Global Oil Risks in the Early 21st Century

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Abstract:

The Deepwater Horizon incident demonstrated that most of the oil left is deep offshore or in other locations difficult to reach. Moreover, to obtain the oil remaining in currently producing reservoirs requires additional equipment and technology that comes at a higher price in both capital and energy. In this regard, the physical limitations on producing ever-increasing quantities of oil are highlighted, as well as the possibility of the peak of production occurring this decade. The economics of oil supply and demand are also briefly discussed, showing why the available supply is basically fixed in the short to medium term. Also, an alarm bell for economic recessions is raised when energy takes a disproportionate amount of total consumer expenditures. In this context, risk mitigation practices in government and business are called for. As for the former, early education of the citizenry about the risk of economic contraction is a prudent policy to minimize potential future social discord. As for the latter, all business operations should be examined with the aim of building in resilience and preparing for a scenario in which capital and energy are much more expensive than in the business-as-usual one.

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1. Introduction

An economy needs energy to produce goods and deliver services and the size of an economy is highly correlated with how much energy it uses (Brown et al., 2010a, Warr and Ayers, 2010). Oil has been a key element of the growing economy. Since 1845, oil production has increased from virtually nothing to approximately 86 million barrels per day (Mb/d) today (IEA, 2010), which has permitted living standards to increase around the world. In 2004 oil production growth stopped while energy hungry and growing countries like China and India continued increasing their demand. A global price spike was the result, which was closely followed by a price crash. Since 2004 world oil production has remained within 5% of its peak despite historically high prices (see Figure 1).

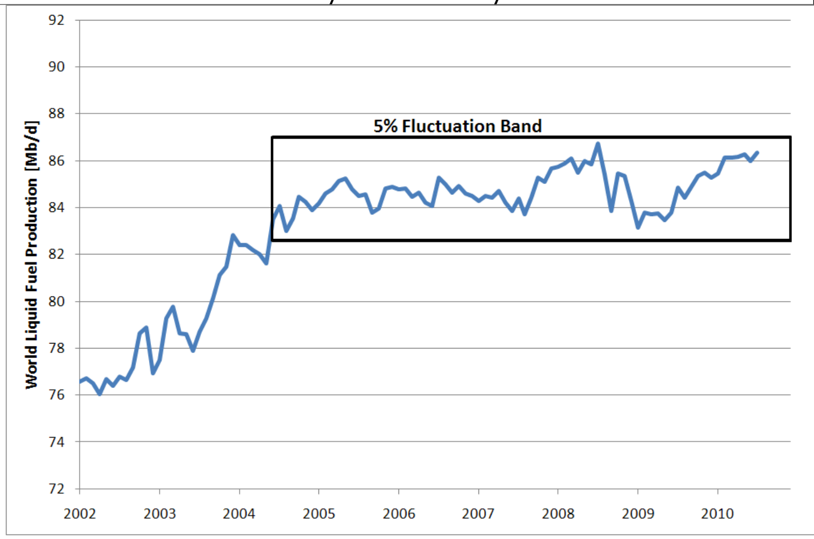

Figure 1. *Oil production stopped growing in 2004 while demand continued to increase. The result was a global oil price spike that contributed to the subsequent economic contraction. Liquid fuels include crude oil, lease condensate, natural gas plant liquids, other liquids, and refinery processing gains and losses as defined by the EIA. Source: Hirsch (2010)*

The combination of increasingly difficult-to-extract conventional oil combined with depleting supergiant and giant oil fields, some of which have been producing for seven decades, has led the International Energy Agency (IEA) to declare in late 2010 that the peak of conventional oil production occurred in 2006 (IEA, 2010). Conventional crude oil makes up the largest share of all liquids commonly counted as "*oil*" and refers to reservoirs that primarily allow oil to be recovered as a free-flowing dark to light-coloured liquid (Speight, 2007).

The peak of conventional oil production is an important turning point for the world energy system because many difficult questions remain unanswered. For instance: how long will conventional oil production stay on its current production plateau? Can unconventional oil production make up for the decline of conventional oil? What are the consequences to the world economy when overall oil production declines, as it eventually must? What are the steps businesses and governments can take now to prepare?

In this paper we pay particular attention to oil for several reasons. First, most alternative energy sources are not replacements for oil. Many of these alternatives (wind, solar, geothermal, etc.) produce electricity, not liquid fuel. Consequently, the world transportation fleet is at high risk of suffering from oil price shocks and oil shortages as conventional oil production declines. Though substitute liquid fuel production, like coal-to-liquids, will increase over the next two or three decades, it is not clear that it can completely make up for the decline of oil production.

Second, oil contributes the largest share to the total primary energy supply, approximately 34%. Changes to its price and availability will have worldwide impact especially because alternative sources currently contribute so little to the world energy system (IEA, 2010).

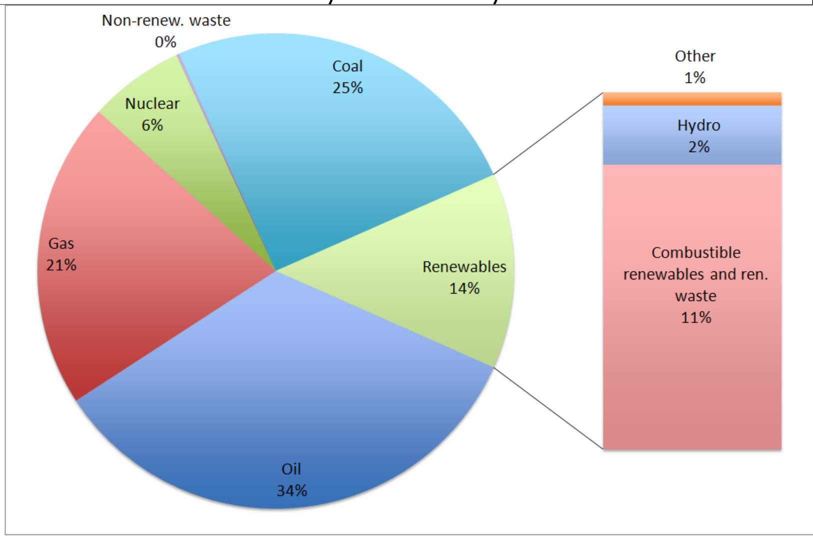

Figure 2. *Fuel shares of world total primary energy supply. The "other" category includes tidal, solar and wind generation. Source: IEA (2007)*

Last, oil is particularly important because of its unique role in the global energy system and the global economy. Oil supplies over 90% of the energy for world transportation (Sorrell et al., 2009). Its energy density and portability have allowed many other systems, from mineral extraction to deep-sea fishing (two sectors particularly dependent on diesel fuel but sectors by no means unique in their dependence on oil), to operate on a global scale. Oil is also the lynchpin of the remainder of the energy system. Without it, mining coal and uranium, drilling for natural gas and even manufacturing and distributing alternative energy systems like solar panels would be significantly more difficult and expensive. Thus, oil could be considered an "enabling" resource. That is, it enables us to obtain all the other resources required to run our modern civilization.

2. The production perspective

It is commonly claimed that peak oil, i.e. the concept that oil production will reach a maximum level and then decline, is only about geology. To some extent this is a result of the polarized debate that has raged between geologists, such as Hubbert (1949; 1956) or Campbell (1997; 2002), and economists, including Adelman (1990) and Lynch (2002; 2003). In fact, peak oil is the result of a complex set of forces that includes geology, reservoir physics, economics, government policies and politics. However, a solid understanding of the peaking and subsequent decline of oil production begins with acknowledging the natural laws that create a framework for everything. The intrinsic limitations of these laws eventually affect all human activities because neither economic incentives nor political will can bend or break these laws of nature.

There are a number of physical depletion mechanisms that affect oil production (Satter et al., 2008). Depletion-driven decline occurs during the primary recovery phase when decreasing reservoir pressure leads to reduced flow rates. Investment in water injection, the secondary recovery phase, can maintain or increase pressure but eventually increasingly more water and less oil is recovered over time (i.e. increasing water cut). Additional equipment and technology can be used to enhance oil recovery in the tertiary recovery phase, but this comes at a higher price in terms of both invested capital and energy to maintain production. The situation is similar to squeezing water out of a soaked sponge. It is easy at first, but increasingly more effort is required for diminishing returns. At some point, it is no longer worth squeezing either the sponge or the oil basin and production is abandoned.

Another way to explain peaking oil production is in terms of predator-prey behavior, as Bardi and Lavacchi (2009) have done. Their idea is that, initially, the extraction of "*easy oil*" leads to increasing profit and investments in further extraction capacity. Gradually the easiest (and typically the largest) resources are depleted. Extraction costs in both energy and monetary terms rise as production moves to lower quality deposits. Eventually, investments cannot keep pace with these rising costs, declining production from mature fields cannot be overcome and total production begins to fall.

An additional factor plays an important role. In both models, regardless of the abundance of capital or high prices, an oil well is unable to deliver net energy at some point. Hubbert (1982) wrote: "*There is a different and more fundamental cost that is independent of the monetary price. That is the energy cost of exploration and production. So long as oil is used as a source of energy, when the energy cost of recovering a barrel of oil becomes greater than the energy content of the oil, production will cease no matter what the monetary price may be.*"

These physical trends conspire to make oil production increasingly difficult and expensive in monetary and energy terms. Economic incentives and technological advancement can slow these trends but they cannot be stopped.

2.1 Oil production today

Production peaks occur for many energy sources ranging from firewood and whales to fossil fuels (Höök et al., 2010). Currently, around 60 countries have passed "*peak oil*" (Sorrell et al., 2009) — their point of maximum production. In most cases this is due to physical depletion of the available resources (e.g. USA, the UK, Norway, etc.) while in a few cases socioeconomic factors limit production (e.g. Iraq).

Attempts to disprove peak oil that focus solely on the amount of oil available in all its forms demonstrate a fundamental, and an unfortunately common confusion between how much oil remains versus how quickly it can be produced. Although until recently, oil appeared to be more economically available than ever before (Watkins, 2006), others have shown this to be an artifact of statistical reporting (Bentley et al., 2007). Further, it is far less important how much oil is left if demand , for instance, is 90 Mb/d but only 80 Mb/d can be produced. Still, the most realistic reserve estimates indicate a near-term resource-limited production peak (Meng and Bentley, 2008; Owen et al., 2010).

Total oil production is comprised of conventional oil, which is liquid crude that is easy and relatively cheap to pump, and unconventional oil, which is expensive and often difficult to produce. It is vital to understand that new oil is increasingly coming from unconventional sources like polar, deep water, and tar sands. Almost all the oil left to us is in politically dangerous or remote regions, is trapped in challenging geology or is not even in liquid form.

Today, over 60% of the world production originates from a few hundred giant fields. The number of giant oil field discoveries peaked in the early 60s and has been dwindling since then (Höök et al., 2009). This is similar to picking strawberries in a field. We picked the biggest and best strawberries first (just like big oil fields they are easier to find) and left the small ones for later. Only 25 fields account for one quarter of global production and 100 fields account for half of production. Just 500 fields account for two-thirds of all the production (Sorrell et al., 2009a). As the IEA (2008) points out, it is far from certain that the oil industry will be able to muster the capital to tap enough of the remaining, low-return fields fast enough to make up for the decline in production from current fields.

All oil sources are not equally easy to exploit. It takes far less energy to pump oil from a reservoir still under natural pressure than to recover the bitumen from tar sands and convert it to synthetic crude. The energy obtained from an extraction process divided by the energy expended during the process is the Energy Return on Energy Invested (EROEI). It is a return on investment calculation applied to a physical process. As Hubbert noted, regardless of the price the market is willing to pay for oil, just as we won't spend a dollar to receive only a dollar in return, when we expend as much oil as we get back from a particular oil deposit, production will stop.

The EROEI of US domestic oil production (chiefly originating from giant oil fields) has declined from 100:1 in 1930 to less than 20:1 for developments in the 2000s, e.g. Gulf of Mexico,(Gately, 2007; Hall et al., 2008; Murphy and Hall, 2010). Since giant and super giant oil fields dominate current production, they are good indicators for the point of peak production (Robelius, 2007; Höök et al., 2009). There is now broad agreement among analysts that the decline in existing production is between 4-8% annually (Höök et al., 2009). In terms of capacity, this means that roughly a new North Sea (~5 Mb/d) has to come on stream every year just to keep the present output constant.

In 2010, the IEA (2010) abruptly announced that the peak of conventional oil production was reached in 2006. The IEA also again lowered their estimate of total world oil production to less than 100 Mb/d by 2035. However, it has been shown that the IEA oil production model is flawed. To reach the production level in their model, they assume oil field depletion rates that are so high that they have never been seen in any oil region before (Aleklett et al., 2010). The remaining oil simply cannot be produced as quickly as would be required to push the production peak as far into the future as they project, thus the peak must occur sooner than the IEA asserts. Miller (2011) found that the IEA had not addressed any of the recent critique and concluded that the IEA outlooks likely remain too optimistic.

Most discussions about oil focus on the size of the resource left. However, in the near term, it is far more important to pay attention to production flows and the constraints operating on them. Peak oil is the point in time where production flows are unable to increase. It is not just underinvestment, political gamesmanship or remote locations that make oil production increasingly difficult. The physical depletion mechanisms (increasing water cut, falling reservoir pressure, etc.) will unavoidably affect production by imposing restrictions and even limitations on the future production of liquid crude oil. No amount of technology or capital can overcome this fact.

3. The economic perspective

3.1 The economics of oil supply

One important feature of oil supply is its cyclical boom and bust cycle in prices and production. Maugeri (2010, p. 12-13) describes this phenomenon: "*if petroleum becomes scarce and there is no spare capacity…oil price climbs. This rise in prices fosters a new cycle of investment from which new production will flow. It also triggers gains in energy efficiency, consumer frugality and the rise of alternative energy resources. By the time the new production arrives at the market, petroleum demand may have dropped. This vicious circle has been a feature of all oil crises of the past.*"

However, oil production recently became less responsive to traditional economic stimuli. The first decade of this century witnessed a dramatic increase in oil exploration and production when the price of oil increased (Sorrell et al., 2009; 2009a). Unfortunately, as noted already, total world oil production seems to have reached a plateau nonetheless. To a large degree this is because the oil that remains tends to be unconventional oil, which is expensive and takes more time to bring to market. Some consequences of having extracted much of the easy oil are the following:

a) It takes significantly more time once a field is discovered to start production. Maugeri (2010) estimates it now takes between 8 and 12 years for new projects to produce first oil. Difficult development conditions can delay the start of production considerably. In the case of Kashagan, the world's largest oil discovery in 30 years, production has been delayed by almost 10 years due to difficult environmental conditions.

b) In mature regions, an increased drilling effort usually results in little increase in oil production because the largest fields were found and produced first (Höök and Aleklett, 2008; Höök et al., 2009).

c) Because the cost of extracting the remaining oil is much higher than easy-to-extract OPEC or other conventional oil, if the market price remains lower than the marginal cost for long enough, producers will cut production to avoid financial losses. See Figure 3.

d) Uncertainty about future economic growth heightens concerns for executing these riskier projects. This delays or often cancels projects (Figure 4).

e) Most remaining oil reserves are in the hands of governments. They tend to under-invest compared to private companies (Deutsche Bank, 2009).

f) Possible scarcity rents have to be taken into account. Hotelling (1931) showed that in the case of an depletable resource, price should exceed marginal cost even if the oil market were perfectly competitive (the resulting difference is called scarcity rent). If this were not the case, it would be more profitable to leave the oil in the ground, waiting to produce it until the price has risen. Hamilton (2009a, 2009b) noted that while in the 1990s the scarcity rent was negligible relative to costs of extraction, the strong demand growth from developing countries in the last decade together with limits to expanding production "*could in principle account for a sudden* *shift to a regime in which the scarcity rent is positive and quite important*." In this regard, the Reuters news service reported on April 13, 2008 that "*Saudi Arabia's King Abdullah said he had ordered some new oil discoveries left untapped to preserve oil wealth in the world's top exporter for future generations, the official Saudi Press Agency (SPA) reported*." Therefore, a possible intertemporal calculation considering scarcity rents may have already influenced (i.e. limited) current production. Although the sudden fall of prices at the end of 2008 is difficult to reconcile with scarcity rents, the following quick price recovery to the $70-$120 range during the enduring global financial crisis indicates that this aspect cannot be dismissed. This is despite the assertion by Reynolds and Baek (2011) that the Hotelling principle "*... is not a powerful determinant of nonrenewable resources prices,*" and that "*...the Hubbert curve and the theory surrounding the Hubbert curve is an important determinant of oil prices*." We agree that the Hubbert curve, which defines the depletion curve of a non-renewable resource, may be the prime determinant of oil price but it is not the only one.

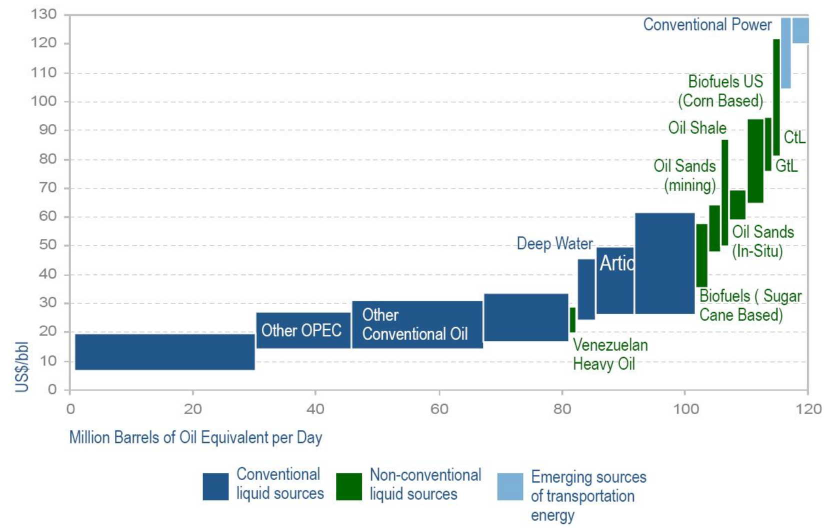

Figure 3. *Global marginal cost of production 2008. Source: LCM Research based on Booz Allen/IEA data (Morse, 2009). The unlabeled items, from left to right are OPEC Middle East, Former Soviet Union and Enhanced Oil Recovery.*

The consequence of these issues is that in the short-medium term the available supply is essentially fixed and thus relatively straightforward to compute. As Figure 4 shows, net production capacity will decline due to the difficulty in finding new reserves at an accessible cost while the existing capacity is steadily depleted. Just as occurred in 2004, by 2011 there is again no new net capacity while the world economy, and thus oil demand, has resumed growth. After 2014, it appears that global oil production will begin its decline (See the second report of the UK Industry Taskforce on Peak Oil and Energy Security (UK ITPOES, 2010), Lloyd's (2010), Deutsche Bank (2009, 2010), the report by the UK Energy Research Centre (Sorrell et al., 2009a) and the 2010 World Energy Outlook by the IEA (2010).)

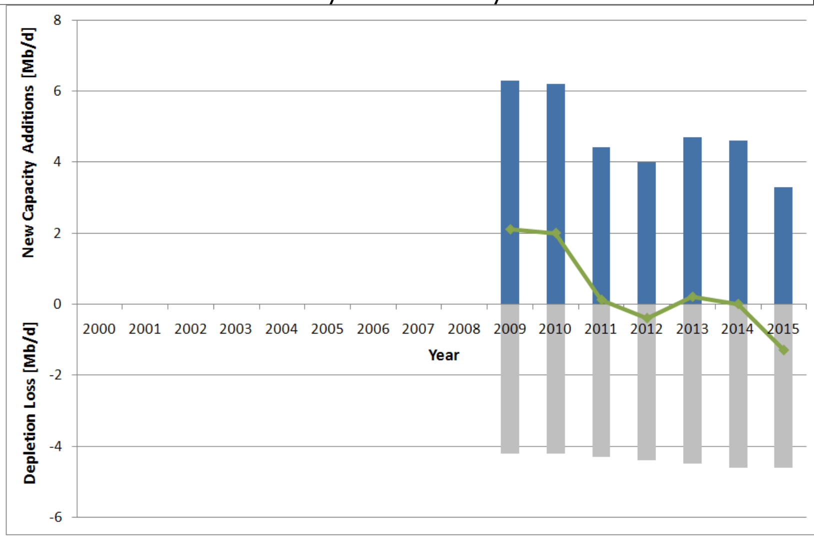

Figure 4. *Global annual new gross production (blue bars), annual decline (grey bars) and net new oil production capacity (thin green line). Source: UK Industry Task Force on Peak Oil and Energy Security (2010)*

3.2 The economics of oil demand

Now an important question is what are the consequences of high oil prices on world economic growth? In the economic literature, Hamilton (2009b) and Kilian (2008; 2009) attempt an answer, while in the professional financial literature, the report by Deutsche Bank (2009) is one of the most comprehensive.

Hamilton (2009b) in particular highlighted the importance of the share of energy expenditure as a percentage of total consumer expenditure. When this ratio is too high, an economic recession tends to occur. Similarly Deutsche Bank (2009) showed how each country seems to have a "*threshold percentage of national income at which crude pricing meets stern resistance and demand is broken.*" Deutsche Bank (2009) asserts that for American consumers this point is when energy represents 7.5% of gross domestic product. This value is close to the one calculated by Hamilton (2009b) but is based on monthly data and uses a different methodology. In a more recent report, Deutsche Bank (2010) lowered this threshold to 6.5 % because "*...the last shock set in motion major behavioral and policy changes that will facilitate rapid behavioral changes when the next one comes and underemployment and weak wage growth has increased sensitivity to gasoline prices. Last time it took $4.50/gal gasoline to finally tip demand, this time it might only take $3.75/gal to $4.00/gal to do it.*" However, they also highlighted that "*Americans have become comfortable with paying more for gasoline, and it may take higher prices to force behavior change*".

Kopits (2009) suggested that when crude oil expenditures exceed 4% of GDP, oil prices increase by more than 50% year-on-year, and oil price increases are so great that a potential demand adjustment should have to reach 0.8% of GDP on an annual basis, then a recession in the US is very likely. A similar outcome was found by Hall et al. (2009) who showed a recession in the US is likely when oil amounts to more than 5.5% of GDP. We remark that the difference between the 4% (Kopits, 2009) and 5.5% (Hall et al., 2009) is simply a wholesale versus retail difference, and the result comes out the same [1].

Finally, Hamilton (2011) highlighted that 11 of the 12 U.S. Recessions since World War II were preceded by an increase in oil prices. Unfortunately, there is no clear alternative source of energy able to fully substitute for oil (see, for example, Maugeri (2010) for a recent non-technical review of the limits of alternative sources of energy with respect to oil). It possesses a combination of energy density, portability and historically very high EROEI that is difficult for alternatives to match.

4. A timely energy system transformation not assured

As oil production declines, significant changes to the current oil-dependent economy in the medium term are likely to be needed. However, it isn't clear that there will the financial means to implement such a change. For example, Deutsche Bank (2009, 2010) suggested that the widespread use of electric cars in the second part of this decade will be the disruptive technology that will finally destroy oil demand. Apart from technology and resource constraints (lithium necessary for electrical batteries is quite abundant in nature but production is currently very limited), the availability of sufficient financial resources to transition the entire vehicle fleet seems dubious. As Hamilton (2009b) demonstrates, tightened credit follows high oil prices and most vehicles are purchased on credit. Others suggest that natural gas is the next energy paradigm. Again, will be there sufficient financial resources to switch to it as oil production declines?

Reinhart and Rogoff (2009, 2010) found that historically, after a banking crisis, the government debt on average almost doubles (86% increase) to bail out the banks and to stimulate the economy. They also showed that a sovereign debt crisis usually follows: not surprisingly we saw Iceland, Greece, Ireland, Hungary and Portugal turning to the EU/ECB and/or the IMF for financial help to refinance their public debts to avoid default. The need to switch to alternative energy sources with the enormous financial investments that such a task would require — and the simultaneous presence of large public and private debts — may well form a perfect storm.

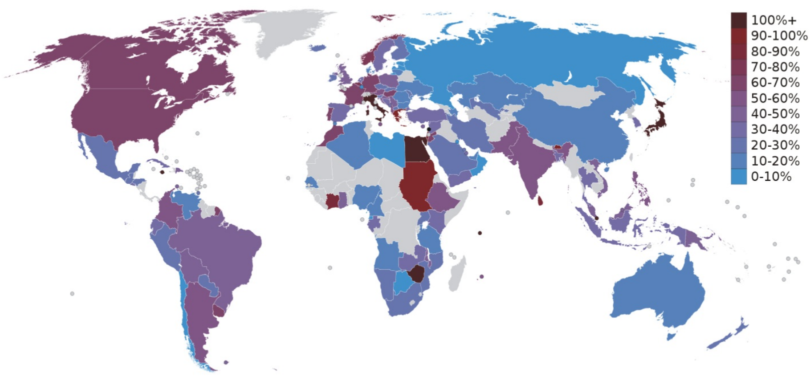

Figure 5. *Public debt as a percent of GDP (2009/2010) taken from CIA Factbook (2010).*

Additional forces will play a role. New regulations to be introduced by Basel III are likely to impact investment expectations, budgeting and planning. Basel III is a new global regulatory standard on bank capital adequacy and liquidity proposed by the Basel Committee on Banking Supervision following the recent global financial crisis and whose aim is to "*...to improve the banking sector's ability to absorb shocks arising from financial and economic stress, whatever the source, thus reducing the risk of spillover from the financial sector to the real economy*", BCBS (2009). Demography will also be extremely important in the next decade as well. Europe and the United States have aging populations and their baby boomers are entering pension age. China faces a similar demographic problem due to their one child policy, too.

The combination of declining oil production (and thus oil priced high enough to cause recessions), high taxes, austerity measures, more restrictive credit conditions and demographic shifts have the potential to severely constrain the financial resources needed to move the economy away from oil and to alternative energy sources. Another consequence of this combination of forces is the likely contraction of the world economy (Hamilton, 2009b; Dargay and Gately, 2010).

4.1 Energy transition risks

With higher priced oil, technology substitution (such as electric cars gradually replacing internal combustion engine cars) and fuel substitution (such as natural gas replacing oil) will occur. History is filled with many such examples and they are frequently highlighted in the debate. However, one must read carefully and not overstate the simplicity of an energy transition.

For example, whale oil was – technically – an energy source in the 19th century, but the economy was based on coal at the time. Whale oil was used only for very specific purposes (primarily illumination), and the transition to kerosene was easy and occurred very rapidly. Bardi (2007) explored this in more detail and made several important remarks that pinpoint how difficult it can be to substitute energy sources. In particular, he showed that resource scarcity often dramatically increases the amplitude of price oscillations, which often slow an energy source transition. Businesses and governments struggle with alternating circumstances of insufficient cash flow to handle price spikes and plummeting prices that don't cover their cost structure. Long term planning in this ever-changing environment becomes extremely difficult and investment — even highly needed investment — can drop precipitously.

Friedrichs (2010) also cautions that after peak oil countries have several sociological trajectories available to them, they can follow predatory militarism like Japan before WWII, totalitarian retrenchment like North Korea, or, ideally, socioeconomic adaptation like Cuba after the fall of the Soviet Union. Given the recent century of conflict and the extensive weapon stocks and militaries held by modern nations (especially the United States, which spends on its military almost as much as the remaining countries of the world combined (SIPRI, 2011), there is simply no guarantee that the relatively peaceful period currently experienced by developed nations that is conducive to rapid energy source transitions will continue much longer.

Koetse et al. (2008) showed that for both North America and Europe the capital-energy substitutability over the long term is large. In other words, if there is abundant capital, the economy can respond to higher oil prices with substitution. However, if declining oil causes a credit contraction similar to the crash of 2008, there may not be sufficient capital to replace existing equipment quickly.

Even if there is sufficient capital, substitution has thus far operated with high and even increasing EROEI fuel sources. Since the transition from whale oil, each subsequent transition has been to an energy source with greater net energy profit. The energy dense fuels we are using now have allowed us to build our civilization. The difficulty this time is that we must move from highly profitable, in terms of energy, sources to lower profit alternatives like solar and wind. Researchers are beginning to ask the following important question: what is the minimum energy profit that must be sustained to allow us to operate our civilization? And, assuming alternatives are up to the job (this is not yet proven), can we complete the move away from oil before the overall EROEI gets too low? (Murphy and Hall, 2010)

A further challenge is that, strictly speaking, for the last 150 years we have not transitioned from previous fuel sources to new ones — we have been adding them to the total supply. We are currently using all significant sources (coal, oil, gas and uranium) at high rates. Thus, it’s common but incorrect to say that we moved from coal to oil. In fact, we are using more coal now than we ever have (IEA, 2010). We never left the coal age. The challenge of moving to alternative energy sources while a particularly important source is declining, in this case oil, should not be underestimated.

4.2 Net oil exports decline faster than overall production

The challenge may be greater still because net oil exports are set to fall more rapidly than overall oil production. Rubin (2007) points out that before the financial crisis many producer countries were experiencing economic booms. These countries export only the oil they don’t use themselves. The Middle East saw annual consumption increases of 5%. Russia was increasing at a 4% annual rate. It was only Russia’s increased production during the same period (accounting for 70% of the increase that came from OPEC, Russian and Mexican production during the early part of the last decade) that oil prices did not break records sooner than they did. Although the IEA has projected that oil use in OECD countries may already be declining (IEA 2010), they think that the oil appetite of non-OECD countries, which includes the producer countries, is not even close to being satisfied.

Brown et al. (2010b) show how significant the squeeze of declining gross production and increasing producer country consumption can be, which they have named the Export Land Model. Increasing producer country consumption due to population growth acts as a strong “*magnification factor*” that removes oil very quickly from the export market. Using the top five exporting countries from 2005 (Saudi Arabia, Russia, Norway, Iran, and United Arab Emirates), they construct a scenario in which combined production declines at a very slight 0.5% per year over a ten year period for a total of 5%. Internal oil consumption for these exporters continues to grow at its current rate (2010). In this scenario net oil exports decline by 9.6%, almost double the rate oil production declines.

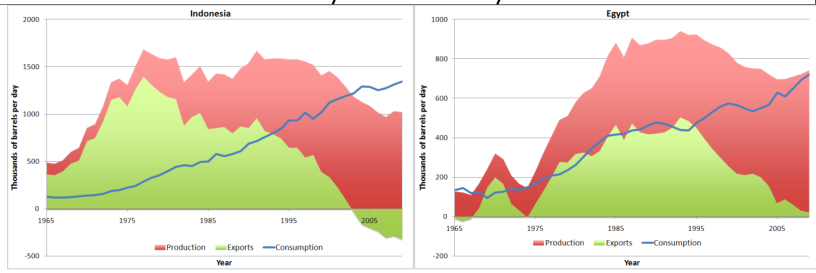

Figure 6. *Crude oil production, consumption and exports for Indonesia (left) and Egypt (right). Steadily increasing internal consumption coupled with a 1/3 drop in domestic production turned Indonesia into a net oil importer just 12 years after its peak of production. Egypt has lost all it oil export revenue and will soon follow Indonesia to become a net oil importer. Source: BP Statistical Review (2010).*

This accelerated loss of exportable oil can be seen in many producer countries that have passed their peak. Figure 6 shows the typical cases of Indonesia and Egypt. Indonesia has withdrawn from OPEC because they have no more exportable oil to offer the world market. Egypt is already incurring a public debt and is on the cusp of becoming a net oil importer, which will exacerbate already stretched public finances. As producer countries continue to grow their oil use even modestly and production declines (again, even modestly), there is an extremely high risk that net exportable oil will decline much faster than most observers are currently expecting.

4.3 Crash program may eventually replace declining oil

Hirsch (2010) points out that a crash program to create liquid fuel savings and additional liquid fuels may be able , at some point, to make up for declining oil production (Figure 7). While the alternatives are ramping up and as oil production is declining, Hirsch (2008) estimates that the world economy will contract at approximately a one-to-one ratio. In his best-case scenario, using a 4% per year decline rate, an idealized crash program to produce liquid fuels does not pause contraction sooner than ten years after the onset of decline.

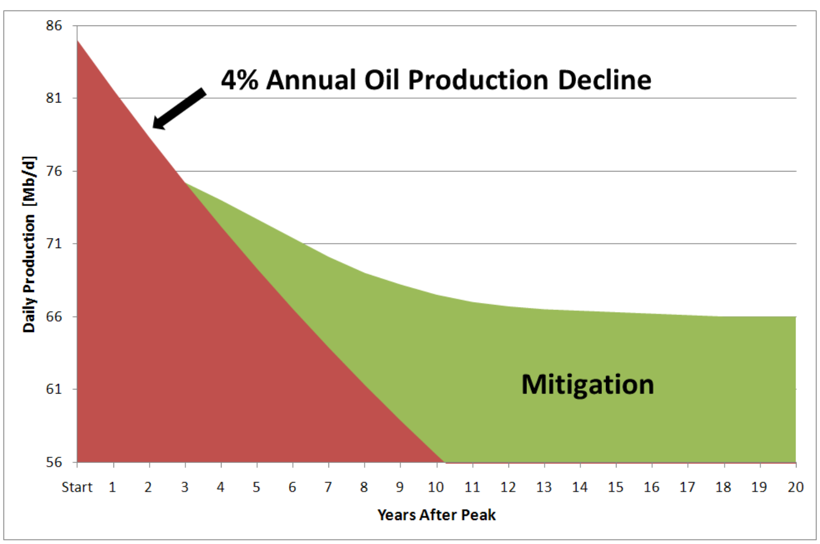

Figure 7. *Liquid fuel mitigation programs take at least ten years before they are able to make up for declining oil production. Source: Hirsch (2010)*

Other mitigation efforts like increased solar, wind and geothermal production may not be prioritized since they do not help the situation — they produce electricity and the world's 800 million transportation, food production (i.e. tractors and harvesters) and distribution vehicles require liquid fuel.

If the peak of oil production occurs this decade, there is insufficient time to avoid contraction because of how long it takes to transition the vehicle fleet. Even in their moderately aggressive scenario, Belzowski and McManus (2010) estimate that in a healthy, growing economy by 2050 still only 80% of the vehicle fleet in Europe and the U.S. would operate on alternative power trains.

5. Government risks

A contracting economy presents governments with a host of problems that are not easy to resolve. Promises made to the citizenry, some in the form of social welfare programs, pensions and public union contracts, will be impossible to keep as the energy base of the economy declines. Downward wage pressure and reduced business activity will lower tax revenue. With lower revenues and greater demands in the form of social welfare support by an increasingly poorer citizenry, it is difficult to see how the accumulated (and growing) government debt can be paid back without rampant inflation. Though it is still unclear whether the government response will be hyperinflation (to minimize the debts) or extensive and massive debt defaults — or both — it is not likely that business as usual will continue as oil production declines.

In business sectors that are highly dependent on oil, such as the automotive sector (Cameron and Schnusenberg, 2009), ill prepared companies that lack understanding of how price volatility may impact their firm will likely fail. In the case of the car companies some may fail a second time because their products are still not yet ready for a high-priced oil environment (Wei et al., 2010). Governments may not be willing to spend the money to rescue these businesses (such as the car company bailouts in the U.S.) and should be prepared for increasing unemployment as vulnerable sectors contract. To minimize potential future social discord, governments should immediately begin planning for contraction and educating their citizenry of the risk of contraction.

Because poverty reduction is highly correlated with capital availability (World Bank 2001), as contraction occurs due to oil production decline, some countries may see the reversal of poverty reduction gains made in recent decades. Some governments may also have to contend with food and fuel riots as they did in 2007 and 2008. Other forms of crowd behavior, namely hoarding of fuel and food, may exacerbate the situation and governments should prepare accordingly.

6. Business risks

In a joint report, Lloyd’s of London and Chatham House have advised all businesses to begin scenario-planning exercises for the oil price spike they assert is coming in the medium term (Lloyd’s, 2010). These planning exercises should scrutinize a company’s operations and balance sheet in fundamental ways.

Like governments, businesses of all sorts may experience similar difficulty paying their debts as sales decline. Banks may see asset values fall further. Manufacturers in particular will have to contend with increased difficulties making and delivering products as oil production declines (Hirsch et al., 2005). It will prove imperative that business addresses this Schumpetarian shock (a structural change to industry that can alter what is strategically relevant) in a timely fashion (Barney, 1991).

A significant benefit of cheap oil was that distance was relatively inexpensive. It is possible now to manufacture goods using far-flung operations. However, as oil declines, distance will, once again, become increasingly expensive, and oil price may begin to act as a trade barrier for many products.

Another risk as oil production declines is the possibility of oil supply disruptions. If this should occur, much modern manufacturing may be impacted. Just-in-time manufacturing systems in which warehoused parts are minimized through the frequent replenishment of parts by parts suppliers — sometimes with multiple deliveries a day — have little tolerance for delivery delays.

To prepare for this risk requires more than the drive for manufacturing efficiency that has generally characterized business. Supply chains should be examined with the aim of building in resilience and greater agility (Bunce and Gould, 1996; Krishnamurthy and Yauch, 2007), implying the loosening of tight and often brittle couplings between suppliers and manufacturers (Christopher and Towill, 2000; Towill and Christopher, 2001). With little or no slack in the system (fewer warehoused parts, etc.), just one supplier failing to deliver a part or supplier hoarding can shut down a production process.

7. Conclusion

The Deepwater Horizon incident demonstrated that most of the oil left is deep offshore or in other difficult-to-reach locations. Moreover, obtaining the oil remaining in currently producing reservoirs requires additional equipment and technology that comes at a higher price in both capital and energy. In this regard, we reviewed the physical perspective of peak oil and some of the limitations on producing ever-increasing quantities of oil were highlighted as well as the possibility of the peak of production occurring this decade.

We then briefly discussed the economics of oil supply and demand, showing why the available supply is basically fixed in the short-medium term, and highlighting the importance of a high energy expenditure share as a percentage of total consumer expenditures sounding an alarm bell for economic recessions. Moreover, we remarked that the potential financial resources available in the future to switch to alternative sources of energy will be limited due to several factors ranging from the high levels of debt (both private and public) to the aging of the populations in Western countries and China. We also noted that, even with very slight production decline rates, net oil exports decline significantly faster than total oil production as the economies of producer countries grow.

In such a context, risk mitigation practices are called for, both at the government level and at the business level to prepare for high and likely volatile oil prices. Governments should begin educating their citizenry of the risk of contraction to minimize potential future social discord. Businesses should examine their operations and balance sheets with the aim of building in resilience. It also implies preparing for a scenario in which capital and energy are much more expensive than in the business-as-usual one.

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