THE STRATEGIES OF BRICS’ NATIONAL OIL COMPANIES FOR ENERGY SECURITY: JOINT VENTURES BARGAINING AND VERTICAL INTEGRATION

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Abstract

In one report published by Goldman Sachs in 2003, they predicted that BRICs will become the “engine of new demand growth and spending power”. Because of the strategic role of oil, the four countries have chosen a State control of this sector. National Oil Companies in the BRICs must fulfill some non-commercial objectives imposed by the Government, among which to ensure the energy security of their country. We consider BRICs as two different groups with different strategies. Russia and Brazil are producers and their NOCs, who search for advanced technology and investments to develop new oil reserves, make partnerships with IOCs. It’s interesting to observe bargaining strategies in joint ventures, where there is an objective of energy security followed by the host country. Energy security strategy is different for China and India, two consumer countries. Asian NOCs integrate vertically in order to enter in new markets and to diversify their supply sources. We present an econometrical model that analyzes the relationship between the dimensions of vertical integration defined by Harrigan (1986) (degree of vertical integration, stages of processing, breadth of activities and ownership form) and the oil supply security.

1. Introduction

The BRIC countries (Brazil, Russia, India and China) have a fast economic growth (GDP growth was above 2.7 % in 2011) and an important influence on the energy market. Brazil might become an important producer and exporter in next decade, thanks to the new pre-salt reserves discovered in 2006. EIA (United States Energy Information Administration) considers that these reserves could increase Brazil’s reserves with 50 million barrels, and others think that is even more. Russia’s leading role in energy market is clear: its oil production was the second most important after Saudi Arabia in 2011 and its proved oil reserves place it on the eighth place. China’s fast growth has meant that it became a net importer starting 1993. Its R/P ratio is very low (9.9) compared to the one of the world (54.2) (BP Statistical Review of World Energy June 2012). BRIC countries are among the ten first consumers of oil, China was the second most important consumer of oil in 2011 and India was the fourth. China and India are competing for oil resources domestically and overseas.

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1 The acronym « BRIC » has been introduced for the first time by the economist Jim O’Neill from Goldman Sachs in 2001, in a study published in the Global Economics Papers, with the title « Building Better Global Economic BRICs ».

2 The R/P ratio (Reserves / Production) is obtained by the division of energy reserves remaining at the end of the year by the production of that year. The result is the period of time for which these reserves will be sufficient if the production level remains the same.
The State has decided in the BRIC countries that the oil sector should remain under his control, by the mean of NOC (National Oil Companies). NOC have non-commercial objectives like oil revenue redistribution to the society, welfare creation for the people or economic development. Some NOCs sell their products at subsidized prices to consumers on the domestic market. Johany (1980) considers that NOCs care about next generations and don’t take the same risks as the IOCs (International Oil Companies). They have more conservative politics and a lower production level. Also, these companies have to ensure the demand for the producing countries and the oil supply, so energy security for their country.

Supply security is used when we talk about energy security. Angelini and al. (2009) split energy security definitions in two categories:

- definitions from the economic perspective: the energy insecurity is the loss of welfare, which is the result of a price change or of the physical availability of energy;
- definitions from the political perspective, who concentrate on the conditions of a sure energy system: accessibility, availability, acceptability.

A sure supply is a regular and continuous flow of energy with an affordable price, starting from the primary energy production and until the final consumer. Supply security concerns the access to primary resources, production, processing, transport and distribution.

Starting 1980, NOCs, who controlled the upstream until then, became interested in downstream oil sector. This new development was seen as an opportunity to diversify profits and integrate into new industries. Traditionally, as Coase notes, vertical integration takes place when the cost of organizing transactions on the market is more important than the cost of a transaction within the firm. This definition is developed in terms on contract law by Grossmann and Hart (1986): “purchase of the assets of a supplier (or of a purchaser) for the purpose of acquiring the residual rights of control”. A company must choose between make or buy or between sell and develop. Stigler (1951) and Williamson (1975) set up a theory that explains why at certain steps of the lifecycle of a company, it chooses the market and in others the vertical integration.

In developing economies, an important part of the technology transfer is done by the multinational companies of the developed worlds. The multinational companies have three kinds of strategies of entry in a country: foreign direct investment, joint venture and technology transfer. In our analysis, we’ll concentrate on the joint ventures, which are legal entities formed by a domestic company and a foreign one. The two
companies have the joint ownership of the business, in which they invest and are paid according their respective share in the business.

We analyze the most important NOCs in the BRICs: Petrobras (for Brazil), Rosneft (for Russia), ONGC (Oil and Natural Gas Limited) for India and PetroChina and Sinopec Corp. (China Petroleum and Chemical Corporation) for China. There are other NOCs that we’re not going to study here. Gazprom, one of Russia’s NOCs, won’t be analyzed, because the development of oil operations in the upstream is more recent, the subsidiary Gazprom Neft was created only in 2005. In India, Oil India Limited (OIL) represents only 10% of the Indian market in terms of crude oil production. Because it’s presence only in the upstream, OIL is not the object of our analysis. Also, China has other NOCs, like China National Offshore Oil Corporation (CNOOC) who’s active only in the offshore exploration and production and it started to develop in the downstream only recently. In 2005 another Chinese NOC was created, the Shaanxi Yanchang Petroleum Group Co. (Yanchang Petroleum Group). Because of its late creation, we won’t take it into account here.

Figure 2. Main NOCs in BRICs

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</thead>
<tbody>
<tr>
<td>Petrobras</td>
<td>1953</td>
<td>Brazil</td>
<td>Exploration and production, refining, oil and natural gas trade and</td>
<td>84 918</td>
<td>55.47%</td>
<td>763</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>transportation, petrochemicals, and derivatives, electric energy, biofuel and other renewable energy source distribution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rosneft</td>
<td>1993</td>
<td>Russia</td>
<td>Hydrocarbons exploration &amp; production, production of petroleum and</td>
<td>60 837</td>
<td>75.16%</td>
<td>869</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>petrochemical products, refining, marketing and distribution.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ONGC</td>
<td>1956</td>
<td>India</td>
<td>Exploration, production, refining, transport, marketing of crude oil,</td>
<td>33 273</td>
<td>74.14%</td>
<td>164</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>natural gas, LPG, ethane, propane, and other petroleum products, but also petrochemical products, power generation, sector services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PetroChina</td>
<td>1999</td>
<td>China</td>
<td>Oil and natural gas supply chain from exploration to sale, production and</td>
<td>552 810</td>
<td>90%</td>
<td>886</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>sale of basic, derivative and other chemical products.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sinopec Corp.</td>
<td>2000</td>
<td>China</td>
<td>Oil and gas supply chain from exploration to marketing, production,</td>
<td>377 235</td>
<td>80%</td>
<td>322</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>marketing, transport of petrochemical, chemical fibers, fertilizers and other chemical products, import/export</td>
<td></td>
<td></td>
<td></td>
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</table>

Sources: Annual reports of NOCs, NOC's website.

Our analysis we’ll be based on the fact that BRICs can be split in two different groups: producers (Brazil and Russia) and consumers (China and India). The strategies of their NOCs for energy security enhancement depend on whether the country is a net oil producer or a consumer. For China and India, their NOCs try to increase their degree of vertical integration and their markets development in order to increase the supply security. On the other hand, Brazil and Russia’s NOCs make partnerships with IOCs to access their advanced technologies or their financial resources and to develop the new oilfields, but also to enhance the recovery ratio of mature oilfields. Most of Russia’s production comes from fields who have reached their maximum in exploration and production years ago. These are declining fields that will never hit their maximum production level. The new reserves ready to be recovered are in small and average deposits, so they aren’t easily recoverable.

The first part of this study will make a short presentation of the NOCs that we analyze in this study. Then, we’ll concentrate on vertical integration strategy, with two examples: China and India’s NOCs. We’ll present theoretic aspects of this strategy, some advantages and disadvantages, but also the specific cases of the two countries that we analyze. There are a certain number of studies that were made concerning vertical integration, but NOC literature is limited. This is the reason why World Bank started in 2008 a study concerning NOCs and value creation. So, NOCs role in supply security has been few studied, some
documents like the CRS Report for Congress\textsuperscript{3} mention it. An econometrical model is constructed in order to show the influence of vertical integration of NOCs on oil supply security in China and India. The third part of our study will present the joint venture negotiation between a NOC and an IOC, with a focus on Brazil and Russia examples. We’ll present some factors who can affect bargaining power of the two players and also a short literature review of joint venture bargaining in oil industry.

2. Some elements about NOCs in BRIC countries

NOCs in BRICs countries are not a homogeneous group, they have been created differently and they have developed in different systems. We present here the NOCs through four points: the process of creation of NOCs, key dates, the State’s role and last events.

Petrobras has been created in 1953 to be at the head of hydrocarbons activities of Brazilian government. Its operations started in 1954 with the production of crude oil, natural gas and refining in Brazil for the government’s account. In 2006, Brazil becomes self-sufficient in terms of energy; oil exports become superior to imports. The oilfields discovered in offshore deep-water (Tupi and Carioca) in 2007 and 2008 could contain 6 to 8 billion barrels and more than 30 billion barrels respectively.

The Brazilian government uses Petrobras in order to fulfill its objectives that usually are in contradiction with the shareholders and company’s desires. Government has the right to name the majority of the board of directors, so the managing of Petrobras. So, Petrobras can make sales and investments which are not always in its own interest. Also, government has the control on Petrobras’ budget, as it fixes limits for the company’s investments and its long-term debts.

Until 1998, Petrobras had the monopoly on exploration, production, refining and oil distribution in Brazil. Starting this year, foreign oil companies had the right to enter on Brazilian market. The law from 1997, who regulates the oil industry, says that oil companies can buy rights to explore defined oilfields, onshore and offshore. They will put up with the risks and costs of exploration on all that’s discovered and have to pay royalties to Brazilian government. Government is making reforms to this system, and in 2010 a new law was adopted, who decided the creation of a regulation authority for pre-salt blocks, the Pré-Sal. This law has also replaced the concessions system by a production sharing contracts for the pre-salt fields and strategic areas. Also, Petrobras has the right to minimum 30 % of participation in all new given permits.

After the USSR’s fall, the Oil and Gas Ministry has been replaced by Rosneftegaz in 1991. Rosneft was created in 1993 as a NOC based on Rosneftegaz’s assets. One of the key dates for Rosneft was when a new management team was created in 1998, and Sergey Bogdanchikov became Rosneft’s President. It’s an important moment, because the new President started to reconstruct the company, which was falling apart. In 2000, when Vladimir Putin became Russia’s President he wanted to increase State’s role in economy and in particular in energy sector. In 2001, Rosneft becomes the competent authority to authorize and implement production sharing agreements and it starts to acquire assets in Russia.

After 2006, when the company has been partially privatized, Rosneft has less of government’s representative in his board of directors’ members. The independent directors still have some strong relationships with the government. The change was really done in 2011, when the Russian President Dmitry Medvedev announced that the companies where they have had regulation actions won’t have any government member in their board of directors.

Licenses are given by a commission of call of tenders named by the Natural Resources Minister. The production sharing agreement system is governed by the federal law on “production sharing agreements” from 1995, who came into effect in 1996. The State of the oil company remains the owner of the mining title and contracting partners are considered as service providers. This law has been reviewed in 2003, and Russia forbids its application for new oilfield projects. Also, this system can only be used if no investor wanted to

\textsuperscript{3} Robert Pirog. \textit{The role of National oil Companies in the International Oil Market. CRS Report for Congress.} 2007.
develop the oilfield under a license contract. Foreign companies’ participation has been restraint in projects of oil development. But Russia seems to review its strategy.

One of last controversial deals of Rosneft is the joint-venture with ExxonMobil for the exploration of Arctic areas; this deal will be presented in the third section of this analysis.

Indian government understands the important of oil and gas sector after the independence. At the end of the year 1995, India creates a Direction of Oil and Natural Gas, but it couldn’t be efficient because it had some limited administrative and financial functions. After several changes of this Direction, who became a commission, and afterwards a public organism, ONGC becomes a limited company in 1994.

India’s exploration activities should have been invigorated by the NELP (New Exploration Licensing Policy) introduced in 1999. Foreign and private companies had the right to participate in call of tenders. Foreign direct investment was allowed even at 100 %. But India doesn’t allow oil and gas exports. The Indian government controls ONGC by imposing restrictions, audits by governments’ agencies and it also nominates members in the board of directors and the managing director. Also, ONGC has to follow the government’s standards for the remuneration of its employees.

A key event in ONGC’s history is the acquisition of the majority of MRPL, which allowed the company to start its vertical integration. One of the last events is the memorandum of understanding between ONGC and CNPC in June 2012 to explore together for oil and gas worldwide. India and China will help each other to consolidate their energy position globally.

Sinopec Corp. and PetroChina have been created after a restructuration of the oil industry by the Chinese government. CNPC (China National Petroleum Corporation) and Sinopec (China National Petrochemical Corporation) have gathered together their core businesses in two other companies. PetroChina was created in 1999 by CNPC and Sinopec Corp. was created in 2000 by Sinopec.

Oil and gas sector reform started in the 80’s, when China needed foreign capital, technology and experience. Production sharing agreements were introduced to attract foreign investments. In order to invest in oilfield exploration and production in China, foreign oil companies have to conclude a partnership with Chinese State companies.

Chinese NOCs have a lot of autonomy, they are not totally controlled by the government. This autonomy is due to their collaboration with precedent ministries, important place of NOCs managers in Chinese Communist Party, but also their size face to government agencies that supervise them. Chinese NOCs are controlled by the Party because it names, fires and decides the promotions of managing directors. Investments projects should be approved by the NDRC (National Development and Reform Commission) and by NEA (National Energy Administration). Downs (2010) notes that these agencies are often less powerful than the Chinese NOCs and don’t have the needed employees.

3. Vertical integration for an enhanced oil supply security. China and India examples

Vertical integration can help oil companies to reduce operating and capital costs (Mitchel, 1976). This strategy means that the market is substituted with transactions within the company. The main advantage of the vertical integration is costs reduction. We first concentrate on the literature and theory of vertical integration, and then we present an empirical study based on China and India’s NOCs.

Theoretical aspects of vertical integration

Coase’s work analysis transaction costs related to information research and contracts negotiation, so transactions costs before the contracts conclusion. Williamson (1971, 1975, 1979) concentrates on transaction costs after the contracts were signed. Long term contracts aren’t complete because of the uncertainty concerning the future and agents limited rationality. If the concluded contracts are only short term contracts who repeat, transactions costs would be high. So, the firm is encouraged to integrate. A
Vertical integration can have advantages with regard to contracts when there are transactional difficulties. This strategy permits to ensure a regular supply of an essential production factor. This is the advantage that is interesting in our analysis. Asian NOCs go abroad in order to reach a more important vertical integration degree or to geographically diversify their proved reserves (Goldstein, 2009). The “Going Abroad” politics has become a national strategy in 1997, Chinese companies where encouraged to develop in foreign countries.

Figure 3 shows some of the advantages and disadvantages of vertical integration.

### Figure 3. Advantages and disadvantages of vertical integration

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company level</strong></td>
<td><strong>Company level</strong></td>
</tr>
<tr>
<td>- costs reduction: economies in terms of communication, improvement of activity coordination, elimination of certain production distribution levels; - economies of scale; - reduction of opportunistic behavior; - vertical integration between downstream and upstream companies permits to avoid taxes or price control; - price control by the government or regulation can be avoided; - monopoly profits increase.</td>
<td>- risky: function of technologies, it can increase costs; - flexibility loss; - loss of competitiveness; - possible capacity surplus.</td>
</tr>
<tr>
<td><strong>Market level</strong></td>
<td><strong>Market level</strong></td>
</tr>
<tr>
<td>- increase of the market power; - improve market strategy; - better control the environment; - product differentiation; - improve anticipation of demand and price changes.</td>
<td>- possible difficult access to supplier and consumers, so loss of information; - risk that company process and technologies become obsolete; - possible antitrust problems; - synergies after vertical integration can be surevaluated.</td>
</tr>
</tbody>
</table>

Integration in pipeline transportation can be a source of cost reduction, because transportation is an important element in the final delivery price of refined oil products. Also, pipelines play a significant role in competition in oil industry. There are several factors who explain that it’s preferable to integrate the pipelines by oil companies: demand variability, specific equipment with long-life, a small number of customers from which a pipeline may pump its volumes. These reasons might determine an increase of pipeline price transportation.

A company non vertical integrated can conclude long term contracts with another firm, who specify price constraints, behavior forms or other constraints. These are vertical restrictions. Williamson talks about hybrids, which are organization forms between the market and the company and who include franchise and different forms of alliances. Often, this type of relationships is translated by contracts.

NOCs who want to integrate in the downstream are ready to make alliances with IOCs. Refining and marketing will offer them the opportunity to capture value added from production and refined products sell. Also, NOCs will have access to new markets and will ensure demand security. NOCs investments in pipelines or refining can help them to respond immediately to domestic demand.
China and India examples: oil supply security problem and NOCs vertical integration

Even if China and India are two consumer countries, we can see that they don’t have the same import dependency. In the 90’s, China wanted to become self-sufficient, but now she understood that she needs oil imports in order to ensure her economic development. Some economists value that China’s dependency will reach 60-80% in 2020 (Downs, 2006, p. 11). Concerning India, IEA thinks that 91% of the country’s oil will be imported up to 2030.

Import dependency in 2011

<table>
<thead>
<tr>
<th>Country</th>
<th>Consumption (MT)</th>
<th>Crude imports (MT)</th>
<th>Crude exports (MT)</th>
<th>Net imports (MT)</th>
<th>Import dependency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>461,8</td>
<td>252,9</td>
<td>1,5</td>
<td>251,42</td>
<td>54,33%</td>
</tr>
<tr>
<td>India</td>
<td>162,3</td>
<td>169,7</td>
<td>0,1</td>
<td>169,63</td>
<td>104,51%</td>
</tr>
</tbody>
</table>

Source: BP Statistical Review of World Energy June 2012

In 1970, China becomes a net oil exporter, after the discovery of several oilfields, among which the Daqing oilfield. But starting 1993, China is a net oil importer. The country thinks that oil is the most important element in supply security, because of its role in the country’s economy and for the army. The measures that China adopts now in order to ensure supply security concentrate on a sure and appropriate supply, and are less concerned about affordable prices.

China’s oil security problem is due to the fact that the reserves that are insufficient for the growing consumption, with a law R/P ratio (9.9 in 2011) compared to the one of the world (54.8). But the country has also oil transportation issues, because it is dependent on the Malacca strait. China has an operational transnational pipeline, and there are two other which are under construction.

India’s oil supply security profile is different. The country doesn’t have many reserves, so it buys assets overseas in countries like Nigeria, Sudan or Angola. This strategy helps the country to reduce the dependency on spot markets and to be less vulnerable at oil price. India’s target is to become self-sufficient.

Chinese NOCs are searching for overseas assets in order to integrate into supply chain, but also to develop their actual properties. With the acquisition of Singapore Petroleum Company by PetroChina, who has important assets in downstream sector in Asia-Pacific area, the company can improve its position in refining, pipelines, storage capacities at Singapore, one of the most important hubs of oil trade. Also, NOCs investments in refining or pipeline abroad can win them credibility in host countries and strengthen their relationships. For example, CNPC and Petronas have signed a Memorandum of Understanding with Sudan for the development of the Khartoum refinery, and the two companies received the right to have access to more projects in the upstream sector.

India’s NOC, ONGC, has followed a plan of vertical integration by the increasing of the refining capacity by mergers & acquisitions. The company also entered in marketing and distribution of petroleum products. With the acquisition of 71.62 % of MRPL (Mangalore Refinery & Petrochemicals Limited) in 2002-2003, ONGC diversifies in downstream sector. The refinery, created in 1988, is placed in Mangalore city and has a total capacity of 86.64 million barrels/year, to be improved to 109.95 million barrels/year. MRPL started to have losses in 1998, when it became vulnerable to price changes and to deregulation impact on the refining sector in India. Even in these conditions, ONGC bought MRPL, because the Indian NOC wanted to enter the refining sector with the help of the state-of-art technology of MRPL. ONGC’s development in downstream has been easier, because the company obtained the Government’s agreement to open 600 outlets for petroleum products coming from the refinery.

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5 ONGC Annual Report 2010-2011.
Analysis of the relationship between oil supply security and vertical integration: econometric approach

One of the best methods to ensure oil supply security in China and India is the diversity of supply sources. Stirling (1994) has shown that the Shannon diversity index is the most appropriate to indicate the balance (the modality to share options) and variety. In Arkel, Boots and Jansen’s (2004) report, there are four indicators used to measure long-term supply security, who introduce following aspects: diversification of energy sources in energy supply, diversification of imports with respect to imported energy sources, long-term political stability in import regions and the resource base in regions of origin, including the home region itself. Starting these four indicators, we’ll construct and index who will measure the oil supply security.

Vertical integration will be measured by using the dimensions that Harrigan (1986) proposes: the degree, the number of stages of processing, the breath of activities and the ownership form. Vertical integration is defined by considering the relationships between a business unit and its sisters. In our case, the main business unit is the refinery. We’ll going to measure these fours dimensions of vertical integration and we’ll analyze how they can be linked to the oil supply security.

Our analysis will be based on a period of 12 years (2000-2011), because Sinopec Corp was established only in 2000.

Construction of oil supply security indicators

We explain in this section how the four indicators on oil supply security are developed, starting with the Shannon diversity index. We’ve based our construction on the Arkel, Boots and Jansen’s (2004) report.

1. The diversity index

The basic indicator for our analysis is the Shannon diversity index. We consider the diversity of oil supply sources for a country (in our case: China and India): imports of crude oil, domestic crude oil production and international crude oil production. Arkel, Boots and Jansen’s (2004) consider the portfolio of primary sources of energy. The formula is:

\[ I_1 = - \sum_i (c_i p_i \ln p_i) \]

where:
- \( I_1 \) = oil supply security indicator no. 1.
- \( p_i \) = share of oil supply source \( i \) in total oil supply.
- \( i = 1 \ldots 3 \): oil source index (3 sources are distinguished).
- \( c_i \) = correction factor to \( p_i \) for indicator \( I_1 \). The correction factors will be equal to unity in case of the first indicator.

A low value of the \( I_1 \) suggests a worse oil supply security than a higher value.

2. Diversity of supply regions

The initial indicator, the allowance for energy import dependency, was created as an adjustment of the import dependency indicator. The Shannon diversity index was applied by Arkel, Boots and Jansen’s (2004) to the import regions of energy source \( i \) from region of origin \( j \). We’ll use this indicator to measure the diversity of sourcing regions \( j \) for the source of oil supply \( i \) (with \( i=1\ldots3 \): imports of crude oil, domestic crude oil production and international crude oil production). As in the reference report, we’ll adjust the portfolio shares of the three sources of oil supply by multiplication with a fraction between 0 and 1. The value of this fraction will be low if the supply dependency will be high and few diversified. The formula for this indicator is:
\[ I_2 = -\sum_i (c_i^2 p_i \ln p_i) \]

Subject to:
\[ c_i^2 = 1 - m_i(1 - S_i^m / S_i^{m,\text{max}}) \]

where:
- \( I_2 \) = oil supply security indicator no. 2 accounting for diversity of supply regions
- \( c_i^2 \) = correction factor to \( p_i \) for indicator \( I_2 \)
- \( m_i \) = share of oil supply of source \( i \) in total supply
- \( S_i^m \) = Shannon index of oil supply flows \( i \)
- \( S_i^{m,\text{max}} \) = maximum value of Shannon index of oil supply flows of resource \( i \)

\[ m_{ij} = \text{share of oil supply of source } i \text{ from region } j \text{ in total supply of source } i \]

\( j = 1..N \): index for region of origin (foreign or domestic). A total number of \( N \) regions of origin are distinguished.
- \( S_i^{m,\text{max}} \) = maximum value of Shannon index of oil supply flows of resource \( i \)

3. Diversity of supply regions and socio-politic stability

This third indicator will add the political stability in regions of oil supply. We’ll use the UNDP Human Development Indicator (HDI) to measure the social-political stability. This indicator is available on line. The formula of this third indicator is:

\[ I_3 = -\sum_i (c_i^3 p_i \ln p_i) \]

where:
- \( I_3 \) = oil supply security indicator 3 accounting for diversity of supply regions and socio-political stability in regions of origin
- \( c_i^3 \) = \( 1 - m_i(1 - S_i^{m*} / S_i^{m*,\text{max}}) \)
- \( S_i^{m*} = \sum_j (h_{ij} m_{ij} \ln m_{ij}) \)
- \( h_j \) = extent of political stability in region \( j \), ranging from 0 (extremely unstable) to 1 (extremely stable)
- \( S_i^{m*,\text{max}} \) = Shannon index of oil supply flows \( i \), adjusted for political stability in the regions of origin

4. Resources depletion

The fourth indicators counts the resource depletion, based on the R/P ratio for each region of supply. Markets are supposed to answer when the ratio R/P reaches values under 50. The formula for this indicator is:

\[ I_4 = -\sum_i c_i^4 p_i \ln p_i \]

where:
- \( I_4 \) = indicator 4 accounting for diversity of supply regions, political stability in producing regions and for the proven regional reserves with respect to the annual production in the region concerned.
\[ r_{ij} = \text{Min}\left\{ \left( \frac{(R/P)_{ij}}{50} \right)^a ; 1 \right\} \quad (a \geq 1) \]

\[ c_i^+ = \{1 - (1 - r_{ik})(1 - m_i)\} \times \{1 - m_i \left(1 - S_i^{m_{\text{max}}} / S_i^{m_{\text{max}}} \right) \} \]

\[ S_i^{m_{\text{max}}} = -\sum_j (r_{ij} \times h_{ij} \times \ln(m_{ij})) \]

\[ r_{ij} = \text{depletion index for oil in region of supply j} \]

\[ r_{ik} = \text{depletion index for oil in home region k, for which the indicators are determined} \]

\[ (R/P)_{ij} = \text{proven reserve-production ratio for oil in region of origin j} \]

This fourth indicator, \( I_4 \), analyzes the resources depletion in import regions, but also in home country (factor \( 1 - (1 - r_{ik})(1 - m_i) \)) and in foreign countries of supply (factor \( \{1 - m_i \left(1 - S_i^{m_{\text{max}}} / S_i^{m_{\text{max}}} \right) \} \)). The value of \( a \) will be fixed to 2, because if \( a \) takes high values, then the depletion value will approach quicker to value 0 when \( R/P \) is next to 0.

We’ll construct a global index and give to each indicator the same importance: \( I = \text{average}(I_1; I_2; I_3; I_4). \)

**Vertical integration measurement**

Vertical integration is a combination of decisions between make or buy. There are four dimensions of vertical integration that we’ll going to present below:

1. **The degree**: is measured at business unit level and represents the percentage of a certain semi-finished product transferred to downstream business units (or the percentage of needs of a certain product bought to upstream units). Companies’ degree of vertical integration will be high if they produce most of their needs internally. In our analysis, we consider that the degree of integration in the upstream is represented by the percentage of self-supplied crude oil by exploration & production in the total of crude oil processed by the refineries. We measure the degree of integration in the downstream by the percentage of production of refined products from the total of sales of refined products.

2. **The number of stages of processing**: the company will have to decide how much to integrate in the supply chain. We’ll compare PetroChina and Sinopec Corp. with other private oil companies concerning the number of stages of transformation needed on the production process. We’ll use an index constructed as the sum of the number of steps multiplied by the value added for each step. Companies having few stages of production, have a low index. In our case, we consider four stages of processing: exploration & production, transport & storage, refining and marketing and distribution.

3. **The breath of activities**: if companies have engaged in an important number of activities at each stage, the breath of activities is important. We measure this dimension by the number of activities in which the firm has engaged in (at a stage of production)/number of activities in which it was possible to engage in. In our analysis, for each stage of production we consider the following activities that the company could engage in:
   - exploration & production: survey, drilling, appraisal, development and production, oilfield services;
   - transport & storage: transportation by pipeline, truck, train, barge, tanker. Storage: vessel for storage, tanks. These activities are considered both for crude oil and for refined products.
   - refining: we consider some of the products that the company can produce (basic petrochemical, derivative petrochemicals, other chemicals, crude oil, gasoline, diesel, kerosene, fuel oil, naphtha, lubricants), but also other services (energy generation, waste water treatment, sulfur recovery, additive production, blowdown systems, handling and blending of products, storage of products).
- marketing and distribution: wholesale refined products, retail of refined products, sale of basic petrochemical, derivative petrochemicals, other chemicals, after-sale service and export.

The breath of activities each year will be an average of all these indicators at each stage of processing.

4. **The form of ownership**: is the percentage of participation in each strategic business unit. The company will chose how much to own in each activity. We calculate an average of joint-ventures ownerships and subsidiaries ownerships of PetroChina and Sinopec Corp. each year, for each stage of production. The final indicator is an average of the ownerships at each stage of production.

We’ll use a regression model to show the relationship between the dimensions of vertical integration and the oil supply security of the period 2000-2011. The model will have the following form:

\[ I_i = a_i + b_i x_i + c_i z_i + d_i t_i + g_i u_i + e_i \]

where:

- \( I_i \) = indicator of oil supply security = average \((I_1; I_2; I_3; I_4)\)
- \( i = 2000 \ldots 2011 \)
- \( a_i, b_i, c_i, d_i, g_i \) = unknown parameters
- \( x_i \) = indicator of degree of vertical integration = average (degree of upstream integration; degree of downstream integration)
- \( z_i \) = indicator of number of stages of processing
- \( t_i \) = indicator of breadth of activities
- \( u_i \) = indicator of ownership form
- \( e_i \) = error term

We couldn’t run the model, because data for some periods are difficult to be found for China and India. The model is only in a conceptual form for now.

4. **How to enhance energy security by partnerships with private companies: Brazil and Russia examples**

The pre-salt blocks discovered by Brazil in 2006 need important investments for exploration and production. In the 2010-2014 Plan, Petrobras intends to invest 224 billion dollars, from which 53% will be used for exploration and production, especially in the pre-salt blocks.

As per the “Energy strategy of Russia for the period up to 2030”, the mean problems for the energy security are the assets’ depreciation in the energy sector (80% in oil refining). Also, the investments in the oil sector are not enough and the sector hasn’t the world’s technological and scientific level. The technologies that are used aren’t efficient and the recovery ratio is low.

Partnerships with IOCs appear to be the best solution to be able to develop new oil reserves which are placed in difficult areas. In this section we’ll present first some theoretic aspects about contracts theory and cooperation agreements. Then, we illustrate the examples of Brazil and Russia. Bargaining in joint ventures is presented in the last party of this section.

**Contracts theory and the cooperation agreements**

Until 1940 and 1950, analysis was done only for simple situations of good and services exchanges. With the contingency notion introduced by Arrow (1964) and Debreu (1959), the theory of the choice in uncertainty of Neumann and Morgenstern (1944), more complex exchanges started to be analyzed. Actual long term and dynamic contracts theory was mostly developed in the 80’s and the 90’s: contracts renegotiation, relational or incomplete contracts. Contracts theory generally involves incentive theory, theory of the information and theory of economic institutions.
There are two problems concerning incentive: adverse selection, which concerns hidden information, and moral hazard, where the action is hidden. Adverse selection was first introduced by Mirrlees (1971): one of the Agents characteristics is not known by the Principal, so the Principal must make the Agent to reveal its type (the revelation principle). Signaling models is characterized by the fact that the Principal is the informed party and plays first. He sends a signal through the contract or through his behavior before the contractual phase who can reveal information about his type. The Agent will try to decode his message. Moral hazard model analysis the contractual problem of an Agent who takes a decision (“action”) who affects his utility and the Principal’s utility, but the Principal can only observe the result of this action, which is not Pareto-optimal.

In practice, almost all long-term contracts are incomplete. They don’t describe all situations that can present; there are decisions or transactions that will have to be determined latter. Contracts’ optimization variables are often ownership titles allocation between contractual parts, control rights, decision rules, and authority. Grossman and Hart (1986) have developed a theory of ownership rights, based on residual control rights. The firm is a set of assets who belong to an owner, who has residual right on these assets. They create a theory of costs and benefits of integration and can determine when is right to integrate.

Cooperation strategies can be explained by different economic theories: market power theory, transaction costs theory, agency theory, resources theory, transaction value theory, real options theory, theory of increasing returns.

In transaction costs theory, cooperation strategies are considered as a mean to reduce organization costs of international transactions. This theory has been used in order to analyses a company’s entry methods into a foreign market (Anderson and Gatignon, 1986), selection and configuration of alliances shapes (Hennart, 1988, Parkhe, 1993) and new firms’ creation (Oviatt and McDougall, 1994).

Resources theory considers the company as a set of resources, of which a part is collectively available and others are specific to a certain industry or sector, or specific to a company (Amit and Schoemaker, 1993). Only the strategic, scarce resources can create competitive advantages. Alliances permit to acquire strategic and complementary resources. Madhok and Tallman (1998) explain the advantage of a joint venture or an alliance: the company is not obliged neither to buy a part or an entire other company, nor to be limited to a single market.

Joint ventures analysis as real options to invest in a foreign market, new technology or the possibility to buy another company, is quite recent. Real options suppose that an investment is made into one or more real assets with the option to increase the investment and to have the entire ownership in the future. Joint ventures can be considered as real buy options on more important real investments (Kogut, 1991). The savings made by a joint venture permits the access to new technologies or to new markets, can be used to make other joint ventures or to can be kept to exercise the option, buy the partner.

**Brazil and Russia reserves situation and their NOCs’ strategies**

Historically, in a joint venture between a NOC and an IOC, the IOC will bring its expertise in risk and project management, but also its advanced technology, financial resources and access to downstream market: the NOC will offer the access to resources otherwise not available for the private company. The joint ventures are used in the upstream because an important investment and a developed technology are needed. Hydrocarbons production offshore has an increased level of complexity and is capital intensive with regard to the onshore production. Experts say that the cost of an offshore well is 10-20 times higher than the one of an onshore well. Also, risks in large exploration & production projects are important and no company, even a multinational, doesn’t want to take full exposure. Also, the preventive actions and equipment are expensive. NOCs can’t fulfill the objectives given by the State and finance in the meantime the exploration and production. NOCs haven’t the needed technology to fully develop resources, so a joint venture with IOCs can give them access to other resources otherwise unavailable.
A joint venture can be created because of the regulation in the host country imposing that foreign private companies can have access to the country’s resources only if they partner with local companies. This was the case in Russia, where federal resources can only be used by legal entities registered in Russia, with a minimum five years of experience in country’s resources exploitation and in which Russia has at least 50% of vote shares.

Technology transfers can come from different sources, like other countries’ NOC or the oilfield service companies, which are IOC competitors. But historically IOCs have done them, because they can communicate their technology and they have clear and efficient process. NOCs are a technology transfer chain in many emerging and developing countries, they can accumulate new technologies and pass them on to other parts of the domestic market.

Technology transfer is not the only reason for joint ventures creation. During call of tenders organized in order to offer licenses for exploration and production, there is an information asymmetry between competitors. If some companies have already made exploration and production activities in areas next to the ones opened for auction, they have some private information. They can know the potential of the acreage offered during the call of tender and how much they should bid. As Iledare et al. (2004) notes, companies make partnerships with other possible competitors in order to have this private information and to put resources jointly. Empirical studies show that there is a positive relationship between the number of joint ventures, the bidders and the offers. Also, partnerships reduce uncertainty, because companies who participate to a call of tender can share their resources, technologies and expertise. Partnerships help companies to improve their analysis capacity for future call of tenders.

Veblen (1915) and Gerschenkron (1962) sustain that the rate at which backward country can catch up is function of the difference in development levels between a country less industrialized and an industrialized country. This is also true for oil companies: the rapidity of technology transfer is function of the difference between the levels of technology of the two companies. The explanation is the same: the greater the gap between the two companies, the greater the pressure to change and the faster is the transfer of technology. Before it’s transferred, technology might need to “accommodate” to the new environment, this is the role of overseas subsidiaries of international oil companies.

Joint ventures can be preferred to acquisitions or takeovers for reasons of energy security or for political reasons. This strategy permits to have the benefits of cooperation, but without the economic and political risks of a merger for example.
Petrobras example

The National Agency of Petroleum, Natural Gas and Biofuels (Portuguese: Agência Nacional do Petróleo, Gás Natural e Biocombustíveis – ANP) splits the sedimentary basins in blocks for exploration and production, which are won during call of tenders that the agency organizes. Usually, companies make pools in order to explore the given blocks, in order to split risks for Brazil’s offshore fields for example. Pool companies sign two different contracts: a licensing agreement with the ANP and an individual contract to regulate relationship into the pool.

Figure 2 shows blocks acquired by Petrobras or other companies alone or in partnerships. We can see Petrobras’s preference to participate to call of tenders in partnerships with other companies, as the Brazilian NOC has made in average 27% of partnerships during rounds 1 to 4 and 22% during rounds 6, 7, 9 and 10. The reasons of these partnerships were different. For the rounds 1 to 4 companies saw that Petrobras was an associate who had experience with Brazil’s fields and already an infrastructure for onshore and offshore production. During next rounds, private international companies wanted to share their investments and be protected against competition. Also, joint ventures gave them more chances to gain a good acreage. For the Round 0, Petrobras was encouraged to make partnerships, because of some imposed constraints like the long waiting time before the first exploration period. Also, Brazil NOC wanted to be in contact with the production.

Technology transfer has been done by Petrobras’ partnerships with IOCs like Shell, Repsol, Chevron. The Brazilian NOC has succeeded to share risks and the investments that this kind of projects needed, especially for the pre-salt reserves of Santos Basin. Petrobras has also made joint venture abroad, in Venezuela, for the fields Oritupano-Leona, Acema, La Conceptión et Mata, where the government is the mean shareholder.
Rosneft example

Russia has important oil reserves, especially domestically, but the country’s initial reserves have been used at more than 50% (even 65% for the European area of Russia and 70% for Volga and Oural). As for the remaining reserves, at a national and important companies’ level, 77% of the actual oil production comes from depots of reserves that will be out of stock in 8-10 years. The part of reserves which are difficult to recover is increasing and it reaches 30-65% for the most important oil companies.

Rosneft have to face the decline of its mean reserves in Western Siberia and European area. A solution would be the development of Eastern Siberia and Arctic area, but their exploration needs an advanced technology. Rosneft has a privileged access to these areas, it acquired most of the available licenses in Eastern Siberia. In the continental Russian shelf, the company acquired areas in the South of Kara, Laptev, Okhotsk, Barents, Pechora and Black Sea. The company is searching for abroad investments, as the government wants to increase Rosnefts’ role in global economy.

Joint ventures role in Russia’s production has increased with the Sakhalin projects. Two of them are production sharing contracts (Sakhalin-I and II). In August 2011, Rosneft has made a partnership with ExxonMobil for the exploration of Arctic reserves. This cooperation will be extended to the exploration into the Black Sea and the extraction of heavy oil in Western Siberia. Russian NOC will have the possibility to participate in other joint ventures in partnership with ExxonMobil in Canada (Arctic area), Gulf of Mexico’s offshore and in Texas.

We can see in Figure 3 the licenses for which Rosneft participates in partnership with another company, in joint venture or not.

![Figure 5. Licenses owned in joint venture or partnerships](http://www.rustocks.com/put.ptml/lsnt_Offering_Circular.pdf, 14th of July 2006, p. 160) and Management's discussion and analysis of financial condition and results of operations for the eals ended 31 December 2007, 2006 and 2005 (http://www.rosneft.com/Investors/results_and_presentations/)

<table>
<thead>
<tr>
<th>License</th>
<th>Operator</th>
<th>Partner</th>
<th>Rosneft’ share</th>
<th>Geographical location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venineft (Sakhalin-3)</td>
<td>Venineft</td>
<td>Sakhalinskaya Oil Company</td>
<td>49.8%</td>
<td>Russian Far East</td>
</tr>
<tr>
<td>West Schmidtneftegaz (Sakhalin-4)</td>
<td>West Schmidtneftegaz (Sakhalin-4)</td>
<td>BP Exploration Company Limited</td>
<td>51%</td>
<td>Russian Far East</td>
</tr>
<tr>
<td>East Schmidtneftegaz (Sakhalin-5)</td>
<td>East Schmidtneftegaz</td>
<td>BP Exploration Company Limited</td>
<td>51%</td>
<td>Russian Far East</td>
</tr>
<tr>
<td>Kayganneftegaz (Sakhalin-5)</td>
<td>Elvary Neftegaz</td>
<td>BP Holdings International B.V.</td>
<td>51%</td>
<td>Russian Far East</td>
</tr>
<tr>
<td>Kamchatkneftegaz (Kamchatka de l'Ouest)</td>
<td>Kamchatkneftegaz</td>
<td>Korean National Oil Company</td>
<td>60%</td>
<td>Russian Far East</td>
</tr>
<tr>
<td>Blec Temryuksko-Akhtarskiy (Mer d’Azov)</td>
<td>Priazovneft</td>
<td>LUKOIL</td>
<td>42.5%</td>
<td>South of Russia</td>
</tr>
<tr>
<td>Blec Zapadno-Chonsky et Verhneiechersky</td>
<td>LLC Vostok-Energy</td>
<td>CNPC</td>
<td>51%</td>
<td>Oriental Siberia</td>
</tr>
</tbody>
</table>

Bargaining strategy in joint ventures

Joint ventures in oil industry are different from other joint ventures, because there is no joint profit. The common target of the partners is the search of profit or to jointly make operations. Joint ventures in oil industry are usually contractual and they don’t involve the creation of a new entity. Joint operating agreements are the most usual forms of joint ventures in the oil industry.

The relationship between a NOC and a private company involves cooperation and conflict elements. The NOC (the government) and the private oil company have different objectives, values and priorities. The government wants to obtain the maximum welfare from its natural resources, and the private company’s target is to maximize its participation and the welfare by the oil resources that it will find at the lowest cost and the most important margin possible. For the success of a joint venture, these two partners must make the effort to agree on common ground.

Bargaining in joint-ventures using game theory has been studied in the literature by different economists. Rao and Shakun (1974) present a joint venture frame of bargaining between the government of a host country and a multinational company. They use game theory and the bargaining is imagined as a chain of decisional sequences. The two players have the opportunity to make concessions at each step of the game function of each one’s behavior. The bargaining process has also been studied in the literature by Harrigan (1984), who presents a negotiation framework from the mother-company viewpoint, and the factors that can determine the bargaining power of each player. Joint-ventures instability due to intern factors of companies has been studied by Inkpen and Beamish (1997). Their analysis is based on the fact that the bargaining power and the dependency between the two partners can evolve in time. Yan’s (2011) recent article proposes a negotiation model of joint-ventures profits, using as variables the partners’ needs of profits. Game theory is used in order to develop the bargaining process.

Bargaining process helps companies to resolve their disagreements and to work together. NOCs negotiation power comes from the fact that they possess the oil reserves to which private companies want to have access. Private oil companies’ bargaining power relies on their technology, know-how and financial resources that NOCs need to explore the oilfield in areas difficult to access. There are several factors that can influence the bargaining power of an IOC or a NOC. First, of the IOC has a good reputation, it will have a greater bargaining power. The possibility to substitute the country’s host reserves with other reserves gives to the IOC an advantage. But if the IOC had done an unfavorable contractual arrangement with another state, this will limit its power in the negotiation process. Also, a good reserve replacement ratio is a good indicator of the technology level of the IOC, so it will increase its bargaining power. NOC’s reputation in the host country can also bring in some bargaining power. Also, if the resource that the NOC can have access to is scarce, then the NOC will increase its negotiation power.

Joint ventures’ most important point in negotiations is control of the partnership (including its equity structure), followed by technology transfer conditions. Also, valuation of the assets that each party has brought to the joint-venture is important. Other points are discussed, like how to resolve a conflict, joint venture dissolution, transparency.

The partners of the joint venture could decide that in a certain part of the acreage to be explored only the joint venture will have access. Non-exclusive areas could be negotiated, in which both partners could engage in, and also the joint-venture. These non-exclusive areas can be complexes from a commercial, governance and competition point of view. Also, another sensitive point of joint ventures is the projects for each one of the partners don’t agree. In this case, the project will be undertaken by a sole partner (“sole-risk” or ‘non-consent’ project).

Brazilian and Russian NOCs’ strategy in exploration and production sector will remain based on partnerships. They will have to face technological constraints (like the extraction of oil from Tupi field where the company will have to drill until 4800 m under the sea’s floor, through salt and rocks), but also financial (for example, the exploration and production in deep and ultra-deep areas) and materials (existing facilities, wells). Also, the companies will always search to share risk and obtain a good ratio risk/return on investment. Companies who can help them in one of these four fields are a potential partner for these NOCs.
Concluding thoughts

NOCs growing role in the demand-offer game raises questions about their objectives, politics and priorities. The study made in 2009 by Petroleum Intelligence Weekly (PIW) shows that among the first 50 world oil companies, 28 are NOCs. PIW uses five criteria: oil reserves and production, gas reserves and production, refining capacity and products sales volume.

In this era of scarce oil resources, Russia and Brazil continue to make partnerships with IOCs to develop their actual proved resources. IOCs still can teach NOCs how to manage efficiently their teams or a complex exploration project and they are still the most advanced in terms of technology. Technology transfers from IOCs to NOCs haven’t only positive effects. If the property rights are imperfect, the private company might transfer some obsolete process to the state-owned company. IOCs might choose the quality of technology to transfer.

Joint ventures bargaining between NOCs and IOCs remains an interesting game between two players with different objectives. The paradox is that NOCs have to make joint venture to ensure supply security, because they can’t have access to all the reserves otherwise, but in the meantime, they have to protect their reserves from IOCs. So, the bargaining game is difficult for NOCs, because they have to find the right equilibrium.

Van der Linde (2000) sustains that the desire to ensure supply and demand security has sustained the vertical integration and the internalization of oil companies since the beginning of the modern oil industry. China and India’s NOCs make overseas acquisitions to develop their vertical integration degree. But they should demand until when they should integrate, because vertical integration can also bring less flexibility and obsolete technology.

The econometric model that we’ve proposed here to analyze the relationship between oil supply security and vertical integration can be developed by introducing some other variables, like oil transportation by pipeline, tanker, truck. We would then have nine types of supply sources, for each type of transportation. Also, this model could also be used to forecast oil supply security, but some calculations for HDI projections should be made.
References


