GLOBAL OIL TRADE:
The Relationship Between Wealth Transfer and Giant Fields

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SUMMARY
Massive wealth transfer resulting from oil trading has shown its potential to destabilize the world's economy. It is surprising that little consideration is given to the impact of trade inequality (selling low cost oil at high prices). Overcoming a woeful lack of oil reserves information is required for modeling future wealth transfer resulting from oil trading. This paper illustrates that quantifying wealth transfer resulting from the oil trade is largely a function of the rate oil is produced from the giant fields and proposes two steps for building a more credible oil supply forecast.

BACKGROUND
Economists have long appreciated that the oil industry concentrates more capital than any other industry. Less appreciated is the corollary that the global economy is more sensitive to the oil trade than to other industries. Furthermore, confusion about the volume of global oil supply is a distraction from the issue of massive wealth transfer which results from some parts of oil trading. Thus the significance of trade imbalances and the magnitude of the massive transfer of wealth originating from rising oil prices are largely unrecognized. Leaving this trade imbalance unabated and not understood is clearly not in the best interests of the developed economies of the world.

There is widespread confusion between the volume of global oil resources and the rates at which they are extracted (i.e., 'supply'). Adding to this confusion is ignorance about the proportionate contribution of the estimated 17,000 +/- large oil fields that make up all but a tiny amount of the daily supply and the aggregate future delivery capacity. Understanding the geographic origin of the oil supply and the associated transfer of wealth is a multi-dimensional challenge. Factors such as production rate, decline rate, timing and amount of investment, cost and time all impact supply and in turn, wealth transfer. Understanding this complex set of interrelationships in multiple thousands of fields may seem an impossible task, but fortunately, it is not as difficult as it appears.

This paper presents two proposals to improve oil-supply forecasting as a precursor to, and basis for, improved macro-economic models of wealth transfer.

Transfer of Wealth Is Unrecognized

Historically, oil has been cheaper and more abundant than any other energy source and this condition is unlikely to change anytime soon.

Oscillation in demand and price volatility of oil was rather modest for the first hundred years of the oil age, when price was largely determined by the lowest-cost, large-scale producers. Until the mid-twentieth century, the imported volume and unit cost of oil allowed manageable trade balances.

Through the 1960's, the transfer of wealth from oil trading was mostly insignificant to the global economy. Price and cost had a fair relationship due to competition and supply exceeded demand; the low cost producer was successful. To the general public, the prolific fields of the Middle East, United States, Venezuela, North Africa and the North Sea seemed to provide an inexhaustible supply of cheap oil and modest prices encouraged profligate consumption.

Then during the mid 1960s the U.S. became an oil importer, and at first, the transfer of wealth was insignificant. This worked well initially because the volume of imports and low prices was not sufficient to impact either global trade or the transfer of wealth. Consequently, importing oil was no cause for alarm and did nothing to change consumption habits, but over time, volumes and costs increased steadily.

Up to this point, low-cost exporters with huge supply capacities kept global oil prices low, but almost unnoticed, oil dependence grew as did transfer of wealth. Figure 1.1 illustrates the growth in volume, commodity price, and value of the global oil trade since the eighties. Almost imperceptibly, trade imbalances and a shifting of liquidity grew. At $70/bbl., approximately 1 trillion USD/year, is transferred to exporters. Liquidity is created largely in countries with giant fields because of a combination of high production rates and low unit costs. An insignificant trickle has grown into a flood of wealth transfer, *but for all the attention to 'are we running out of oil,' there is no forecast of the future rate of wealth transfer or its consequences.*

Inequitable Costs

The price for oil can be detached from the cost to produce for limited periods of time. For example, a low cost producer may reduce competition by lowering the price below cost. In contrast, if demand exceeds supply, price is determined by the highest bidder. From a global viewpoint, the cost of production varies widely between the largest fields, the more modest sized ones and those of lower quality. The handful of giant fields is the major controlling agent in both future delivery capacity and the transfer of wealth.

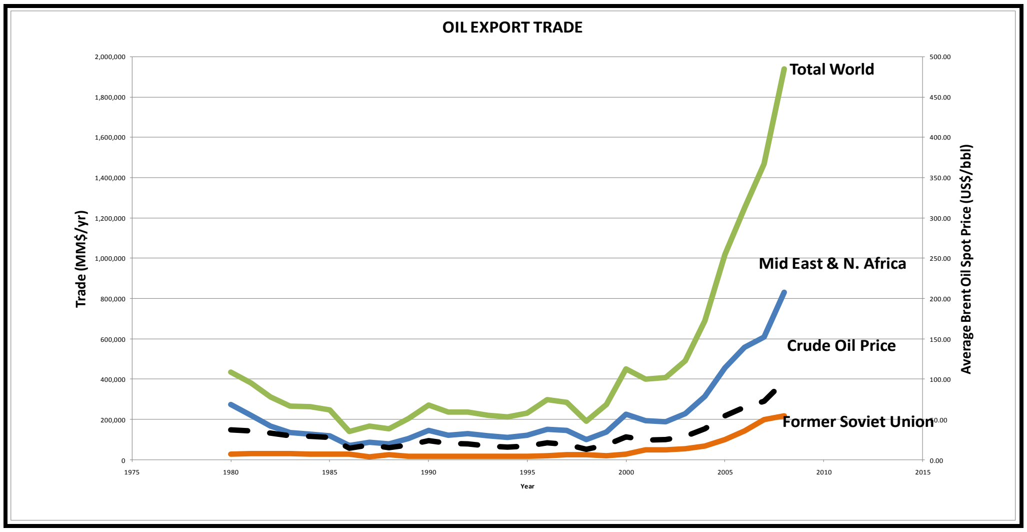

Figure 1.1 Value of global oil trade (British Petroleum, 2009 data).

Table 1.1 illustrates the current cost of adding a million barrels a day from different areas and operating environments.

AREA	$BILLION USD TO ADD 1 MILLION BOPD	COMMENT
Middle East	8	cost to drill wells and build pipeline
Deep Water	30-35	cost of topsides, not drilling
Onshore US	30- 35	cost of drill wells, not transportation
Heavy oil (Canada and Venezuela)	40 - 45	cost to extract and transport

Table 1.1 Comparison of cost to add 1 million bopd of production from different areas of the world.

Clearly the Middle East, with its concentration of giant fields is not only the high volume producer but also the low cost producer. Figure 1.2 illustrates the gross cash receipts by country or area. The combination of low costs and high volumes generate excess capital in the Middle East far exceeding other oil exporting regions. The consequences of such large wealth transfer and concentration of liquidity are simply unknown.

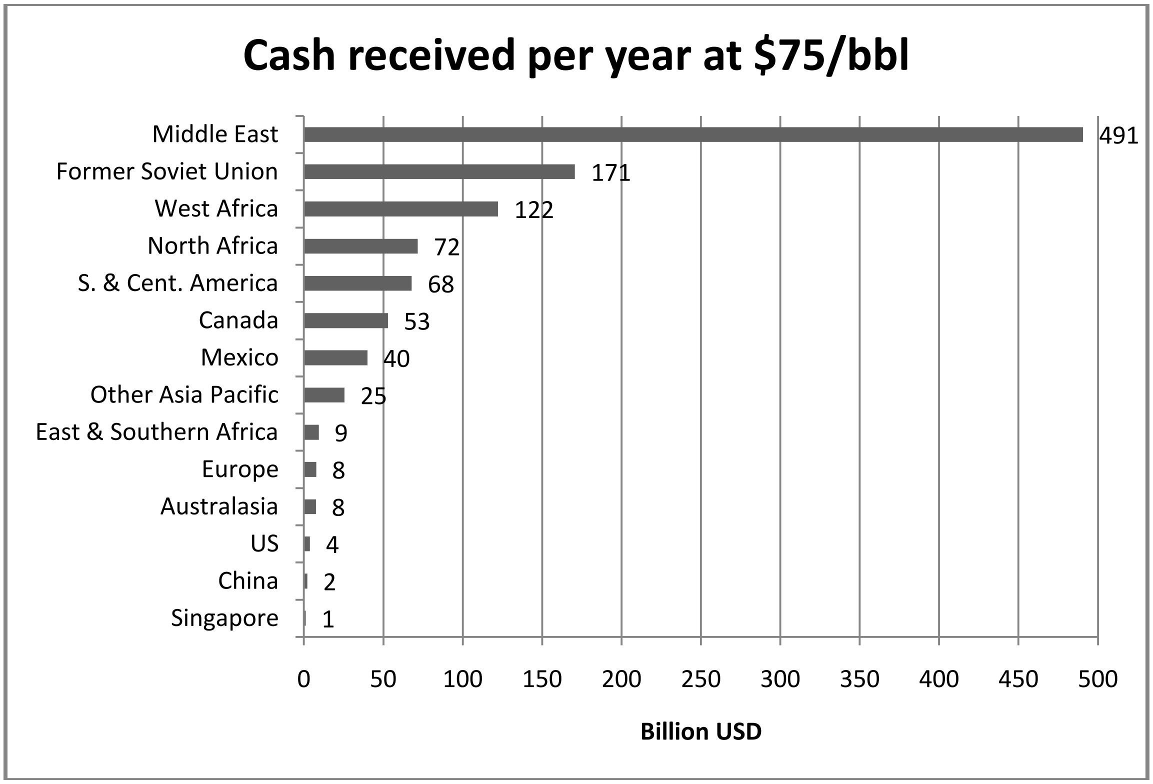

Figure 1.2 Comparison of gross revenues using export volumes for 2008 and $75/ bbl. (British Petroleum, 2009).

Impact of Wealth Transfer

It is well known that as supply and demand converge, the average price will increase and will be subject to extreme volatility. What is not known is the impact on global economic activity arising as wealth and liquidity change hands ,becoming more geographically concentrated. Clearly, the potential impact on the global economy is huge. Currently, the Gulf States alone receive about $550 billion USD/year, -- which the EIA conservatively projects will grow to $1.8 TRILLION/ year in 20 years.

Massive changes in the global financial model will be required to reduce oil dependencies. However, before public policy-makers can determine what is required to compensate for transfer of wealth from the oil trade, its value must be accurately quantified, and policy makers must have confidence in the forecasts used. Even in totalitarian states, political courage is required to challenge public perceptions that cheap energy is a right. Politicians will not attempt to change energy consumption habits until there is an overwhelming consensus for the need to do so.

It is the responsibility of the energy industry to provide the public with the data and expertise to provide forecasts that the public can use with confidence to plan effectively.

TWO PILLARS OF A MANAGEABLE PROBLEM

The proposals in this article start with the belief that it is necessary to link a macro-economic model to future oil supply in order to predict future oil trade and its economic impact. The pillars of this model are first predicting oil-production rates and second modeling their economic consequences, the latter being a function of the former. In other words, forecasting future oil supply is more of an economic issue than a barrel issue.

A model of the global transfer of wealth features a complex set of relationships but is credible only if supply-side forecasts comport with known (not assumed) geologic and engineering constraints specific to each field. Improving these forecasts is a manageable problem that must be addressed, but the range of uncertainty among current forecasts is too great to allow meaningful macro-economic models to be made (Fig. 1.3).

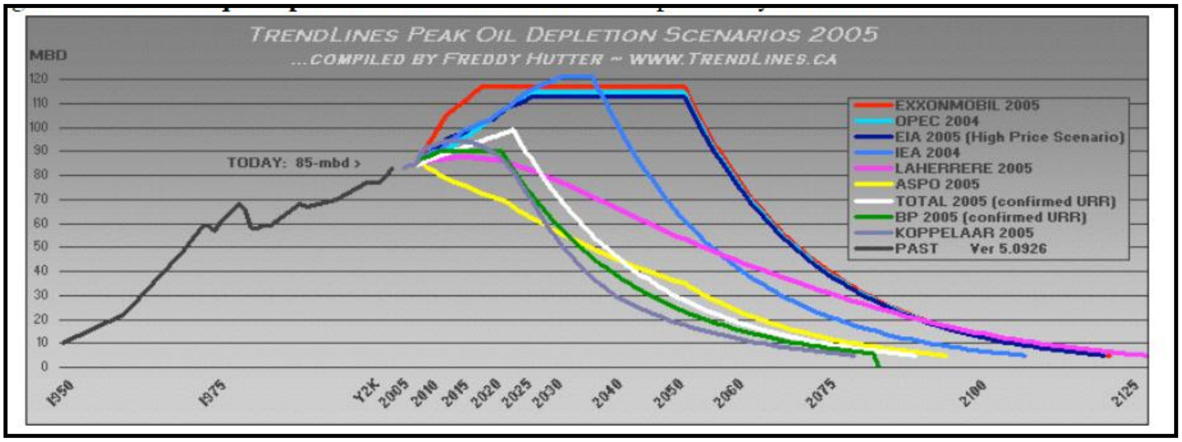

Figure 1.3 Oil supply forecasts from multiple sources and methods lead to uncertainty that is too great for macroeconomic modeling (Laherrere, 2005).

Forecasts of future oil-production rates must be done differently in order to be more credible than previous ones. Toward that end, a different methodology for building said forecast, improving the confidence in results, is proposed, i.e. modeling the 320 +/- giant fields of the world rather than the 17,000 +/- large oil fields. Doing so would be a significant step toward forecasting global production because these few fields produce over 60 percent of the world's production

The proprietary nature of oil exploration and production, the many variables in geological and reservoir properties, advances in technology, and price all complicate the modeling of supply. Prior attempts to predict future supply capacity have had a wide variation in outcomes, resulting in much controversy (Fig. 1.3). This will not change until the data are made public and a consensus regarding the prediction method is reached.

PILLAR I: Macro Economics

To improve the utility of oil supply forecasts, the cost to achieve that production in $/bbl/day must be considered. Cost will inevitably rise as new fields decrease in size, and the difficulty, expense and time of finding a sufficient number of small ones to offset normal declines increase.

Figure 1.4 illustrates the essence of this proposal. The normal forecast (white area below curve) is a statistical distribution of production but does not include the effects of rising prices. The two lines below the normal distribution are price and cost which change as production includes an increasing mix of smaller, more remote, deep water and /or hard to produce fields. The lower line of the cost curve illustrates a normal rise in cost as the commodity is depleted with nominal increase in price. The second line of the cost curve results from an increase in price which originates from production of lower quality resources. The shaded area on the curves shows the portion of production coming from high-cost resources, and once past the peak, the only way to maintain a production plateau is for price to drive recovery of these resources. If post-peak oil production (a plateau) is to be maintained, prices must increase, and this paper proposes methods to model such a future.

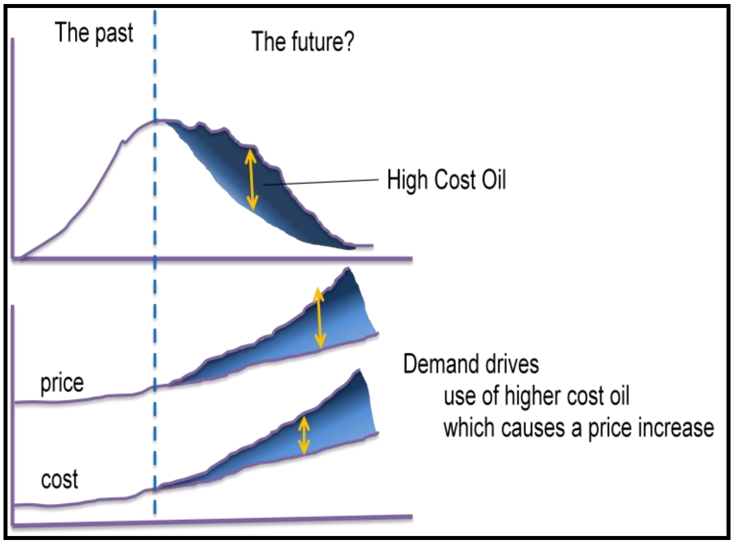

Figure 1.4 See text for explanation.

PILLAR II: Improving Global Production Forecast by Using the Giants

The role of giant fields in contributing to world oil supply and concern about its sustainability is well established (e.g., Klemme, 1977; Nehring, 1980; Horn, 2003; Simmons, 2002; Schollnberger, 1998, 2006, 2008; Robelius, 2007, Hook, 2009). Thus, a forecast of the giant fields indicates total oil supply,. The most recent data (Robelius, 2007) show 60 percent of daily production is from only 320 of the world's 17,000+ large oil fields. This proportionate relationship between giant fields and total production has been remarkable consistent for nearly a century as illustrated later in figures 3.1 and 3.2. Construction of a public data base of these few giants would allow forecasts to be made based on an evaluation for the future production potential from each individual field. This is in contrast to forecasting based on past production.

In addition to building a data base of discovered giants, it is also recommended that the US Geological Survey (USGS) re-visit its 2000 assessment and focus on assessing only undiscovered large fields and on building supply curves for oil-producing basins from the large fields.

The supply of conventional oil is unlikely to grow (Jackson, 2009), and the cost of supplementing conventional oil with heavy oil or other alternatives at the rate of a million bopd/year is unlikely in the near term (this paper). As noted below, forcing massive liquid assets into ever more risk-prone investments contributes to further destabilization of the interdependent global economy.

PILLAR I: GLOBAL MACRO-ECONOMIC FRAMEWORK

Massive Cash Flow Strains the Global Financial System

A combination of savings, capital flows, and fiscal imbalances contributed to the recent global economic predicament. Capital in-flow into some oil exporting countries is largely assimilated by the local economy (Fig. 2.1 A). However, in countries with small or undiversified economies, and with a low cost of production, (i.e., small countries with giant, low cost fields) this capital cannot be efficiently deployed in the local economy and is invested externally (Fig 2.1 B). This provides a utility of the excess capital, which is expected to grow until it can be repatriated. Only the world's largest economies can efficiently absorb the large inflows of capital derived from the oil trade on a continuous basis. However, even these giant economies have limits, and foreign investment may exceed even their capacity to utilize capital (Fig. 2.1C). In such an event, the overabundance of concentration of liquidity may destabilize the global financial system. So long as the massive transfer of wealth associated with the oil trade continues in its present form, frequent and reoccurring financial crisis are to be expected.

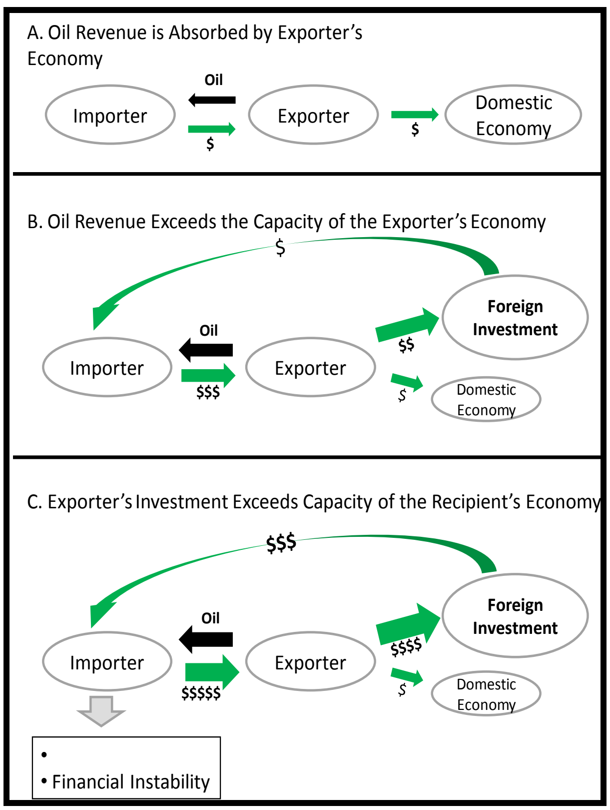

Figure 2.1 Stages in the uses of oil revenue. A: the domestic economy can absorb it. B: the domestic economy cannot absorb all of it, resulting in foreign investment. C: invested in a foreign country, it may exceed the capacity of that economy as well, resulting in economic damage.

No other economic activity concentrates capital and creates such a large movement of wealth as the oil trade, and in the last decade, the increase in oil price has caused massive concentrations of capital. The degree to which re-distribution of wealth by the oil trade may have contributed to the recent failures of the global financial system is not thoroughly understood.

Domestic markets of several oil exporting economies could not utilize the vast pools of liquidity from this trade, which resulted in sovereign wealth funds placing this capital with major financial institutions in the Western world. Capital availability eventually exceeded conventional demand in the markets, and the financial industry created non-conventional financial products to accommodate excess liquidity. The resulting securitized financial products and other credit-rated investments initially absorbed this capital and made enormous profits for their creators. Although technically credit-worthy, these instruments eventually became high-risk as more money poured into the system, pushing the values of assets beyond reason, and when the bubble burst the entire global financial system was affected.

Unfortunately, the fundamental problem arising from massive pools of liquidity remains unaddressed. The oil trade transfers more than one trillion dollars per year from importing to exporting nations; just seven countries are the primary beneficiaries. Of particular concern are those of the Middle East where cost may be as little as 5 percent of the value of exported oil. Growth of these liquidity pools will continue as smaller exporters, such as Mexico, become importers. As the number of exporters shrinks, the rate of wealth transfer to the largest ones will grow, and as long as this trend continues, it will exacerbate both the overabundance and concentration of liquidity that increasingly threaten global economic well-being.

The volumetric side of supply is fundamental to the relationship between the oil trade, imbalances of capital flow, and their impact upon the global financial system. Measures to prevent a recurrence of the recent crisis, no matter how meritorious, will be insufficient to bring long term stability to the system as long as massive transfer of oil wealth continues as it has in the past.

Other Economic Impacts:

All oil importing nations face the negative economic consequences of wealth transfer albeit differing in severity and timing. As the largest oil importer, the U.S. is most illustrative of this condition by continued diminution of its economy (transferring about $1 billion per day at $70/bbl), together with reinjection of much of this money into major financial institutions by oil exporting nations. Concentration of liquidity is exacerbated both by oil exporters not purchasing a comparable amount of goods and services from importers and by imbalance in the relative cost of goods to oil price, which favors the oil exporters. Both the US and international economies are susceptible to economic disruptions caused by the oil trade, the obvious vulnerability being any sudden interruption of oil supply. The less recognized and possibly even greater threat to global economic security is over-concentration of liquidity.

In the longer term, demand-driven price hikes worsen the global imbalance of liquidity, weaken financial markets, and reduce the ability of oil importing economies to fund a transition from oil dependency. Importers suffer a net erosion of their financial bases by continuing oil imports. Demand for capital by the energy industry in the next 20 years will be huge, and these countries may be unable to finance such projects.

Political Impacts: Evolving Political Influence

Over the next 5-10 years, oil supply from such areas as Mexico, North Sea, Indonesia, Egypt, Ecuador, and others will quietly decline, and these countries will begin to compete for oil with current importers. In contrast, oil supply is likely to increase from Canada, Brazil, perhaps Russia, and possibly even Venezuela if policies change. As this evolves, capital will go to regimes that in many cases have significantly different cultural and political views from those of the importers. New importers will also undergo contraction of their social programs, which may cause changes in public policy in response to declining standards of living.

Impact on Global Balance of Power and Risk of Conflict

As wealth moves from importer to exporter, power is transferred, and national interests evolve. The high rate of wealth transfer increasingly destabilizes regions, which, in a world with little excess capacity, can cause volatility in oil markets and further economic stress. Re-militarization in Russia and Venezuela, plus increased tension over oil between China and India, are contemporary examples.

Looking Forward

In order to manage the impact of massive wealth transfer associated with the oil trade, importing and exporting countries must address some difficult questions such as:

- How to stabilize a global economy that is experiencing massive and highly concentrated liquidity?
- How can exporting countries manage their liquidity?
- At what time and at what rate are oil alternatives needed?
- What regulatory measures will promote alternatives to oil?

Answering these questions requires a global economic model that includes a reliable forecast of oil supply.

PILLAR II: GIANT FIELDS (Discovered and Undiscovered)

SIGNIFICANCE OF GIANTS' PRODUCTION

Giant fields act as a reserve bank for oil, and Nehring (1980) was perhaps first to document their contribution to supply. Table 3.1 uses more recent data to illustrate the percentage of reserves contained in giant fields, but despite their impressive volumes, this table does not illustrate the daily rate of supply and it is supply rate that impacts economies.

OF THE WORLD'S KNOWN 2258 BBO, THE PERCENTAGES IN GIANTS:		
522 FIELDS=> 500 MBO	996.3/2258	44.1 PCT
222 FIELDS => 1000 MBO	804.9/ 2258	35.6 PCT
93 FIELDS => 2000 MBO	634.5/2258	28.1 PCT
42 FIELDS => 5000 MBO	488.4/ 2258	21.6 PCT
OR OF THE WORLD'S 16,000 OIL FIELDS:		
TOP 20 FIELDS =	342.2/ 2258	15.2 PCT
TOP 50 FIELDS =	522.5/ 2258	23.1 PCT
TOP 321 FIELDS =	884.9/ 2258	39.2 PCT

TABLE 3.1 Data from BP (2009) and Horn (2000).

New data have updated the earlier work and confirmed the contribution of giant fields has been around 60 percent of global production since the mid-1960s (Figs. 3.1 and 3.2).

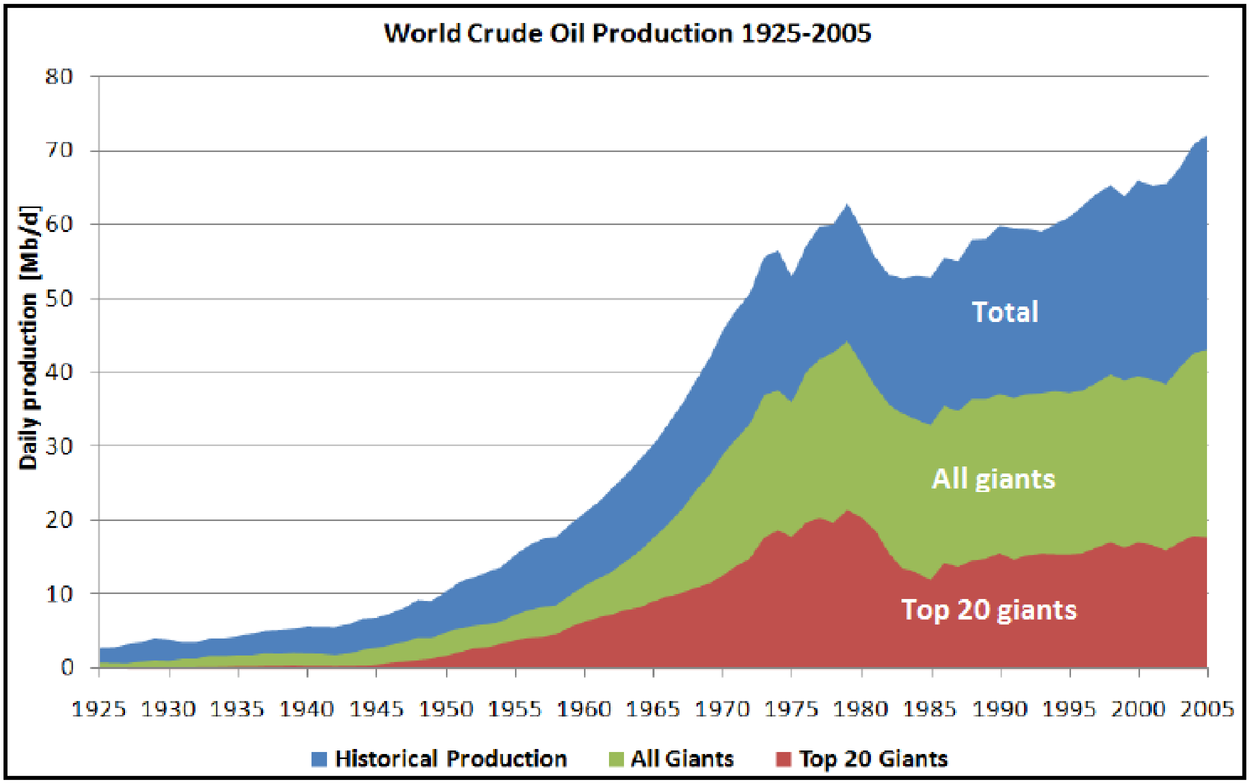

Figure 3.1 World daily oil production showing the contribution of giant fields (Kelley, et al, 2009, *after* Robelius, 2007, and Hook, et al, 2009).

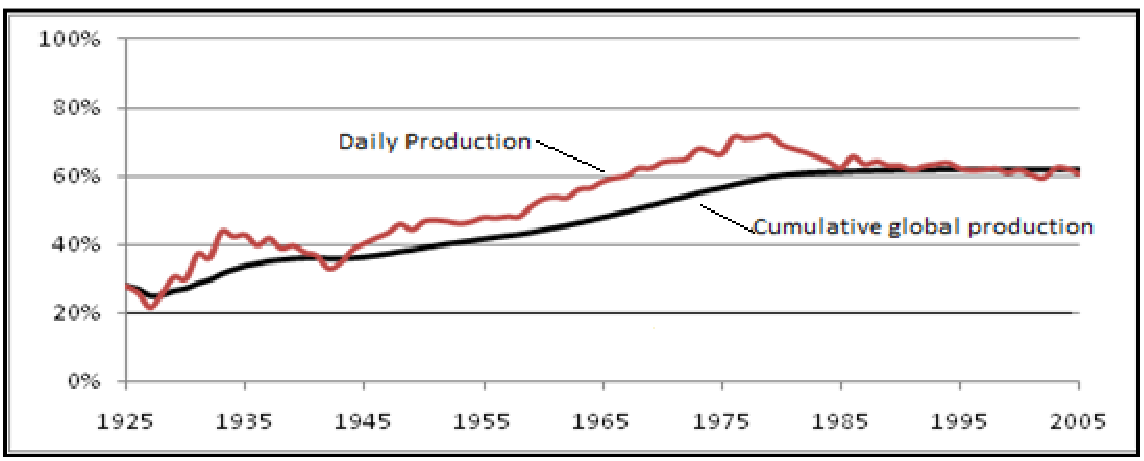

Figure 3.2 Production from giants as a percentage of daily production and total global cumulative production. (Kelley, et al, 2009, *after* Robelius, 2007, and Hook, et al, 2009).

With such a large portion of total oil coming from so few fields, it is clear that forecasting production of these giants will predict a large part of total oil production. Decline of oil fields can follow many patterns, but Figure 3.3 illustrates the end members.

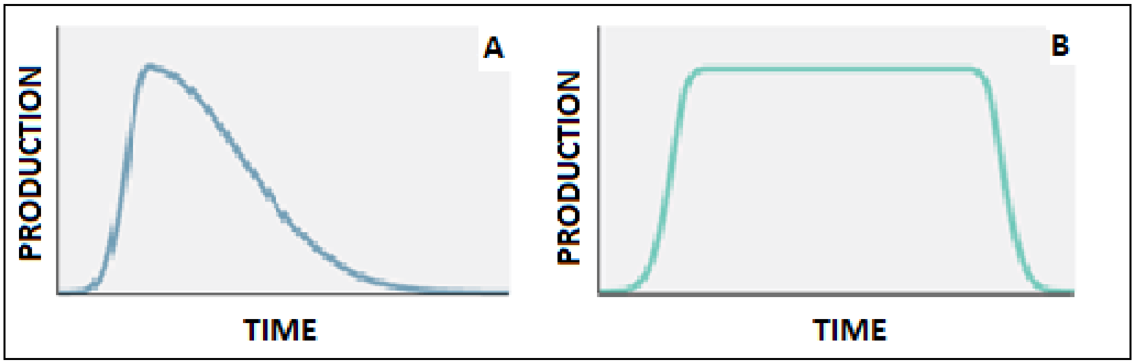

Figure 3.3 Typical production-profile end members: A, **non-OPEC. B, OPEC.**

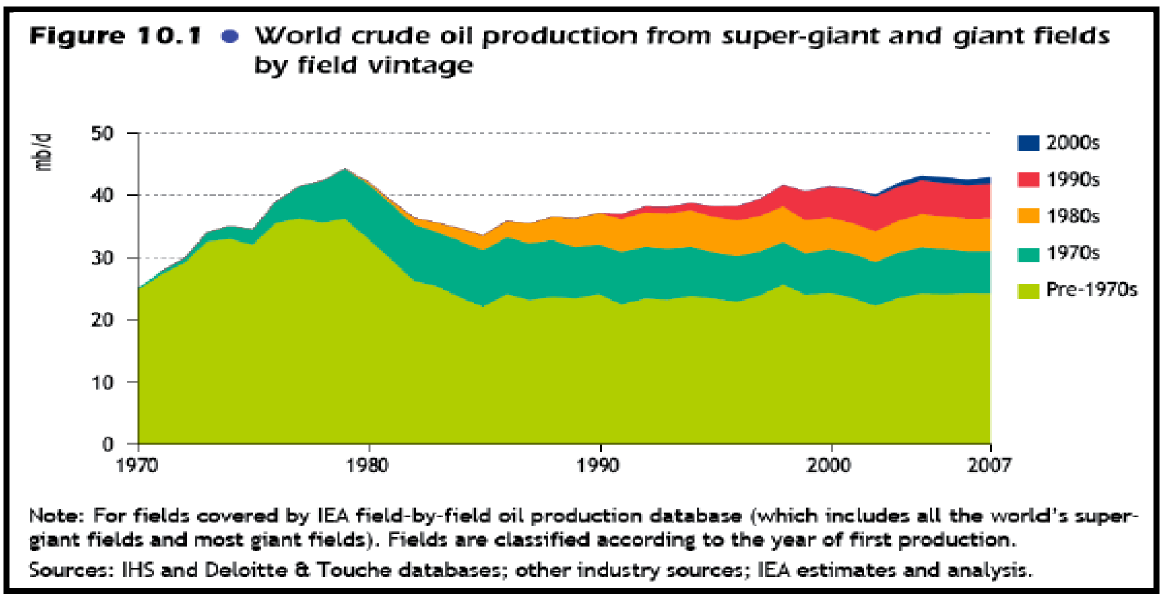

Figure 3.4 Production histories from giant and super-giant fields (Simmons, 2002).

This figure shows the production histories of OPEC countries. Note the long duration of plateau production for these fields, but the key unknown is how long the plateaus can last.

DISCOVERED CONVENTIONAL GIANTS

Proposed Deliverables

The authors call upon the operators to collaborate in building a publicly accessible data base of giant fields so that forecasts can be made by many different groups using the same primary data. These forecasts should attempt to define uncertainty by showing a range of possible profiles (Figure 3.5).

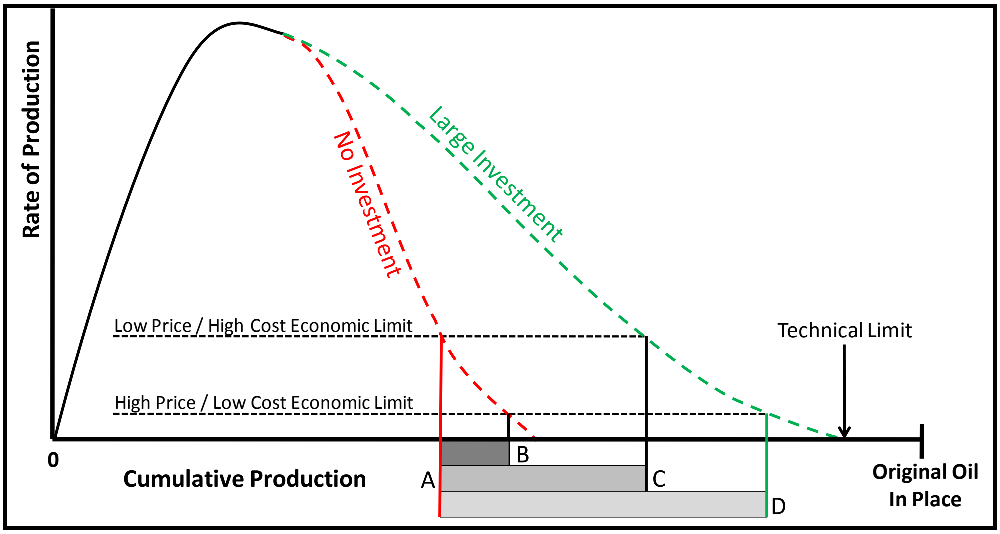

Figure 3.5 Proposed format for oil supply forecasts (Kelley, et al, 2009).

The volume range shown by AB is driven largely by low price, ABC by a combination of intermediate investment and intermediate price, and ABCD by early high investment plus high product prices.

In short, what is required includes:

1. A publicly available digital library containing reservoir models of about 300 of the world's largest fields.
2. A library of primary data (logs, seismic, well and production records, etc.)
3. Production histories and forecasts for each field.

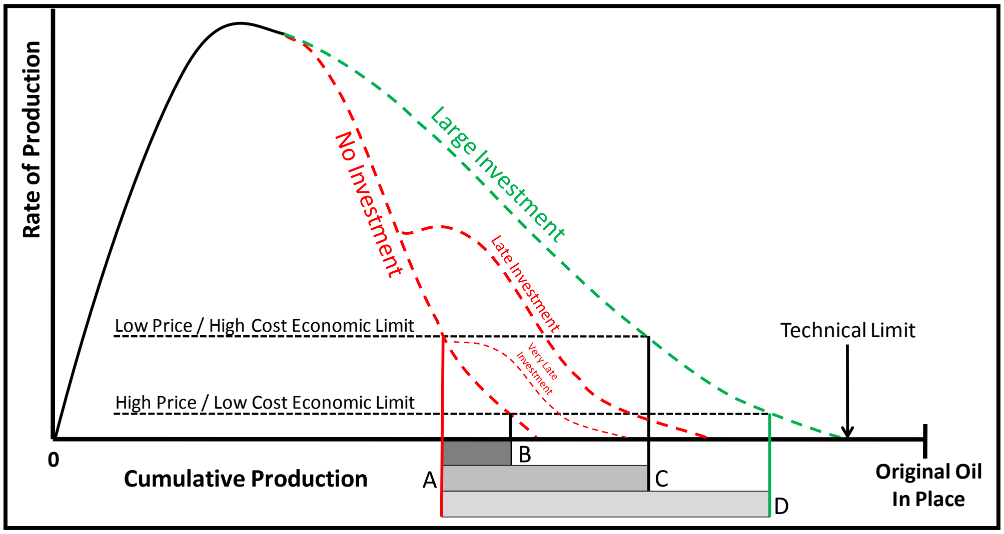

Figure 3.6 Variation on format of Figure 3.5 showing how timing of investment can affect recovery efficiency (Kelley, et al, 2009).

Figure 3.6 shows the effect of investment timing on ultimate recoverable oil, most importantly that late investment cannot raise recovery efficiency to that of early investment. Although new technologies sometimes yield significant improvement in recovery efficiency, it is not correct to assume that they can raise that of the whole field. Therefore, if an old field had an initial recovery of 30 percent and new technology can extract 50 percent, applying it at a late date will not achieve 50 percent for the whole field but something much less. Thus, forecasts should include cost scenarios to show where investment makes the largest difference in production rate and future volumes.

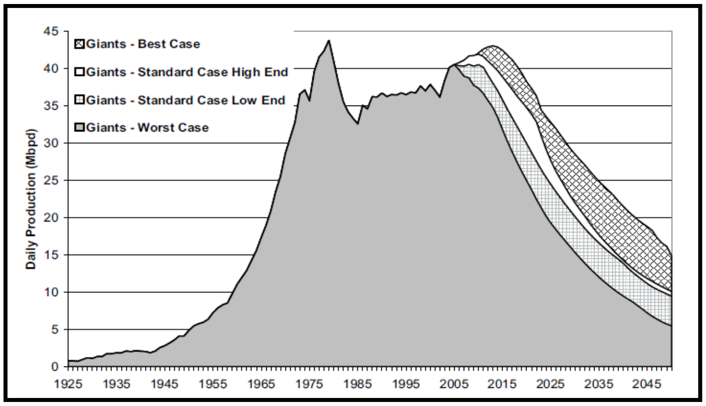

Figure 3.7 Forecasted future oil production from 322 giant oil fields (Robelius, 2009)

Figure 3.7 shows a similar forecast made from reported ranges of estimated ultimate recoverable oil (EUR), assuming decline rates unique to each field, tempered by any known re-development projects. Although this is probably as much as can be done with such data, it may not be sufficient to convince policy-makers. The primary geotechnical and engineering data should be gathered and used to build this type of forecast 'from scratch,' including costs associated with the modeling.

Discovered But Undeveloped or Discovered But Idle Capacity

The BP annual report (2009) stated that the world has 1258 billion barrels (BB) of proven reserves, which, at current consumption of 30 BB/y, will last for about 40 years. This is a seemingly healthy cushion and it implies substantial shut in capacity and or discovered but undeveloped capacity. Nehring (2009) cited proved developed reserves of 670 BB, leaving 588 BB proved but in an unknown state of development.

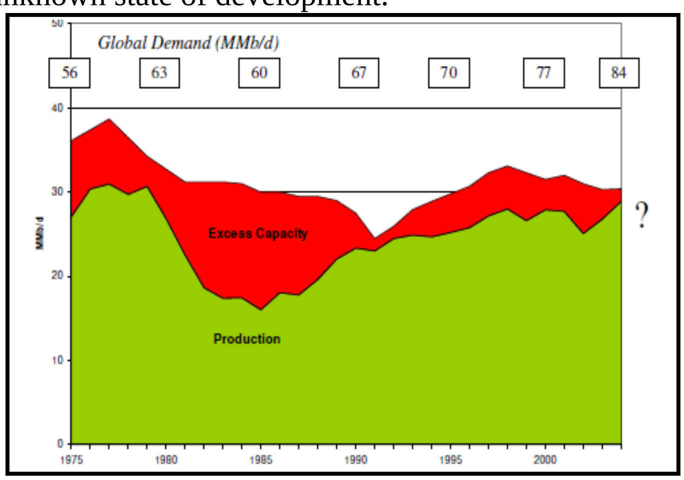

Figure 3.8 OPEC excess capacity (Petrie, 2005, *after* IEA).

Within OPEC, excess capacity seems to be greatly diminished (Fig. 3.8) and as shown in Figure 3.9, there is no excess capacity in non-OPEC countries, with Russia perhaps being the exception. Declining production in spite of rising real prices is a strong indicator that the non-OPEC countries have no idle capacity. Thus, any significant ability to increase global production probably lies within OPEC, implicitly from giant fields. Assuming this capacity exists, it will be from discovered but undeveloped resources, thus requiring investment and time before they contribute to global oil supply. .

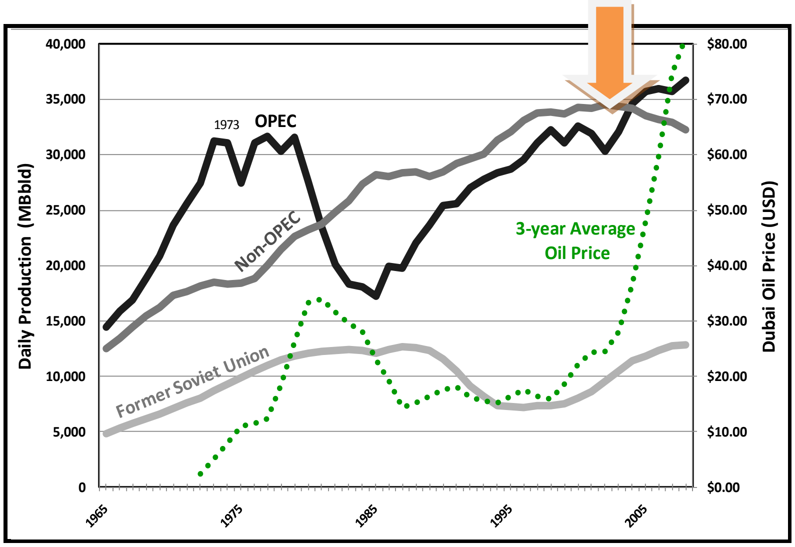

Figure 3.9 Global oil production from 1965 and the 3-year average oil price in nominal dollars ((British Petroleum Data 2009)*after* Leonard, 2009).

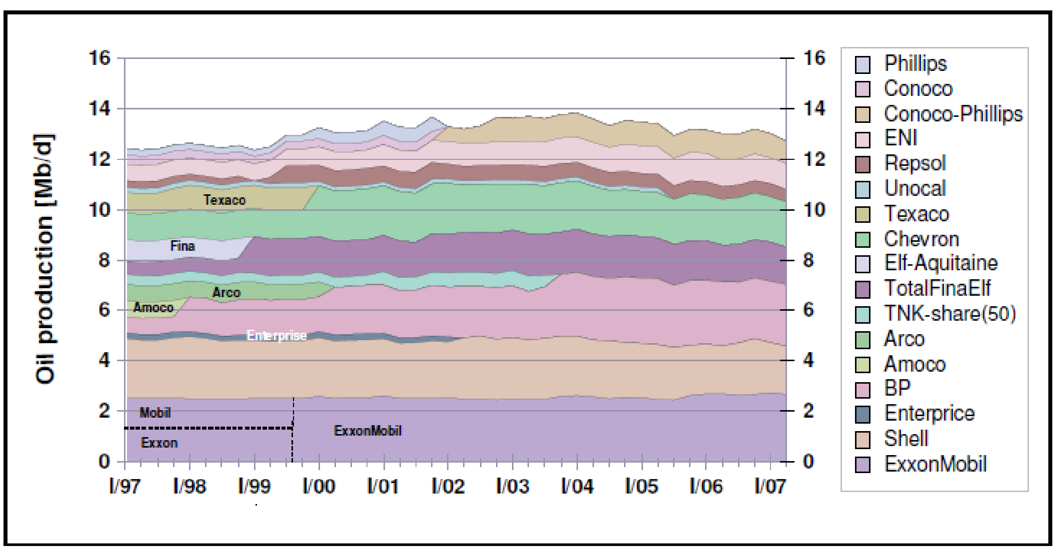

Figure 3.10 Oil production of majors in a decade in which production was basically unchanged. This occurred during a period of good oil prices (Zittel and Schindler, 2007).

Figure 3.10 is another indicator that non-OPEC suppliers are having difficulty adding production. It shows that oil production from the majors for 1997-2007 is basically flat, i.e. they are finding enough to offset declines but not adding capacity.

DISCOVERED UNCONVENTIONAL GIANTS

Discovered but unconventional have massive resource volumes but will cost more to develop and produce than their conventional counterparts. Although heavy oil is attractive in the near term, the extremely large reserves may not be sufficiently developed to offset the decline of conventional giants without government financing. Canada has recently announced reserves of 172 BB of heavy oil, and the USGS (2010) estimated mean recoverable resources in the Orinoco at 513 BB. The projection of added supply from heavy oil is straightforward, because these are the only two major occurrences. Figure 3.11 illustrates that unconventional oil is expected to add 15 million bopd in 10 years. 'Non traditional' is perhaps a better term to use because the unconventional in Figure 3.11 includes deep water; the heavy oil contribution would be about 11 million bopd over 10 years (Pete Stark, IHS, personal communication).

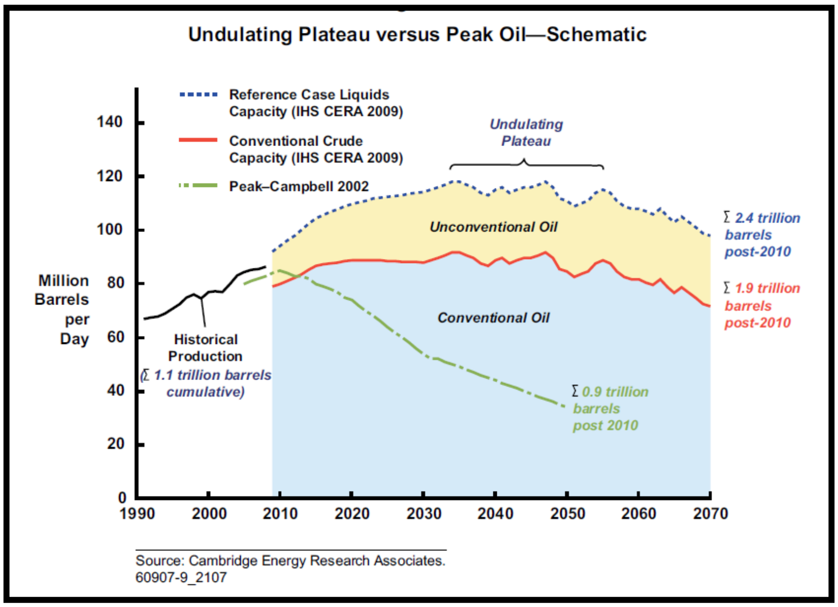

Figure 3.11 Global oil supply forecast from CERA (Jackson, 2009). ***["Use of this graphic was approved by IHS CERA in advance. No further reuse or redistribution is permitted."]***

Estimating the cost to bring a million bopd of heavy oil online is uncertain, because costs are declining but the Canadian Association of Petroleum Producers (Anonymous 2006, 2009), estimate that adding one million barrels a day by 2015 will cost about $44 billion USD. Recent announcements (Eni, 2010) on Venezuela are about $35 billion to add 1 million bopd. Thus, adding 11 million bopd of heavy oil over 10 years presumably would cost $350 to 450 billion. These figures do not include the cost of added refining capacity, nor do they account for the smaller amount of refined product from heavy oil than from conventional oil.

Putting this size project in perspective, $44 billion is twice the $22 billion per year projected by Petrobras in its 5-year $110 billion offshore Santos basin project. $350 billion is larger than ExxonMobil market capitalization while $450 billion is equivalent to 3 Apollo programs spent in

10 years instead of 13. The latter was four percent of the US budget in 1966 ($136 billion total in 2007 USD).

BP and Husky recently announced a 37 percent decrease in cost for the Sunrise heavy oil development (www.bloomberg.com/apps/news?pid=20601082&sid=aGw2sL7JwHG8). Although such declines are significant, the size of the effort still requires consideration of how to finance such large projects and avoid economic distortion of the exporting economy. This would be the largest project ever attempted by the private sector, and it is likely that only government(s) can attempt something of this magnitude.

UNDISCOVERED GIANTS AND LARGE FIELDS

Table 3.2 summarizes the annual contribution from discovery of conventional oil at current rates. Daily production rates from new discoveries are based on an assumed decline rate of 10 percent, probably high for an average. Nonetheless, it is apparent that current finding rates do not significantly exceed the fairly conservative decline rates assumed for existing production. These declines are more representative if it is assumed that a large number of fields are on plateau production, rather than in decline.

RECENT GLOBAL FINDING RATES:
4 – 8 billion bbl/ yr
RECENT GLOBAL CONSUMPTION RATES
28 - 31 billion bbl/ yr
POSSIBLE ADDED PRODUCTION AT 10 PERCENT DECLINE
4 bbl/yr = 600,000 bopd
8 bbl/yr = 1,200,000 bopd
CURRENT GLOBAL PRODUCTION ~ 85 MILLION BOPD
at 1 % decline = - 850,000 bopd lost capacity
at 3 % decline = - 2,550,000 bopd lost capacity

Table 3.2 Comparison of recent global finding rates (bbl/yr), possible added production, and decline of current global production at 1 and 3%.

TOTAL DISCOVERED CONVENTIONAL OIL		
	PRODUCED	**1000 BBO**
	RESERVES	**1258 (BP 2009)**
		2258 BBO
UNDISCOVERED (USGS 2000 ASSESSMENT ONLY)		
	MEAN OIL	**649 BBO (non-USA)**
	MEAN NGL	**207**
	MEAN USA	**83 (from 1995 USGS Assessment)**
		939
GROWTH TO KNOWN		
	OIL	**612**
	NGL	**42**
	USA	**76**
		730
GRAND TOTAL	***UNDISCOVERED***	***1669 BBO***

Table 3.3 Produced, discovered, and USGS assessment (2000) of undiscovered resources. 'Growth to known' is oil added largely by improved technology and field extensions.

In 2000 the USGS published an assessment of undiscovered oil and gas expected from the world's most promising basins (Ahlbrandt, et al, 2005). Table 3.3 summarizes the key results of their efforts.

Assessments of undiscovered oil are inherently difficult and are commonly controversial regarding specific volumes. The following comments are not intended to be critical of the Survey because they recognized a number of things correctly, such as identification of basins with the highest potential, location of oil-prone basins, and a robust ranking of basins. Considering volumes alone, this assessment of 1669 BB is a sizeable number, but the finding effort associated with these volumes should also be considered. It is also appropriate to remove the NGL from the calculation, because it comes largely from gas fields, leaving 1428 BB of undiscovered black oil.

The concern for finding effort arises from the assessment of fields as small as 1 million barrels. The result is assessed median field size of 22 mbo in 10,840 fields, which means 5420 fields are between 1 and 22 mbo. Although fields in this size range have local economic value, they do not have a significant impact on global production rate. For example, at current finding rates of 4-8 BB per year, it takes 178 to 357 years to find 1428 BB, even with current technology and higher prices.

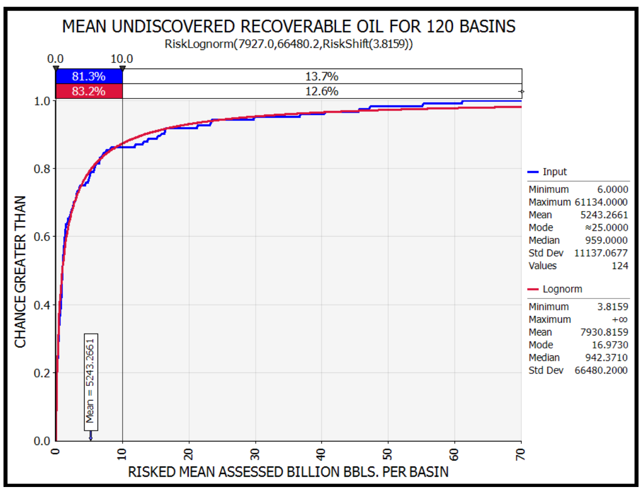

Figure 3.12 Probability plot of mean undiscovered oil (mbo) for 120 basins assessed by USGS (2000). These assessments have not been adjusted for growth.

Figure 3.12 shows the probability distribution of undiscovered oil (not adjusted for growth) in the 120 basins assessed by the USGS (2000). Undiscovered volumes in the basins are lognormal, as are size distributions of fields. More than 60 percent of undiscovered oil is contained in only 10 basins. Importantly, most basins with greater than 10 BB potential are not easily accessible, e.g. one is Arctic, 2 are in deep water, and others are politically inaccessible.

The lognormality also gives an indication of the rate of supply from undiscovered volumes. About 85 percent of basins (102) have mean assessments of less than 10 BB of oil. If it is assumed that a field of that size can produce at 1 million bopd, then 85 percent of basins assessed probably will not add a million barrels a day. Although this is a crude approximation and does not include the growth-to-known portion, it does indicate how long it takes to add production.

Another indication of distribution of the assessment is the median value of 959 mbo, which means that 50 percent (60) of assessed basins have less than a BB of undiscovered oil. Since only 15 percent (18) of basins have the capacity to add significantly to the rate of oil production, the industry must be thoroughly familiar with them.

CONCLUSIONS

FUTURE SOURCES

Discovered and Developed Reserves

More than 70 percent of the world's reserves are in 320 giant fields. How much that production can be expanded and how long before it begins to decline is not known but presumably can be determined.

Discovered and Developed Excess (Shut in) Capacity

This is not found in non-OPEC countries with the possible exception of Russia and appears to be mostly gone in OPEC countries (Petrie, 2005).

Discovered but Undeveloped Resources

These are not well known but may be substantial (Nehring, 2009, estimated more than 500 BB); the largest potential for increased rate of supply in the near term lies in the giants of this group.

Heavy Oil

This probably cannot be expanded by 1 million bopd/year but may add supplies of a few 100,000 bopd/year for many years.

New Discoveries

Currently these add production at rates similar to or smaller than the global decline rate and are unlikely to increase supply rate over a short period of time.

FUTURE ACTIONS

Discussion of world oil supply commonly focuses on volume, as independently derived from either historical finding/ production rates, or derived from forecasts of global economic and population growth. Furthermore, even though the oil industry has made a clear distinction between resources and reserves, supply forecasts commonly do not link resource volumes with the cost to transform them into reserves, let alone supply.

These generalizations have resulted in misunderstanding by the public and uncertainty within the industry. For example, any suggestions that high oil prices or shortages are attributable to environmental activism, (George Will, 2009) create misconceptions which can lead to bad science, bad economics and worse policy. In the event of a significant interruption of supply, public outcry may become polarized and politicized which may result in poor strategic decisions, a situation to avoid.

The energy industry should build public confidence in its forecasts so that governments can lead the public to address the serious economic and social challenges associated with increasing cost of oil and acceleration in the transfer of wealth. The private sector cannot do this alone.

As the largest oil importer, the United States exports about ONE BILLION DOLLARS per day. Largely because of the oil trade, the US has exhausted its former monetary surplus to become the world's most indebted nation. There are limits to which any nation can continue exporting such large amounts of wealth, but there is little progress in modifying the social and economic structure to reduce oil consumption.

Changing the Attitude

Communication of facts regarding oil supply requires education. Changes of public attitudes toward such things as litter on the highways, smoking, air and water pollution, etc. have resulted from education of the public. Similarly, the oil industry is called upon to provide leadership, science, and guidance.

All agree that oil supply is finite and at some point it will level off and then decline. Catastrophic as that may appear, it is more disconcerting to face a world in which the major economies are reduced in their ability to compensate for that eventuality. Such weakened economies without the financial capacity to transition from oil are a threat to global security. Preparedness is a moral imperative.

Cheap oil will not last forever which means that the central bank reserves of the importers may well be exhausted before the oil is exhausted. This is what we mean by '*which runs out first, the oil or the money?*' At what cost, and in what time frame supplies become constricted, must be known in order to plan and succeed in evolution from the oil age. The alternative to a successful transition from an oil dependent economy could be a very long dark age.

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