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Viewpoint

Peak Oil and other threatening peaks—Chimeras without substance

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ABSTRACT

The Peak Oil movement has widely spread its message about an impending peak in global oil production, caused by an inadequate resource base. On closer scrutiny, the underlying analysis is inconsistent, void of a theoretical foundation and without support in empirical observations. Global oil resources are huge and expanding, and pose no threat to continuing output growth within an extended time horizon. In contrast, temporary or prolonged supply crunches are indeed plausible, even likely, on account of growing resource nationalism denying access to efficient exploitation of the existing resource wealth.

1. Unwarranted resource pessimism

The commodity boom that emerged in 2004 and that still rages most commodity markets has stimulated high-pitched claims, the Peak Oil gospel being one among many, that resource depletion is now a painful reality.

Prophecies of impending catastrophes based on resource pessimism are as old as humanity (Maurice and Smithson, 1984). In more recent times, the following ones can be noted:

- 140 years ago a seriously worrying British "Peak Coal" was seen to be looming (Jevons, 1865). In reality, production levels were maintained until the 1950s. The subsequent sharp decline was not caused by a depleting resource base but by competition from other domestic and imported sources of energy. Remaining British coal reserves have become worthless in consequence.
- Until the early 20th century, South American guano was a valuable exhaustible material for the production of fertilizer. Its strategic importance caused diplomatic conflicts, even war, to obtain control over its supply (Skaggs, 1994). Scientific progress in chemistry early in the 20th century has made guano superfluous.
- Perception of inadequate petroleum resources has repeatedly aroused widespread worries. In 1920, when the US produced 1 mbd, the US Geological Survey reported that the country's oil would be depleted before the end of the decade (Lindstedt, 2005), but 80 years later, production had risen to 6.9 mbd.
- Early in the 1970s, the Rome Club published a somber outlook about an impending depletion of the physical resource base (Meadows et al., 1972). By the turn of the century, our materialist civilization was likely to collapse as an increasing number of critical natural resources were becoming unavailable.

A common characteristic of the doomsday prophecies listed above, and many others, is that none of them has actually occurred (Simon, 1996). Resource scarcity has been successfully handled with the help of technical progress that has widened the resource base and/or by substitution. The 20th century has been referred to as "the age of substitutability" (Goeller and Weinberger, 1976). The 21st century will be even more so. Human inventiveness and flexible competitive markets are regularly sufficient to overcome emerging problems. The real prices (a measure of scarcity) of virtually all primary commodities traded in competitive markets exhibit a long-run downward trend (Radetzki, 2008).

2. Gospel of the Peak Oil prophets

The Peak Oil representatives have recently given the concept "resource pessimism" a specific interpretation. Their message about an impending global oil production peak caused by an inadequate resource wealth has been widely spread. The oil price increase during the current commodity boom has been interpreted as an indication of accentuated resource scarcity. Media have accepted this view, while energetic politicians have employed the message as a motive for launching unwieldy subsidies to uncompetitive energy alternatives. The conviction about impending peaks has spread also to other products, notably coal and copper, whose prices too exploded during the boom.

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Thus, Peak Oil is a perception that the world's oil resources are in the process of acute depletion. Details of the message are hard to pin down, because they vary among the large group of followers (e.g. Campbell, undated, circa about 1998; Bentley, 2002; Goodstein, 2004; Roberts, 2004; Deffeyes, 2005; Simmons, 2005 among the leading ones), and also because they tend to shift over time. An international organization, the Association for the Study of Peak Oil (ASPO), was established in 2000 (''and Gas'' was later added to the name). In summary, the gospel asserts that global oil production will culminate when half of the ultimately recoverable oil resources (URRs) have been exploited. ASPO further affirms that this peak will occur in the very near future, certainly within a decade. The world will then suffer from a permanent oil crisis, where continued demand growth is confronted by declining supply. An earlier ASPO view was that the peak related exclusively to the exploitation of conventional oil deposits, but more recently, some non-conventional resources have been added to the culminating total.

The purpose of this paper is to employ ASPO's own assertions to demonstrate that the Peak Oil view of the prospects for global oil production is inconsistent, void of theoretical foundations and has no support in empirical observations. The analysis is therefore defective and misleading, and that the message about an impending peak is a chimera without substance.

3. Culminating production and its plausible causes

Peak Oil expresses contempt of economic analysis, and gives no attention to economic considerations. To an economist like myself, the clear case of depletion is a situation where exploitation becomes increasingly more expensive and where the price rises in consequence, leading to falling demand, in the extreme case down to zero. In my studies over forty years of the economics of raw materials, I have not come across any indubitable example of an exhaustible resource material whose costs and prices have risen due to depletion, with an ensuing long-run decline in consumption and output.

In contrast, it is easy to point to cases where the production of exhaustible resources reached a peak and then declined over extended periods, possibly permanently, in consequence of technological change and substitution, economic decline and reduced consumption needs, changing tastes, emerging awareness of toxicity, or because demand was cut by monopolistic prices exerted by a producer group.

The above examples of British coal and South American guano demonstrate how technical progress can make a resource superfluous, and its production redundant. Contracting demand during the 1930s depressions forced an extended fall in global output for metals and fossil fuels from the 1929 peak. Asbestos and mercury experienced their peaks in the 1970s, with declining production ever since (USGS, annual) as their detrimental health effects became known.

OPEC governments control 75% of the world's proved oil reserves. The cartel's long-run pricing policy has been based on extremely restrictive utilization of this resource wealth. In the 28-year period 1979–2007, OPEC's production capacity remained virtually stagnant (BP, Annual), all while global oil consumption expanded by one-third. The policy gave the cartel considerable monopolistic pricing power. Even more ambitious pricing goals cannot be precluded. A peak in production, with an ensuing decline, could then occur in response to contracting demand caused by the cartel's price ambitions.

A similar Peak Oil scenario will ensue if politicians decide that consumption must be suppressed to avert a climate threat. Just as in the extreme cartel case, output must then be adjusted to falling usage, but again the decline will have no relationship to inadequate resource availability.

4. Peak when half of URR has been used up

The prophets of Peak Oil rely heavily on Hubbert (1956), whose fame is based on a correct prediction that oil output in the US will reach a maximum around 1970. It should be noted, however, that Hubbert's method has no theoretical support in geology, engineering sciences or economics. Furthermore, his projections of a global oil peak and peaks in gas and coal in the US have proved to be utter failures (Smith, 2008).

Indeed peaks do often occur when half of the total recoverable quantity in an oil field has been extracted, but it does not follow that the same would hold when half of global URR has been used up, and the adherents of Peak Oil do not provide any convincing reason why it should be so.

But even if a plausible ground to the relationship did exist, the global URR must represent a quantity that is constant over time, or else it will be impossible to know when half of this total has been used up. The Peak Oil prophets assert that the technology of exploration and exploitation is now so mature that believable ultimate quantities can be determined. They share this view with self-assured experts and analysts of 100 years ago.

Many assessments of URR made in the past 60 years (Fig. 1) point to a widespread around a clearly rising time trend. This trend is bound to continue, since it expresses advances in knowledge and technology.

The assertion of Popper (1957) is still fully valid:

> ''The total supply of any mineral is unknown and unknowable because the future knowledge that would create mineral resources cannot be known before its time.''

The method used by the adherents of Peak oil to determine the timing of the peak, therefore, emerges as a chimera.

The five fat observations in Fig. 1 have been made by Colin Campbell, a leading representative of the Peak Oil movement. Note that Campbell has added 300 billion barrels to URR, enough for 10 years' global oil consumption in the 14 years covered by his observations, thereby implicitly confirming the continuous URR change.

The spread of observations at each point in time in Fig. 1 depends importantly on how the URR is defined. The Peak Oil adherents' tendency to restrict the definition to conventional oil resources explains Campbell's low numbers, but are there any technical or economic reasons to distinguish between conventional and non-conventional resources in an analysis of what is ultimately recoverable? Fig. 2 provides illumination to this query.

Until mid-2000 about 1100 billion barrels of oil had been globally extracted. Campbell's assessment of remaining URR in 2005, about 2000 billion barrels, comes close to IEA (2008) number for proved reserves of conventional oil. However IEA also depicts (Fig. 2) the vastly greater volumes of unconventional resources that are economic to recover with oil prices up to $60. The figure additionally demonstrates the absence of a clear economic dividing line between the two resource types. Furthermore, unconventional resources are regularly reclassified into conventional when their exploitation has become common, and the extraction costs have declined. Finally, new resources are constantly added on the right extreme of the figure, as novel technology makes their exploitation economically feasible.

With the remaining resource base at 4–5 billion barrels, a very long time remains before one half of all the oil in the ground will have been exploited, so even in Peak Oil's own premises, the peak will not occur in the foreseeable future.

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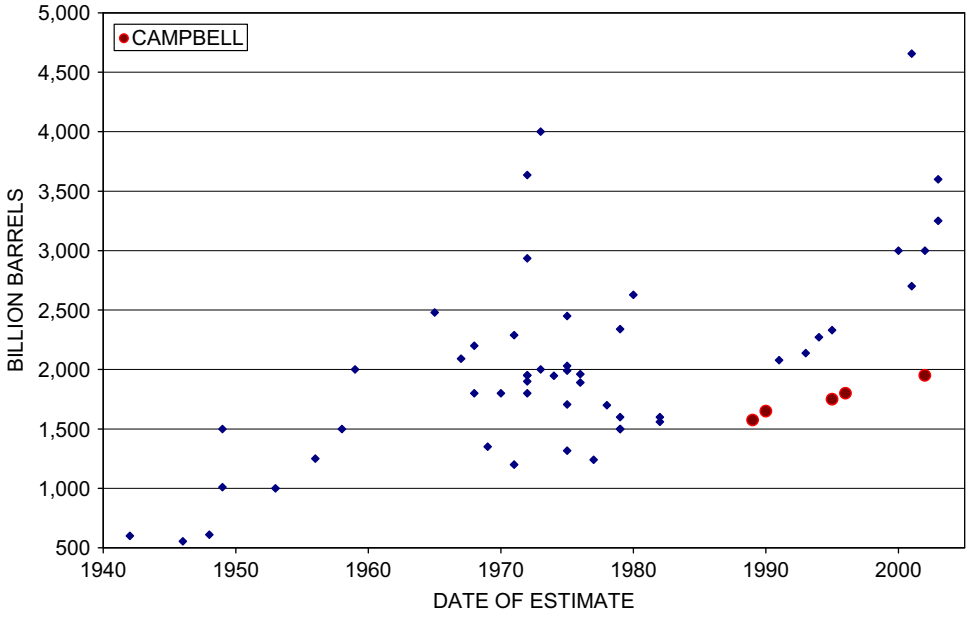

Fig. 1. Estimates of URR at different points in time.
Source: Personal communication with Michael Lynch.

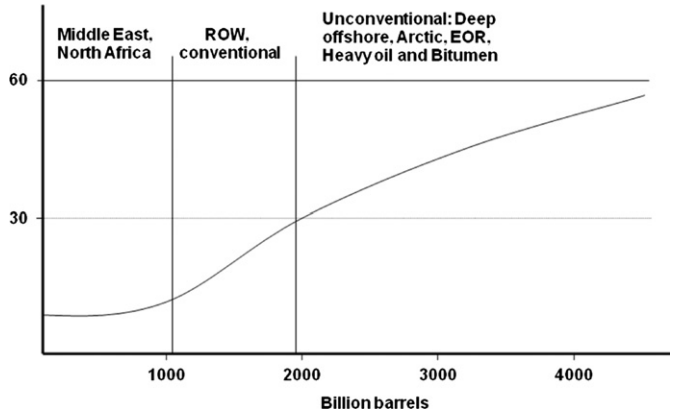

Fig. 2. Oil resources and economic price, $(2008)/billion.
Source: Based on IEA (2008).

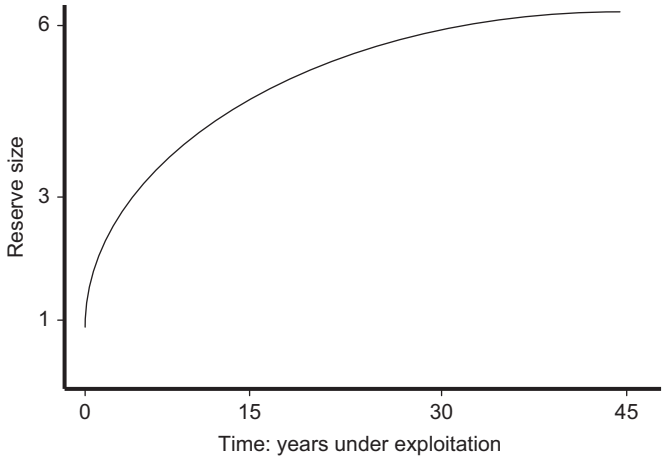

Fig. 3. Appreciation of proved reserves after discovery.
Source: IEA (2005) based on material from US Geological Survey.

While the natural resource base does not appear to be a constraint for continued increases in oil production, the political access to these resources is problematic. Some 90% of the world's conventional oil resources are controlled by governments, which keep a tight rein on oil policy (Economist, 2010). Most of their state owned enterprises are unwilling or unable to undertake necessary investments to assure supply expansion in line with the development of demand (Economist, 2006). This results in repeated supply crunches.

5. Discoveries and proved reserves

"Proved reserves" are defined as quantities of oil in identified fields that can be economically extracted using state of the art technology. "Resources" is a wider and less tightly defined concept.

The Peak Oil representatives identify three worries reflecting accentuated resource inadequacy: (a) in recent decades, the volume of new discoveries has been smaller than extraction; (b) newly discovered fields have been considerably smaller on average than those discovered in the 1960 and 1970s and (c) there is a serious doubt about the huge Middle East reserves. These worries are all based on an erroneous and inconsistent application of the concept of "appreciation" and on closer scrutiny they all appear to be by and large fallacious.

It is correct that the volume of new discoveries has been smaller than extraction since the 1980s, and yet, proved reserves have continued to grow. The explanation to this paradox is that the quantity of reserves in new discoveries regularly appreciates in the process of field development exploration and subsequent exploitation. The quantity is further appreciated as more efficient technology is taken to use, permitting a fuller exploitation of the oil in the ground. Historical data from the US reveal (IEA, 2005) that the ultimately recovered oil when a field ceases to produce is on average six times as large as the volume announced after the initial discovery (Fig. 3).

Oil producers will devote efforts to greenfield exploration, with the hope of making discoveries, only if this is seen as a cheaper way to create reserves than appreciation-enhancing field

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development exploration. The above paradox is then explained by the fact that the sum of discoveries and appreciations regularly exceeds extraction, permitting reserves to grow. The Peak Oil worry on this count is misguided, and caused by an unwillingness to recognize the full role of appreciation.

Peak Oil's concern about declining field sizes in new discoveries over time is also misleading, again partly caused by the adherents' selective consideration of appreciation. In the Peak Oil analysis, old discoveries are fully credited with all appreciations that occurred since they were first identified. Their size is therefore exaggerated when compared to new discoveries with little appreciation to show. Nothing is wrong with the small size of trees in a newly planted forest. Another factor is also at work. The world's richest oil resource base is in the Middle East. This is where the giant fields were discovered in the past, and where truly huge future discoveries can be expected. However, little greenfield exploration has been undertaken in the region since the governments took control of the oil industry and its resource base in the 1970s, and the inactivity has reduced the global average size of new findings. Taking these two factors into account dispels most of Peak Oil's depletion worry on this count.

In 2009, proved oil reserves in the Middle East amounted to more than half of the global total (BP, Annual) but Peak Oil casts doubt on the reliability of the numbers. The reason for the doubt is that these reserves were increased in the 1980s from 430 to 750 billion barrels, despite a virtual absence of greenfield exploration and new discovery. However, the Peak Oil doubts ignore some 15 years of development exploration and technological progress since the governments took over, which resulted in wholesale appreciation that fully motivated the reported change. The credibility of the upward shift can be put in perspective by comparison with the even more spectacular change in Canada's proved reserves during the present century, from 15 to 180 billion barrels, when its huge oil sand deposits were reclassified as proved, after technical progress had made them economically exploitable (EIA, 2002, 2003).

The Peak Oil adherents are overly bound by the perception that oil resources are available in a fixed quantity, irrevocably decimated by ongoing exploitation. It is more realistic to see resources as a result of the dynamic creation process prompted by expanded human capital and needs (Bradley, 2007). The quote by Adelman (2002) demonstrates how reserves are flexibly adjusted to human needs:

> "In 1944 world proved reserves were 51 billion barrels. In 1945–1998, 605 billion barrels were removed, leaving 1035 billion in the ground…"

6. Is there then a reason to believe in an impending Peak Oil?

The perception that oil—an exhaustible resource—must deplete is intuitively appealing, but more than intuition is needed if the threat of an impending production culmination due to inadequate resource availability is to be taken seriously.

The fears of oil depletion in the near future, with an ensuing oil crisis as production declines have been expressed repeatedly over the past 100 years, with especially shrill voices during periods of high oil prices, and the peak has been constantly seen 5–10 years into the future. There is nothing new in the current Peak Oil message, and, as demonstrated in the above discussion, the fallacies of the underlying arguments make it an unrealistic chimera, just as was the case with its predecessors. But even though the catastrophe message is untenable, it has been popular in media and gained wide support in the political establishment. Global oil supply can be compromised for many reasons, notably if resource nationalism spreads and accentuates. In contrast, the oil resource base is adequately large and growing, with little prospect that its depletion could cause a supply crisis in any foreseeable future.

References

Adelman, M., 2002. World oil production and prices. Quarterly Review of Economics and Finance 42.

Bentley, R.W., 2002. Global oil and gas depletion: an overview. Energy Policy 30, 189–205.

BP, Annual. BP Statistical Review of World Energy.

Bradley, R.L., 2007. Resourceship: an Austrian theory of mineral resources. Review of Austrian Economics 20.

Campbell, C.J., undated, about 1998. The Coming Oil Crisis. Multi-Science Publishing, UK.

Deffeyes, K.S., 2005. Beyond Oil, The View from Hubbert's Peak. Hill and Wang, New York.

Economist, 2006, 10 August.

Economist, 2010, 1 July.

EIA (annual), 2002, 2003. International Energy Outlook, Energy Information Administration, Washington, DC.

Goeller, H.E., Weinberger, A.M., 1976. The age of substitutability. Science.

Goodstein, D., 2004. Out of Gas: The End of the Age of Oil. W.W. Norton and Company, Inc, New York.

Hubbert, M.K., 1956. Nuclear energy and the fossil fuels. Publication 95, Research Division, Shell Exploration.

IEA, 2005. Resources to Reserves. International Energy Agency, Paris.

IEA, 2008. World Energy Outlook. International Energy Agency, Paris.

Jevons, S.W., 1865. The Coal Question. Macmillan, London.

Lindstedt, G., 2005. Olja, DNs förlag, Stockholm.

Maurice, C och, Smithson, C.W., 1984. The Doomsday Myth, 10000 Years of Economic Crises. Hoover Institution Press, Stanford, CA.

Meadows, D.H., et al., 1972. The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind. Universe Books, New York.

Popper, K., 1957. The Poverty of Historicism. Harper, New York.

Radetzki, M., 2008. A Handbok of Primary Commodities in the Global Economy. Cambridge University Press, Cambridge.

Roberts, P., 2004. The End of Oil: On the Edge of a Perilous New World. Houghton Mifflin Company, Boston, MA.

Simmons, M.J., 2005. Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy. John Wiley & Sons.

Simon, J., 1996. The Ultimate Resource 2. Princeton University Press, Princeton, New Jersey.

Skaggs, J.M., 1994. The Great Guano Rush. Macmillan, London.

Smith, J.L., 2008. World oil: market or mayhem? CEEPR 08-015. Massachusetts Institute of Technology, Cambridge.

USGS, annual. Mineral Commodity Summaries. US Geological Survey, Washington, DC.

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