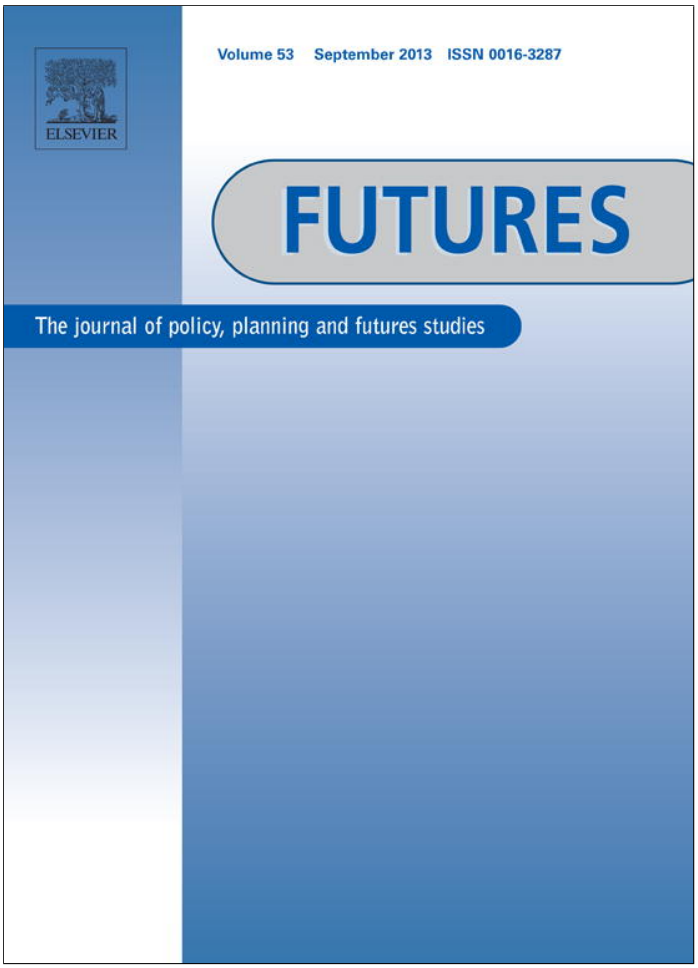

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Peak oil supply or oil not for sale?

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ABSTRACT

The restrictions imposed by climate change are inevitable and will be exerted either via precautionary mitigation of (mainly energy-related) CO_2 emissions or via irreversible impacts on ecosystems and on human habitats. Either way, oil markets are bound to incur drastic shrinking. Concern over peak oil *supply* will crumble when the irrevocable peak oil *demand* is created. Replacing oil in the world's energy economies requires redirected market forces, notably in the form of steadily increasing oil end-use prices. Yet, thus far, crude oil prices have obeyed the market fundamentals of expanding-contracting demand and oligopolistic supply. A hockey stick supply curve supports high sales prices, providing large rents to submarginal sources. Cutting oil demand and maintaining high prices implies reducing the supply hockey stick's length by curtailing some oil producers. In such a scenario, the alliances, goals, and tactics of oil geopolitics are set to change. We identify a distribution over friendly and hostile oil suppliers, with others drifting in between the two sides. Conflicts and warfare are less aimed at conquering oil fields for exploitation than at paralyzing production capabilities of opponents or of unreliable transient sources. Covert warfare and instigation of internal conflicts are likely tactics to exhaust hostile opponents.

1. Introduction

Recent studies have demonstrated that there is a close relationship between oil and conflict. Ross [55] finds that resource-rich countries, a category that includes oil producers, are more than twice as likely to be plagued by civil wars than comparable resource-poor areas (see also [30,39]). Colgan [10] shows that at least one quarter of all interstate wars since 1973 are connected to oil, though he adds that not all of these conflicts are caused by oil nor is oil the only causal factor in any of them. The seemingly endemic unrest and war in the wider Middle East further testifies to the explosive potential of oil to stir geopolitical tensions and conflict.

Many observers interpret such conflicts as part of a global struggle to obtain cheap oil resources, with countries "addicted to oil" in the vanguard. They often expect more militarized conflicts or "resource wars" in the future as a result of dwindling reserves, with peak-oil supplies allegedly dooming on the horizon [14,24,33,34,36,54]. We concur that oil reserves have a significant potential to stir or shape geopolitical tensions and conflict, yet not because of their scarcity but because of their abundance. Contrary to the prevailing discourse of nearby peak-oil supply as a driver to more conflict, this article joins the

Abbreviations: b, barrel of crude oil; Gb, Giga or billion barrels (10^9); Tb, Terra or trillion barrels (10^{12}); GCC, Gulf Cooperation Council with as members Saudi Arabia, the Emirates, Qatar, Bahrain, Oman, Kuwait (also named: The Cooperation Council for the Arab States of the Gulf).

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perspective of an oil surplus: there is too much oil available in a world that should head for increasingly tighter limitations on the use of oil to bypass the cliff of irreversible climate change.[1]

The restrictions imposed by climate change are inevitable and will be exerted either via precautionary mitigation of (mainly energy-related) CO_2 emissions or via irreversible impacts on ecosystems and on human habitats. Either way, oil markets are bound to incur drastic shrinking. If meaningful CO_2 mitigation policies are put in place, oil demand will be severely trimmed. According to the IEA [25: 553], world oil demand would need to shrink by at least 0.4 percent on average each year between 2010 and 2035 to keep global warming below 2 °C. The agency adds that no more than one-third of proven reserves of fossil fuels can be consumed prior to 2050 if the world is to achieve that goal. In other words, two-thirds of the world's fossil fuel reserves must remain in the ground [26,27]. If, by contrast, no serious mitigation policies are implemented, climate change will accelerate. While this may unlock new oil provinces in the mid-term (e.g., in the Arctic),[2] it will likely destroy oil demand as the costs of global warming spiral out of control (loss of coastal cities, slumping economies, etc.).[3]

Current developments suggest that the world's major economies are not adopting consistent policies that push for a swift and deep transition away from oil and fossil fuels in general [45]. Climate change is a major global collective action problem. The USA, being strongly oil-addicted, did not ratify the Kyoto Protocol. In spite of the Kyoto commitments by other major economies, the IEA recently showed that today's global energy supply is as carbon-intensive as it was in the 1990s [26] and that the world is on track for a temperature increase of between 3.6 °C and 5.3 °C [27]. The agency also sees global oil demand climbing from 87.4 mb/d in 2011 to 99.7 mb/d in 2035 [25]. Moreover, the boom in shale and tight oil and gas production, particularly in North America, has unlocked new reserves (as well as immense carbon and methane deposits) that were previously unreachable.[4] While some voices still see oil supply peaking despite the shale boom (e.g., [7,11,50]), there seems to be a broad consensus that the world is not running out of oil and that oil demand will continue to grow for the foreseeing decades.

At the same time, however, some analysts believe that oil demand has peaked or is about to peak. Citigroup [8] expects oil demand to level off by 2020, caused by the combination of high oil prices; gas-for-oil substitution in ships, power stations, petrochemical plants and household and industrial heating systems; the removal of fuel subsidies; and, last but not least, increased fuel economy. The shale gas revolution, along with new discoveries of vast conventional gas fields, has recently helped to make gas a tough competitor for oil. Ever-tougher fuel efficiency standards are being adopted in the OECD, but also in emerging economies.[5] In the OECD, oil demand has already fallen from 50.1 mb/d in 2005 to 45.5 mb/d in 2012 [1].

While the oil majors and the IEA disagree with this perspective of a demand peak, this article conducts a thought experiment by taking the view of an imminent demand peak as a given and examining its geopolitical consequences. Thus, we are not confronting alternative futures or scenarios but we are conducting "prefactual reasoning" by asking a "what if" question about the future of oil geopolitics [46].[6] What if oil demand has indeed already peaked or is about to peak? We find that the prospect of an impending cap on oil demand casts a whole different light on the geopolitical conflicts that take place in oil-rich areas such as the wider Middle East. Rather than being struggles to gain access to a declining resource, we argue that these conflicts revolve around the unlocking or closure (not necessarily the exploitation) of production fields for global markets in order to obtain the maximum revenues (rents) from the limited oil quota left over for human use in the coming years.

Explicitly [37] or implicitly [65], many scholars and journalists distinguish between "friendly oil sources" and "hostile oil sources".[7] Cataloging oil sources in "friendly" (countries that accept and protect foreign investment [64]), "hostile" (the opposite of friendly), and "transient" (drifting between both extremes) is key to explain actual propaganda, positions and moves in oil geopolitics. Since several years, the axis US (with NATO allies) – Arab Gulf States (assembled in the Gulf Cooperation Council) represent friendly oil. Hostile oil is led by Iran with a few committed allies (e.g., Venezuela). Many oil export countries are drifting between the extremes, but explaining every case's position requires a cocktail of domestic and international geography, geology, demography, history, culture, religion, economics, and politics.

The strategic goal of Western countries and their Arab allies is to cover global oil market demand as much as possible with friendly oil charged at high prices, at the expense of hostile oil. This way, their sales revenues are maximized, and they capture part of the added value of competitor economies highly dependent on oil imports (Japan, China, and other Asian growing economies). The corollary of the strategy is to block market access for hostile oil sources and to keep production

[1] All fossil fuel markets are bound to shrink due to the limitations imposed by climate change. Yet, our focus on oil is justified because oil is the leader of the hydrocarbons band and it assumes a representative role for all fossil fuels.

[2] A recent study found that the Arctic may be completely ice-free during summertime as early as from 2020 [71].

[3] The Stern Review estimates that, "if we don't act," climate change could strip "at least 5% of global GDP each year, now and forever" [62].

[4] The successful extraction of methane gas from frozen undersea deposits of methane hydrates by a Japanese research group in March 2013 opens the prospect of adding even more carbon to the current pool of reserves, which is already larger than the world can afford to burn if the 2 °C goal is to be met.

[5] See also, "The Future of Oil: Yesterday's Fuel," *Economist*, August 3, 2013; Javier Blas, "Peak Demand Theory Shakes Up Oil Debate," *Financial Times*, April 2, 2013; Nick Butler, "Oil Demand Could Peak Within Five Years," *Financial Times*, March 4, 2013.

[6] For an alternative approach whereby three scenarios are identified that pertain to peak oil supply, see [44].

[7] Here, an important disclaimer is in order. The adjectives "friendly" and "hostile" are relative to adherence to one or the other side, and do not represent any kind of value-judgment from the authors. Western interests (USA, UK, NATO members), but also China, consider states where direct foreign investment is allowed and protected as friendly. Lip service or no weight is assigned to human rights, democracy or authoritarian repression. The categories are more explicitly defined at the end of Section 3.

from transient sources on hold. As this article will demonstrate, this western geopolitical strategy is firmly rooted in the rent-earning fundamentals of the oil market, with politics and military action as complementary tools.

In Section 2, the relations between peak oil production and climate change are highlighted in a two-by-two matrix contrasting opposite opinions about both issues. From the descriptions, the conclusion is drawn that mitigating ongoing climate change [28] supersedes oil supply peaking as the key issue of concern. Put differently, in order to have a reasonable chance of staying within the 2 °Celsius average global warming limit, peak demand for oil must outpace peak supply. Demand peaking truncates the symmetric Hubbert bubble by hollowing its right side. Section 3 provides an overview of the market fundamentals of demand (short-run and long-run) and supply, supported by a graphical analysis. It helps to better understand both the effects of oil price hikes and the way in which such hikes are created by a combination of standard market forces, now and then "adjusted" by dominant players. Building on this analysis, Section 4 documents the case of controlling and adjusting the global supply curve (as the aggregated short run marginal cost curve segments of the oil producers), again in a short-run and long run perspective. It is applied to the case of shrinking oil demand due to effective climate change mitigation. Section 5 analyzes the future of oil geopolitics in the Middle East in case the peak oil demand is realized and oil supply surpluses have to be avoided. It builds on observed geopolitics since several years, shedding light on the destinies of Iraq, Libya, Syria, and Iran. Finally, Section 6 offers elements for conclusion.

2. Peak oil and climate change

The nexus between peak oil and climate change is important for designing effective and efficient policies on the intertwined fields of energy security and climate change mitigation. Both evolving phenomena are discussed in the scientific and popular press, with a myriad of views being expressed on their actual state and on their likely state in the (near and distant) future. Normally (bell-shaped) distributed opinions show "believers" at the one end and "non-believers" at the other. Because of different worldviews, incomplete and asymmetric information, and diverging interests, settling consensus on one or the other opinion is unlikely any time soon [23,72].

On peak oil, some confusion results from vocabulary difficulties. In its leanest definition peak oil refers to the all-ever highest extraction level of petroleum from natural reserves during a given year. Three additional substantiations define the common term peak oil as a *supply* peak: first, oil refers to conventional petroleum being more restricted than the upcoming term "liquid fuels" including also unconventional oil (from oil sands, heavy oil, shale oil), natural gas liquids, gas to liquids, and biofuels [1,68]; second, the peak should result from physical shortage in crude oil supply due to unrestrained exploitation of natural reserves; third, the common visualization is based on Hubbert's curve [3,21] being the bell-shaped density function, with the corollary that an equal quantity of oil used up to the peak year is also available after the peak year [43].

For the supply peak, the price of oil does not matter directly, although attention for and belief in peak-oil intensify during periods of higher oil prices [68]. At the same time, high oil prices induce technological innovation to bring more oil to the market, for example by increasing the recovery rate of producing fields, by exploring and developing new sources, and by transforming some of the vast oil resources in oil reserves. When successful, the technology expands the reserves, pushing the supply peak beyond next years.

At the other side of the market, high oil prices stifle the *demand* for oil, causing temporal peaks ([61]; their Fig. 2). The oil peaks observed so far are not caused by physical shortage, but by peaking demand [48,68]. Or, more precisely: oil sales peaked in a given year because demand regressed during one or several of the subsequent years. High oil prices first nip oil-based economic growth, but also induce efficiency technologies and practices, and oil substitution. When oil prices fall back and no policy constraints are imposed on oil use, demand for oil again expands, creating new records in oil supply. This is the pattern that oil prices have followed since World War II [1].

Climate change covers various physical phenomena: rising global temperatures, melting of glaciers and ice masses in the arctic regions, changing rainfall patterns, droughts, storms, floods, etc. [28,29]. There is a massive amount of data, analysis and carefully weighed evidence about the reality of ongoing climate change following the anthropogenic emissions of greenhouse gases [28]. Burning fossil fuels is the direct source of ca. 60% of total anthropogenic greenhouse gas emissions [25, p. 68]. Limiting climate change implies a reduced use of fossil fuels, including conventional oil and, *a fortiori*, unconventional oils with high upstream emissions factors ([72]; their Fig. 1).

At the 1992 Rio summit, world leaders agreed on a Framework Convention to address climate change. Building on this set of agreed principles, the parties to the convention negotiated the Kyoto Protocol in 1997. Even though the Protocol's impact on mitigating climate change has been disappointing, its demoted prolongation was accepted at COP18 in Doha (December 2012). While a majority of the global population and leadership accepts that climate change is ongoing and escalating, the differences of opinion on how to address the challenges are paralyzing progress in policies and in effective mitigation. The "sense of urgency" is unevenly spread across people, CEOs of companies, and politicians [23].

Table 1 shows the prominent issues and recommended actions for the four combinations of beliefs in (No/Yes) oil supply peaking and in (No/Yes) urgency for addressing climate change. *Without* urgency for addressing climate change: (a) when oil supply peaking is considered a non-issue, a (laissez faire) cornucopian worldview prevails; (b) when oil supply peaking is evaluated as constraining, the exploitation of unconventional oil resources is on the agenda. In both cases, the unanswered question is: "How facing irreversible impacts of climate change?" *With* urgency for addressing climate change the working program is almost identical for both No and Yes beliefs in oil *supply* peaking: create as soon as possible the definite oil *demand*

Table 1
Crossing oil supply peaking and urgency for addressing climate change.

	NO Urgency for addressing climate change	YES Urgency for addressing climate change
NO Oil Supply Peaking	Cornucopian view of no limits to growth. How facing irreversible impacts of climate change?	Quickly reduce use of fossil fuels, i.e., create Oil Demand Peak, through Oil Price setting, necessitating Levies policy.
YES Oil Supply Peaking	Maximize the search for oil resources, and develop unconventional oil. How facing irreversible impacts of climate change?	Quickly reduce use of fossil fuels, i.e., create Oil Demand Peak, through Oil Price setting, necessitating Levies policy. Optimize Oil Demand Peak with looming Supply Peak.

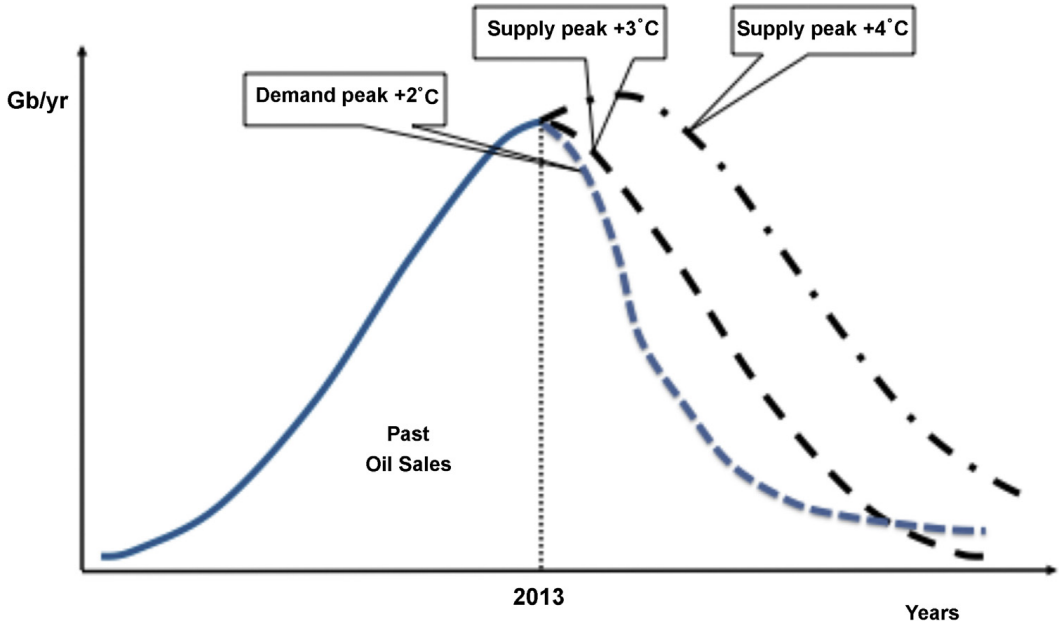

Fig. 1. Three future oil use scenarios with assessed global temperature rises of +2 °C, +3 °C, and +4 °C.

peak. This task could perhaps be easier with oil supply peaking within reach, but still would require a sound tuning of mitigation efforts.

Balancing the eventuality of oil supply peaking in a rather far future against accumulated evidence of ongoing, irreversible, and self-reinforcing climate change, assigns strict priority to the latter global challenge [62,66]. Fig. 1 relates oil use (and peaking of this use) with expected future global temperature rise caused by higher concentrations (following from emissions) of greenhouse gases.[8] Several scholars have published projections of future oil supply curves from a production perspective [31,41,49]. Matutinovic [43] explored the impact of market and policy driven factors (see his Fig. 1). Table 1 and Fig. 1 run against widespread talk about oil supply peaking and climate change as two juxtaposed issues to be addressed by societies and politics [15,17,65], and certainly against statements of scarce oil availability imposing limits on mankind's ability to affect the climate [20]. Unfortunately for climate politicians, oil availability did not peak, is not peaking, and will not peak in the nearby decades [47,51,68], although many scholars believe oil supply peaking is imminent (e.g., [50]). We adopt a clear position: peak oil *supply* is no problem; the real challenge is in creating the irrevocable peak oil *demand* [6]; the urgency of doing it is high because greenhouse gas concentration in the atmosphere is irreversibly increasing, with irreversible impacts on climate and related ecosystems, changing the world to an unapt living place for humans [60]. Concern over climate change is set to become the spearheading driver in reducing the use of hydrocarbons and oil in particular. Other drivers, not studied here, are: environmental disruptions (e.g., air pollution, smog, dangerous substances like PACs and PICs, etc.); protection of natural and cultural heritage endangered by oil exploration and production; rejection of political, economic, and social deterioration by state formation or deformation based on oil rents [30].

Up to early 2013, mankind has roughly utilized 1.25 Tb (trillion barrels of oil); the remaining conventional and unconventional oil resources probably are in the order of 3–4 Tb ([51,68], based on IEA publications). When accepting as truth the hypothesis of oil supply peaking in 2013 along the smooth bell-shaped extraction model, another 1.25 Tb is waiting to be combusted or otherwise used. Considering that the past emissions of fossil fuels have already caused an average global

[8] The curves do not represent statistical observations of oil use (at a plateau of 30 Gb/year during the five year period 2007–2011 [1]), nor sophisticated projections of future curves. The message they convey is the correlation between oil (and other hydrocarbons) use and temperature rise on earth.

temperature rise of +1.5 °C, gliding down the Hubbert curve will cause a global temperature rise of about the double, i.e., +3 °C. That is, unless practices such as carbon capture and storage and geoengineering become technologically feasible, economically viable, socially accepted and widely implemented [53,58]. The already ongoing climate changes, due to the first °C temperature rise, cause positive feedbacks, further accelerating global temperature increase. If the oil consumption peak is delayed for some years, the Giga tons of emissions will escalate, as will the concentration of greenhouse gases in the atmosphere causing a global temperature rise of +4 °C or more.

If the world community is serious about capping global temperature rise at +2 °C (Copenhagen Accord 2009), oil use should peak in a nearby year. This is tantamount to an oil *demand* peak, leaving the Hubbert extraction curve aside as historical curiosum of human imagination. At future equilibrium, a limited share of today's oil barrels are used as feedstock and for essential end-uses for a very long time. Referring to an average oil production of 30 Gb/year during the years 2007–2011 [1], and to the necessary truncation of the oil curve (Fig. 1), perhaps a global oil quota of 600 Gb (0.6 Tb) could be used in the leftover 88 years of the 21st century.

The past teaches that oil demand reduction is driven by high oil end use prices. Today, crude oil and oil product prices are largely determined on international markets, although refinery product prices are often increased with excise taxes or reduced with subsidies by governments. No single government has successfully implemented proper levy systems (including carbon taxing) on the various uses of oil and fossil fuels in their societies with the sole purpose of incentivizing the transition to a low-carbon energy economy. The present system of privately steered pricing of oil, on the one hand, and the alternative scheme of deliberate public pricing in support of transitions to low-carbon energy economies, on the other, differ crucially in terms of both the distribution of rents (growing to several times the expenses of supplying oil), and the purposes for which the money is used [72].

The next section discusses how rent creation and corresponding crude oil pricing by suppliers may evolve in the coming years when public interests continue to play but a subsidiary role in oil pricing.

3. Oil demand and oil supply (market fundamentals in graphs)

To explain the volatility of oil prices some observers refer to mastermind manipulative speculation, others to demand and supply fundamentals [59]. Probably the best explanation is built on the ground-stream of fundamentals with other factors like business cycles, sudden geopolitical events, politically driven interventions, causing price hikes and falls ([4,43], citing [40]). In this section, today's market fundamentals are described with a set of graphs, first focusing on demand for oil, later complemented by supply curves.

3.1. Demand for oil

The demand for oil (like for fuels or for electricity) is analyzed as occurring in the short run and in the long run, dependent on the consumers' degrees of freedom in adapting to a change in price. In the short run, a higher price means either an encroachment on the energy service level or on the wallet of the consumer, because there is no time for deploying alternatives to oil use. The short run price elasticity of demand is generally low, for example −0.25 to −0.33 [16]. In the long run, there are more options to adapt to the oil price rise by substitution, efficiency, innovation, change in activities and practices, etc. The long run price elasticity of demand for energy is approximately equal to −1 [38]. Fig. 2 shows the pattern of long run demand curves with price elasticity −1, being orthogonal hyperboles revealing that (price charged/paid) × (quantity sold/purchased) equals a constant sales/spending volume. For the lowest curve in Fig. 2 three equilibrium points S^i are shown, that a country may attain after having experienced for a long time the corresponding price level of P^i. A country adapts to a sticky price level P^i by selecting economic activities, and by developing technologies and practices that direct their use to the respective quantities Q^i. The long run curve shows all three equilibrium points

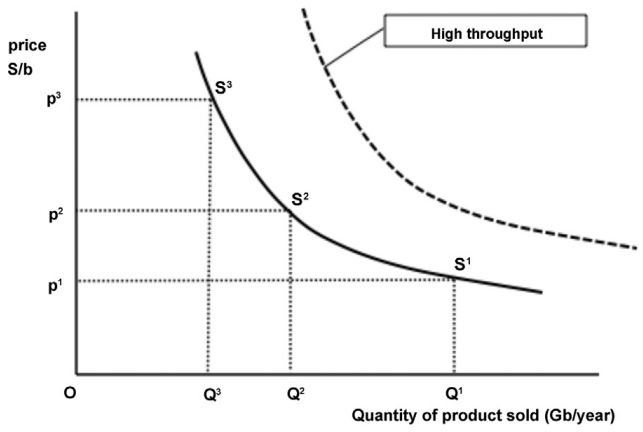

Fig. 2. Long run demand curve for oil (at price elasticity −1, price × quantity is constant).

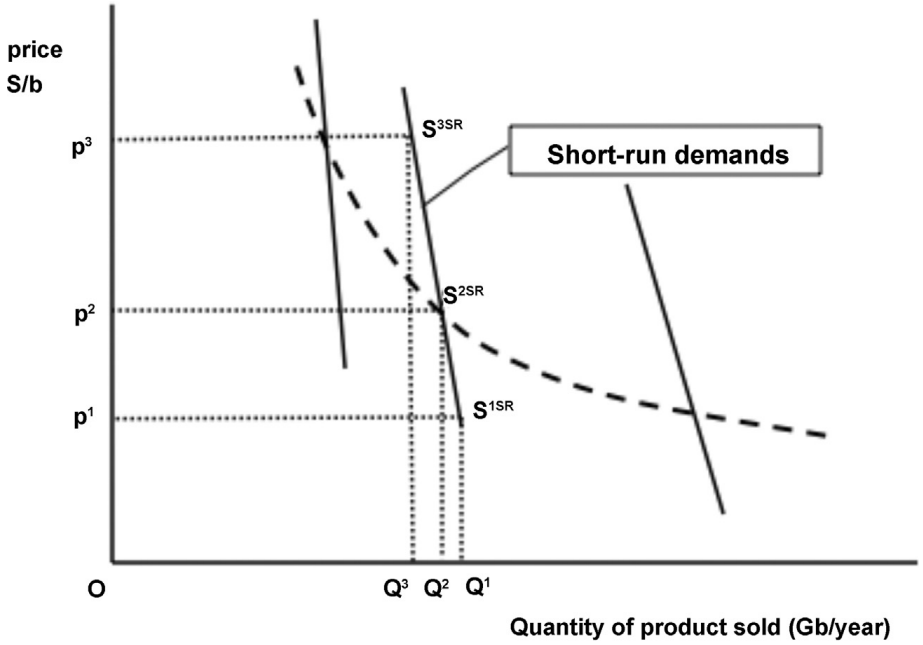

Fig. 3. Short run oil demand curves ($-1 <$ elasticity < 0), attached to a long run demand pattern.

bring equal bills,[9] graphically represented by the rectangles with O–S^i as diagonal. Staying on one particular long run demand curve would reflect a stationary world without, for example, population or GDP growth. In reality, since World War II the long-run demand for oil has almost continuously expanded to higher output levels (the dashed hyperbole in Fig. 2) [2].

In Fig. 3, short run demand curves are attached to the long run demand curve. Starting from the equilibrium S^{2SR} (at price P^2), a price rise to P^3 implies a small reduction in demanded quantities (from Q^2 to Q^3), and a significantly higher bill (rectangle O–S^{3SR}) compared to the initial situation (rectangle O–S^{2SR}). A price decline slightly lifts the demanded quantity in the short-run (from Q^2 to Q^1), but the main effect is lower bills (rectangle O–S^{1SR}).

Price volatility is a short run phenomenon: suddenly and sharply rising prices cause payment problems for, in particular poor, consumers, who lack direct substitutes: they either pay the high bills to get their usually consumed oil products, or they must drastically change their usual activities. For a consumer to move along the long run demand curve, it requires several years to reduce physical oil consumption and to restore original monetary spending on oil. Hence, in the short run, for oil price hikes lasting a few years, oil sellers can obtain significant cash flows from oil consumers. After a few years, prices generally crash, as do the bills. Oil importing countries and people feel relieved, and economic activity can boom again. However, consumers that invested a lot in reducing oil demand then feel somewhat frustrated, because the return on their investments is much lower than expected. In addition, neighbors that did no or little effort to save oil seem to be awarded. This retards efficiency and the search for substitutes for oil, entrenching societies longer in the oil economy. Oil price volatility thus disturbs strategic investments [18].

The mechanisms of demand are obvious. Demand evolves in predictable directions in accordance with the changing drivers, the most notable of which is the price. Oil demand volatility is low, but when drivers push in the same direction during many consecutive years, significant demand change occurs. When supply capacity cannot keep up with demand expansion, higher prices are the result, with extreme oil price volatility resulting from sudden shifts in short-run supply, mostly due to incidental or geopolitical events. Higher oil prices also stimulate supply capacity expansion, eroding if not withdrawing the floor under high oil prices.

3.2. Supply of oil

In a global market with numerous suppliers of a private good, the short run market supply curve is the horizontal addition of the short run marginal cost[10] curves of the separate suppliers. Fig. 4 shows the price–quantity (P^1, Q^1) equilibrium at the

[9] This argument is clearer when using energy (oil/electricity) intensity as quantity variable (e.g., [74]). Then equal bills means equal shares of their GDP spent on energy supply. Then, also the spread of the long run curves across countries and over time is limited.

[10] This article applies the common vocabulary of "cost" and "marginal cost" of oil supplies; however, most of the costs of oil use are "external costs" (climate change, environmental disruptions) not included in the prices of oil. The prices include expenses for supplying oil to consumers and rents. Also the graphs situate demand-supply equilibrium at the crossing of short-term demand curves with short-run marginal cost curves, implicitly assuming that prices result from a competitive model ([4]; Wirl [70] assumes monopolistic price setting, where marginal revenue falls below demand; Kaufmann et al. [32] illustrate the difficulty of identifying clear market structures in the crude oil production sector; Fattouh and Mahadeva [13] review various models).

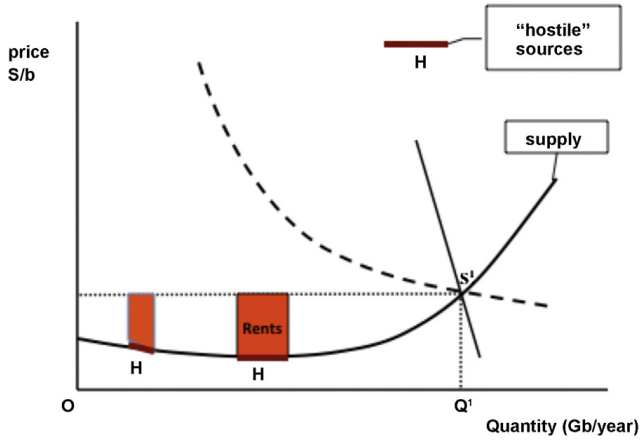

Fig. 4. Static equilibrium in the oil market, where supply is not perfectly competitive.

crossing S^1 of the short run supply and demand curves (the case shown assumes short run and long run demand cross at S^1). In a free market, numerous suppliers enter or exit the market according their competitiveness, excluding extra profits (rents) on top of a normal return on invested capital as standard part of the costs of supply.

The global oil supply stems from a countable number of sources and actors. Some of them do not simply accept market conditions as they are, but influence or shape the conditions [43]. When this maneuvering succeeds, suppliers gain rents of the size covered by the area between the aggregated marginal cost curve and the line P^1–S^1. Individual market shares and supply costs determine the share of total rents that a supplier actually gets. The size and sharing of rents are central themes of managerial strategy [57] at corporate level and of geopolitical chess-like games in the global oil business [30]. Rent creation and appropriation imply complicated games of suppliers versus consumers, and among suppliers.

Since World War II the global oil business developed in pace with global population and economic growth. The major oil suppliers maintained R/P (Reserves/Production) ratios higher than 40 years, being a span sufficient for their investment planning. In the past, temporal price volatility has been followed by longer periods of stability (with low to moderate prices), safeguarding the oil business growth trend (by expanding long-run demand curves). Oil supply peaking (Section 2) would alter this usual strategy.

However, either by catastrophic deterioration of climate stability or by precautionary drastic transitions of the world's energy economies, climate change impedes a future of continued repetition of past cycles. If the +2 °C limit is respected, urgent and drastic transitions are due [62], imposing a much earlier oil demand peak (Fig. 1). When the total quota for future global oil use is absolutely fixed (for example at 0.6 Tb for the rest of this century), the global ballpark for pumping oil is fenced. Oil interests can then only maximize revenues (extra profits, rents) by optimizing price setting over time. Every resource owner will strive for his own best results within the overall constraints and will face new competition and coalition opportunities in a shifting geopolitical setting.

Different groups of net oil suppliers can be distinguished. On the one hand, there are dominant supply countries and companies (US, UK, Netherlands, Arab states of the GCC) that control what from a Western viewpoint is called "friendly oil sources" [37]. On the other hand, there are countries that contest the dominance of the first group and that deliver "hostile oil" (Iran, Venezuela, Sudan, Ecuador). Fig. 4 shows that hostile oil is a component of the global supply curve, and so gains part of the global rents created by high crude prices. "Friendly oil" will try to minimize the share of the rents that is acquired by "hostile oil", especially in light of the fact that oil markets must shrink in the future (Fig. 1; Section 4). In between the opponent camps, there are some oil-rich countries that are drifting in transient positions that depend on the camps' power to convince, seduce, enforce, or eliminate doubters. Canada and Norway adhere to the friendly oil camp. Brazil, Indonesia, Mexico, and Nigeria stay at further distance. By more or less violent political change, Algeria, Angola, Iraq, and Libya were "freed" from the hostile camp. Russia attempts to build its own oil and gas empire, after losing control on the sources in the Caucasus and Central Asia that now enjoy independence. Most actors in a transient position follow (by allowing foreign investment; documented examples are provided by [64]) or – sometimes grumbling – accept the ruling of the dominant group.

4. Supply policies in a constrained oil world

The strategy of the dominant friendly oil forces combines short-run with long-run control. Advantageous for sellers in the short-run is a marginal cost (i.e., supply) curve with a hockey-stick handle at its end (Fig. 5). The textbook pattern of a short-run marginal cost curve is sloping up at its end, in a smooth way, not kinked. A kinked handle could be due to extraction at high expense of the last oil barrels from marginal sources. This could reflect physical depletion of oil reserves, only finding resolve in costly maverick oil exploration and development projects. Norgaard [52] points out that development paths of

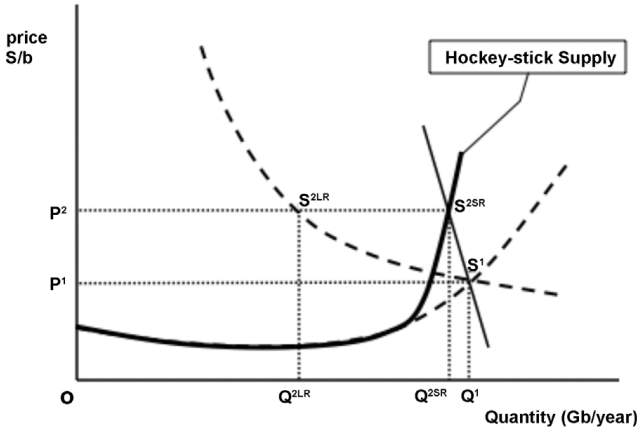

Fig. 5. Hockey-stick curve of oil supply in the short run.

natural resources are often erratic and could show temporal kinks. Geopolitical behavior distorts development paths by altering risk calculations,[11] causing occasional kinks.

But a reality of ample oil reserves, combined with tightening constraints on pumping oil because of greenhouse gas overloads in the atmosphere, delivers an almost flat supply curve with only shallow upturns at its end. Such cost conditions would result in rather stable and low crude prices. Prices can be inflated, though, bending the curve's end upwards, by simulating or by creating scarcity in supply. Simulating scarcity is the oldest seller's trick on earth, still to experience when buying rugs, but also when booking a plane seat or hotel room on internet sites consistent in announcing the few "free places left". Similarly, the international oil industry has for decades been preoccupied with the question of "how to organize scarcity in the face of prodigious abundance" [5]. The oil scarcity syndrome is supported by the peak oil discourse. Simulation creates the social scene, but maintaining inflated prices high is only effective when sufficient infra-marginal (cheap) barrels are physically withhold from the market. Speculators are incapable of withholding sufficient crude oil in artificial storages to influence the price [38]. Keeping oil in natural caverns to maximize rent-appropriation is a common practice among producers. However, agreeing on and enforcing production quotas is not evident, not even within a formal cartel, as OPEC's history exemplifies (Section 5.1). A coalition of actors willing to counteract market forces must accept strong discipline, enforced by a respected authority. As the dominant supplier in the dominant group of friendly sources, Saudi Arabia assumes world leadership in crude oil supply. Saudi Arabia functions as a so-called "swing producer", i.e., it maintains and operates sufficient spare capacity for ramping up/down oil production to bridge or create gaps between short run demand and supply. This way, it can support a strategy of keeping oil prices within a certain band [13].

Fig. 5 shows the price hike occasioned by a steeper end at the marginal cost curve of oil (hockey-stick supply). In the short run the quantity sold is slightly reduced from Q^1 to Q^{2SR}, but the volume of rents expands to the area between the hockey-stick curve and the horizontal line P^2–S^{2SR}. Fig. 5 also projects the shadow of the long run equilibrium S^{2LR}: when the price is maintained at P^2 during many years, consumers have fully adapted to the higher price of oil; then, the reduction in oil use is significant and the bills paid (rectangle O–S^{2LR}) are back at the level where they were years before (rectangle O–S^1). The bulk of rents for the suppliers will then have returned to about the size of before the price hike.

In the past, the long run equilibrium at S^{2LR} remained a virtual point because of two reasons: first, crude oil prices have been volatile and have never been kept at high levels for a sustained period of time; second, economic growth and oil market expansion has shifted long run demand curves outwards (Fig. 2).

However, in case the world is serious about climate change mitigation, it will shrink hydrocarbon use, and the long run demand equilibrium S^{2LR} of Fig. 5 could be materialized. The latter requires the oil end-use price to stay at P^2, a situation that the dominant oil interests can easily blow up by keeping the price low during some years. Price yoyos have been observed in the past [4,1].

However, in order to sustain the transition to a low-carbon society, the move to S^{2LR} can be stimulated by tax or budget reforms designed by enlightened governments to maintain the price at P^2 and to transform rents in public income [43,22]. To maximize their share of the rents, oil producers respond by charging P^2 as selling price. Placed in a market context, the oil business shifts the hockey-stick supply curve to the left, i.e., cuts the length of the stick itself while keeping the handle in place (Fig. 6). Cutting the stick's length means that several low-cost producers have to be driven from the market or forbidden access to it: holding a lot of oil in the ground, not for sale. Suppliers prefer selling their own oil, and attempt to block the competitors from selling. This is where the fight between "friendly" and "hostile" oil is growing tenser (and, indeed, sometimes bloodier) than ever before.

[11] See for example ERNST&YOUNG's "Top 10 risks": http://www.ey.com/GL/en/Industries/Oil—Gas/.

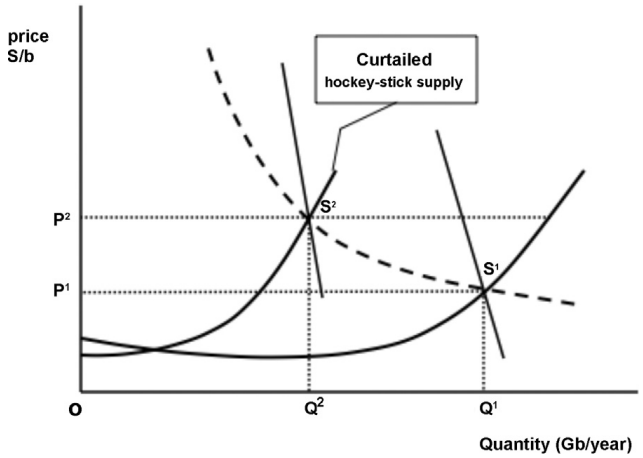

Fig. 6. Curtailed hockey-stick curve of oil supply in the long run.

Before discussing these emerging oil surplus geopolitics, it is worth highlighting that alternative scenarios are thinkable, though perhaps less realistically (see, e.g., [44]). One of these is the creation of an international funding mechanism to compensate oil producers who decide to leave their oil underground. A similar scheme has been agreed upon for non-deforestation, so it could in theory also happen for oil. In fact, OPEC countries have already successfully demanded compensation to help diversify their oil-dependent economies as an adaptation strategy [12]. In 2007, Ecuador launched a far bolder proposal to leave oil underground in the Yasuni National Park in the Amazon in exchange for international compensation [42]. Yet it remains to be seen whether these examples will succeed and be replicated.

5. Geopolitics in times of oil surplus

This section is not a prediction or forecast, but a "what if" exercise, as explained in the introduction. It sheds light on power relations and their likely evolvement, if the world rallies around urgent and drastic mitigation of climate change. Under such a scenario, respect for the +2 °C warming limit should install the irrevocable peak oil demand in a nearby year, imposing a global oil quota of about 600 Gb for the rest of the 21st century. Even when the accompanying shrinking of the oil business (Fig. 1) is too horrible for oil interests to face, they know that the world has no other chance than moving in that direction, sailing into unknown territory. Shrinking oil use is a 180° reversal from the current practices of managing fluctuations and disruptions in expanding and highly profitable businesses. With scarcer space every coming year, crowding opponents out is the most likely strategy, because it concurs with optimizing rent appropriation by separate actors or by coalitions of a few allied actors within the +2 °C bounded fundamentals of oil markets. Financial interests and objectives remain the foundation of geopolitical maneuvering in oil supply. This section points to only a few salient events during the last decade and expected evolutions in the Middle East and its neighboring regions, which host the bulk of the world's conventional oil supplies.

5.1. The role of OPEC

OPEC's first and main successes occurred in the 1970s, a period of booming oil use. By setting higher crude oil prices, the self-declared cartel significantly raised oil revenues with ample rents for the members. The backlash from this strategy came in the first half of the 1980s, when crude prices crumbled, as did the market share of OPEC [4]. Iran was at war with Iraq, and Saudi Arabia attempted to assume the role of swing producer. This role is costly when the market shrinks, but financial and political beneficial when the market expands or boosts. OPEC survived the dip, but its power waned in the buyer's market that prevailed for the subsequent two decades. Revenues and rents had to be supported by rationing production, with shared quota among the members. Oil revenue cuts brought economic peril to the weaker members, which had to allow more and more foreign direct investment in order to maintain their production capacities [67]. From 1993 onwards OPEC's market share was stabilized above 40% with crude prices in the range of $15 to $30 per barrel for the next decade [4]. Then crude prices climbed to the unexpected height of $147/b in the summer of 2008, followed by a price fall to $35/b in the same year, before stabilizing at around $100/b in subsequent years. The volatility is often assigned to financial speculation, but fast-shifting demand–supply fundamentals do explain most of the erratic price pattern [59]. OPEC members, like other oil and gas suppliers, benefited from the high price periods.

In a +2 °C constrained future with a nearby necessary U-turn in fossil fuel use, imperative for addressing climate change (Section 2), can OPEC survive a continuous reduction in the demand for oil? Under a global oil quota of about 600 Gb for the rest of the 21st century, OPEC lacks the discipline and enforcement mechanisms to manage the small quota allocations [9]. Because of unexpected resilience in the past, many observers assume OPEC will survive periods of non-cooperation [13]. If not falling apart altogether, reducing OPEC to its Arab membership would be in line with the geopolitics of too much oil.

5.2. A transverse perspective on oil geopolitics

According to the dominant discourse, oil geopolitics is driven by competition – often morphing into conflict and war – for access to scarce oil and gas resources (e.g., [2,14,33–35]). This viewpoint ignores the actual significance of ongoing climate change. Accepting the necessity of a +2 °C temperature rise limit, including the creation in a nearby year (e.g., 2013) of the irrevocable peak oil demand (Fig. 1), turns the camera around by 180°. Moving beyond ivory tower scenarios and models of smooth transition pathways, this challenge is splitting the largest commodity market of the world, which far outranks the combined value of clothing, food, and automobiles [59]. In the real world, competition, fighting, and war will continue under a +2 °C scenario, but alliances, goals and tactics of the key players will change.

The alliances OPEC versus non-OPEC, oil exporters versus oil consumers, are superseded by the antagonism "friendly" versus "hostile" oil (Section 3). The main goal is neither to acquire access to oil sources for proper exploitation nor to augment world supplies [56], but to control *whose* oil fields and delivery points are allowed to serve the market. The conflicts are not aimed at conquering but at precluding production from hostile sources. The strategy of "predatory militarism" [14] is far too expensive compared with a strategy of "divide et impera" (divide and rule) via igniting and fuelling internal fighting implying hostile oil countries. The fighting is not intended to conquer the opponent and enlarge the friendly camp, but to devastate or paralyze hostile sources and unreliable transient ones.

5.3. Changing oil geopolitics in and around the Middle East

Since the 1979 nationalistic revolution and changed relationship with Western oil interests, Iran became a focal target of American-led Western hostility. Iran is the main oil and gas rich country bringing "hostile oil" to the market. The country is burdened with sanctions, significantly hampering its oil production and exports [73]. But Iran is large and endowed with large resources, ranking second globally in terms of oil and natural gas reserves. Since the 1980 military invasion by Saddam Hussein, backed by Western interests and by financial support from Kuwait and Saudi Arabia [63], ensuing in eight years of warfare, Iran has built up an experienced defense capability. Israel's military superiority exerted in a wide radius outside its borders, clearly unfettered by international treaties or UN resolutions, is only contested by Iran.

In 2004–2005, J. Negroponte replaced P. Bremer as the highest civilian US official in Iraq; Negroponte's next career step was to lead the widely uncontrolled US national intelligence. Secret warfare, covert operations, death squads, and sectarian divide were complementing and gradually replacing direct confrontation in Iraq, the ensuing stalemate delivering a higher benefit/cost ratio for the US and its allies. On the friendly–hostile scale, Iraq is now a transient case. The Iraq war has denied global markets access to significant amounts of oil [2]. Projected high post-war exports based on the size of physical reserves are not realized [35,69]. The IEA [25] points to several technical barriers, but their slow removal may be due to geopolitical considerations about a Shiite majority and government too near to Iran. Presumably, Iraq's oil export will be kept low, for example by permanent conflict or civil war between Shiite and Sunni populations. Its Kurdish area, welcoming Western foreign investment, may be decoupled from Iraq and linked to the friendly camp.

Iran remains a focal target. A stick to keep Iran docile is the control over its nuclear program, although the Western approach of nuclear proliferation complies the biblical "seeing the mote in one's brother eye but not the beam in one's own". The nuclear alarm helps to demonize Iran's authoritarian regime, isolate the country, and to weaken it by trade sanctions, not at least by the oil export embargo. "The US has been happy [...] letting China source more Arab oil to squeeze Iran. But what this also highlights is that the Saudi-Iran relationship is at the heart of US-China relations in the region" [22].

The US encircles Iran militarily by land, sea, and air, and Israel is trying to destabilize it. Iranian nuclear scientists are murdered, cyber-attacks have perturbed several industrial complexes in the country (Stuxnet; New York Times, June 1, 2012), and drones are spying all over the country. Western power play may backfire when Iran's proud population feels targeted. The US and Israel discuss a direct military attack on Iran, but this adventure could entail too much danger and harm for the attackers and their Arab allies united in the GCC. Hamilton (2012) observes that such a war could produce a pretty spectacular oil price spike, probably being of little concern for the "friendly oil" camp, which will then appropriate most of the spike-related rents.

The active role of GCC members of the "friendly oil" alliance (mainly Saudi Arabia and Qatar) in the wars in Libya and Syria is openly documented. Libya is now a transient case after having been "freed" from the hostile camp. It stays in the purgatory state until full Western control on the oil sources is guaranteed. Syria is not destabilized because of its mince oil sources, but because of its strategic position in the Middle East and its friendly relations with Iran, Hezbollah and other opponents to Israel. The Syrian opposition is supported by Qatar and Saudi Arabia, also with weapon deliveries. Russia and China, who are more and more conspicuous of the cliff between free market talk and almost imperial acting by Western powers, support the dictatorial Syrian regime of Assad. From an intricate cohabitation of a patchwork of religions, Syria is pushed in the sectarian Shiite/Sunni divide. This divide has proven functional in stalemating Iraq. It is applied successfully in Syria, causing daily bloodshed and engraving wounds for decades all over the Middle East, exaggerating the ethnic-historical-cultural and economic Persian/Arabic Gulf differences. Bassam Haddad (George Mason University) argues[12]: "the war in Syria is not instigated for obtaining (quick) victory but to deplete the military capability of Syria, whoever would control it, the present

[12] Comments delivered in the EMPIRE debate "Syria and the US: The complicity of silence", available on Al Jazeera, January 30, 2013.

dictatorship or the opposition." This objective is pursued in an extremely efficient, cruel and brutal way. The outcome serves Israel, and the US sees it as an opportunity to break Syria from Iran.

When the Syrian domino falls, more active warfare against Iran may start. The Shiite/Sunni divide is not workable inside Iran to instigate a broad conflict, but Kurds, Azeri, Baluch, and other non-Persian populations could be instigated to revolt. As in most Middle East countries, Iran's population is divided in western modernity and traditional-nationalistic aisles. Increasing the wedge between the aisles and supporting, eventually arming, the opponents of the government, belongs to covert warfare. The propaganda, interventions, and pinches do not pursuit conquering, but devastation and paralysis. It is more beneficial for the "friendly oil" alliance to contain Iran, than to start an open war. Victory in war is uncertain or could inflict serious havoc on Arab allies, and even Israel. Total victory could bring Iran in the friendly camp where space is shrinking, and where there is already too much oil "for sale" that must be converted in "not for sale".

6. Conclusions

Confronting peak oil supply and climate change supports two recommendations. First, mitigating climate change is of absolute priority [62,66], superseding peak oil *supply* as the key issue of concern. In fact, mankind must manufacture the irrevocable peak oil *demand* (by preference in a very nearby year). Second, inducing and maintaining peak oil demand requires robust and permanent pressures by high oil and fossil fuel end-use prices. Design and application of proper end-use prices by adjusting energy and carbon levies are probably today's most relevant tasks of public authorities from the global to the local level. These are two elephants in the room of politics, but many observers are skeptical that politicians will ever look to price hydrocarbons out of the market to keep carbon emissions at 'safe' levels [22].

To explain the volatility of oil prices some refer to mastermind manipulative speculation, others to demand and supply fundamentals [59]. The best explanation is built on the ground-stream of fundamentals with politically driven forces boosting the price hikes. An urgent and drastic reduction of hydrocarbon combustion, including oil, is analyzed within the same market framework and mechanics, but shifted into reverse.

Within evolving market constellations sellers aim at maximizing profits, consisting for a good deal of rents [57]. Rents can be maximized through shaping the supply curve (short run marginal costs) as a hockey stick with an upright handle crossing the short-run demand curve. Hockey stick supply curves can result from exploiting expensive marginal sources. Peak oil supply adepts will see confirmation of their belief in fast depletion of oil reserves. But rent skimmers may deliberately create kinked handles. High oil prices in the short run cause minor shifts in oil volumes, but major shifts in oil bills. When high prices are maintained for many years, oil volumes will shrink significantly bringing oil bills in line with earlier financial spending levels. In case of effective climate policies reducing the use of hydrocarbons, including oil, suppliers will compete with public interests for setting the (necessarily high) oil prices and thereby obtaining the rents. When oil suppliers prevail, they will compete among themselves to crowd out the opponents in a shrinking market, in alignment with the adopted priority for mitigating irreversible climate change. The issue is not one of oil shortage, but rather abundance of, mainly cheap, oil.

Competition in oil supply markets could spill over in geopolitical turmoil, conflict and war. Cataloging oil sources in "friendly" (countries that accept and protect foreign investment), "hostile" (the opposite of friendly), and "transient" (drifting between both extremes) is basic for explaining actual propaganda, positions and moves in oil geopolitics. Since several years the axis US (with NATO allies) – Arab Gulf States (assembled in the GCC) represent friendly oil. Hostile oil is centered in Iran, followed by a few committed allies (e.g., Venezuela). Many oil export countries are drifting between the extremes, and have to absorb the brunt of the power fights and stalemates. Camps, goals and tactics in oil geopolitics have changed. The camps OPEC versus non-OPEC, oil exporters versus oil consumers, are superseded by the antagonism "friendly" versus "hostile" oil. The main goal is not to conquer oil sources for exploitation, but to gain control over oil production and delivery possibilities, by precluding and containing hostile sources. As a strategy, predatory militarism is too expensive compared with "divide et impera" (divide and rule) via igniting and fuelling internal fighting implying hostile and transient oil countries. The fighting is not intended to conquer the opponent with as consequence an enlargement of the friendly camp, but to devastate or paralyze hostile sources and unreliable transient ones. This way, allowed oil sales at high prices can generate high rents for friendly sources.

This article suggests that geopolitical tensions and conflicts may arise over the possibility of selling one's oil in a stagnating international oil market. This consideration does neither imply that such tensions will necessarily result in armed conflict or war, nor that all of the geopolitical tensions in the Middle East can be reduced to such dynamics. An interesting point warranting further research is whether privately owned oil concerns would gain more, or less, than state-owned oil concerns in a "hockey stick world" (that is, if a deliberate hockey stick supply curve is created). The transition from carbon intensive to low-carbon energy economies is, according to our analysis, very different from a walk in the park.

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