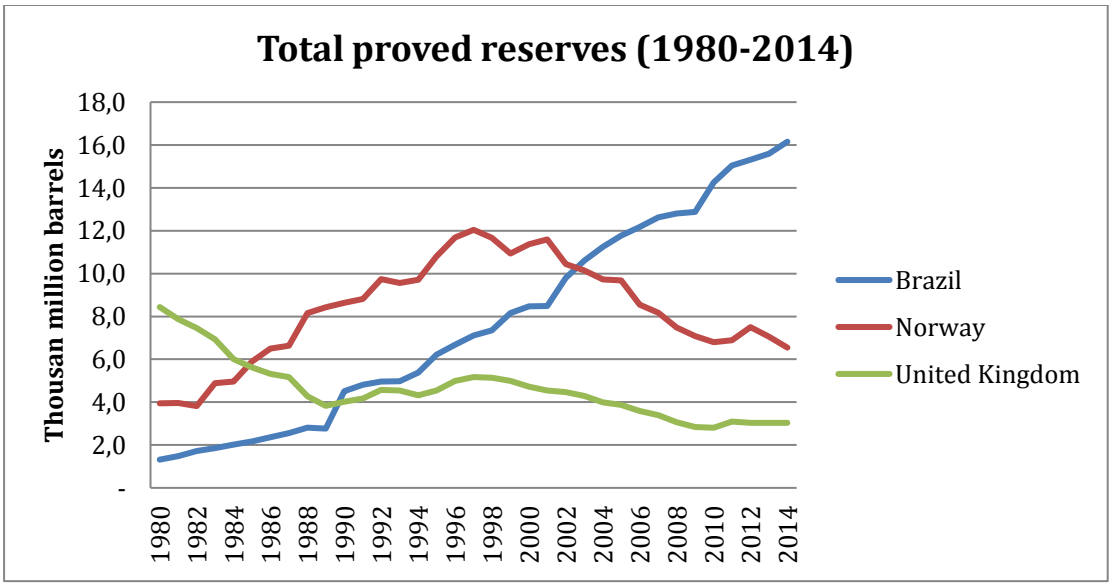
was Namorado with 250 million barrels of oil.[6] But with a fast increasing population and an even faster growth in oil consumption per capita, the subsequent increase in production was falling far behind the target of self-sufficiency. In terms of production and proven reserves, Brazilian growth was moderate compared with Norway and the UK. For most of the period between 1980 and 2000, production in the UK was four times as large as Brazil's, and in Norway three times as large.[7] Thus, in the first 35 years after drilling offshore first started in the mid-1960s, Brazil was well behind the United Kingdom and Norway.




But then came a shift. In the early 2000s production fell sharply on both the Norwegian and British continental shelf. The production in Brazilian fields continued to increase. Already in 2006, before the scope of the so-called pre-salt reserves became known, Brazil's production was larger than the UK's. In 1980 1.3 billion barrels were discovered in Brazil. That same year, the UK had proven oil reserves equivalent to 8.4 billion barrels offshore, while Norway had 4 billion barrels of proven reserves. In 2013 these figures were turned upside down. Brazil now had proven reserves equivalent to 15.6 billion barrels. Norway had 8.7 billion, while the UK, due to an intensified exploitation strategy, was left with only 3.0 billion barrels. The Brazilian figures do not include several major new pre-salt finds, since there have

[6] Craig J.Beasley, Joseph Carl Fiduk, Emmanuele Bize et. al. "Brasil's Presalt Play", *Oilfield Review*, Schlumberger 2010, p. 35.
[7] BP Statistical Review of World Energy 2014, workbook.xlsk.

not yet been any secure estimates on how big they were and how much they could potentially produce. However, a doubling of reserves has been discussed, close to 30 million barrels. In 2014/2015, after a year of oil prices falling to around $50 per barrel and a corruption scandal which has shaken Petrobras and the Brazilian oil industry to its core, there has been a new wave of pessimism. Anyhow, in the longer historical perspective, Brazil's upstream offshore oil sector can show a record of unprecedented, continuous growth.




**Industrial capacity, policy or geology?**

A superficial view on long historic production curves and yearly development of reserves in Norway, UK and Brazil surely suggest that industrial capacity and policy might be the most important factors, explaining why Brazils oil development was so slow. If one assumes the Norway and Britain was more advanced than Brazil and that Britain with its 55 million habitants compared to Norway's 4 million had a larger industrial capacity, it might also explain why Britain managed to increase its production level so much faster than Norway's. Here also policy comes in. From the mid 1970s till the late 1980, the term "moderate pace" of exploration and investments was a much-repeated headline in different Norwegian governments policy documents. The steep increase in production both before and after this policy was left behind in the late 1980s suggest that industrial capacity was more important than policy. However, the main focus in this paper is to understand the development in Brazil. To understand Brazil we therefore need to look more detailed in to the development of the dominant state oil company Petrobras, its relations to the international oil industry, the efforts to develop relevant local industrial capacity and what always is central when one analyzes development of mineral resources; geology.

**Finding oil**

When Petrobras was established in 1953 its main aim was partly to take control over and expand an already existing downstream oil industry and partly to find oil. When Brazil decided to rely on a new state oil company to find oil, not experienced foreign oil companies, it was because this was considered to be the best way to ensure that as much as possible of rent from potential finds ended up in Brazil. Secondly, in a situation when the major oil companies was suspected to control oil markets as a cartel, it was not obvious that they would have intensified exploration and development of potential oil fields in Brazil if they had had an opportunity to do so.

Even if Petrobras had the role as operator and owner, it could always open Brazil for the foreign oil industry by the backdoor, by hiring foreign firms that had the necessary equipment's and expertise to run operations. This was actually how the first drilling operations were run. The main priority, when Petrobras first developed its own upstream capacity was to establish a strong knowledge of Brazil's geology. It took some time for these efforts to bring results. Even if Brazil had an old, large mining industry, Brazilian universities at the time did not have the capacity to educate geologists.[8] In the early years a large number of geologists were foreigners. However, in the early sixties the first Brazilians took their exams in geology at local universities. Many of those soon got jobs in Petrobras. From the mid-1960s, when offshore activities took off, Petrobras had a core group of around 200 geologists.[9] This strategy of development of local content and skill in this key area when it comes to drilling of oil has paid off well for Petrobras throughout its history.

However, geologist was not the only profession that benefited from the growth in upstream petroleum sector. Both when the first offshore rigs started to drill in the 1960s and when production facilities were installed in the 1970s, one of Petrobras' priorities was to make sure that local Brazilian industry got some of the contracts. This was entirely consistent with the kind of import substitution orientation that dominated industrial policy in Brazil at the time. Brazil was known internationally at the time for its efforts to create a car industry. Less well known, but more relevant to the offshore oil sector, was the country's effort to build up a local shipbuilding industry.[10] Here, Petrobras, together with the Navy, was instrumental by ordering the building of new tankers from the new local shipyards. In this sense it was no big step

---

[8] Emilio Velloso Barosso, Josue Alves Barroso, Arthur Eduardo Diniz Gonclaves Horta, "The 50th anniversary of the Rio de Janeiro Geology course". In B. Geoco, *Petrobras*, Rio de Janeiro – v. 16, n. 2, p. 269-289, May/Nov. 2008.

[9] G. Estrelle, "Breaking Paradigms, Super-Giant discoveries in Brazil", AAPG Denver 2009, Powerpoint.

[10] Fernando Oliveira de Araujo, Paulo Roberto Tavares Dalcol, Waldimir Pirro a Longo, "Diagnosis of Brazilian Shipbuilding Industry on the Basis of Methodology for an Analysis of Sectorial Systems of Innovation", *Journal of Technology, Management & Innovation*, 2000, Volume 6, Issue 4.

to make sure that drilling rigs and productions platforms were constructed on some of the same yards.

**The first oil related local industries**

The drilling operation that led to the Guaricema offshore find in 1968 was carried out by an American company. Already in 1966, before oil was discovered offshore, management in Petrobras decided to build an offshore drilling rig locally in Brazil. The jack-up rig P-1 was built by Mecanica Psada from Taubaté and the Mauá shipyard in Niterói in Rio de Janeiro.[11] The rig had living quarters with capacity for 40 people. In retrospect, developments in Brazil and Norway at this time appear to be remarkably parallel. Ocean Traveler, the first rig that was used on the Norwegian shelf, was a semisubmersible rig built in the U.S. In 1967, however, a twin rig, Ocean Viking, was built on license at a Norwegian shipyard.

Common to both the Ocean Viking and the Brazilian P1 rig was that all drilling equipment had to be imported from the United States. When rigs were put into operation, there were also personnel from the US drilling companies that operated the drilling equipment. Although most drilling on the Norwegian shelf in the beginning was done by foreign-built rigs, Ocean Viking made history when it completed the well that proved the existence of the Ekofisk field. It was a foreign rig that proved the existence of the Guaricema field in Brazil. Nevertheless, the Brazilian build P 1-rig was in place shortly afterwards to implement several important test drillings. However, when it came to hiring special expertise, like the companies which performed engineering work, seismic services and well services, it was the same international, mainly U.S. based firms that carried out the actual work in both Brazil and Norway. For instance, one of the pioneers doing seismic surveys on the Brazilian continental shelf was the U.S. company Western Geophysical Co. Western Geophysical conducted similar geophysical surveys in the North Sea in 1965 on behalf of BP, using the same vessel and the same equipment. Other companies could also alternate the use of personnel, vessels and equipment between offshore Brazil and Norway.

Nevertheless, the starting point for Brazil was fundamentally different from Norway's in the sense that it was the national company Petrobras that was the responsible owner and operator of all activities. In Norway, foreign companies dominated as owners and operators in the first years.[12] There are no accurate statistics that make it possible to exactly compare the amount of local content in the new oil industry in Norway and Brazil. The time lag, with Norway staring an intense construction phase in the early 1970s, while Brazil had a slower start, with the first large projects in the late 1970s and early 1980s, contributes to making the comparison difficult. In the development

[11] Pesqusa, Advance under Sea. Forty years ago the P-1 was built, the first moveable Brazilian oil drilling rig.
[12] Helge Ryggvik, *Building a skilled national offshore oil industry. The Norwegian experience.* Akademika 2013

of the two first large Norwegian oil finds (Ekofisk and Frigg) Norwegian local content was low (according to a government calculation, it was 28 per cent in 1975).[13]When plattforms was constructed for the large Statfjord and Gullfaks field in the late 1970s and early 1980s Norwegian local content was much larger.

Anyhow, it appears that the local content in the first phase of the development of oil fields in shallow waters on the Campos basin in Brazil at least was as large as Norway's. Only the first of the permanent installations that was to be used in the shallow water part of the Campos basin in the late 1970s and early 80s, the Nomarando field (PNA-1), was originally built and equipped abroad.[14] The platform was built by the U.S. construction company Brown and Root at a British shipyard. Like the Ocean Traveler a few years earlier, on its way to Norway, the PNA-1 was wrecked when it was towed over the Atlantic. Both the steel jacket and deck structure for the first fixed installation Garoupa was constructed by the Petrobras-owned yard São Roque do Paraguassu-Bahia. The same yard constructed the first permanent installation for the Enchova field. For the second installation on the Namorado field, both the construction of a steel jacket and deck structure were added at the Paranagua Yard at Parana. The Paranaguá yard was also responsible for deliveries of a steel jacket for the first platform on the Cherne field. The second platform on the Cherne field was built at São Roque do Paraguassu. For the Pampo field, the steel jacket, deck structure and several modules were produced by Mendes Junior in the company's own shipyard by Panta Laje-Bahia.

The questions remains, does Brazils insistence on opening offshore activities with only the state oil company Petrobras as operator slow down the ability to discover oil? And did the early local content policy slow down the development of the fields that was found? It might seem obvious that if the only measuring stick were the discovery rate, a larger participation form foreign companies would have been an advantage. In the 1970s, unlike the 1950s, the oil majors had all reasons to intensify drilling outside OPECs sphere influence. However, it does not follow from this that Brazil with a much larger foreign participation, like Norway in its first concession rounds, would have discovered a similar number of large finds. In fact, with the benefit of hindsight, it is now possible to conclude that Petrabras was clever in finding what was possible to find in the water debt where it was possible to operate at the time. The efforts to build a local industry might have slowed down the pace of which new finds was developed. But it was not the case that there at the time was a large global industry that on short notice and with low cost could supply Brazil with all that was necessary to expande the activities in the Campos basin. Petrobras continued to use the best international expertise in the offshore supply industry in instances where it operated on the edge of what was possible. The main question both for Brazil and for Norway was whether the effort to build a local industry would develop the countries ability to strengthening the further development of its oil sector in the near future.

---

[13] Ibid. p. 53.
[14] Information aquired from SINAVAL.

**Brazil open up for international participation**

In Brazil Petrobras' dominant position was challenged in 1975 when during the former general Geisel's period as president, large areas of the Brazilian continental shelf were opened up for foreign oil companies. The initiative came precisely because no large oil fields had been found up till then. For those that wanted an opening for foreign oil companies the initiative was badly timed. It was exactly in 1975 and the following years that Potrobras had its breakthrough in the Campos basin, the area north of Rio de Janeiro that for years to come was the main oil producing region in Brazil.[15]It has subsequently been stressed that the opening for foreign oil companies only applied to a limited degree to the Campos basin. The areas that were open to foreign investment between 1975 and 1988 were areas where geological knowledge was limited. However, these areas covered a large part of the Brazilian continental shelf. In all 243 agreements with foreign oil companies in different ownership positions were signed.[16] This resulted in investments of around $1.5 billion. But apart from a gas field found by a company owned by Shell, no significant oil field was found. Actually, in the years that followed, Petrobras found some medium sized and small fields (Tubarco, Estrela do Mar, Coral), in blocks where foreign companies had had drilling rights. It also worth mentioning that the areas where the companies could apply drilling rights were the same areas where Petrobras found the large pre-salt fields in the 2000s.

**Entrepreneurs and engineers**

In retrospect, the list of construction of offshore installations in Brazilian yards from the mid 1970s to the early 1980s is impressive. However, even if Brazilian industry in particular seemed to be ahead of or par with Norway for a time when it came to the volume of new contracts, Norwegian companies were soon in positions where the strategically aim was to break into more technologically advanced parts of the industry.

On the drilling side, Norway was different from Brazil in the sense that Norway not only had shipyards, but also a large shipping industry, run by international oriented ship owners who were trained in moving flexible and fast based on the direction of business circles. When, following the Ekofisk find, it became clear that there would be a large demand for semisubmersible drilling rigs both on the Norwegian and the British continental shelf, they filled this gap in a few years. From the mid-1970s these ship-owners dominated the market for drilling rigs in the North Sea as a whole. As in Brazil they had to rely on specialized American firms to do the actual drilling. However, with their ownership control of key equipment, they had become actors that were in a good position to acquire the necessary knowledge by close-up learning.

---

[15] Adilson de Oliveira, …

[16] *Oil and Gas Journal*, "Petrobras' role in Brazil's economy disputed". 1/14/1991.

International comparisons between different national shipyards in the period conclude that productivity on Brazilian shipyards was low.[17] When the Norwegian ship owners ordered new semisubmersible rigs, many opted for the Aker H3 rig, a Norwegian developed rig based on learning from the construction of the rig Ocean Traveler. This example points to another important difference between Norway and Brazil. The Norwegian ship building industry was older and more developed than Brazil's. Norway was struggling with competition from Japan, where large investment had increased the capacity for the building of ever-larger supertankers. However, both in the shipbuilding industry and in Norwegian industrial policy in general, it had been a priority for years to strengthen engineering expertise. Hence, even if offshore installation was a new product for Norwegian shipyards, engineers at the plants soon learned to copy and improve the technology. This was more challenging when it came to large offshore production installations. Here industrial policy played a more important role. Acknowledging that engineering was a key to future technological development, the leader of Statoil, Arve Johnsen, worked hard to make sure that a Norwegian engineering firm large enough to take on the design of large offshore platforms was established. There was no similar development in Brazil.

The first generation of platforms on shallow waters in the Campos basin had many similarities with the first installations at the Norwegian Ekofisk field.[18] The depth of water was more or less the same. When Norwegian industry came in with full force on the construction side of the industry from the late 1970s on, the bulk of the activities were directed towards somewhat deeper waters (180 – 350 meters). Apart from relying on generally more solid installations the activities such depth had to rely on some extremely advanced diving. In this period the Norwegian offshore industry was supported by the same kind of protectionism that characterized Brazilian policy at the time. In fact, some of the policy even envisioned the kind of local content policy that Brazil was to introduce in the early 2000s. For a while the Norwegian ministry of industry kept statistics on local content performance related to separate field projects. However, the main focus was on the transfer and development of technology.

It is difficult in retrospect to make an accurate assessment of how far the first generations of a Brazilian offshore supply industry were from succeeding in the next phase, when Brazil - like the rest of the international offshore industry - went into deeper waters. Even if Brazil did not have a strong shipping sector like Norway, there

---

[17] Lars Bruno & Stig Tenold, "The Basis for South Korea's Ascent in the Shipbuilding Industry, 1970-1990", in *The Mariner's Mirror*, 97:3, 201-217. Stig Tenold, *Tankers in Trouble – Norwegian shipping in the crises of the 1970s and 1980s,* St. Johns, Netherlands 2006.

[18] C.T. da Costa Fraga, F. A. Borges, C Bellot, R. Beltrao, M. I. Assayag, Petroleo Brasilere S. A., "Campos Basin – 25 Years of Production and its Contribution to the Oil Industry". OTC 15219, Houston, Texas May 2003.

were examples where both traditional Brazilian owned industrial firms as well as large entrepreneurial firms went into the offshore sector and created local subsidiaries for the purpose. But unlike Norway, where the oil sector was ever-larger compared to the rest of the economy, the oil sector in Brazil never reached this relative importance as an potential growth sector compared to other parts of the economy. Typical examples might be Brazilian companies like Galvão, Etesco and Odebrecht. These were all large, established companies with a long history as contractors for major construction projects on land in Brazil. They also had an international orientation. All of them had had major building contracts for Petrobras downstream offshore activities. These ranged from the construction of Petrobras' headquarters in Rio de Janeiro to the construction of refineries. In the late 1970s and the early 1980s, they all established affiliated companies directed towards offshore oil activities.

**Crises**

It can of course be argued that the very political and economical framework in Norway and Brazil is so different that now comparison is relevant. Norway as rich developed egalitarian industrial society, whit strong democratic tradition on one side, with Brazil as an unequal newly industrial society, ran by an unelected military government on the other side. In some ways the different size of the populations make the cases more similar. With its 200 million people, Brazil could have rather advanced pocket of development, even if it did not affect the whole country. Ironically, it was in the period from the last half of the 1980s in to the 1990, when Brazil went from being a military dictatorship to again become a democratic country, the disparities between the Norwegian and the Brazilian oil sector became most apparent.

During the crises in the late 1980s and early 1990s, most of what had been the embryo of a Brazilian owned offshore supply industry either collapsed or was reduced to a minimum. The crisis was worst for the shipbuilding sector. It was here where efforts to succeed in the offshore sector had been strongest. Measured in the number of employees, the shipbuilding industry in Brazil peaked in 1979 with 39,155.[19] At this time the development of the Campos Basin accounted for a significant proportion of activity. In the first half of the 1980s the building of new ships stopped. Work related to the first generation of platforms for the Campos Basin helped to sustain activity for some more years. But when orders from the oil sector also dried up, the sector collapsed. During the decade that followed, a number of shipyards closed. An absolute nadir was reached in 1998 with 1,880 employees in the shipbuilding industry. In other words, an entire profession had been decimated.

---

[19] Fernando Oliveira de Araujo, Paulo Roberto Tavares Dalcol, Waldimir Pirro a Longo, "Diagnosis of Brazilian Shipbuilding Industry on the Basis of Methodology for an Analysis of Sectorial Systems of Innovation", *Journal of Technology, Management & Innovation*, 2000, Volume 6, Issue 4.

In Norway too there have been periods when the offshore supply industry was struggling. Typical for a period with low oil prices would be that oil companies reduced investments in exploration. This would immediately hit both drilling companies and yards that specialized in construction of offshore oil rigs. One of the challenges following a successful local content policy was that the local industry became more exposed to fluctuations in oil companies' investments.

However, if new finds and promising profitable investments were the defining factor, Brazil's industry should have been in a position to expand, not contract, in the late 1980s and 1990s. In September 1984 Petrobras found the Albacora field at 300 meters depth in the Campos Basin. The field was located at the edge of a relatively shallow part of the basin where drilling had taken place in the first offshore phase. Soon afterwards, Petrobras started drilling the full 837 meters, somewhat to the south of Albacora. Drilling at more than 800 meters represented the limits of what was possible for the most advanced platforms and drilling technology at the time. The actual work was done by a contracted foreign firm.

The drilling was interrupted at first because of technical problems, but when drilling was resumed a few months later, in February 1985, Petrobras found the Marlim field. The Albacora field had reserves equivalent to 520 million barrels. Later estimates for the Marlim field show total reserves of 2.7 billion barrels. That meant that Brazil had now fields of a size similar to the largest fields that had been discovered in the North Sea ten years earlier. It was now clear that oil production offshore in Brazil would have a future. Moreover, given that the production installations that now had to be built would necessarily be larger and more robust than previous ones, the demand for supply services and new equipment would grow. The question was whether Brazil's industry, based on lessons learned from the first phase in shallow water, was able to meet the challenges of the new phase. This new phase was the very same period when the Norwegian offshore supply industry first managed to conquer most of the different segments necessary to produce oil under challenging circumstances offshore. In several segments related to subsea activities, Norwegian companies became world leaders. With Norway's membership of the Enlarged European Area (EEA) all previous formal protectionist barriers had to be abandoned. So why did the Brazilian supply industry collapse instead of flourishing under these circumstances?

**Reasons for the collapse**

First, compared to the Norwegian offshore industry, the Brazilian industry's much weaker engineering skill became a serious drawback when the industry moved to challenging deep sea activities. Compared to Brazil, both the protectionist element of the Norwegian system and oil policy in general seem to have been more oriented towards technology transfer and innovation. With Petrobras' research facilities at CENPES in Rio de Janeiro and other initiatives, Brazil also had a policy of supporting

research and development.[20] These initiatives were active both in the 1980s and 90s.[21] Dantas and Bell who have studied how Petrobras developed knowledge networks over time show that Petrobras, from being a mere recipient of developed technology in this period, participated in an active interaction with the suppliers involved.[22] But these were mainly foreign suppliers. The incentives were not strong enough to give substantial results in the form of an independent Brazilian supply industry. Without the necessary engineering capacity and capital groups with the structures and entrepreneurial spirit to become dominant actors, there was no real bridge between this research and the actual development of the industry.

Second, Brazil's debt problems and a more or less continuous economic crisis throughout the 1980s and 1990s was a constant load on all actors in the Brazilian oil sector. When Brazil like many other New Industrialized Countries (NIC) received large loans from international banks in the late 1970s, part of these was meant to finance the development of the offshore oil sector. However, when the U.S. Federal Reserve from 1979 turned up interest rates to 10 per cent and higher, many of the countries that had received loans were caught in a classic debt trap. For Brazil with its high oil import the situation became particularly acute with the new tripling of oil prices in the aftermath of the Iranian revolution in 1979. The state kept the economy going through printing money. In this way Petrobras got sufficient investment funds for the first development of the Campos Basin. But the result was an uncontrollable inflation. In the late 1970s and the early 1980s Brazil witnessed an annual inflation rate of about 100 per cent. A sharp economic downturn in 1983 did not curb the upward pressure on prices. Later, in the early 1990s, inflation was over 1000 per cent. Such extraordinary economic problems of course created difficulties both for Petrobras as the dominant operator and the local companies that aspired to take part in the offshore market. Even if Petrobras with its well established network to world leading offshore suppliers and service firms demonstrated a surprising capacity to find oil, the continuous struggle to get enough investment certainly delayed the development of production facilities.

In the early 1990s, in the early phase of the development of the Barracuda and the Marlim fields, Petrobras went through periods where the company did not have sufficient funds to pay its own employees. The major local suppliers had similar problems, although many times more serious. Since they all were private entities they

---

[20] *Adilson De Oliveira and Diana Roa Rubiano,* "Innovation in Brazilian Oil Industry: From Learning by Using toProspective Capacity to Innovate in the Technological Frontier", in….. 2014.

[21] Andre Tosi Furtado, Saul B Suslick, Newton M Pereira, Adriana G de Freitas and Laurent Bach, "Assessment of direct and indirect effects of large technological programs: Petrobras Deepwater Programme in Brazil", in *Research Evaluation,* volume 8, number 3, December 1999, pp. 155-163.

[22] Eva Dantes, Martin Bell, "Latecomer firms and the emergence and development of knowledge networks: The case of Petrobras in Brazil." Elsevier, *Research Policy* 38 (2009), pp. 829-844.

did not have the privilege of having the support of the state. In the 1970s and 1980s there were many examples in developed countries where industries of national interest survived in difficult times as a consequence of direct or indirect support from the state. However, Brazil's dire straits left little leeway for this kind of support. So, even if Petrobras' large finds, not in the short, but at least in the medium term could create a substantial market for building concrete installations at Brazilian yards, most skilled workers at these yards were made redundant, with all the negative consequences this had for degrading expertise.

Third, there was also a strong political element in the collapse. From February 1983 Brazil had to ask for help from the IMF to solve the debt crisis. In Brazil, as in other debt ridden countries at the time, institutions like IMF and the World Bank used their strong position to promote neo-liberal economic policies. Neither the military dictatorship nor democratic elected political governments gave in to this pressure in relation to Petrobras' dominant role in the oil sector. In fact, Brazil's first democratic constitution in 1988 formalized Petrobras' monopoly. This closed the door to participation of foreign companies, which had been open from 1974. However, while Petrobras' position dominated many public controversies, the role of the supply industry did not get the same attention. So when Petrobras in the period gave most key contracts to foreign companies, this was not only a means to obtain the most advanced technology, it was also in accordance with general economic advice from the lenders at the time.

A fourth factor has to be mentioned, at least with the recent crises in the Brazilian oil sector in mind. When several shipyards went bust in the 1980s and 90s, the crises were often accelerated by allegations of corruption.[23] The most serious were the so called SUBAMAN crises. Sometimes the crises themselves contributed to expose corruption. In a period where companies could need political goodwill both from governments and capital markets to survive difficult periods, such revelations are of no help. The corruption scandal in the Brazilian oil sector, staring with revelations in early 2014 suggest that this has been a systemic dragons on the whole sector.

## The reforms

Even if the constitution from 1988 strengthened Petrobras' monopolistic position, in all the political administrations that followed immediate afterwards there was a growing perception that foreign participation would accelerate the pace of

[23] Alcides Goularti Filho, "Presença e ausência do Estado na trajetória da indústria da construção naval brasileira - 1959-1989" in *Nova Economia*, vol. 24 no. 2, Belo Horizonte May/Aug. 2014.

development of the offshore oil sector. The first president that was able to challenge Petrobras' monopoly was Henrique Cardoso. Cardoso got a strong political mandate from his success in curbing inflation.

The decisive change to the constitution in relation to Petrobras' future role was passed in Congress on 9 November 1995 from a constitutional amendment (no. 9). In addition to an opening for foreign oil companies, the resolution laid the basic foundation for the creation of a regulatory institution that removed some of Petrobras' political responsibilities. The new opening in the constitutions laid the basis for the new petroleum law of 6 August 1997 (law 9. 478/97). The 1997 law in turn laid the basis for a new concession system and the establishment of the new regulatory institution The National Petroleum Agency (ANP). Petrobras kept its strong position by ensuring its ownership of key proven oil fields. Petrobras was also ensured a 30 per cent ownership in all new concessions. But from now Petrobras had to apply for concessions like foreign oil companies.

While the 1997 reform created a whole new framework for oil companies, the most important change for the international offshore supply industry it was the Constitutional Amendment no. 6 form 1995. In the original Article 171 of the Brazilian National Constitution of 1988, Brazilian companies were defined as companies that were owned by Brazilian capital. Under the new constitutional amendment, Brazilian companies were defined as companies that were registered in Brazil with a local headquarters and local management. In practice this meant that foreign oil companies and foreign oil suppliers who set up a branch in Brazil according to the law should be treated in the same way as companies that had Brazilian owners. The change was particular important for international supply and oil services companies because it limited the governments ability to set up protectionist restrictions, at least protectionism in the old form as import substitutions or open preferences for local owned firms. This was the same change the oil sector in the North Sea had been through with the establishment of EUs internal market. Norway was formally linked to the EU internal market as a result of the EEA Agreement, with effect from 1994.

In the very first award of licenses under the new reform, the so-called round 0 in 1998, oil companies that applied for a license established a local headquarters and register as a Brazilian companies, according to the new regulations. The only provision directed towards supporting local Brazilian offshore industry was the requirement that announcements of contracts should be conducted in Portuguese. The idea was to make it easier for companies with relevant expertise to bid in competition with foreign firms. However, there was no requirement that any particular proportion of deliveries should come from companies registered in Brazil. This enabled Petrobras as well as the foreign oil companies that could now operate in Brazil to buy and rent what services and equipment they needed from the international market, without going through local branches. In practice this gave political legitimacy to the policy that Petrobras

had already adopted for the development of the deep-water Barracuda and Marlim fields.

But as early as the official round 1 in 1999, the first round conducted by the new regulatory institution ANP, the term *local content* was introduced as one of the criteria for license awards. The most important criteria were what the oil companies were willing to pay in form of a signature bonus (40 per cent) and equally importantly the scale and scope of the companies' planned drilling programs (40 per cent). But companies' commitment to "local content" should according to the criteria count for 20 per cent. Since the awards had to be based on assumptions of the size of the deliveries the companies' investments would create, it would be difficult to verify whether they would fulfill what they were committed to. However, this was a clear signal that the development of a local offshore supply industry was back on the political agenda in Brazil. In the subsequent yearly rounds 2, 3 and 4, all implemented under Cardoso's presidency, similar criteria were used.

In the first licensing round with Lula as president and Dilma Rousseff as the minister responsible, the ANP reinforced the local content requirement content in the form of specified minimums. In the 5th and 6th concession rounds, respectively 2003 and 2004, the minimum requirements for deep water oil fields were set at 30 per cent. For blocks in shallow waters the requirements were somewhat more stringent, with 50 per cent for exploration and 60 per cent for development of production installations. For onshore fields the requirement was set to 70 per cent. The new requirements got a lot of attention and were seen as a symbol of the new political direction of the incoming, left wing political administration.

However, the requirements in themselves could hardly be seen as a radical break with the directions laid out in the reforms from 1997. The requirements were first and foremost an incentive for established foreign offshore suppliers to establish local subsidiaries in Brazil. The requirements accepted the non-discriminatory core of the 1995 amendment no. 6.A. It could also be argued that 30 per cent local content was not much more than what one could expect from foreign companies without any incentive, given that geographically closeness to actual operations would in some instances be an advantage. It also has to be added that it would take time before the new formal requirements had a real effect. First, it could take several years from when a company got an award to the first drilling started. In the case of large finds it would take many years before production facilities were operative. Thus all fields that were under development in the first five years of the 2000s were fields that Petrobras had acquired before the new concession rounds.

The most important effect of the new local content requirement was that it sent a signal to suppliers that local content in the future would be considered as an important criterion to get access to the Brazilian offshore market. In the early 2000s one could observe a stream of well-known foreign offshore service and supply companies establishing themselves in Brazil. For many smaller companies this often started with

nothing more than a sales office, with the aim of expanding activities according to the contract one secured. Other companies started their activities in Brazil by acquiring small Brazilian firms. The third option, more common later, was to establish new construction capacity by so called greenfield investment.

**Supply vessels and Christmas trees, two examples**

An example of the kind of dynamic that characterized the local participation in new growth in relations to the Brazilian oil sector from the late 1990s was the building of platform supply vessels (PSV) in Niteroy, on the northern side of the Rio bay. The initiative started in 1996 when a group of small Brazilian investors bought a small part of a former shipyard that was lying idle. The purpose was in the first instance to establish a workshop that could perform simple repairs and maintenance on smaller offshore vessels. But the gradual growth linked to the development of the Campos bassin led to significant demand for supply vessels. Under the name Promar, the group got its first contract for the construction of a PSV in 1998. At this time the company employed both older experienced shipyard workers and young workers who had to be trained up. However, given the changes in the constitution from 1995 and the increased focus on local content Promar was a perfect candidate for a foreign take-over. In 2001 the Norwegian shipbuilding group Aker Yard became the majority shareholder. Aker was by far the largest Norwegian offshore supplier. For Aker the yard in Niteroy was considered as a way to get access to Brazil's promising growing offshore market.

Regardless of its motives, Aker's acquisition of Promar brought both capital, technology and human expertise to the Brazilians who already worked there. Aker Promar was regarded as a Brazilian company, although the majority of its ownership was foreign. With a growing focus in Brazil on local content, the company was well positioned for the future. Most of the numerous supply vessels used in connection with installations in the Campos Basin were owned and operated by foreign shipowners. In 1995, only 43 of the total of 168 supply vessels that were used in Brazilian fields were built in Brazil. By adding the construction of ships locally, the same shipowners could increase the "local content" in the services they offered Petrobras. Twelve years later, in 2007, the number of Brazilian vessels had risen to 100. Many of these were built by Aker Promar, who completed an average of two vessels per year.

In 2008 the yard got new owners when Aker sold out to the South Korean group STX. However, the Norwegian connection was till there because STX had acquired the Norwegian group Vard. As an example of the complex international integration of ownership and value creation in the offshore sector, Vard was singled out and bought by an Italian company. However, Norwegian engineers from Vard continued to

perform engineering activities for the construction processes that took place in Brazil. Also typical for the period was that most of the key equipment on board, like dynamic position systems, engines and propellers were imported, many of them from Norway.

Another telling example of the dynamic that took place was the local production of Christmas trees, a key installation on all subsea production wells. As an adaption to the earlier regime to promote local content, the CBV company had produced Christmas trees under license from the American company FMC from the 1960s. In the beginning the company's activities were limited to assembling parts already manufactured in the U.S. Christmas trees for onshore installations were less complex than similar installations underwater. However, CBV established a fabrication capacity. But when it came to producing Christmas trees that were to be operated at 800 meters depth without divers on the Marlim field, the company needed support from FMC. At this time FMC had bought up a Norwegian company that provided the installations with the kind of advanced steering mechanism necessary to operate the equipment from the platforms above. In 1997, with the new legislation, FMC decided to buy CMV. During the 2000s the company set up real advanced fabrication facilities in Brazil. Through these, local content in relation to sub-sea activities could be increased. However, a large part of the advanced sensors, valves and steering mechanisms that were used to operate the equipment were imported.

The growth in the Brazilian offshore supply industry in the first years in to the 2000s was real. In 2005 the number of workers in shipyards was 19,000, ten times as many as when the bottom was reached in 1997. Most of them was building offshore oil installations and vessels. There certainly was some technology transfer taking place. Nevertheless, if one categorizes the activities in terms of how technologically advanced they were, the bulk of the Brazilian activities came in on the lower steps of the ladder. It was still the case that most advanced technology came in through imports of equipment and services. Even in cases where in international supply companies performed a substantial part of construction and fabrication processes in Brazil, major engineering works usually was done abroad, most often near the companies international headquarter.

In relation to ownership the situation in Brazil was very different from the comparable opening of the Norwegian offshore market in the first part of the 1990s. As in Brazil there was a rush into Norway of foreign companies buying up Norwegian firms. The main aim was to secure positions in the Norwegian offshore market. However, there were other examples where the foreign controlled offshore supply firms in Norway became focused on export. And very differently from Brazil, while several foreign companies strengthened their position as owners in Norway, Norwegian groups acquired similar positions in other foreign markets. Norwegian firms had both the capital structures and the technology to become equal partners in the global web that characterized the international offshore supply industry. This was still not the case in Brazil.

**Pre-salt**

When in autumn 2006 the drilling company Transocean's drillship Deepwater Expedition found oil in Block BM-S-11 in the Santos basin, this was a breakthrough that would change all previous assumptions, not only for Brazil but also for that part of the international oil industry that was focused on oil production offshore. Deepwater Expedition was drilling for Petrobras who had the majority ownership in a block where also the foreign companies British Gas(BG) and Petrogal had a ownership shares. The drilling that led to the discovery was challenging enough because it started at a water depth of 2,126 meters. But to reach the oil it had been necessary to drill through a 2 km thick salt layer. The oil was located at 4,895 meters below the seafloor. This meant that the field was located 7,000 meters below sea level. The field, named Tupi (later renamed Lula), was estimated to contain 8 billion barrels of oil. Moreover, the Lula field was expected to be only one of several fields in the same geological formations. Expectations in relations to Brazil's future as an oil country soon reached unimagined heights.

To the frustration of both foreign oil companies and the international offshore industry, the new finds led to a new process of changes in Brazil's oil policy. Seen from a Brazilian perspective this made sense, both because of the new challenges the oil industry now was facing and the fact that Brazil's bargaining position towards foreign oil companies had changed substantially. From 2008 the yearly concession rounds came to a temporary halt. After an intense but rather fast political process, a new regulatory regime for pre-salt fields was established. For oil fields outside and above the salt layer the old system based in the 1997 reform would prevail more or less in the same manner as before. For the pre-salt operations Brazil moved from a licensing system to a system based on so-called Production Sharing Agreements (PSA). From the early 1990s, PSA agreements had typically been used in countries with large proven reserves, but which lacked capital and expertise to exploit these in a satisfactory manner. Two new laws in 2010 constituted a framework for the new Brazilian pre-salt regime. Law 12, 304 laid a framework for a state unit separate from Petrobras. Pre-Sal Petroleo SA (PPSA) would, in the same way as the Norwegian Petoro, have an ownership position but not operative responsibilities in large fields. Law 12.351 constituted the framework for the PSA system. The financial conditions for companies that chose to enter the PSA agreements were not resolved until the law 12.734, which was adopted in 2012.

With Petrobras being ensured the role of operator on all fields, the pre-salt system was a step back to the period where Petrobras had a monopoly position. Petrobras was ensured a stake of at least 30 percent in all producing field, like in the 1997 conseesion system. This left a large space for foreign oil companies acquiring ownership in large pre-salt fields. However, the Brazilian state could secure a

controlling 50 percent interest with the new state controlled PPSA's holdings. Through PPSA the state would virtually have a veto for all strategic decisions.

Soon after the discovery of the Lula field, several slightly smaller fields were found in the same pre-salt area (Suger Loaf, Jupiter). Then there was a period with several dry exploring wells. But when the Libra field was found in 2010, optimism reached new heights. The Libra field was considered to contain the same amount of oil as the Lula field. The international business press reflected some concerns about the risk involved in making the nesseary investment to develop the fields ready to production.[24] The extreme water and drilling depth increased cost of every segment both in the exploration and the production phase. Due to short supply of deep-water drilling rigs globally the cost of renting them (rig-rates) had increased. A main concern was how wells passing the large, relative soft salt layer would cope during a long production process. However, concerns related to risk and cost was more than outweigthed bye the size of the fields and increased oil prices. In 2009, that was before the Libra find, ANP estimated the potential reserves in the Santos basin to be around 80 billion barrels oe.[25] Since this was only estimations, not proven fields where investment decisions made soon ready for production the technical terms would be resources, not reserves. At the time Brazils oil reserves was estimated to be around 12 billion barrels. However, such optimistic estimations increased the oil fever in large part of the Brazilian society.

For the Brazilan offshore supply industry the cost estimations in relation to the development of the new fields was no big reason for concern. Quite the contrary, large investments could potentially lead to accordingly increased growth for the companies involved. With a leadership that responded well to political demand for increased local content Petrobras contributed to the optimism by presenting investment plans decades in to the future. From around 2010 Petrobras regularly presented budgets for what the company would need in terms of large units in the long term to develop the new finds. An overview of early 2012 gives an indication of the enormous scale of the planned investment. In the period between 2013 and 2020, according to the estimates, Brazil would need 88 new oil tankers, 48 new drilling rigs, 197 new supply vessels and 38 new large production units (FSPO, FPO). There were other budgets, stretching into the 2020s. Given what had become an even stronger focus on local content, the new situation created great possibilities both for those firms that were already active on the supply and service side of the industry and for potential new entrants.

One immediate response to the new opportunities was to strengthen the formalistic local content demands that were developed in relation to the 1997 reforms. In the 7th round of allocations which was completed in 2005, just before the pre-salt find, the

[24] The Economist, The next oil giant? Brazil's oil industry has big hurdels to clear. March 19th 2009.
[25] The Economist 2009, Ibid.

requirements for local content had been tightened further. From now on, companies that would operate in deep waters committed to local deliveries of 37 to 55 per cent in exploration and 55 to 60 per cent in development. The requirements for local deliveries in shallower waters and onshore were tightened accordingly. After the pre-salt find the main change was in the development of a more systematic following up of these demands. This was partly conducted by ANP, where a separate department was established for this purpose. On the company side, a small new industry was developed where auditing firms took on the role of certifiers of local content. Most important, probably, was that Petrobras under the leadership of Almir Guilherme Barbassa from 2005 had a strong focus on local content in its handling of contracts.

**A new opening for local Brazilan capital**

But unlike the period after 1997, where *Brazilization with foreign ownership* could summarize the direction of the local content policy, after the pre-salt finds there were major initiatives where Brazilian capital groups were mobilized in coordinated efforts to create Brazilian firms. The creation of SETE Brazil in 2011 was undoubtedly the most important single initiative in this respect. SETE Brazil was established and owned by a group of eight Brazilian and international banks (Banco de Brasil, Itaú, Santander, Bradescp, SMCS, City Bank, Scotiabank, Standard Chartered). In addition Petrobras had a 10 per cent ownership. The banks and Petrobras together mobilized an initial capital totaling $4.2 billion. SETE Brazil defined itself as an investment company.

SETE Brazil's main asset became a gigantic long-term drilling contract for Petrobras pre-salt, which it got in 2012. The contract had a duration of 21 years. This contract was said to have been awarded in competition with other companies. However, there was no great secret in the industry that the process from Petrobras' side was tailor-made to fit SETEs purpose. It would have been a strange behavior if Petrobras had invested a large sum in SETE, without giving the company the possibilities generate income by getting a contract. SETE had two underlying objectives. Without an operative organization there was no way the company could take on large drilling operations itself. To fulfill its obligations SETE therefore involved several foreign drilling companies, among them the Norwegian owned Odfjell and the Norwegian related Seadrill. Apart from giving SETE the capacity to fulfill its obligations, the role of foreign firms was to assist the development of Brazilian drilling companies. So, as part of its accession to SETE, Odfjell in August 2012 signed a joint venture agreement with the Brazilian partners Galvão Óleo & Gás. Odfjell's cooperation with Galvão was linked to the first part of the contract period of 5 years. A second Brazilian company, with an almost identical name was Querioz Galvão Óleo & Gás. This company had a similar agreement with the Dutch offshore company SMB Offshore.

SETE Brazil's second role was to strengthen the development of the Brazilian shipyards with the capacity to construct offshore installations. In SETE's contract with Petrobras this was formalized in the form of a guarantee of the amount of local content in the services the company provided. In practice this meant that all drilling rigs and drillships that were needed for the operations should be constructed at Brazilian shipyards. Based on orders from companies taking part in SETE Brazil, two entirely new shipyards were established (Enseada Indústria Naval and Jurong Aracruz Shipyard). Three other yards got contracts that made it possible to enlarge existing capacity (Etaleiro AtlanticiSul, Rio Grande Shipyard (ERG II), BrawFELS Shipyard). Together with other large contracts directly with Petrobras for building production installations, this laid the basis for a further massive expansion of the Brazilian offshore-related construction capacity. According to SINAVAL the number of workers employed in the shipyard sector in 2013 had reached 78. 136. The shipyards were based on joint venture-like alliances with foreign companies. Many of these companies had an Asian background, most of them Japanese. However, a new factor compared with the period after 1997 was that Brazilian capital groups came in strongly on the ownership side.

**The second crisis**

The sense of a bonanza in Brazil in the years immediately after the pre-salt finds was boosted by the fact that they were made in a period where oil prices reached a historically high level. The financial crisis in 2008 contributed to wide swings in oil prices. But in the same way as the first optimism after major discoveries in Norway in the early 1970s in the late 1970s laid the foundation for several disappointments, Brazil experienced a similar cold shower from 2014. Back in the 70s the huge investments that were needed before oil production got fully started on the Norwegian shelf led to large deficits in both the trade balance and the state budget. The establishment of a state oil company involved a financial risk for the nation. A number of bottlenecks arose at the construction sites. It often took much longer than expected to get the oil on stream. The cost was pushed stratospherically upwards. At one time many feared that even the development of the large Statfjord field would run at a loss. Norway, however, was saved by a new tripling of oil production after the Iranian revolution in 1979. In the early 1980s there was also production fully underway. Brazil was not so lucky.

The problem in relation to the investment boom in Brazil was partly an aspect of an international phenomenon. The sharp rise in oil prices from the early 2000s had led to a sharp rise in investment in all levels of the industry, which in turn pushed costs up. An important indicator for the economic situation and costs in the offshore petroleum industry is rig rates. After remaining relatively flat from the early 1990s until 2003, the rates suddenly started to rise sharply. This was especially the case for rigs operating in deep waters. An offshore rig that cost $100,000 per day in 2004 reached

rates of around $550,000 per day in 2008.[26] After a temporary decline during the financial crisis from 2008, rates reached corresponding heights in the following years. Oil fields such as Lula and Libra were so large that many had taken it for granted that they would be profitable, although the costs would be great. But it soon became clear that the lower limit for what oil prices Brazil could endure was high. Early in 2015 Petrobras stated that the break-even price for oil coming from the pre-salt fields would be around $50 to $52 when costs in relation to infrastructure were included.[27]

With the long planning horizon pre-salt reserves gave, there were rational economic arguments to defend Brazil's local content policy. Apart from economic ripple effects, in the long run a such oil related supply and service industry should have the possibility to become competitive, even as in the case of Norway, become a Brazilian export product. However, although the Brazilian shipyards invested in latest industrial mechanical equipment, it would necessarily take time to educate and orient a local workforce to compete with similar groups of Korean and Chinese shipyards. And timing was essential here. Based on the boom in both the Brazilian offshore sector, West Africa and other offshore regions, international offshore service firms increased their fleet of relevant offshore vessels rapidly. Since Asian yards were the largest, most experienced and most effective, most contracts ended up here. At least with the benefit of hindsight it is clear that this situation sooner or later would lead to an oversupply of vessels, probably without a falling oil price. The expansion of the Brazilian oil sector, both in deep-water Campos and later in the pre-salt Santos, had been instrumental in driving up international investment. When Brazil up on that growth massively increased its capacity to do major construction works locally, it surly contributed to create overcapacity internationally. If the oil prices had stayed high, and offshore vessel had been in short supply for some years to come, Brazil could hope to keep its new offshore yards active based on strict local content requirements. However, in a situation of overcapacity one could expect prices and rates to fall in the international offshore market, making foreign constructed installation and equipment and foreign services relatively much cheaper than Brazilian equipment.

Petrobras' massive investment plan created an equivalent deficit in the company's and Brazil's finances like what Norway experienced under the construction boom in the late 1970s. While Norway was saved from similar dilemmas when oil prices rose towards the end of the 1970s, Brazil experienced the opposite in 2014. In late June 2014, the price of North Sea Quality (Brent) oil stood at around $113 in the international markets. But then began a gradual decline. In August and September prices fluctuated around $90. From October 2014, however, prices plunged until they bottomed out at under $50. After a short stabilization the prices plunged again late

[26] RS Platou, Global Support Vessel, Monthly, July 2013. p. 5.
[27] http://interfaxenergy.com/gasdaily/article/14976/the-calculated-risk-in-brazils-pre-salt

2015 early 2016, reaching numbers below 30 dollars. With oil prices below $50, originally the break even limit for the development of pre-salt fields, Petrobras came under an enormous pressure to cut cost. With oversupply and falling prices on the international offshore supply and service market, the costly local content policy was one obvious target. But the result could then be a similar decimation of local competence like what Brazil experienced in the 1990s.

**Corruption**

Moreover, crises rarely come alone. That is, the corruption that was uncovered in Brazil parallel to the fall in oil prices in autumn 2014 had been going on for a long time. The revelations that now followed showed that the very core of what had been the main strategy to promote local content in the Brazilian oil sector was effected. It all started in March 2014, with the public prosecutor in Rio de Janeiro indicting the Dutch offshore company SMB Offshore for having paid employees of Petrobras to secure a contract.[28] A few days later, the former Petrobras director Paulo Roberto Costa was arrested because of his relationships with criminal money launderers. The political stake in the corruption case reached new heights when da Costa, as part of a negotiated agreement with the authorities, named a number of parliamentarians who had received financial support. Da Costa had a background in the downstream part of Petrobras' activities. Refining had been previously hit by corruption cases. The offshore part of the oil industry was most seriously drawn into the crises when in autumn 2014 it became known that SETE Brazil was involved. The case took a sensational turn when the leader of SETE Brazil between 2010 and 2013, Pedro Barusco, came forward and said he was willing to repay $100 million (!) that he had earned through corruption.[29] It turned out that key people in all the shipyards involved in the construction of offshore installations had met with top executives of SETE and agreed on a system where 1 per cent of all revenues were placed in the appropriate bank accounts. The corruption scheme had been agreed on during a meeting in Italy. Now several foreign suppliers were also under investigation (Keppel, SembCorp, Rolls-Royce).[30]

As new revelations and details emerged during 2015 it became clear that corruption was systemic. With Petrobras itself, several foreign supply and service firms and then the new Brazilian actors, almost all key parts of the industry were involved. The most vulnerable actors involved were the many companies related to SETE Brazil. Struggling in a difficult establishment phase and sinking oil prices, several of them were threatened with elimination. Particular hard hit were the new yards under construction. At the shipyard Enselada in Bahia almost all the 5,000 workers lost their

[28] http://www.economist.com/blogs/americasview/2014/03/dilma-and-petrobras
[29] http://www.nytimes.com/2014/12/08/world/americas/brazil-to-indict-key-figures-in-oil-company-graft-scandal.html
[30] Financial Times 11. April 2015.

jobs. The first really strong effort by Brazilian capital to establish thoroughly Brazilian firms in the offshore industry seemed to end up as a failure.

**Concluding remarks**

With the benefit of hindsight, knowing better which amounts of resources that have been hidden in the ground, and at the same time comparing the development of the Brazilian oil sector with in particular the parallel development of the oil sector of Norway, the first general conclusion is that

1) There is no reason to criticize Petrobras for being inefficient when it comes to the most important objective for an oil company, being able to find oil. This must partly be related to the early policy of developing local expertise in what is core knowledge for any oil company, geology. If Petrobras and Brazil were slower than Norway and Britain in developing their resources, it was because the bulk of Norway's and Britain's resources were at depths that were accessible with the actual technological expertise at the time. Petrobras found oil in pre-salt layers when the necessary technology was available.
2) However, even though Petrobras first developed its own geological competence and after a while some engineering expertise, it was never "locally available technology" that determined the reach of Brazilian oil activities. In all phases, from when drilling started offshore in the mid-1960s till today, Petrobras has developed the Brazilian oil sector in tight symbiosis with the international offshore supply and service industry. In some periods there may have been some delays, due to political crises and financial constraints. In the 1970s and 1980s, it was in the North Sea and Norwegian Sea that the industry broke the most barriers. With large finds in ultra-deep waters, Brazil has now adopted a similar position. But is the same international supply and service industry that dominated in the different places and phases.
3) The fact that it is the expertise of the international offshore supply industry that has been the main factor determining what kind of development has been possible and what has not been possible, does not mean that efforts to develop a local Brazilian offshore supply industry have been in vain or irrational. First, from a purely economic point of view, making sure that as much value creation as possible takes place locally can be important in itself form a nations point of view. Creating workplaces around offshore petroleum activities can have both purely economic ripple effects as well as raising general technological capabilities among trained workers as well as among engineers. Moreover, as the Norwegian example shows, creating a skilled local supply industry can make local industry as such itself a driving force of the further development of the industry, both locally and globally.

4) In the 1970s and early 1980s, local Brazilian industries seemed to develop in a fairly comparable speed to similar local industries in Norway. When early Brazilian initiatives either collapsed or were weakened in the late 1980s and the first half of the 1990s, this was partly due to the general economic crises following Brazil's debt problems. This again had political consequences, leaving little room for initiatives that sought to rescue or strengthen what existed as an embryo of a local Brazilian offshore oil industry. However, as we have shown, if the development of a Norwegian supply industry succeeded and Brazil's initiative in the period did not, this was also due to different historical frameworks and significant different policy emphases. While the focus in Brazil early on was more on volumes and workplaces as such, the policy in Norway seems to have emphasized much more strongly the development of technology and engineering expertise. Norway also seemed to be able to develop dynamic local firms early on which manage to combine access to new technology and mobilize necessary capital to expand.
5) With Norway's membership of the EEA from 1994 and a constitutional amendment in Brazil in 1995, Norwegian and Brazilian offshore supply companies operate within a similar legal framework in the sense that it was no longer allowed in either country to discriminate against companies based on whether they were foreign or locally owned. This was why Brazil whether under Cardoso, Lula and Rousseff had such a strong focus on local content, mainly in the form of requiring that as much as possible of value creation in foreign owned firms should take place in Brazil. This policy has in many instances increased costs. At the same time it has had the intended effect in the form of creating many workplaces with workers, engineers and other relevant occupations learning from working inside the most skilled companies in the industry worldwide. It is difficult, if not impossible, to make a final calculation how costs and revenues for such a policy add up. Increased costs are, as we have seen, a general trend in the whole offshore industry since the early 2000s.
6) However, when Brazil removed all formal protectionist barriers towards foreign owned offshore supply and service companies, this was from a much weaker starting position than Norway. When Norway opened up for foreign capital, several Norwegian companies were acquired by foreign firms. But at the same time Norway had companies that acquired foreign firms, and sometimes also established new subsidiaries in other countries. Brazil did not have firms that took part in this global web of firm structures, technology transfer and complex ownership relations. When a financial/political initiative tried to compensate for this with the creation of SETE Brazil, local drilling companies and stronger local shipyards it seemed to collapse again in 2014, partly due to a fall in oil prices and partly as a consequence of systemic corruption. It is too early to know the final outcome of this.
7) Despite all the financial constraints, political problems and corruption scandals, Petrobras in 2015 was still effective when it comes to actual

expanding of oil production. In 2014, a year with a substantial fall in oil prices, with oil from the pre-salt fields coming on stream Brazil increased its oil production by 11.2 per cent.[31] Only the U.S. could show similar growth. However, if this numerical growth creates little relief in Brazil after a year full of crises, the explanation can be found in a similar statistic. In the same year Brazil's consumption of oil increased by 5.2 per cent.[32] This was the largest growth in any part of the world outside some countries in the Middle East and Bangladesh. In the crisis year 2015 Petrobras own production continued to grow, from 2.014 million barrels per days in 2.914 till 2.128 million barrels per day in 2015, a 4.7 per cent growth.[33] However, The consumption of oil has increased by more than 50 per between the pre-salt find in 2007 and 2014. This points to the main historical problem for Petrobras and the company's finances. From the establishment of Petrobras in 1953 up until today Brazil has operated with a policy where oil for consumption has been subsidized. This policy has survived in democratic periods as well as during military dictatorships, with right and center leaning as well as left leaning governments. From the 1960s the Brazilian car industry has been an important lobby supporting such a policy.

[31] BP Statistical Review of World Energy, 2015, p. 8.
[32] Ibid. p. 9.
[33] Oil & Gas Journal, Newsletter Jan. 18 2016.