

Oil and its markets

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1. Introduction

The oil industry is complex, with production stages that are technically quite different from one another (exploration for new oil fields, oil production, transport, refining, distribution of a variety of oil products) and with significant differences between the crude oils produced in different fields, due for instance to different density or sulfur content. It also displays a set of interrelated problems of different natures: juridical, economic, political, engineering, environmental. Moreover, it is characterised by strong economic and political interests intertwined in an interplay of conflicts and alliances that evolve over time, while technology, the organisation of the markets and their size also dramatically change.

Let us begin with a point raised already sixty years ago by Sylos Labini,¹ and before him by Paul Frankel (1946), a US economist who in the 1960s went on to be a consultant to Enrico Mattei's ENI. All the stages of the oil industry are characterised by a high ratio between fixed

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¹ Sixty years ago the then Italian Prime Minister, Mario Segni, entrusted two researchers with the task of studying the oil market and its legal foundations in some countries who already had a long experience in the field: the US, Canada and Mexico. Their report should have served as a guide for an Italian law on oil research and production. This was a hot topic and pressure was exerted by the American ambassador, Clare Boothe Luce, for a law favouring Exxon. The two researchers, an economist and a jurist, were young but already well known for their abilities and for their autonomy of judgement. The report they presented at the end of their study mission paved the way to a law that, far from being neo-colonial, favoured the development of ENI, the Italian state-owned company, without cutting the major international oil companies out of the Italian market. The report was published in 1956 as *L'industria petrolifera* (Giuseppe Guarino and Paolo Sylos Labini, 1956).



and variable costs, with a sizeable minimum dimension of plant relative to the size of the corresponding market, which constitutes a barrier to the entry of new firms into the market. This barrier is due to the fact that entry of a new plant involves an increase in production. Selling the additional production is more difficult the greater the productive capacity of the new plant as a share of the market itself. It is precisely this element on which Sylos Labini builds his theory of concentrated oligopoly, in his book *Oligopoly and Technical Progress*, originally published in 1956.² We may recall, for instance, the cost of building a new pipeline; or recall that in the 1870s it was precisely thanks to his control over the transport of oil from the production areas inside Pennsylvania to the refineries on the coast that John Rockefeller built his near-monopolistic Standard Oil Trust.

In what follows we shall briefly consider a number of interrelated issues: the early history of the oil sector up to 1952 (§ 2), the golden period of the oil majors (the so-called Seven Sisters) and the interpretative key of trilateral oligopoly (§ 3), the 1973 oil crisis and the increasing importance of OPEC (§ 4), the 1985-86 counter-crisis, showing the limits of OPEC's hold on the markets (§ 5), the increasing role of financial markets in the determination of oil prices (§ 6), a critique of the idea that oil prices are determined by supply and demand, with supply scarcity-constrained, and a look at the notions of proven reserves and ultimately available resources and at their trends over time (§ 7), a brief mention of shale oil as an instance of technical change in the oil sector and its importance (§ 8) and some provisional conclusions (§ 9). Each of these issues would deserve a much more detailed treatment, but this, apart from bringing the article to book-length, would obscure the interrelations between them and the usefulness of the key of trilateral oligopoly for interpreting the present state of the oil sector and its history.

² On the origins and interpretation of Sylos Labini's oligopoly theory, see Roncaglia (2014; 2015).

2. From one anti-trust ruling to another: 1912-1952

The final decades of the 19th century preceded the epoch of mass motorisation or the use of oil as a source of energy: at the time, oil lamps, for which previously whale oil was utilised, were still considered as the most important source of the demand for crude oil. In a not-so-wide market, Rockefeller's advantage was enormous; Standard Oil Trust's market power could only be countered by public intervention. Thus, in 1911 (hence immediately before the beginning of the era of mass motorisation with the start of the epoch-making Ford Model T assembly lines) the US Supreme Court decreed the fragmentation of the Standard Oil Trust into 34 different companies, among them Exxon (also known at the time as Standard Oil of New Jersey) and Mobil (Standard Oil of New York), subsequently merged into Exxon-Mobil.

A period of increased competition followed (even if certainly still far from perfect competition), also thanks to a vigorous growth of the market, with the expanding utilisation of oil as a source of energy. New large companies appeared on the scene, such as Texaco, thanks to the discoveries of giant new Texan oilfields, while outside the US Shell and BP achieved dominance. A price war that began in the Indian market in 1927-28 soon expanded to international markets, bringing about an abrupt price fall with disastrous consequences for oil companies.

What happened in that situation was discovered only years later, by a commission of inquiry of the US Senate on the oil cartel. The commission published their results in 1952:³ the lively text, extremely well documented, revealed the existence of two agreements between the major oil companies, both dating from 1928. The first is known as the Red Line Agreement: a line drawn on a Middle East map by Gulbenkian, the mediator who had brought the companies into agreement, indicating the Middle East area within which the companies had agreed to operate oilfields only jointly and in a regulated way. The second is the so-called Achnacarry Agreement – taking its name from the castle in Scotland where the top managers of the major oil companies had met – providing

³ Federal Trade Commission (1952). See also Blair (1976) and Sampson (1975).

for a coordination of the supply of oil products in consuming countries, on the basis of the market shares prevailing at the moment of the agreement; for instance, the documents collected by the US commission of enquiry include the minutes of the meetings of the local representatives of the major oil companies, where agreement was reached on the bid prices for the auction for the provision of gasoil for the Stockholm public transport system. For Sweden alone, there were more than 50 meetings of this kind every year.

US policy aims at ensuring competition within the country, while reasons of foreign policy appear to justify a benign neglect in the face of a cartel concerning foreign countries. Even within the US, however, when confronted with the expanding production of the giant Texan oilfields and the fall in demand induced by the 1929 crisis, public authorities intervened with the closure of the US to oil imports (with further restrictions introduced in 1959, and an opening of the frontiers only in 1973) and with a prorationing mechanism, namely rotatory closure of oil wells so as to reduce production under the control of a public authority, the Texas Railroad Commission. The US companies that succeeded the Standard Oil Trust were also connected by a web of interlocking shareholdings and interlocking directorates including the major banks as well.⁴

The 'Seven Sisters' – five US companies, plus Britain's BP and the Anglo-Dutch Shell, subsequently joined by France's Elf and, after Mattei's death, by the Italian ENI⁵ – thus continued collaborating in exploiting Middle East oilfields; for a quarter of a century after the end of the Second World War, the prices of crude oil and oil products remained relatively stable, while production and demand grew *pari passu*.

⁴ Cf. Roncaglia (1985, pp. 72-74).

⁵ In the initial stage of its growth, ENI adopted a strategy of opposition to the majors, particularly with major oil purchase agreements with the Soviet Union starting in the second half of the 1950s and with the joint production agreements for Egyptian (1955) and Iranian (1957) oil, embodying better conditions for the producing countries than those generally offered by the majors (Frankel, 1966). Nowadays the debate still goes on, though relations between ENI and the majors had started improving before Mattei's tragic death.

The major oil companies are all vertically integrated companies, namely active in all stages of the supply chain, from research to production, transport, refining and distribution. Notwithstanding their strategic preference for an internal structure as balanced as possible between the different stages of activity, disequilibria have always been present; these were met with long-term agreements between crude-long and crude-short companies, namely between on the one side companies with a production of crude oil greater than the quantities required by their subsidiaries active in refining and distribution, and on the other side companies with the opposite imbalance. As far as the crude oil is utilised internally, the transfer price between the different subsidiaries is determined by the central offices of the company with the aim of minimising the overall fiscal charges; this price is then also utilised by the companies as their official price ('posted price'), though it is well known – as an old saying of the oil industry goes – that 'only fools and affiliated pay posted prices'. As far as the long-term agreements between the oil majors are involved, prices are part of complex agreements including indexation rules, and are a well-guarded secret, though as a rule they involve large discounts compared to posted prices.

The market power of companies gradually decreased as the market expanded and the production shares of countries outside the 'red line' increased (among these, the Soviet Union, Egypt and Libya, on the production of which the expansion of ENI was founded). In 1950 the Seven Sisters plus France's Elf controlled 99.4% of crude oil produced outside of North America and the communist countries; in 1957 this share was already down to 92%; in 1970, a little before the oil crisis and the stage at which Middle East countries acquired control of their oilfields, the share was down to 68.4%.⁶

⁶ Data taken from ENI (1981), table 133b. On the evolution over time of the market structure of the oil sector, in particular on the loss of market shares on the side of the majors in the stage preceding the 1973 oil crisis, see Linde (1991).

3. Trilateral oligopoly

According to the interpretation of various oil experts,⁷ the oil crisis of 1973 marks the end of the dominance of the international oil companies and the beginning of the era of the big exporting countries belonging to OPEC. In turn, this stage lasts up to the 1985-86 counter-crisis, when the price of crude oil collapsed and Saudi Arabia itself decided to leave the task of setting crude oil prices to the market, within a framework of long-term agreements. However, as we shall see, this is a market *sui generis*.

As a matter of fact, market power is always distributed – though with important changes over time – between three groups of agents: the international oil companies, the producing countries (among which the OPEC countries play a leading role) and the biggest consuming countries, the USA in particular. We are thus confronted with what we might call a ‘trilateral oligopoly’: both producing and consuming countries and especially international oil companies are not few, but with an unequal distribution of market shares, so that the main agents within each group exert some market power, especially when they are able to join forces with other agents. Obviously the distribution of market power between groups of agents and within each group changes over time, due to technological, political and economic factors (such as changes in the size of the market). Thus, in order to understand the evolution of the oil sector we may focus on the strategic choices of the stronger agents – the major companies, OPEC countries (Saudi Arabia in particular) and the USA among the consuming countries (taking into account the fact that they are also a major producing country) – and on the evolution of market power between the three groups and within each group.

Trilateral oligopoly (Roncaglia, 1985) should be considered not as a model aimed at determining the equilibrium of the market at any given moment in time, but rather as an interpretative key for reading the evolution of the oil sector over time, focusing on the changes in the power of the major agents, on their strategies, their conflicts and their

⁷ See for instance Adelman (1995).

alliances. This interpretative key is alternative to that, hinted at above and widely adopted, of a sequence of stages characterised by the dominance of major oil companies up to 1973, of OPEC up to 1986, then finally of the 'market', with the prices for the various kinds of crude oil indexed to the price of a reference crude, the latter price being determined in an organised market, hence – it is assumed – reflecting the oscillations of demand and supply. As a matter of fact, as we shall try to show, the three groups of protagonists – companies, exporting and consuming countries – are persistently at the centre of the stage with their strategies, even when one of the groups acquires greater relevance, while reference to a market ruled by the laws of supply and demand is but a misleading tribute to the myth of the invisible hand of the market.

4. The 1973 oil crisis

The dramatic turning point of 1973, marked by the war between Israel and the Arab countries, may itself be read through the lens of trilateral oligopoly. We should recall, in fact, that the embargo decreed by Arab countries on oil exports to Western countries considered allied of Israel does not stand alone; there is also a US decision, the sudden opening to oil imports decided in April 1973, after years of restrictions. As a consequence of this, US demand for Middle East oil grows rapidly, much more than the fall of Arab exports and more than counterbalancing the fall of European and Japanese imports. With a different policy by the US, it is likely that the 1973 oil crisis might have lasted only a few months, with a lesser and only temporary increase in prices.

The price increase also eased the transition in ownership of the giant Middle East oilfields from the international oil companies to the Arab countries, with compensation and cooperation agreements for the joint management of the oilfields. In other terms, the dominance of OPEC in the period from 1973 to 1985 was made possible by the strategic choices of the biggest consuming country, the USA, and by the continuous cooperation of the international oil companies.

Of course, the traditional international oil companies, vertically integrated, found themselves heavily unbalanced, with the upstream squeezed in favour of the national oil companies of oil exporting countries, such as Petromin in Saudi Arabia, and in a lesser measure in favour of ‘independent’ companies, while the downstream more or less retained its original size. As an immediate reaction, the international companies entered into long-term purchase agreements with exporting countries; then, they started looking for additional reserves in new areas, even if technologically difficult ones; all this notwithstanding, gradually their share in oil product markets decreased to the advantage of the new entrants but also to the state companies of producing countries who in turn tried to expand in the downstream (as did China, a great importer of crude oil, who recently became net exporter of oil products). The process of vertical re-integration on the side of traditional international oil companies is still under way, even if most recently in some cases the companies appear to be pursuing it with lesser determination, keen to renounce to it when confronted with excessive technological difficulties or with political uncertainty and insecurity (as in the case of the withdrawal from oilfields in the Nigerian mainland).⁸

5. The 1985-86 ‘counter-crisis’

Already in the golden period of OPEC, in the years following the 1973 crisis and the 1979 Iranian crisis, the control of OPEC countries over the oil sector was far from absolute. Their market share was gradually eroded by countries outside of OPEC, among them the Soviet Union, or the United Kingdom with their North Sea oilfields, or Nigeria; but there was also a creeping competition inside OPEC itself, a cartel much less solid than the interpretation of events in the oil sector based on a succession of stages illustrated above would like us to think.

As a matter of fact, the weight of the control of the market was left to fall on Saudi Arabia alone, on the grounds that it has enormous

⁸ See for instance Macalister (2014).

reserves and very low production costs, but also a limited population, so that it could allow itself not to exploit its oilfields at the maximum rate. Thus, in order to avoid excess supply, Saudi Arabia gradually decreased its own production, from 10 to 2.2 million barrels per day in the interval between the end of the 1970s and August 1985. At that point, however, both for strategic reasons of defence of her market share and for simple reasons of economic opportunity, Saudi Arabia abandoned her role as a swing producer (the producer who has the task of bringing supply into parity with demand) and duly increased her production and let the price of oil precipitate.⁹

A stage characterised by deep changes in the organisation of the market then followed. The price-setting system on the side of OPEC was abandoned. It was a system based on implicit collusion: as it happened at the time of dominance of the major international oil companies, the so-called posted prices were official prices, with the difference that earlier they were set by the companies while post-1973 they were set by OPEC. However, as already recalled above, ‘only fools and affiliated pay posted prices’: everybody else would buy crude oil at prices that were kept secret but that were generally inferior to the posted ones, while at the end of the chain the oil products were sold at prices computed on the basis of the posted prices, with the addition of refining, transport and distribution

⁹ On this stage cf. in particular Adelman (1995, ch. 7); the essays collected in Kohl (1991) and especially Al-Chalabi (1991) and Askari (1991). Let us notice that there seems to be a cyclical element in this pattern: in the past few years, up until recently, Saudi Arabia had once again accepted the role of swing producer, increasing her production when extraction was reduced in other parts of the world, mainly due to political upheavals or wars (Libya, Iraq, ...) and reducing it when the opposite conditions prevailed. Saudi Arabia’s production was again around 9.5 million barrels per day in August 2014, less than the target rate that in the absence of explicit declarations on the side of Saudi authorities may be set around 12 billion barrels per day. In this situation, further reduction in production was still acceptable to the Saudis, but beyond a certain limit the moment of a change in strategy arrives. This is what I predicted at the Lincei conference where this paper was originally presented in April 2014, and this is in fact what happened in subsequent months. Once again, as in 1985-86, the change in strategy of Saudi Arabia, with the abandonment of the role of swing producer, gave rise to a strong and relatively sudden fall in prices, even if this time the floor was higher than on the previous occasion – though lower than most commentators had foreseen.

costs, so that all agents active in the sector realised a healthy profit margin.

After abandoning the system of posted prices, initially Saudi Arabia chose a system of ‘netback pricing’, namely crude oil prices deduced from those of refined products, so as to guarantee a profit margin to the refineries utilising Saudi crude: a system which breaks the collusive mechanism and opens the door to real competition in the markets both for crude oil and for oil products. The new system favoured the drastic fall of crude oil prices, and was quickly abandoned.

In a few months, with the cooperation of the other producing countries and the oil companies, there was a shift to a new system, so-called ‘formula pricing’, in which the prices of the different types of crude oil are determined, with the addition of a specific differential, by the price of a reference crude, in most cases (market gossip says about 70% of internationally traded crude oil) Brent, a North Sea oil lifted in Scottish waters. This is the system still in use, though with some important changes, in particular the shift from reference to a physical market to reference to a financial market for Brent derivatives.

6. Financial markets and the price of crude oil

The system by which the reference price for crude oil – the so-called ‘marker price’ – is determined is a complex one; here we shall leave aside some aspects, for the sake of simplicity, such as the choice of the reference crude.¹⁰ Suffice it to recall that there are different reference crudes, though Brent ended up being adopted in the majority of cases. Other reference crudes of lesser importance are Dubai, a crude oil lifted in the Arab peninsula and mainly sold in Asian markets, the price of which is set as a differential to Brent, and especially West Texas Intermediate, a crude oil only utilised within the USA that maintains some margin of independence relative to Brent.

¹⁰ On this aspect, and more generally on the system by which the price of crude oil has been determined in the most recent stage, cf. Fattouh (2011) and Carollo (2012). On the first stage of development of the Brent market, cf. also Horsnell and Mabro (1993).

Thus, let us focus our attention on Brent. In a first stage, up to about 1996, the reference price was the one referring to physical exchanges, more precisely to a standardised contract known as ‘Dated Brent’, concerning crude to be lifted on oil tankers in the subsequent month, so that the same cargo of Brent can be the object of many exchanges, with a chain of buyers many of which in fact do not want to end up receiving physical crude and with complex rules to establish – through a succession of so-called *nominations* – who remains ‘with the match in his hands’ at the end of the day, the so-called ‘five o’clocked’ party, since the end of the game is called exactly at 5 p.m. of the last day of trading before the cargo is assigned to a buyer.

Differently from Middle East oil and from oil from other countries sold through multi-year agreements, Brent sales concern standard cargoes, each of 600,000 barrels; this means only a few cargoes each week, moreover a decreasing number of cargoes as Brent oilfields approach exhaustion; thus, other kinds of crude have been taken into consideration over time, always from North Sea oilfields; now there is some talk of also considering African crudes, with obvious problems due to different quality levels and geographical localisation. The contracts concerning dated Brent are ‘over the counter’, namely direct agreements between an individual buyer and seller; moreover, buyers and sellers alike do not have any obligation to communicate to anybody the price at which the cargo of crude is sold, and there are no penalties for false communications. The so-called PRAs or price reporting agencies (the main ones being Platts and Argus), collect the information and publish the reference price each day, which is then accepted by the market as an official price: even if, when confronted with enquiries concerning the opacity of the whole procedure, Platts – the most important of the two – answered that they simply perform a journalistic role in disseminating price information, and not an active price-setting role.¹¹

With the decreasing frequency of physical exchanges, in order to set the price day after day Platts adopted complex valuation rules, at least partly subjective and modified again and again over time. In more recent

¹¹ See for instance Blas (2013).

years a growing role has been played by the price set for the Brent futures contract in London's International Petroleum Exchange: a standardised contract of a purely financial nature, not giving rise to physical exchanges of crude. Dealings in this market are many times (27 times, in the recent period)¹² those in the dated Brent market, though the same cargo is the object of many dealings in this latter market as well.

The price set by Platts for an intermediate market, the so-called 'Brent forward', is taken as a reference for the closure of the futures contracts; there is thus a dangerously closed circuit, on which the European Commission has recently focused attention,¹³ though their enquiries will most likely take a rather long time to be completed. More precisely, according to the interpretation of an oil expert, Bassam Fattouh from the Oxford Institute for Energy Studies (Fattouh, 2011), the price determined in the Brent futures market is connected to the price of dated Brent through two steps, both involving over-the-counter markets, for which we have at our disposal only assessed, not observed prices (with prices assessed by the PRAs, in particular by Platts): the so-called 'exchange for physicals', in which a future contract is exchanged with a 'Brent forward' contract, and the CFD, 'contract for differences', connecting 'Brent forward' to 'dated Brent'.¹⁴ These latter markets moreover are dominated by very few operators: in the dated Brent market the four major buyers account for more than 70% of total trading (Fattouh, 2011, p. 423). At the theoretical level it is impossible to establish the direction of cause-and-effect relations; at the practical level, the financial market for futures is considered the centre of the system – a system that on the whole remains far from being transparent.¹⁵ Since July

¹² Carollo (2012, p. 16). Carollo's book, apart from illustrating the 'physical' Brent market and its relation with the financial markets connected to Brent, considers the instability of crude oil prices subsequent to the 2008 financial crisis, with a fall from around 150 to around 40 dollars per barrel followed by an ascent to well above 100 dollars again at the time of the writing of his book, and points to the possibility of manipulations in the forward Brent market, in particular to the so-called 'market squeeze'.

¹³ See for instance Makan and Blas (2013).

¹⁴ For a detailed technical analysis of the wide spectrum of financial markets dealing with energy products, cf. Kaminski (2012).

¹⁵ As for many other financial markets, commentators tend to rely on the virtues of competition (in our case, competition among the price reporting agencies, though in a

2000 Saudi Arabia utilises as a reference an index directly computed on Brent futures, while most international oil companies still prefer the prices assessed by Platts.

7. The price of oil: demand, supply and scarcity

Reference to markets where the price is determined on the basis of supply and demand allowed the cultural dominance of a rhetoric of competition, forgetting the complex nature of the international oil sector, as if the financial markets or the market for dated Brent, which only constitutes a very small segment of the overall physical market, and with its own specific characteristics, would truly be able to determine the price of crude oil by taking into account the ‘fundamentals’ regulating the movements of overall supply and demand.

Reference to the ‘fundamentals’ is in fact rather vague. Agents active in the oil markets or newspaper commentators are thus able, when commenting on the day-to-day events in the market, to explain price levels and movements by quoting the most disparate pieces of news, once the halt to production in Libya, once the slowing down of the Chinese economy, and so on. The underlying theoretical model appears to be one based on demand and supply curves, the first one decreasing and the second one increasing with the price; the point where the two curves meet determines, at each moment in time, the equilibrium price level. Current news may be interpreted as movements along the one or the other of the two curves, or as their shifts in the price-quantity space; the effects on crude oil prices then obviously come to depend on the estimates of the shift along or of the curves and of their inclination.

As a matter of fact in the market for physical crude oil, supply and demand are not independent from each other: as in the case of the car

sector which as we saw is characterised by a high degree of concentration, with positions of absolute dominance in the different segments of the market) in order to maintain that regulation and oversight on the part of public authorities is not necessary, considering the importance of reputation for the PRAs. Cf. for instance CEPS (2013, pp. 98-99). The 2007-2008 world financial crisis, which followed the liberalisation of financial markets, seems to constitute a not as yet learned lesson.

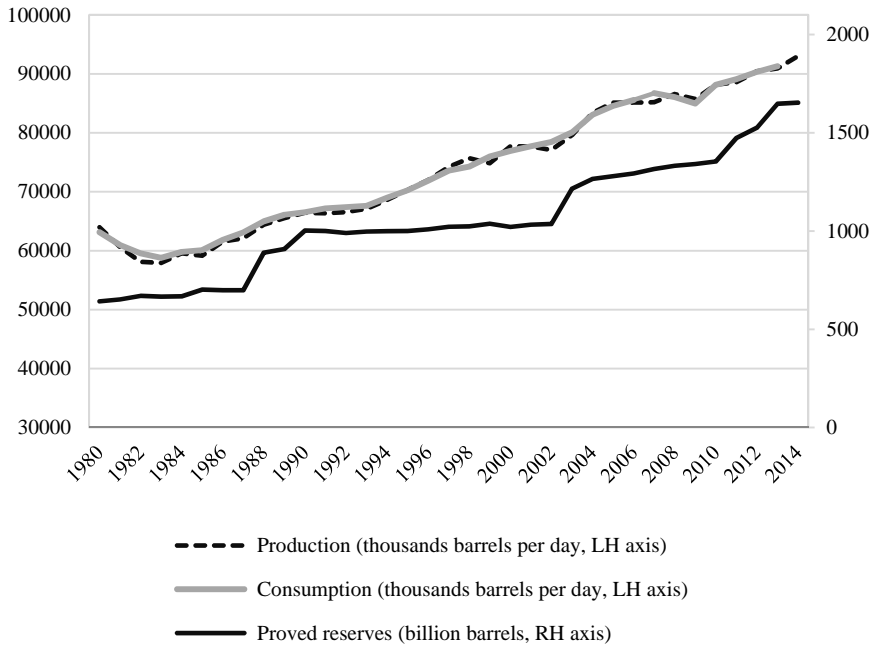
industry, or of so many other reproducible commodities (in particular in the case of oligopolistic markets),¹⁶ production follows demand, with inventories cushioning unforeseen movements in production and consumption.

The supply changes required for meeting in a continuous way the shifts in demand are ensured by commercial inventories, kept by producers, refiners and by the managers of transport infrastructures (such as those at the main terminal of the pipeline system for West Texas Intermediate at Cushing, Oklahoma). Oilfields represent an inventory themselves, when, as commonly happens, the pace of extraction can be changed in a very short time. There are then strategic inventories held by public authorities; in particular, US strategic reserves oscillate at around 90 days of consumption.¹⁷

The main rhetorical commonplace of demand and supply is the one presenting oil as a scarce natural resource. Obviously everything is scarce, namely available in a limited quantity at a given moment in time; what matters in our context is economic scarcity, which does not exist in the case of reproducible commodities, as for agricultural and manufacturing products, the production of which can be increased whenever demand grows (provided that intended buyers are able to pay for the commodity), if only unemployed workers and unutilised productive capacity are available, as most certainly has been the case over the past few years. As a matter of fact, oil can be included among these commodities: as figure 1 shows, its production increased *pari passu* with its utilisation; its reserves grew over time, more than doubling in about thirty years; its exhaustion is sufficiently far away as to not have any meaningful influence on the path of prices today.

¹⁶ Cf. Sylos Labini (1956).

¹⁷ In order to estimate the security margin guaranteed by strategic reserves we may consider a simple example. When Iraq invaded Kuwait and the Kuwaiti production disappeared from the market all at once, if we assume (with a simplification not far from reality, here chosen for ease of computation) that for a country like Italy crude oil imports from that country represented 10% of national consumption, it would have been possible to fully substitute oil imports from Kuwait by drawing on inventories for about 900 days: a period of time more than sufficient for a solution to the problem (the return of Kuwait to the market, an increase of crude oil exports from other countries or a reduction in consumption) to present itself.

Figure 1 – *Production, consumption and reserves*

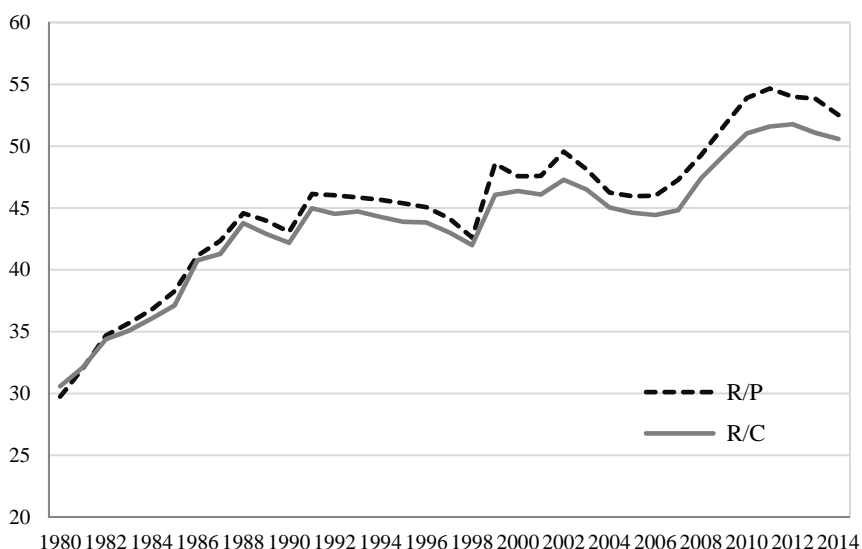
Source: US Energy Information Administration (EIA).

The thesis of the imminent exhaustion of crude oil comes to the fore again and again over time. In 1972 a report of a MIT research group financed by the Club of Rome (Meadows *et al.*, 1972) foresaw its exhaustion within 18 years, namely by 1990. In the last decade there has been increased attention paid to the so-called ‘peak theory’, namely the imminent (or already passed) transition through a peak of production in existing oilfields accompanied by the impossibility of discovering new oilfields at a pace sufficient to cover the loss of production in already active oilfields.¹⁸ However, when we look at the data (tables 2 and 3),

¹⁸ The first proponent of the ‘peak theory’ is Hubbert (1969), a US geologist and author of detailed forecasts on the path of reserves and oil production. The peak theory has then

proven crude oil reserves expressed in years of residual production at the current pace of production are today higher than they were twenty or fifty years ago: half a century ago they oscillated around thirty years of production, now they constitute around fifty years of production, with a tendency of the ratio to increase in the past few years (possibly also as a consequence of the efforts towards vertical re-integration on the part of the major international oil companies).

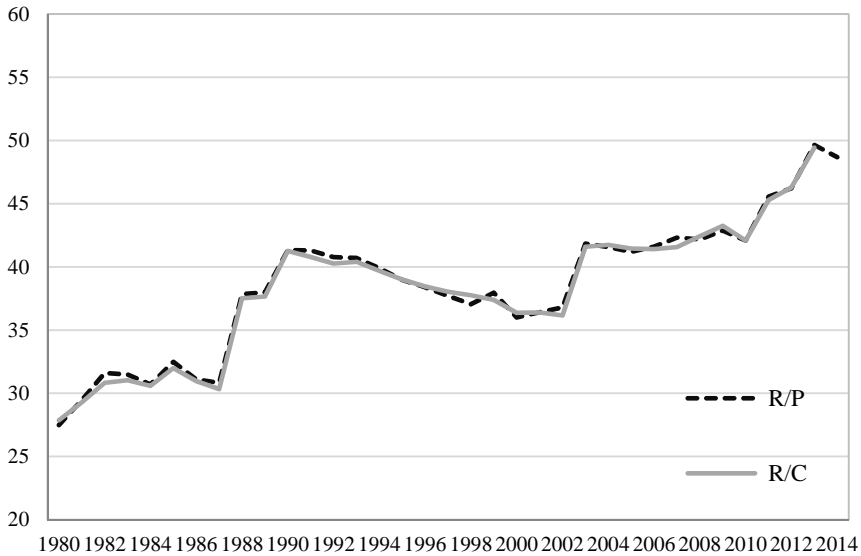
Figure 2 – *Proved reserves (R), in years of production (P) and consumption (C)*



Source: BP (2013), *Statistical Review of World Energy*.

been repeatedly re-proposed (for instance by Campbell, 1997). Its main defect is that it ignores – because of its unforeseeable nature – the progress in exploration technology and in the technology of oilfield exploitation. As a matter of fact, the forecasts based on this theory are commonly considered as ‘pessimistic’ (cf. the survey by Ahlbrandt, 2006).

Figure 3 – *Proved reserves (R), in years of production (P) and consumption (C)*



Source: US Energy Information Administration (EIA).

The difference between the two graphs, though not enormous, is due to the different estimates of the two sources.¹⁹ This points to the difficulty of statistically estimating variables such as proven reserves, though defined in a precise way as reserves the location, size and characteristics (quality of crude, depth and pressure of the field) of which are already known, and on the basis of such data it has been confidently decided that they are economically recoverable with known technology at a prevailing price-cost relationship. This means that proven reserves are a sort of shelf inventory for oil companies, a necessary means of production that can be

¹⁹ International oil companies, BP in this case, have a vested interest in providing optimistic evaluations of their own proven reserves, since such data affect the evaluation of their shares in the stock exchange, while official estimates (in our case, those of the US Energy Information Administration) tend to be more conservative.

produced, through exploration activity for localising new oilfields or through further development of already known oilfields.²⁰ Technical progress allows for the extraction of a larger share of the oil available underground; as a matter of fact, this has been the most important element in determining a continuous and large increase of proven reserves.²¹ In more recent years, technical progress allowed exploiting so-called unconventional reservoirs: ultra-heavy crude such as that in the Orinoco Belt in Venezuela, tar sands as in Canada and recently shale oil (or shale gas) in the USA and elsewhere, as we shall better see in the following section.

The traditional definition of proven reserves, recalled above, has been traditionally accompanied by a definition of ultimately available resources: a highly speculative notion, open to wildly different evaluations (obviously much higher than – commonly a multiple of – the evaluations of proven reserves), though at the theoretical level it is the one connected to the idea of oil as a scarce natural resource. This dichotomy, however, is now making way for the use of more refined definitions, such as the partition into nine categories adopted by the IEA (2013, pp. 37-39). Most importantly, in the case of ultimately available resources the estimates tend to grow over time, due to a systematic under-evaluation of the potentialities of technical progress.²²

In the case of oil, in fact, there has been a repetition of what happened with coal: around the middle of the 19th century, one of the protagonists of the marginal revolution, Jevons (1865), considered its

²⁰ Cf. Roncaglia (1985, pp. 27-28).

²¹ The share of oil that can be lifted on average from oilfields went from about 10-15% in the years 1960s to the 50% and more obtained in more recent years in some oilfields, for instance in the North Sea. On the role of technical progress in increasing proven reserves, see IEA (2013).

²² Estimates of ultimately available reserves are continuously provided by private experts and by institutions in the sector such as the International Energy Agency. An idea of the evolution over time of such estimates may be obtained by comparing those by Odell (1970 and subsequent editions), which at the time were considered very optimistic, with the survey by Ahlbrandt (2006) and finally with the recent ones by the IEA (2013, pp. 37-39), according to which ultimately available resources are about 3.5 times proven reserves; all these estimates are always presented in a cautious way, as surrounded by a fog of uncertainty, mainly due to the unforeseeable nature of technical progress.

exhaustion imminent, with dire consequences for manufacturing activity; on the contrary, technical progress brought not only an enormous increase in coal reserves, but also to the substitution of coal with other sources of energy on many accounts superior to it, like oil or natural gas, but also nuclear energy and renewable energy sources.

The nature of oil as an exhaustible resource, thus, cannot influence its current price: exhaustion is too far away in time (more than a century, according to the more reliable estimates of ultimately available resources), and moreover it appears to be shifting continuously further and further into the future. In this way we may exclude that the price of oil is determined as predicted by the Hotelling theorem (Hotelling, 1931), according to which the price of an exhaustible natural resource must grow over time at a rate equal to the interest rate, so as to reach, when the resource will be totally exhausted, a level sufficiently high as to ensure its full substitution with other means of production and consumption. The theorem may be applied to a situation in which the amount of the resource ultimately available is known with sufficient certainty and the exhaustion is foreseen to take place in a sufficiently short span of time; if this does not hold, uncertainty stemming from the impossibility of foreseeing the effects of technical progress makes the theorem irrelevant.²³

If the oil market were a fully competitive one, prices should be determined by production costs, more precisely by marginal costs. As is well known, this requires the assumption of increasing marginal costs both for individual firms and for the industry as a whole. However, as noticed above, the weight of fixed costs in the oil sector is such as to render totally implausible the assumption of increasing marginal costs for the individual firm, and it is well known that the case of decreasing marginal costs is incompatible with the assumption of competition.

The existence of an increasing supply curve for the oil sector as a whole is commonly argued by recalling the Ricardian theory of rent: the increase in production, especially in the case of an exhaustible natural

²³ For a detailed exposition of the Hotelling theorem and of the assumptions on which it is founded, cf. Dasgupta and Heal (1979, pp. 153 ff.), who conclude (p. 191): "if the stock is large an extracted resource is much like a conventional produced commodity".

resource, requires recourse to less and less ‘fertile’ fields.²⁴ However, this solution also relies on shaky foundations: the Ricardian theory of rent refers to the whole agricultural sector, not to a specific productive sector, and its objective is not the determination of the equilibrium of the individual firm but rather the determination of a distributive variable, the rent accruing to landowners; its application to a specific productive sector encounters insurmountable difficulties, as was shown by Sraffa (1925).²⁵

As a matter of fact, oil prices are even nowadays above production costs in most of the main costly oilfields. We should rather say that it is current prices that determine marginal cost, allowing for the exploitation of high-cost oilfields, while oilfields with much lower production costs – such as the Middle East oilfields – display large margins of unutilised productive capacity.²⁶ Prices are also quite unstable, which hinders investment in frontier-technology oil, such as shale oil outside of the US or deep-water fields.²⁷

²⁴ For a more complex attempt at building the notion of a ‘marginal barrel’ based on the notion of ‘maximum economic finding cost’, cf. Adelman (1972; 1995). See Roncaglia (1985, pp. 40-44) for an illustration of this theory and its critique.

²⁵ Once again let me refer to Roncaglia (1985, pp. 36-40) for a more detailed illustration of this criticism.

²⁶ Cost estimates are numerous and are very uncertain (and indicate large differences between the different oilfields). However, even the highest ones (such as those by IEA, 2013, pp. 227-230) turn out to be much lower at current prices. The most optimistic ones (such as those by Golombek, Irarrazabal and Ma, 2014, p. 37) indicate costs lower than 10 dollars per barrel (at 1996 dollars) for OPEC oil and less than 14 dollars per barrel for non-OPEC oil. Obviously errors in the estimates or unexpected events may cause higher costs for some oilfields. A well-known example is the Kashagan Field in Kazakhstan, where after a number of postponements production still has not begun: the project is kept alive mainly because the enormous investment expenditures undergone up to now are to be considered as sunk costs that cannot be recovered if the project is dropped.

²⁷ The theme has been repeatedly recalled in the debate; the idea of an international fund for stabilising the prices of raw materials was advanced by Keynes in the 1940s and by his followers, like Kaldor, in the 1960s. Cf. Sabbatini (1989) for an illustration of these proposals and Roncaglia (1991) for their application to oil. Occasionally, when confronted with strong tensions in the oil market, recourse to the extensive US strategic inventories has been suggested for the purpose of stabilising prices.

8. Shale oil

It may be useful here to open a parenthesis, in order to consider the recent shale oil revolution:²⁸ a technology utilised with good results also for natural gas, that in recent years allowed for a large increase in production in the US. As a consequence of this, the price of West Texas Intermediate is now noticeably lower than that of Brent, a relatively inferior oil. This implies an advantage for the US petrochemical industry: an advantage increased by the relatively low price of natural gas in US markets, thanks to the fact that outside of the US, gas prices are commonly indexed to crude oil prices in the context of long-term supply agreements, which hinders a competitive pressure for lower prices. The advantage for the USA is strong especially in high-energy industries, such as the petrochemical industry,²⁹ paper and steel, but is by now clearly perceivable in other sectors of the economy as well, favouring US re-industrialisation and the recovery of that economy.

Price indexation of gas to crude oil might make sense if the two commodities were to constitute a single fully competitive market with well-established technologies. On the contrary, when considering the gradual expansion in the recourse to natural gas as an energy source, which is part of a sequence of technological transitions towards superior sources of energy – from wood to coal, from coal to oil, from oil to natural gas and renewables – and above all when considering the non-competitive nature of oil markets, the indexing of natural gas to crude oil appears as a way to transfer to the natural gas market the oligopolistic control obtained in the crude oil market: a system which favours big producers like Gazprom but which can be accepted by the big buyers like ENI or Enel only until these succeed in transferring to final buyers the higher gas prices, and in any case a system which only delays the technological transition, with negative repercussions also on the environmental front.³⁰

²⁸ The term ‘revolution’ has been used by Maugeri (2012) and is by now in common usage in the debate.

²⁹ On the crisis of the European refining industry cf. Carollo (2012, pp. 131-154).

³⁰ Cf. Guarini (2015).

Shale oil represents a new source of crude; its production exploded over the last few years, bringing the US towards the status of important exporting country, with a radical change in perspective for the whole international oil market. Not only this: while producing shale oil will likely be difficult in Europe, for environmental reasons (some projects in Poland were soon abandoned at an infant stage), China seems to be eager to utilise this new technology on a large scale, with results that may be more significant – measured on quantities produced – than those of the US. Brent prices – differently from those for West Texas Intermediate – appear up to now to be curiously insensible to the perspectives that this new technology is opening.

9. Hypothetical conclusions

In financial markets like the IPE, where exchanges of derivatives related to Brent are concentrated, prices are determined on the basis of very short period views and strategies: one buys when foreseeing a price increase in the next day, or hour, or few minutes. What happens subsequently, on the time scale of some weeks or some months, operators on these markets do not care about: as Keynes said, even if I foresee exactly what will happen over the long run, the market is able to bring me to bankruptcy if it takes too much time to reach the ‘right’ price. There is nearly nobody left who believes in the theory of efficient financial markets (Fama, 1970), according to which prices of financial assets reflect at every moment the so-called fundamentals, namely the elements underlying supply and demand: this theory, which brought the Nobel prize to its author, holds rigorously speaking only under wholly unrealistic assumptions, as we have been able to verify repeatedly, in particular during the course of the financial crisis.

Keynes added that financial markets are dominated by conventions driving agents’ decisions. The dominant convention, nowadays, in the financial markets dealing with Brent derivatives, is that the price is determined by demand and supply movements. Notwithstanding the feeble theoretical foundations of this convention (discussed above, in §

7), each agent will continue to adhere to it while convinced that other agents adopt it as their guide.

This means, for instance, that agents pay extraordinary attention to a few elements: the political vicissitudes of producing countries, hence the risks of an exit, even if partial and temporary, of some of them from the market; the changes in inventories, in particular the data on US inventories held in the pipeline node of Cushing, Oklahoma (other data are quite often largely unreliable: much as if in the world market for cars the daily price were to be determined by agents speculating in derivative markets conventionally looking at the data on car inventories in General Motors factories alone); and finally to the path of GDP in the main consuming countries, such as China. Occasionally other developments are considered, for instance on the advances in shale oil production. More than the quantitative size of the influence on demand and/or on supply of each of these developments, too difficult to estimate especially in the very short time span available to agents for taking their decisions, what matters is the sign foreseen for such influence; the financial operator knows that s/he will earn a profit if s/he is the first or in the very first group to move in the direction that will be followed by the mass of other operators, however right or wrong this direction might prove to be in the longer time horizon.

In markets where the presence of the major oil companies is noticeable, the news of a fall in inventories or the expectation, more than any actual announcement, of cuts to production or a rise in demand, pushing prices upward, appear to have systematically a greater weight than news of an opposite development: as it is well known, in financial markets the formation of speculative bubbles is very easy. In any case, as we tried to show above, this mechanism of price formation has very little to do with the 'real' conditions of the oil sector.

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