Unconventional trade-offs? National Oil Companies, foreign investment and oil and gas development in Argentina and Brazil

ABSTRACT

These are turbulent and uncertain times for the global oil and gas industry. This paper examines the industry's emerging new political economy in terms of competition (or a trade-off) both between and within International Oil Companies (IOCs) for rival oil and gas prospects. A qualitative cross-case analysis of Argentinian shale and Brazilian deep-water finds that unconventional and deep-water projects are complementary rather than competing assets of an IOC's portfolio. Further, despite the technical challenges IOCs face in developing these reserves, it is the non-technical risks and uncertainties that are more pressing for these companies and are the greater inhibitors to investment.

Keywords: Oil and gas; Foreign direct investment; political economies; Non-technical risks

Acknowledgements: This research was funded by the UK Research Councils (Grant No: EPSRC EP/L024756/1 and NERC NE/G007748/1) as part of the UK Energy Research Centre (UKERC).

INTRODUCTION

The global oil and gas industry is currently experiencing a period of significant uncertainty and disruption. The emergence of shale gas and tight oil in North America has been transformative to the industry and has played a major role in the recent decline in global oil and gas prices. At the same time, international oil companies (IOCs) are seeing the decline of access to 'easy oil' (i.e. conventional and cheap to produce), which is leading them to explore and potentially develop conventional reserves in extreme environments (e.g. Brazilian pre-salt, Arctic oil). In turn, lower oil and gas prices challenge the economic viability of such ventures, and all oil companies are operating under capital constraints. An estimated US$620 billion in projects have been cancelled or deferred through to 2020 (England, 2017).

In this new market environment, IOCs are increasingly cost conscious, and the days of investing in oil ventures regardless of energy prices (given their cyclical nature) are gone (Crooks and Adams, 2015, England and Slaughter, 2016). For reserve-holding states, the combination of the IOCs' circumspection and the growing urgency for climate change mitigation raises the spectre of 'stranded assets'. Oil-rich countries have seen their bargaining power with the IOCs eroded in an increasingly competitive market as rival oil and gas ventures, such as shale, have become viable. The rules of the game have changed, the net result of which is a new political economy that is altering the dynamic between the IOCs and the reserve-holdings states (Raszewski, 2018).

Under this scenario of constrained capital and a 'lower for longer' oil price, this paper addresses the competition for capital that may or may not exist between two prospective developments (and, more broadly, between deep-water offshore and onshore tight oil and shale gas): Brazilian deep-water 'pre-salt' resources (which reside offshore under a thick layer of salt); and shale resources in Argentina, focussed in the Vaca Muerta (Dead Cow) formation. The need for capital investment is clear in both cases. In 2010, soon after the pre-salt discovery, Brazil's national development bank (BNDES) estimated that investments of between US$150 billion and US$430 billion would be required in the Brazilian oil sector before 2027 (Almeida and Accurso, 2013). Industry experts believe between US$140 billion and US$200 billion will be required to realise the large-scale development of the Vaca Muerta (The Economist, 2014). This paper examines the interrelationships between the technical and non-technical characteristics of these resources with regards to what might deter or encourage foreign investment. The analysis also offers insight into the differences between the two countries' policies towards resource governance.

A qualitative cross-case analysis examines these sectors across several dimensions and draws on semi-structured interviews conducted in Buenos Aires, Sao Paulo and Rio de Janeiro over two weeks in November 2016. A semi-structured format for the interviews was adopted as this provided a coherence to the discussions, whilst also offering the interview subject flexibility in their response and supports and the gathering of detailed contextual information. Interviewees were selected through 'non-probability sampling', whereby subjects are "deliberately selected to reflect particular features of, or groups within, the sampled population" (Ritchie et al., 2003), and were identified primarily through documentary research. Four groups of actors were targeted: governmental actors, oil companies (IOCs, national oil companies (NOCs) and smaller national/regional operators), industry bodies and academic experts. Documentary analysis provided more detail around the areas of discussion. Once the interviews were transcribed, template analysis was used as the primary method of organising the data, which involves iteratively identifying a set of emergent 'themes' in the data, from which a narrative can be formed. It is noted for its effectiveness in examining the "perspectives of different groups within an organisational context" (King, 2004).

A total of sixteen interviews were conducted. An overview of the organisations at which these were held is presented in the table below. A final follow-up interview was conducted in the UK in January 2017 with the Deepwater Portfolio Manager of 'Operator-2 (anonymised hereafter as 'Interviewee-B'). All interviewees and their organisations have been anonymised where this was requested.

Table 1: Overview of interview subjects

<table>
<tr><th></th><th>Argentina</th><th>Brazil</th></tr>
<tr><td>Government</td><td>Ministry of Energy and Mining (MEyM)</td><td>National Petroleum Agency (ANP); Ministry of Mining and Energy (MME)</td></tr>
<tr><td rowspan="2">Oil companies</td><td>‘Operator-1’; ’Operator-2’; ‘Operator-3’; ‘Operator-4’; ‘Operator-5’</td><td>‘Operator-2’</td></tr>
<tr><td colspan="2">This includes two IOCs, one NOC and two national/regional operators.</td></tr>
<tr><td>Industry Bodies</td><td>Argentinian Institute of Oil & Gas (IAPG); Argentinian Group of Suppliers for the Oil and Gas Industry (GAPP)</td><td>Brazilian Institute of Petroleum (IBP)</td></tr>
<tr><td>Academic Experts</td><td></td><td>Rio de Janeiro State University (UERJ); University of São Paulo (USP); Federal University of Rio de Janeiro (UFRJ)</td></tr>
</table>

The paper explores three research questions:

1. What are the supporting and inhibiting mechanisms (both technical and non-technical) to foreign investment by the IOCs?

2. To what extent does competition for investment exist between conventional and unconventional resources in the portfolios of IOCs?

3. What are the policy lessons that can be gleaned from the case study countries’ approaches to resource management, including the role of NOCs in national energy strategy?

LITERATURE REVIEW

This review draws on two areas of academic research to provide the necessary context ahead of the paper’s analysis: (i) the challenge for resource holding states, including avoidance of the resource curse, establishment of NOCs and development local content requirements; and (ii) the recent changes in the global energy system and the challenges these pose for IOCs with regards to strategy and international business.

The resource curse, local content and NOCs

It is paradoxical, but nevertheless undeniable, that, on average, resource-rich nations perform worse in terms of economic progress than resource-poor nations (Auty, 2001, Rosser, 2006). This effect is known as the ‘resource-curse’ (Auty, 1993), and typically refers to fossil fuel and mineral resources, with a more specific ‘oil curse’ attributed to countries heavily reliant on the production of oil (Ross, 2012). The poorer economic performance of oil-rich nations is surprising, given the large windfall gains that can be reaped from the extraction of oil. However, there are many examples of countries that have suffered from the resource curse, such as the Netherlands (which gave rise to the term 'Dutch Disease'; Corden, 1984), Venezuela (Hammond, 2011) and Nigeria (Sala-i-Martin and Subramanian, 2013). The curse is not so much a product of an abundance of resources but rather the dependence on them (Badeeb et al., 2017).

There is compelling evidence that the resource curse can be attributed to the failure of state leaders to effectively manage a resource abundance through appropriate policies and governing institutions (Khanna, 2017). Each country possesses a unique institutional context (North, 2009); institutions being the formal and informal 'rules of the game' (North, 1992) that govern the interactions between individuals and groups. There is a strong argument in the literature that it is the quality of institutions that makes the difference when it comes to achieving economic progress through the exploitation of natural resources. Countries with strong institutions before and during the development of the resource - political stability, low corruption and political risk, effective bureaucracy, strong rule of law - tend to benefit from their resource abundance; whilst those with weak institutions are more likely to submit to the curse (Mehlum et al., 2006, Robinson et al., 2006).

The resource curse is not inevitable, and there are several cases of oil-rich nations that have avoided it. Most prominent of these is Norway, with its strong institutional framework and effective public policy and resource management approach regarded as key features of its success (Badeeb et al., 2017). Norway, and other resource-rich nations, have addressed the threat of the resource curse though policies and strategies that are focused on extending the benefits of resource extraction to other sectors of the economy. Pursuing 'local content' is a common policy response in such situations. Local content can refer to the sourcing of domestically produced materials, personnel, goods and services, and can be enforced/encouraged through contractual requirements, regulation, taxation, or incentives (such as tax breaks). It emerged in the North Sea development in the 1970s, where it was successful in creating opportunities for employment, sectoral growth and technology transfer. However, historical cases - particularly those in the developing world - illustrate several barriers to the effectiveness of local content policies, such as the availability of sufficient pools of competitive local suppliers and qualified personnel, and the technology level of the domestic industry. Further, and related to the maturity of the local supply sector, local content can raise costs, impair quality and create delays in projects (Warner, 2017).

Oil-rich nations will often further increase state participation through the establishment of an NOC. There are over one hundred NOCs globally, and they are found in almost all oil exporting and many oil importing developing countries (McPherson, 2003). They control an estimated 90 per cent of global oil reserves, 75 per cent of global production, and an estimated 60 per cent of the world's undiscovered resources are in countries in which NOCs operate with privileged access (World Energy Council, 2013).

It is commonplace for NOCs to be used to address a broad agenda of economic, social and political objectives beyond those of the sector. In fact, the ways in which NOCs are "tied to the national purpose" (Khan, 1987: 188) is a distinguishing characteristic in comparison with private enterprises in the industry. In comparison to their privately-owned counterparts, NOCs have been observed to exhibit several shortcomings. Some of these stem from their remit of both commercial and non-commercial objectives, which Stevens (2003) found can often be in conflict. For example, NOCs have been observed to prioritise employment policies over considerations of profitability (Gochenour, 1992), both over-employing and overpaying their personnel (Eller et al. , 2011). They have also been known to focus on immediate financial gains rather than long-term profitability (Hartley and Medlock, 2008); whereas private enterprises have historically had to strive for efficiency and productivity, often through investment in technology and competence building. Shielded from competition, NOCs, have tended to focus on managing the asset base that was handed to them, leading them to be less efficient and lacking in technological prowess, managerial competencies and technical expertise (Tordo et al. , 2011).

Nevertheless, there are many examples, particularly in the 'developed world', where national oil and gas industries have addressed both sectoral development and national development through fiscal, regulatory and contractual frameworks without utilising an NOC to drive non-commercial objectives. Engen (2009) describes how Norway, following the discovery of significant offshore oil reserves in the 1960s, went on to both establish itself as a force in the global oil and gas market and maximise the benefit from the development of these reserves for the broader Norwegian society. However, 'developing economies' often lack the institutional strength required to balance sectoral and national growth, leading them to rely on the NOC as a tool for policymaking. As such, the role of NOCs in developing world contexts is often linked to the resource curse.

Changes in the global energy system and challenges for IOCs

Of course, the creation and management of NOCs is only part of the picture in describing the commercial exploitation of oil resources. Where countries are amenable to their participation, IOCs pursue opportunities for oil production, either in partnership with the NOC or independently. In some countries, the participation of the NOC is mandatory. Access is granted to IOCs in exchange for a variety of payments including: bonuses, royalties, taxes and/or a share of the production. The latter is often formalised with a Production-Sharing Agreement that might also include local content requirements. This is more common in developing countries, where an IOC can address domestic shortcomings with regards to knowledge, skills, technological competence and financial capital. It is also often hoped that the presence of IOCs in the national oil sector will result in the transfer of expertise and technological prowess to domestic companies through partnerships, again, often as a result of local content agreements.

It is important to note the grey area that exists between IOCs and NOCs: some IOCs, such as BP and Total, were previously NOCs, prior to privatisation (in the UK and France, respectively); and NOCs such as Norway's Statoil (now Equinor) and Brazil's Petrobras, whilst partially-privatised, still operate in ways that support the interests of their national governments.

As noted above, NOCs now dominate both global oil production and global reserve holdings (to an increasing degree), whereas forty years ago IOCs controlled 85% of global reserves. Consequently, IOCs are being driven to consider oil prospects that in the past would have been deemed too risky, either technically or politically. For example, Chevron, Total and Shell continue to invest in Venezuela despite high levels of political unrest and uncertainty. Strategically, IOCs seek to mitigate political risks and uncertainties through the diversification of projects globally. However, this does not detract from how significant institutional contexts are to an IOC's performance in those projects (Florêncio, 2016). These same IOCs invest elsewhere in oil prospects that present unforeseen technical challenges (such as 'ultra-deep water' oil) or stray from their long-established expertise and business practices (such as shale oil and gas). And despite the pursuit of new oil ventures, these companies are struggling to replace their reserve holdings of late. For example, ExxonMobil - the world's largest oil company - has failed to replace its output for the last two years running (67% in 2015; 65% in 2016), after more than twenty years of consistently replacing at least 100% of production (Davis, 2017a).

The recent years of turbulence in the oil industry have challenged the power of the leading IOCs, the effectiveness of their long-held business model, and their competitive advantage, leaving their fate uncertain (Stevens, 2016). This section of the paper briefly discusses the key shifts in the industry and the ways in which these present challenges for the IOCs.

Having remained above US$100/bbl (per barrel) for over three years, the Brent Crude oil price crashed in mid-2014, halving within a matter of months. The crash was caused by a multitude of factors, including falling demand from emerging economies (e.g. China, Russia and India), Saudi Arabia's strategic stabilisation of production despite falling prices, and the boom of shale oil and gas production in the United States (which will be discussed subsequently). By January 2016, it reached a low of US$30/bbl. A modest recovery in 2017-18 has led the price back to above US$60/bbl (averaging US$54/bbl in 2017; Statistica, 2018) but fluctuations in the price throughout this period cast a large shadow of uncertainty over the industry. These short-term cyclical adjustments are not offering much reassurance to the IOCs as they continue to prepare for a lower for longer future by reducing debt, cutting capital expenditure and improving project returns (Malek, 2018). A lower oil price ultimately squeezes margins at a time when the IOCs are increasingly losing access to 'easy oil' (now dominated by NOCs) and thus moving towards more technically-challenging and higher-cost prospects.

In the past, IOCs could be assured that a low oil price would recover as part of a cycle of lower prices followed by higher prices. However, demand is slowing in a post-Paris Agreement world, with countries imposing controls on emissions and fossil fuel consumption, removing subsidies on oil production, raising sales taxes on oil products, and targeting the elimination of petrol and diesel cars. As such, the low oil price may not produce the sort of demand response seen in the past (Stevens, 2016). It is broadly accepted that the oil price fluctuations of the last several years are not part of the cyclical pattern of old but rather that it signals a deeper long-run structural transformation in oil demand. With slowing demand, and that demand increasingly being met by low-cost supply from NOC-led markets and unconventional resources, a price recovery of the magnitude observed in the past is unlikely. Industry experts assert that a new equilibrium price will be found - significantly under the US$100/bbl price of the early part of this decade - and IOCs are accordingly preparing for a 'lower for longer' future, with Shell even bracing itself for a 'lower forever' future and applying the mantra 'fit for the forties' (Davis, 2017b). Slowing demand also means that there is less room in the market for the high-cost, long-term projects that have dominated the IOCs' investment portfolios in the past (Maher and Mikulska, 2016).

As noted above, the shale revolution has played a significant role in lowering the oil price. However, the impact of shale - and more broadly unconventional oil and gas - on the competitiveness of IOCs extends far beyond this. The shale revolution occurred swiftly due to the unique mineral ownership rights of the United States, leading the US to a 46-year high of oil production in 2017 (EIA, 2017). Its development is notable for being driven by independent oil companies, rather than the IOCs that are now playing catch-up. This was possible due to the different profile of unconventionals compared to conventional oil and gas (in addition to the availability of lending to operators under favourable conditions). Shale development calls for a much shorter investment cycle, with relatively low upfront costs and short lead and payback times. Unconventional production is also much quicker to come online and peaks much sooner. Exploration activities are minimal, given that the location and broad characteristics of the main 'plays' are well known. The sector is much more agile - a trait that strongly reflects the nature of drilling unconventional wells - and can respond sooner to changes in price. This latter point is one of the leading arguments for a 'lower for longer' scenario, given that any increase in price can be met swiftly by an increase in shale production, and vice-versa, thereby leading to fewer, shorter and smaller price swings (Krane and Agerton, 2015).

These differences are at the heart of the erosion of the IOCs' competitive advantage and the challenge to their long-held business model. For decades, competitive advantage has stemmed from the IOCs' investment muscle, world-leading technologies and wealth of experience. In contrast, unconventional projects require comparatively modest investment, are relatively 'low-tech', and do not require the project management skills that conventional oil and gas projects do. In fact, unconventional projects require a very different approach to project management, as will be illustrated through the case studies in this paper. Any IOC considering venturing into unconventional plays will need to balance this with finding business model solutions to address capital constraints and a 'lower for longer' future, tackling the technical challenges of extreme oil frontiers, and diversifying their business models (e.g. into renewables) with slowing oil demand.

THE OIL AND GAS INDUSTRIES OF BRAZIL AND ARGENTINA

Oil and gas prospects present a lot of technical challenges and risks, and the two case studies presented here are no different. However, the significance of technical challenges in the industry can lead the significance of non-technical risks to be diluted in analytical studies (Florêncio, 2016). As an antidote, this analysis focuses on the non-technical risks posed by the development of Brazilian deep-water and Argentinian shale. However, it is first necessary to understand the nature of the resource base and technical challenges in relation to the two cases.

Quantity and characterisation of the resources

In 2007, Petrobras discovered huge offshore oil resources in Brazilian seas (termed the 'pre-salt'), estimated to hold over 50 billion barrels of oil. The oil resides beneath a thick layer of salt in a deep-water marine environment. Similar reservoirs, although rare, do exist elsewhere in the world and are usually found in shallow, warm seas. Sub-salt exploration and production presents a new technological paradigm in many technical disciplines and the Brazilian pre-salt is, to date, the only sub-salt oil and gas resource to have been explored and developed. Pre-salt production oil now exceeds over 1.4 million barrels per day and accounts for fifty per cent of Petrobras' oil production (GlobalData, 2018). The task for oil companies comes not in meeting the technical challenges posed by sub-salt oil and gas, but rather meeting them in a commercially-viable manner that also meets the demands of the state.

Argentina is thought to have the third largest shale gas reserves in the world (behind the US and China), most of which are found in the Vaca Muerta formation within the Neuquén province, which covers a territory the size of Belgium. The Vaca Muerta is estimated to hold 16.2 billion barrels of technically recoverable shale oil resources and 308 trillion cubic feet (Tcf) of risked, technically recoverable shale gas. Argentina's total technically recoverable shale resources are estimated at 27 billion barrels of shale oil and 802 Tcf of risked shale gas (EIA, 2013). The thick shale strata contain high quality, organic-rich shales, confined under high pressure. To date, productivity of wells in the Vaca Muerta has been in line with the top shale operations in the US (Wilson, 2016). Shale production in the Vaca Muerta is expected to grow by one-third in 2018 over 2017 levels, according to Wood Mackenzie (2017).

National oil companies: historical contexts and expertise bases

Petrobras was established in 1953. Whereas most global NOCs are created to appropriate rents from oil, this was not the case with Petrobras (Rocha, 2012). In the early 1950s, there was very little in terms of proven oil reserves in Brazil. From its earliest beginnings, Petrobras adopted an investment strategy focussed on technological development and competence building, which succeeded in creating one of the country's most important sectors from the ground up. Oil operators are typically characterised as having 'low R&D intensity' (Perrons, 2014). High levels of R&D investment can be observed in Petrobras since the discovery of deep-water oil resources in the mid-1980s, which led the company to venture into increasing depths in the subsequent decades (Silvestre and Dalcol, 2009). To this day, the company continues to lead and control the technological value chain in the Brazilian offshore.

Petrobras was privatised in 1997 but remains majority-owned by the Brazilian government. It is a vital contributor to the national economy, accounting for 13 per cent of total GDP in 2015 (Petrobras, 2016). It is part of Brazil's national identity and is entrenched in the country's political landscape. This has been all too evident lately as a result of the corruption scandal emerging from Operation Lava Jata in 2014, which implicated several of the country's highest government officials in corruption and money laundering allegations involving the misappropriation of billions of dollars via Petrobras. The position of Petrobras has been undermined further by the recent decline of the oil price, which calls into question the economic viability of the existing pre-salt reserves and demonstrates the conditional nature of such difficult-to-develop resources.

In keeping with the global industry, Petrobras has scaled back its investment strategy, reducing its five-year investment plan (2015-19) by twenty five per cent from the original forecast (Pearson, 2016). The company is also undergoing an assets sales programme that will oversee divestments of US$21 billion in 2018-22 (Costa and Bautzer, 2016).

The corruption scandal and the country's broader economic downturn have made Brazil an unattractive prospect for foreign investment at present. Management consultancy A.T. Kearney identified such considerations as explanatory factors for a 12 per cent drop in foreign direct investment (FDI) inflows to Brazil between 2014 and 2015 (Rapoza, 2016). However, an interviewee at one IOC currently operating in Brazilian deep-water stated that Petrobras remains an attractive partner because of its technical expertise and the two companies' long-held relationship. Interviewees from Brazil's National Petroleum Agency (ANP) similarly stated that Petrobras will continue to be a likely and desirable partner due to its expertise, technology base and strong R&D performance.

As with Petrobras, YPF is majority-owned by the national government. However, it is important to note that over the last twenty-five years the company's ownership has gone from nationalised, to privatised, to renationalised. In 1993, YPF was privatised as part of a national privatisation programme to alleviate national external debt, and natural resources, such as oil, were utilised as an 'economic resource', rather than a 'sovereign resource' (McGowan, 2011). This culminated in Spanish oil company Repsol acquiring a 98 per cent share of the company holdings in April 1999. Overall, privatisation was successful in significantly increasing YPF's oil production and capital expenditure.

The start of YPF's return to nationalisation can be traced to the period between 2008 and 2011, when an increasing share of it was incrementally acquired by the Argentine organisation Grupo Peterson, although Repsol remained the majority shareholder. During these years, YPF's domestic production declined significantly, to a point where Total S.A. surpassed it as the leading oil producer in the country, and Argentina became a net importer of energy for the first time in almost twenty years. Repsol attributed YPF's stagnation to the export and pricing controls imposed by the state (Carter, 2013). The government in turn argued that Repsol was underinvesting in YPF and increasing the dividends sent abroad; claims that Moreno et al. (2013) ably surmise were largely baseless. This would come to form the platform for the renationalisation of YPF in April 2012, which should be understood in consideration of several political, economic and market factors at the time. It was part of a nationalist movement under President Cristina Fernández, which included pledges to regain control of the Falklands Islands (Islas Malvinas), increase non-tariff barriers to trade, nationalise other Argentinian companies (including airline Aerolíneas Argentinas), and pursue 'energy sovereignty'. For the oil and gas industry, this meant greater controls and interventionism from the government, whereas prior to this, Argentina was one of only five countries in the world that could be considered to have a truly open market in which foreign and local companies competed on an even playing field (Moreno et al. , 2013). Hailed as a patriotic victory, YPF's renationalisation distracted from a number of high profile corruption scandals and the country's negative economic conditions at the time. Following the discovery by Repsol-YPF of vast shale deposits in the Vaca Muerta formation in 2010, there was clearly also great appeal in controlling these reserves and driving their development in the hope of alleviating the financial burden of costly natural gas imports.

The expropriation of YPF caused significant reputational damage and drew attention to the high levels of political risk in Argentina at the time. This is now being addressed under the stewardship of President Mauricio Macri, inaugurated in December 2015 after twelve years of populist governance. Macri is a free-market proponent and was outspokenly opposed to the renationalisation of YPF. He has introduced several economic reforms to encourage foreign investment and return the industry to an open market, which will be discussed later. This has significantly changed the relationship between the government and YPF, as was discussed with Marcos Porteau, Secretary of Hydrocarbon Resources at MEyM: "I think the previous government had more of a view of YPF being a tool for policy, and that is no longer the case. […] We see YPF as a private company with the government as a shareholder that should work under the framework of a private company" (Marcos Porteau, MEyM). This sentiment was reiterated by two business strategists at YPF. However, Argentina remains a source of political risk and uncertainty for investors. The country has a turbulent history of economic crises, the latest of which in mid-2018 brought about soaring inflation and saw the value of the Argentine peso against the US dollar reach a record low (Otaola and Bianchi, 2018).

As with Petrobras, YPF is currently operating under a significant budget cut. The company is facing up to this challenge, as well as its limitations with regards to expertise and technology pertinent to shale gas development, through partnerships with IOCs that are similarly working within capital constraints.

Contrasting business models and similar goals

The oil companies' position of constrained capital is coupled with high costs in Argentina. The cost per well in the Neuquén is 2-3 times that of a similar well in the US (Solbrække and Triana, 2016). This can be attributed to logistical challenges (including the need for all equipment and resources to be delivered by road), labour conditions and import taxation on equipment. Interviewees from several operators were asked about the leading challenges they face and a universal response was cost. This is being met by a change in business model, described as completely different from that employed in conventional oil and gas. One interviewee from an IOC described the introduction of a "new mindset": one focussed on cost reduction and increased flexibility and responsiveness. According to another, this focus on costs does not come naturally to many IOCs as it is often not a priority in traditionally high-profit offshore markets. Further, a lean approach such as this is difficult for a huge, hierarchically-structured IOC to adapt to. The heterogeneous nature of unconventional reservoirs and the need for many more wells than required in a conventional project mean that scale efficiencies are harder to achieve: "each well is a reservoir within itself" (Interviewee-A, Operator-1). This calls for a more precise, flexible and responsive approach to exploration and production. One interviewee described the "complete disaster" some European and US firms have had in trying to impose their conventional business model on small unconventional firms they acquired.

Whilst this business model differs from that of conventional resources, many of the IOCs operating in Argentinian shale have learnt a lot of valuable lessons from US shale that can be transferred. A respondent from one IOC said that the company aims to be "as nimble as an independent" whilst utilising the company's wealth of expertise. They are, in fact, utilising the same drilling and completion teams as were active in the US, with drilling being monitored in Houston and US benchmarks used to measure success in Argentine operations.

A further part of this business model is cooperation across operators, described by one interviewee as "coopetition" (i.e. cooperative competition): a notion consistent across all operators interviewed. This includes not only the sharing of data and information to improve recovery, reduce costs and find the most prospective areas (or 'sweet spots'), but also the sharing of equipment (e.g. rigs are co-owned by several operators and their design is standardised to a mutually-agreed specification).

The pre-salt, on the other hand, is being pursued through a tried and tested conventional offshore business model. Operators are similarly preparing for a 'lower for longer' price scenario by addressing the need to reduce costs. However, in this case, this is focussed on technological innovation to bring large-scale cost reductions. Shell, for example, is leading the development of a subsea factory concept, which would see the entire production process moved to the seabed and, once finalised, is expected to deliver drastic cost savings and productivity gains. This need for breakthrough technologies in "a new reality" of 'lower for longer' was similarly expressed by Antonio Guimarães of the Brazilian petroleum industry association IBP. For Shell's Chief Executive, Ben van Beurden, the Brazilian deep-water is "where the lowest break-even prices can be realised" (Leahy, 2016) - even as low as $US40/bbl (Webb and Alper, 2017) - and technological innovation is crucial for this.

As with Argentinian shale, cooperation amongst oil companies is a mainstay of this business model. Offshore projects, being much more capital intensive, require partners and it is natural that these partners collaborate in delivering such projects. One interviewee from an IOC that will soon enter the pre-salt described the mutual benefit the company and its partners (including Petrobras) were enjoying from sharing expertise and international experience, including reduced cost and increased productivity and reliability. Similarly, operators are working with their first-tier suppliers (companies that offer products and/or services directly to them) in the pursuit of technology solutions for cost reduction. One first-tier supplier in subsea technologies described a series of innovations that had resulted in reductions in cost of between thirty and fifty per cent.

Several IOCs are active in both Argentinian shale and Brazilian deep-water. Shell, BP and ExxonMobil are all examples of such and are each pursuing operatorship in Brazil now that restrictions against this have been lifted (as discussed below). They have each demonstrated an impressive discipline over capital investment and cost management in light of changing market dynamics and a lower oil price. BP operate under a mantra of 'value over volume', stating that the market will "reward businesses that can remain highly competitive at these prices" (BP, 2017). As of 2016, the company had reduced capital spend by 35% from peak levels in 2013, and controllable cash costs had fallen by US$7 billion reduction since 2014 (BP, 2017). Similarly, ExxonMobil recently reported a reduction of US$11 billion in operating costs since 2013 (ExxonMobil, 2018).

Shell emphasise a 'lower forever' mindset, focussed on lowering capital expenditure, reducing debt and improving project returns. A 2016-18 divestment programme of US$30 billion is in place and being adhered to, with further divestments of at least US$5 billion planned over the period 2019-20 (Shell, 2018a). Operating costs have fallen by more than 20% since 2014 (Shell, 2017). Capital efficiency has improved significantly, with a reported 5.8% return on average capital employed in 2017 against 3% and 1.9% in 2016 and 2015 respectively (Shell, 2018a). In 2017, capital expenditure was at less than 60% of 2014 levels (Shell, 2017). Over the same period, the company's deepwater operations delivered well cost reductions of 50%, well duration reductions of 35%, and unit development cost reductions of 48% (Shell, 2018b). Shell has also reshaped its portfolio in recent years, so as to be more resilient to lower prices and future price shocks, which includes increasing its investment in leading shale prospects, such as the Vaca Muerta.

Competition for capital exists within Shell (and other IOCs) between conventional and unconventional resources: there is currently more investment being made into conventional offshore, whereas the company's shale operations must mature to make them more attractive for investment. However, this competition occurs - as an interviewee from one IOC explained - "in a way that means they are complementary as well" (Interviewee-B, Operator-2). Whilst pre-salt requires much higher investment, is inflexible and reaps long-term gains, shale is very flexible, allowing operators to advance at their own pace, and offers returns within months, rather than years. Companies require high quantities of oil reserves in their portfolios for the foreseeable future and Brazilian deep-water satisfies this (the interviewee noted the limited opportunities globally for accessible oil for IOCs). It also builds upon the company's established competencies. Shale, however, whilst competing for capital, satisfies a different aspect of the portfolio and its flexibility is particularly attractive in a volatile price environment. Activity can be wound down under a low price and ramped up following a price recovery within a matter of months (which would take years in the conventional offshore). As such, it offers a level of resilience to operators towards potential future shocks.

> "They both make sense, both for economic reasons but also for portfolio reasons. [Operator-2] is a company that needs a mixture of things in its portfolio and in a down cycle it is handy to have short cycle projects that you can shut down and allow the company's capital programme to decline. Equally, in the up times, it is great that you have production that is on-stream and when the oil price goes up the cash that is coming in goes up immediately, which is what deep-water does" (Interviewee-B, Operator-2).

Shell's Upstream International Director, Andrew Brown, reiterated these sentiments in early 2018, stating that "[shale] gives us a balance in our portfolio where you can ramp investment up and down, [...] unlike deepwater which is quite chunky. They sit nicely together in a portfolio" (Bousso and Zhdannikov, 2018). Shell's CEO, Ben van Beurden, has similarly stated that "we need both characteristics in our portfolio. [...] They complement each other" (Triepke, 2017).

Analysis from the Deloitte Center for Energy Solutions illustrates how a balanced portfolio can strike an equilibrium between production, investment and returns: the low initial capital investment but high repeat capital of shale is balanced by the high initial capital but low repeat capital of deepwater; the high initial volumes but high decline rates of shale are balanced by the low/medium initial volumes but low decline rates of deepwater; and the high production cost variability of shale is balanced by the relatively stable production costs of deepwater (Deloitte, 2018). The authors identify a trend of IOCs remaining committed to long-cycle resources, such as deepwater, whilst suggesting the future will also see many utilise short-cycle shale resources to bolster their diversified portfolios and drive overall production ("the key missing factor until now"; Deloitte, 2018).

There is one further complementarity between these resources. There are opportunities for the competencies and technologies developed in the pre-salt to also benefit an oil company's shale operations, and vice-versa. For example, reservoir modelling is a challenge to both resource types and the development of 3D and 4D seismic technologies will prove important to the economic viability of both. Similarly, several interviewees suggested that the predictive methodology, cost efficient approach and lessons from enhanced recovery stemming from shale operations would benefit their conventional oil and gas operations.

Comparing policy frameworks

The political and institutional risks of investing in Latin America are well known. Here, we focus on how these risks manifest themselves in the dynamic between reserve holding states and foreign investors in the industry, and the impact this may have on future investment levels in the respective case study countries' oil and gas sectors given the current turbulence in the industry.

Brazil has a history of protectionism in its core industries, particularly during two periods from 1956 to 1961 and again from the late 1960s to mid-1970s (known as 'the Brazilian Miracle'). Both periods saw exceptional national growth driven by governmental interventions that controlled imports, encouraged foreign direct investment, established national champions in key industries (including Petrobras), founded a national development bank (BNDES) and promoted selected sectors (Baer and Paiva, 1997). However, a protectionist approach to governance has its drawbacks, and these periods are also notable for the huge levels of foreign debt that were accrued and the sustained hyperinflation endured. Within industry, isolated from international competition, sectors were inefficient and lacked innovative capacity (Roett, 1997). These shortcomings remain evident in Brazil's oil and gas industry today. Growth stagnated in the 1980s and gave rise to the 'New Economic Model', which moved away from industrial protectionism and would eventually lead to the privatisation of Petrobras in 1997.

The liberal market policies of the late 1990s and early 2000s attracted a lot of investment from IOCs, with Brazil only one of three countries at the time (along with the US and Canada) to offer pure concession contracts where projects could be entirely foreign and private-owned. However, the pre-salt discovery a decade later proved the impetus for a renewed faith in protectionism. A series of regulatory reforms were introduced, aimed at increasing governmental control of the industry, and particularly the pre-salt, with the objective of maximising the economic and societal benefits for the country. Auctions were halted between 2008 and 2013 as the country established its new regulatory framework, during which time, it should be noted, the shale revolution led IOCs to invest elsewhere, other attractive deep-water prospects in Africa emerged, the oil price fell dramatically, and Brazil's strong economic performance and political stability reversed. This new policy framework included enacting legislation (Federal Law No. 12.351/2010, Article 4) that ensured Petrobras was the only operator permitted in the pre-salt region and that the company must hold at least a 30 per cent minimum stake in all pre-salt projects. Just as with preceding governmental regimes, Petrobras was once again a vehicle for energy sovereignty. Protectionism of this nature, otherwise termed 'resource nationalism', is regarded as a significant political risk and has been shown to substantially destroy asset value (Click and Weiner, 2010).

Petrobras' exclusive rights were repealed by Congress in late-2016 (Bill 4567/16); however, other protectionist artefacts remain. This includes Pre-Sal Petróleo SA (PPSA), a state-owned company created to represent the government's interests in the pre-salt, which holds a majority decision-making power in all pre-salt projects, despite not contributing any capital. Florêncio (2016) discusses how PPSA's involvement in projects is a significant deterrent to IOC investment, and the author's arguments will not be repeated here for reasons of brevity. We focus instead on local content, which was identified by interviewees as a leading concern for IOCs looking to invest in Brazilian petroleum.

The Brazilian model of local content focuses on domestically sourced materials, goods and services, and is imposed on oil companies through mandatory targets. Targets have been in place since 2003, and were increased considerably as part of the 2010 regulatory reforms and made part of the public tender. At the time of our fieldwork, these targets were of significant concern. Antonio Guimarães (IBP) described a set of 64 technical areas, each with a varying percentage of local content, all of which operators must comply with or incur financial penalties. "Certainly, that model has proven not to be effective. Lots of penalties, very few developments, and you can argue how much it has helped to develop the local industry. [...] Local content cannot be a wide blanket to cover everything. [...] It's impossible. [...] The penalties are so high that they end up making some of the projects unfeasible". From IBP's perspective, local content raised two concerns. Firstly, there was a lack of focus on supply sectors that present real opportunities for growth in the country. Tordo et al. (2011) emphasise the importance of focussing on a country's existing strengths and areas with the highest potential for growth with any local content intervention. Secondly, the price inflation and delays associated with using Brazilian suppliers and/or the penalties resulting from not using Brazilian suppliers were significantly challenging the economics of projects. Industry experts estimate that local content has led to cost overruns as high as 50 per cent (Chauhan et al. , 2014), whereas fines for local content breaches often reach tens of millions of US$ (e.g. BG Group's US$71 million fine in early 2015). This was regarded as a serious risk to attracting IOC investment.

Nevertheless, the IOCs we spoke with were not opposed to local content per se, but rather the form of local content Brazil had chosen to enact. As an interviewee from one IOC explained: "local content is good because once you are in a country you need to have local support for your operations. There is a lot of value in developing the *right* local content" (Interviewee-C, Operator-2). The industry, along with IBP, has long been pushing for a new model of local content in Brazil. Whilst a reduction of the mandatory targets (and number of technical areas that must be addressed) was identified as being of grave importance, there was also a lot of support for the introduction of incentives to increase the participation of Brazilian suppliers (including the creation of joint ventures).

The need for a new approach to governance and regulation was apparent following the 13th concession bid round in Brazil in late 2015, when participation fell well short of expectations. Of the 266 blocks on offer (182 onshore and 84 offshore), only 37 received bids (only two of which were offshore), and all major IOCs and NOCs (including Petrobras) withdrew from placing bids. Mr. Guimarães described this "appalling" outcome as a response from the industry to the unattractive environment for investment.

Changes to the local content model were enacted in late-2017 in preparation for the 14th concession bid round in September 2017 and two further auctions of pre-salt blocks in October 2017. This was aimed at reducing state involvement in the industry and boosting competition. Of the changes enacted, local content was removed as a criteria in the bid rounds, the dozens of technical areas were reduced to five broader sub-groups, and the targets for these sub-groups were set at a more-realistic 18% in the exploration phase and between 25 and 40% in the development phase (depending on the sub-group; ANP, 2017). Incentives were also introduced to increase the participation of small and medium-sized companies, reduce royalties for new frontier areas and mature basins of greater risk, and grant companies more freedom and greater flexibility in negotiating with suppliers (Powell, 2017).

The pre-salt auctions - the first since October 2013, and the first opportunity for companies other than Petrobras to acquire blocks as the operator - were a success. Consortia of various NOCs and IOCs, including Shell, ExxonMobil, Equinor, BP and Total, were successful in acquiring six of the eight pre-salt blocks available. Three of these successful bids included Petrobras; the company maintains its right to choose in advance which pre-salt blocks it wants to operate with a minimum 30% stake.

The 14th concession round was also deemed a success, with ExxonMobil paying a record US$700m for one block (with joint partner Petrobras): a record in a South American country, and signalling the company's return to Brazil after halting drilling in 2012 following disappointing results. The round raised a total of US$1.2 billion in signature bonuses, which ANP reported as the largest for a single bid round for the country (Davies, 2017). However, of the 287 blocks available, only 37 were acquired: the government had hoped to sell up to 40% (Alper and Gaier, 2017). The two pre-salt rounds raised a total of US$1.8 billion in signature bonuses, falling some way short of the US$2.3 billion that it was hoped all eight blocks, if sold, would have raised (Schipani, 2017).

A 15th concession bid round (comprising onshore, offshore deepwater and offshore pre-salt blocks) was run in March 2018, which attracted a record breaking US$2.4 billion in signature bonuses, vastly exceeding the US$390 million the government had thought the round would raise (Wood Mackenzie, 2018). It was described by ANP as having "surpassed all expectations" (Guthrie, 2018). Twenty-two offshore blocks were acquired of the forty-seven offered, which included acquisitions from Chevron, Repsol, Shell, BP and Equinor. ExxonMobil again broke the record for a single block, paying US$844 million as part of a consortium with Petrobras and Qatar Petroleum (the latter's first foray into the pre-salt). Industry analysts attributed the round's success to a combination of improved oil prices and the country's recent regulatory improvements (Wood Mackenzie, 2018).

The Argentinian government, by comparison, has introduced several investor-friendly initiatives aimed at attracting IOC investment. In mid-2013, the 'Investment Promotion Regime' was established, which offered benefits to IOCs investing at least US$1 billion in Argentinian oil and gas projects, such as tax-free exportation of up to 20 per cent of the extracted hydrocarbons from the fifth year of a project. In October 2014, the 'Hydrocarbons Reform Law' was passed, which, along with updating and unifying the regulation, taxation, permitting and concession processes for Argentina petroleum, offered further incentives to boost exploration and development activities and attract foreign investment. The law applies a 25 per cent reduction in the royalty payments due from operators of unconventional oil and gas production in the ten years following the pilot-test period. Further, it lowers the limit at which IOCs can access the Investment Promotion Regime to US$250 million.

Recent reforms are succeeding in attracting sizeable investments from the world's leading IOCs. Following President Macri's inauguration, the country's long-held inhibitive currency controls (which included the requirement for exporters to convert foreign currency to Argentinian pesos and prohibited the expatriation of oil revenues) were removed, and import and export controls relaxed. However, heavy taxation (taxes currently account for 50-60 per cent of rents for IOCs), production and demand subsidies, and the use of price controls have so far endured. These were identified by interviewees from several operators and industry associations IAPG and GAPP as inhibitive to investment.

The Ministry of Mining and Energy (MEyM) - created by Macri as part of his Economic Cabinet - has been tasked with reducing subsidies, reorganising the industry's regulatory framework and redesigning its governing policies. Two interviewees from MEyM acknowledged the push for market liberalisation and deregulation but stated that the transition would take several years. Such a move will face considerable opposition from the public, unions and provincial governments. Interviewees from operators similarly recognised the importance of deregulation to increasing activity in Vaca Muerta but that, given the preceding decade of heavy regulation, this will not be a quick process. The deregulation of pricing in particular - which is often referred to as a major turning point for the scaling up of US shale (Accenture, 2014) - was a request of interviewees from three operators:

> "No international oil company wants to be government dependent. […] The moment they deregulate and base their price system on an international price […] companies will come because they can somehow foresee what is going to happen and not […] fear that some subsidy paid to them will be eliminated. This will be tremendously important for this industry. And as long as this does not change I do not think that companies will strongly invest in Argentina" (Interviewee-D, Operator-3).

Another interviewee from an IOC echoed this statement by highlighting the disparity between the vast acreage that has been acquired by the industry's leading names and the very modest activity to date. Since the drilling of the first well in the Vaca Muerta in late 2010, there were only 560 producing wells as of the end of 2015. The Eagle Ford shale play in the US, by comparison, saw over 16,000 wells brought to production between 2008 and the end of 2015 (Gomes and Brandt, 2016). The interviewee stated that all operators are waiting on clear fiscal, regulatory and pricing frameworks to guide long-term investment decisions.

Some of the IOCs' concerns were allayed in January 2017 as the government extended a price subsidy on natural gas, scheduled to end in 2017, through to 2020 and reduced the sector's labour costs and contract inflexibility in exchange for increased investment. Several IOCs and YPF duly pledged to invest a combined initial US$5 billion in early-2017, with the goal of increasing this to US$15 billion a year by 2018 (Mander, 2017).

Finally, it should be noted that Argentina has a problem not only with instability when it comes to natural resources policy, but also its credibility. In 2011, tax breaks amounting to US$461 million were offered to oil and mining companies but were later withdrawn and the companies ordered to repatriate the export revenue from the previous year and convert it to Argentine pesos (Mares, 2013a). When Repsol-YPF resisted, the government halted the company's exports until it paid the export debt. Repsol-YPF would later claim this resulted in eight potential partners in Argentinian shale terminating their interest (Mares, 2013b).

Summary

Each interviewee was asked to list the main challenges and strengths that the Brazilian pre-salt or Argentinian shale reserves present. By way of summarising this dataset, these are presented in Table 2 in the form of a SWOT analysis.

Table 2: SWOT Analysis of Argentinian shale and Brazilian pre-salt

	Argentinian Shale	Brazilian Pre-salt
Strengths	Technical: • Quality and size of reserves • Surplus infrastructure in Neuquén • Favourable production conditions • Availability of natural resources (e.g. water) • Production flexibility and competitive OPEX • Regional topography Non-technical: • Governmental relations and support • Existing legal framework • Domestic demand • Community acceptance and low population • Availability of human resources • Labour unions (particularly training of HR) • Strong domestic service sector	Technical: • Quality and size of reserves • Production rates • Reliability and well construction • Cost base (US$6-7 lifting cost/bbl) • Economies of scale • Existing infrastructure Non-technical: • Strong domestic service sector • Public acceptance (vs. fracking) • Political will

	Argentinian Shale	Brazilian Pre-salt
Weaknesses	Technical: • Low productivity (although improving) Non-technical: • Control of labour unions • High manning requirements and inflexible working practices • Modest domestic knowledge and expertise bases • Environmental policies and regulation • Tax regime • Pricing framework • Customs and importation (slow and costly)	Technical: • Engineering challenges - metocean, depths, salt layer, contaminants, distance from shore • Underdeveloped downstream Non-technical: • Local content • Labour conditions • Fiscal regime (Repetro) • Tax regime (inc. state taxation on oil revenues) • Domestic equipment/ technology markups • No specific environmental regulation for pre-salt
Opportunities	• Domestic energy self-sufficiency • Utilise industry's spare capacity • Develop sand production to support hydraulic fracturing	• Develop high-tech domestic service sector • Utilise associated gas (historically regarded as a problem)
Threats	• Community engagement • Public acceptance (fracking) • Governance and regulation uncertainties • Future water supply • Future infrastructure deficit	• Global oil price • Gas may be bottleneck for oil production • Gas management and treatment • Ongoing corruption scandal • Safety/environmental considerations

Both Argentinian shale and Brazilian pre-salt offer challenges to the IOCs. In Brazil, considerable investment in new technologies is needed to deliver pre-salt oil at a breakeven that makes it economically viable. In Argentina, business model innovation is required to better suit the nature of the shale resources and achieve scale economies. Interviewees in Brazil and Argentina clearly recognise the sizeable task at hand in delivering this. However, these are consistently not the type of challenges that IOCs list as their primary concerns. Rather, it is the non-technical risks and uncertainties that the respective investment climates present that are considered most pressing. Whilst IOCs are both familiar with, and adept at, managing such concerns, in a cost conscious and capital constrained industry the extent to which these act as a disincentive to investment is heightened.

There are two constraints in both case studies in this regard. The first is the level of intervention by the government. For a long time, Brazil believed that the pre-salt was such a geologically-attractive prospect that IOCs would accept any and all requirements placed on them. They have since come to realise this is not the case, and by alleviating some of the interventionism imposed of oil companies they have had some success in securing investment. The results of the 15th concession round highlight the need for an attractive fiscal regime and regulatory framework in order to secure large-scale funding given the industry's current investment climate.

The second non-technical constraint is the level of uncertainty. This is perhaps best illustrated by the pricing subsidies offered by the Argentinian government, which, as discussed above, have been renewed until the end of 2020. In announcing the agreement, President Macri stated "we have to give guarantees and provide certainty in order to attract investment" (Misculin, 2017). Whilst this has been met with an increase in investment, it only addresses the problem of uncertainty in the short-term. The pricing subsidies were brought up by several interviewees, none of whom called for the subsidy to be renewed, but who wanted an end to the uncertainty around the subsidy. The Brazilian government also recognises that mitigating uncertainty is a challenge: "the most unattractive issue as of today is the unpredictability" (João Vicente de Carvalho Vieira, MME). Brazil's recent success is somewhat clouded by a general election approaching that could again change the political landscape and revive resource nationalism. One leading candidate, Ciro Ferreira Gomes, has pledged to expropriate the oil fields from recent auctions, whilst the spectre of contract term changes and fewer auctions from a change of leadership also looms (Guthrie, 2018).

The recent history of both countries and their changing motivations for their respective oil and gas industries and NOCs demonstrates large policy swings. The IOCs have had to operate under constant policy uncertainty. Looking ahead, in this new political economy, mitigating policy and regulatory uncertainty is paramount to securing the investment needed to turn the respective resources into proven reserves and output.

CONCLUSIONS AND POLICY IMPLICATIONS

Under the current environment of a 'lower for longer' oil price, national and international oil companies are operating under a position of constrained capital. At the same time, with access to 'easy oil' projects for IOCs all but exhausted, these companies are turning to prospects that offer considerable new technical risks. However, despite the technical challenges the IOCs face, it is the non-technical risks and uncertainties that are more pressing for these companies and, we conclude, are the greater inhibitors to investment.

Whilst both governments have instilled changes to their respective investment environments, the Brazilian pre-salt and Argentinian shale are yet to secure the levels of investment needed to secure the large-scale development of these resources. In Brazil, the recent signs are positive but there is a need for stability in the coming years in order to deliver on the pre-salt's potential. In Argentina, whilst the list of IOCs present in the shale is impressive, investment and activity in the Vaca Muerta has been modest to date. It is clear that today - under a low oil price and constrained capital environment - attractive geology is not enough to secure large-scale investment from IOCs. Clearly there is a bargain to be struck between the requirements of the IOCs and the aims of the resource-holding states, but national governments must work to mitigate non-technical risks, which, we have shown, take the form of both interventionism and uncertainty. A regulatory framework and fiscal regime that are predictable, transparent and stable is critical to realising the potential of these resources and securing the investment from IOCs required to develop them for the enrichment of wider society.

Finally, to the issue of whether Argentinian shale and Brazilian pre-salt are currently competing for capital as two of the industry's leading global prospects - and, by extension, whether deep-water and tight oil and gas projects compete. With capital constrained, they compete within each company, but not in a manner that one could substitute for the other. Deep-water and tight oil and gas offer different strengths and satisfy different components of an IOC's portfolio. Deep-water is high investment and inflexible but this is offset by its long-term gains and high oil content. Shale is flexible, offering a freedom to operators to increase or decrease production in response to the market, and also offers returns within months, rather than years. In this regard, they complement one another. However, national governments must be cognisant that a competition does exist between similar resources (e.g. between pre-salt and African deep-water). Regardless of whether investment in oil and gas is considered a basis for sustainable economic development, the reality is that global competition for investment from IOCs is high in the current capital constrained world, and this competition comes from countries with different contractual mechanisms, political risks and regulatory frameworks. This again underlines the significance of non-technical risks and the need for national governments to mitigate these should they wish to secure such investment. In sum, the current constraints facing the IOCs are serving to reduce the ability of the national governments and their NOCs to dictate the terms of entry for foreign investors.

BIBLIOGRAPHY

ACCENTURE. 2014. Reimagining Argentina: An Unconventional Look Towards 2035 [Online]. Accenture LLP. Available: https://www.accenture.com/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Digital_3/Accenture-Reimagining-Argentina-An-Unconventional-Look-towards-2035.pdf [Accessed 12th December 2016].

ALMEIDA, E. L. F. D. & ACCURSO, V. 2013. Government take e Atratividade de Investimentos na Exploração e Produção de Hidrocarbonetos no Brasil. Discussion Paper 002/2013. GEE/UFRJ.

ALPER, A. & GAIER, R. V. 2017. Exxon Mobil bets on Brazil, buys 10 oil blocks in auction [Online]. Reuters. Available: https://www.reuters.com/article/us-brazil-oil-auction/exxon-mobil-bets-on-brazil-buys-10-oil-blocks-in-auction-idUSKCN1C22UY [Accessed 28th September 2017].

ANP. 2017. Brazil Bidding Rounds 2017 [Online]. Agência Nacional do Petróleo, Gás Natural e Biocombustíveis. Available: http://www.anp.gov.br/wwwanp/images/palestras/OTC/2017_OTC_Brazil%20Bidding_Rounds_Eliane-Petersohn.pdf [Accessed 12th November 2017].

AUTY, R. M. 1993. Sustaining Development in Mineral Economies: the Resource Curse Thesis, London, Routledge.

AUTY, R. M. 2001. Resource abundance and economic development, Oxford, Oxford University Press.

BADEEB, R. A., LEAN, H. H. & CLARK, J. 2017. The evolution of the natural resource curse thesis: A critical literature survey. Resources Policy, 51, 123-134.

BAER, W. & PAIVA, C. 1997. Brazil. In: RANDALL, L. (ed.) The political economy of Latin America in the postwar period. Austin, TX: University of Texas Press.

BOUSSO, R. & ZHDANNIKOV, D. 2018. In the deepwater versus shale oil contest, Shell backs both [Online]. Reuters. Available: https://uk.reuters.com/article/uk-shell-oil/in-the-deepwater-versus-shale-oil-contest-shell-backs-both-idUKKCN1G41UJ [Accessed 10th June 2018].

BP. 2017. BP Strategy Update [Online]. BP. Available: https://www.bp.com/content/dam/bp/en/corporate/pdf/investors/bp-strategy-update-2017-bob-dudley-presentation.pdf [Accessed 4th July 2018].

CARTER, J. 2013. Profiting from Argentina Oil and Gas Incentives [Online]. Energy and Capital. Available: http://www.energyandcapital.com/articles/profiting-from-argentina-oil-and-gas-incentives/3635 [Accessed 4th December 2016].

CHAUHAN, V., MOURIK, M. V. & FLORÊNCIO, P. 2014. Challenges across Brazil's oil sector and prospects for future production. Oxford Institute for Energy Studies (OIES).

CLICK, R. W. & WEINER, R. J. 2010. Resource nationalism meets the market: Political risk and the value of petroleum reserves. Journal of International Business Studies, 41, 783-803.

CORDEN, W. M. 1984. Booming Sector and Dutch Disease Economics: survey and consolidation. Oxford Economic Papers, 36, 359-380.

COSTA, L. & BAUTZER, T. 2016. Petrobras sells $587 mln in assets, misses two-year target [Online]. Reuters. Available: http://www.reuters.com/article/petrobras-divestiture-idUSL1N1EN13T [Accessed 14th February 2017].

CROOKS, E. & ADAMS, C. 2015. Oil companies seek lasting cost cuts after crude price plunge [Online]. Financial Times. Available: https://www.ft.com/content/1e4570d0-ea5d-11e4-96ec-00144feab7de#axzz41hKoBgz3 [Accessed 7th June 2018].

DAVIES, S. 2017. Brazil's Pre-Salt Continues to Shine. Natural Gas World, 2.

DAVIS, C. 2017a. ExxonMobil Replaces Only 65% of 2016 Production, Sharply Reduces Proved Reserves [Online]. NGI. Available: http://www.naturalgasintel.com/articles/109516-exxonmobil-replaces-only-65-of-2016-production-sharply-reduces-proved-reserves [Accessed 12th September 2017].

DAVIS, C. 2017b. Shell Adopts 'Lower-Forever Mindset' on Crude Oil Prices [Online]. NGI. Available: http://www.naturalgasintel.com/articles/111223-shell-adopts-lower-forever-mindset-on-crude-oil-prices [Accessed 2nd November 2017].

DELOITTE. 2018. Seeking balance in the new normal: Portfolio positioning with the Deloitte Upstream Diversification Index [Online]. Deloitte Center for Energy Solutions. Available: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-er-seeking-balance-in-the-new-normal.pdf [Accessed 4th June 2018].

EIA. 2013. Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States [Online]. U.S. Energy Information Administration. Available: http://www.eia.gov/analysis/studies/worldshalegas/pdf/overview.pdf [Accessed 4th January 2017].

EIA. 2017. Crude Oil Production [Online]. U.S. Energy Information Administration. Available: https://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_a.htm [Accessed 4th November 2017].

ELLER, S. L., HARTLEY, P. R. & MEDLOCK, K. B. 2011. Empirical evidence on the operational efficiency of National Oil Companies. Empirical Economics, 40, 623-643.

ENGEN, O. A. 2009. The Development of the Norwegian Petroleum Innovation System: A Historical Overview. In: FAGERBERG, J., MOWERY, D. C. & VERSPAGEN, B. (eds.) Innovation, Path Dependency and Policy: The Norwegian Case. New York: Oxford University Press.

ENGLAND, J. 2017. 2017 Outlook on Oil and Gas [Online]. Deloitte Center for Energy Solutions. Available: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-er-2017-oil-and-gas-industry-outlook.pdf [Accessed 16th February 2017].

ENGLAND, J. & SLAUGHTER, A. 2016. Short of capital? Risk of underinvestment while oil price is lower for longer [Online]. Deloitte Center for Energy Solutions. Available: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-er-short-of-capital.pdf [Accessed 7th June 2018].

EXXONMOBIL. 2018. 2018 Analyst Meeting [Online]. ExxonMobil. Available: http://cdn.exxonmobil.com/~/media/global/files/investor-reports/2018/2018-analyst-meeting-presentation.pdf [Accessed 14th June 2018].

FLORÊNCIO, P. 2016. The Brazilian 2010 oil regulatory framework and its crowding-out investment effects. Energy Policy, 98, 378-389.

GLOBALDATA. 2018. Brazilian presalt keeps delivering high-productivity performance [Online]. GlobalData Energy. Available: https://www.offshore-technology.com/comment/brazilian-presalt-keeps-delivering-high-productivity-performance/ [Accessed 2nd June 2018].

GOCHENOUR, T. D. 1992. The Coming Capacity Shortfall: The Constraints on OPEC's Investment in Spare Capacity Expansion. Energy Policy, 20, 973-982.

GOMES, I. & BRANDT, R. 2016. Unconventional Gas in Argentina: Will it become a Game Changer? Oxford Institute for Energy Studies (OIES).

GUTHRIE, C. 2018. Brazil reaps reforms rewards [Online]. Petroleum Economist. Available: http://www.petroleum-economist.com/articles/politics-economics/south-central-america/2018/brazil-reaps-reforms-rewards [Accessed 28th June 2018].

HAMMOND, J. L. 2011. The Resource Curse and Oil Revenues in Angola and Venezuela. Science & Society, 75, 348-378.

HARTLEY, P. & MEDLOCK, K. B. 2008. A model of the operation and development of a National Oil Company. Energy Economics, 30, 2459-2485.

KHAN, K. I. F. 1987. National Oil Companies: Form, Structure, Accountability and Control. Petroleum Resources and Development, London, Belhaven Press.

KHANNA, A. A. 2017. Revisiting the Oil Curse: Does Ownership Matter? World Development, 99, 214-229.

KING, N. 2004. Using Templates in the Thematic Analysis of Text. In: CASSELL, C. & SYMON, G. (eds.) Essential Guide to Qualitative Methods in Organizational Research. London: Sage Publications.

KRANE, J. & AGERTON, M. 2015. Effects of Low Oil Prices on U.S. Shale Production: OPEC Calls The Tune And Shale Swings. Baker Institute for Public Policy.

LEAHY, J. 2016. Shell aims to expand in Brazil's deep fields after rules shake-up [Online]. Financial Times. Available: https://www.ft.com/content/8e4ed6b8-a6f5-11e6-8b69-02899e8bd9d1 [Accessed 17th November 2016].

MAHER, M. & MIKULSKA, A. 2016. Energy Market Transitions: Where Will The IOCs Fit? [Online]. Forbes. Available: https://www.forbes.com/sites/thebakersinstitute/2016/07/21/energy-market-transitions-where-will-the-iocs-fit/#6a43306d4805 [Accessed 22nd September 2017].

MALEK, C. 2018. 'Lower for longer' for the oil price is just taking a pause [Online]. Financial Times. Available: https://www.ft.com/content/ebc6ce3a-6a45-11e8-8cf3-0c230fa67aec [Accessed 28th June 2018].

MANDER, B. 2017. Argentina strikes $15bn a year shale investment deal [Online]. Financial Times. Available: https://www.ft.com/content/031d1674-d74f-11e6-944b-e7eb37a6aa8e [Accessed 10th January 2017].

MARES, D. 2013a. Political Economy of Shale Gas in Argentina. Baker Institute for Public Policy.

MARES, D. 2013b. Shale Gas in Latin America: Opportunities and Challenges. Inter-American Dialogue. Energy Policy Group.

MCGOWAN, R. 2011. Privatize This?: Assessing the Opportunities and Costs of Privatization, Oxford, ABC-CLIO.

MCPHERSON, C. 2003. National Oil Companies: Evolution, Issues, Outlook [Online]. The World Bank. Available: http://siteresources.worldbank.org/INTOGMC/Resources/NOCPaperMcPherson.pdf [Accessed 3rd October 2016].

MEHLUM, H., MOENE, K. & TORVIK, R. 2006. Institutions and the Resource Curse. The Economic Journal, 116, 1-20.

MISCULIN, N. 2017. Argentina clinches labor/subsidy deal to attract energy investment [Online]. Reuters. Available: http://www.reuters.com/article/argentina-gas-idUSL1N1F00IV [Accessed 10th January 2017].

MORENO, J. M., LÓPEZ ORTIZ, M. I. & MONTAÑO SANZ, B. 2013. From privatisation to nationalisation: Repsol-YPF, 1999–2012. Utilities Policy, 26, 45-55.

NORTH, D. C. 1992. Transaction costs, institutions, and economic performance. Occasional Papers No. 30. International Center for Economic Growth.

NORTH, D. C. 2009. Institutions, Institutional Change and Economic Performance, New York, Cambridge University Press.

OTAOLA, J. & BIANCHI, W. 2018. Argentina peso closes higher but inflation soars to 25.5 percent [Online]. Reuters. Available: https://www.reuters.com/article/us-argentina-peso/argentina-peso-closes-higher-but-inflation-soars-to-25-5-percent-idUSKCN1IG3CW [Accessed 28th June 2018].

PEARSON, S. 2016. Petrobras cuts 5-year investment budget 25% [Online]. The Financial Times. Available: http://www.ft.com/cms/s/0/b2fafcca-b930-11e5-a7cc-280dfe875e28.html#axzz47fkq8BwR [Accessed 23rd April 2016].

PERRONS, R. K. 2014. How innovation and R&D happen in the upstream oil & gas industry: Insights from a global survey. Journal of Petroleum Science and Engineering, 124, 301-312.

PETROBRAS. 2016. Oil and gas sector contribution to Brazilian GDP reaches 13% [Online]. Petrobras. Available: http://www.petrobras.com/en/magazine/post/oil-and-gas-sector-contribution-to-brazilian-gdp-reaches-13.htm [Accessed 15th March 2016 2016].

POWELL, W. 2017. Brazil's Licence Changes Prove A Hit. Natural Gas World, 2, 28-29.

RAPOZA, K. 2016. Global Corporations Giving Up On Brazil [Online]. Forbes. Available: http://www.forbes.com/sites/kenrapoza/2016/05/03/global-corporations-giving-up-on-brazil/#2aeb581a5155 [Accessed 5th May 2016].

RASZEWSKI, S. 2018. Conclusion: Transitioning from the 'Old' to the 'New' Political Economy of Oil and Gas. In: RASZEWSKI, S. (ed.) The International Political Economy of Oil and Gas. Cham: Springer International Publishing.

RITCHIE, J., LEWIS, J. & ELAM, G. 2003. Designing and selecting samples. In: RITCHIE, J. & LEWIS, J. (eds.) Qualitative Research Practice: a guide for social science students and researchers. Thousand Oaks, CA: Sage Publishers.

ROBINSON, J. A., TORVIK, R. & VERDIER, T. 2006. Political foundations of the resource curse. Journal of Development Economics, 79, 447-468.

ROCHA, F. 2012. Oil and Gas Industry: Capability Building Experiences. In: PUNZO, L. F., FEIJO, C. A. & ANYUL, M. P. (eds.) Beyond the Global Crisis: Structural Adjustments and Regional Integration in Europe and Latin America. London: Routledge.

ROETT, R. 1997. Brazilian Politics at Century's End. In: PURCELL, S. K. & ROETT, R. (eds.) Brazil Under Cardoso. London: Lynne Rienner Publishers.

ROSS, M. 2012. The Oil Curse: How Petroleum Wealth Shapes the Development of Nations, New Jersey, Princeton University Press.

ROSSER, A. 2006. The political economy of the resource curse: A literature survey. Working Paper 268. Centre for the Future State, Institute of Development Studies.

SALA-I-MARTIN, X. & SUBRAMANIAN, A. 2013. Addressing the Natural Resource Curse: An Illustration from Nigeria†. Journal of African Economies, 22, 570-615.

SCHIPANI, A. 2017. Brazil's pre-salt oil auction falls short of expectations [Online]. Financial Times. Available: https://www.ft.com/content/0e7ab34c-bd9b-3afd-ae2e-2607e4efa9e6 [Accessed 28th October 2017].

SHELL. 2017. Royal Dutch Shell plc Management Day 2017: Shell updates company strategy and financial outlook, and outlines net carbon footprint ambition [Online]. Royal Dutch Shell. Available: https://www.slideshare.net/royaldutchshell/royal-dutch-shell-plc-management-day-2017-shell-updates-company-strategy-and-financial-outlook-and-outlines-net-carbon-footprint-ambition [Accessed 10th June 2018].

SHELL. 2018a. Shell Annual Report 2017 [Online]. Royal Dutch Shell. Available: http://reports.shell.com/annual-report/2017/strategic-report/summary-of-results.php [Accessed 4th June 2018].

SHELL. 2018b. Shell Deep Water Developments [Online]. Royal Dutch Shell. Available: http://www.mtshouston.org/pdfs/2018/Shelljanuary2018.pdf [Accessed 4th June 2018].

SILVESTRE, B. D. S. & DALCOL, P. R. T. 2009. Geographical proximity and innovation: Evidences from the Campos Basin oil & gas industrial agglomeration—Brazil. Technovation, 29, 546-561.

SOLBRÆKKE, K. & TRIANA, B. V. 2016. Market Development in Argentina - Is Vaca Muerta Competitive in Today's Market? [Online]. Oil & Gas. Available: http://www.economist.com/news/americas/21582304-recently-nationalised-oil-company-agrees-big-foreign-investment-flogging-dead-cow [Accessed 4th December 2016].

STATISTICA. 2018. Brent crude oil price annually 1976-2018 [Online]. Statistica. Available: https://www.statista.com/statistics/262860/uk-brent-crude-oil-price-changes-since-1976/ [Accessed 26th June 2018].

STEVENS, P. 2003. National Oil Companies: Good or Bad? A Literature Survey [Online]. The World Bank. Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.197.8929&rep=rep1&type=pdf [Accessed 12th October 2016].

STEVENS, P. 2016. International Oil Companies: The Death of the Old Business Model. Chatham House.

THE ECONOMIST. 2014. Dead-cow bounce [Online]. The Economist. Available: http://www.economist.com/news/americas/21613314-politics-biggest-hurdle-developing-enormous-vaca-muerta-field-dead-cow-bounce [Accessed 2nd January 2017].

TORDO, S., TRACY, B. S. & ARFAA, N. 2011. National Oil Companies and Value Creation [Online]. The World Bank. Available: http://siteresources.worldbank.org/INTOGMC/Resources/9780821388310.pdf [Accessed 3rd October 2016].

TRIEPKE, J. 2017. Deepwater Isn't Dead. Signs Of Life Suggest The Stage Is Being Set For A Comeback [Online]. Drillers. Available: https://drillers.com/deepwater-isnt-dead-signs-life-suggests-stage-set-comeback/ [Accessed 10th June 2018].

WARNER, M. 2017. Local Content in Procurement: Creating Local Jobs and Competitive Domestic Industries in Supply Chains, London, Routledge.

WEBB, S. & ALPER, A. 2017. Shell says can pump oil from Brazil's pre-salt fields below $40/barrel [Online]. Reuters. Available: http://uk.reuters.com/article/uk-brazil-oil-shell/shell-says-can-pump-oil-from-brazils-pre-salt-fields-below-40-barrel-idUKKBN1CU1FW?rpc=401& [Accessed 2nd November 2017].

WILSON, J. 2016. Argentina looks to tap into its vast reserves of resources and energy potential [Online]. Financial Times. Available: https://www.ft.com/content/96f02a12-580b-11e6-9f70-badea1b336d4 [Accessed 3rd October 2016].

WOOD MACKENZIE. 2017. Vaca Muerta development study 2017 [Online]. Wood Mackenzie. Available: https://www.woodmac.com/reports/unconventional-oil-and-gas-vaca-muerta-development-study-2017-46452361 [Accessed 10th October 2017].

WOOD MACKENZIE. 2018. Highlights and Commentary from Brazil Concession Round 15 [Online]. Wood Mackenzie. Available: https://www.woodmac.com/press-releases/brazil-concession-round-15/ [Accessed 10th June 2018].

WORLD ENERGY COUNCIL. 2013. The other players: Independents and National Oil Companies [Online]. World Energy Council. Available: https://www.worldenergy.org/news-and-media/news/the-other-players-independents-and-national-oil-companies/ [Accessed 14th December 2016].