A Tale of Two Peaks

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"It was the best of times; it was the worst of times," wrote Charles Dickens. And that may be true of the oil dependent world economy and oil market where the price of oil was down, then up, then down again, but could go up again soon since we may have already surpassed peak oil depending on how the term "oil" is defined and on the trends in its production. Although, a close scrutiny of the world's oil production may reveal some discrepancies in the statistics, requiring a tale of individual producer characteristics in order to understand where the peak has or will occur.

As the late, well esteemed Maugeri (2007) wrote, "all current evaluations of the world's oil resources ... do not take into account the so-called unconventional oils." However, even coal could be construed as a hydrocarbon and an "unconventional oil" reserve if coal-to-liquids are included. Plus Maugeri' predicted 2 million barrels a day (mbd) of $25 per barrel tars-sands, which didn't expand appreciably at a price of $100. So, to decrease confusion about potential energy liquids production, it may be appropriate to use an old Italian saying and "divide and conquer" the definitions of oil in order to understand the energy markets better. Accordingly, the question is: is shale-oil or tar-sands conventional oil? They are not because they are within completely different geological time scale structures, rather like the difference between whale-oil and crude-oil, and where understanding their differences can help our understanding of the cost trends in the over-all liquids market. For example, a large increase in shale-oil production outside of the U.S. may require a correspondingly large increase in oil prices due to the lack of a dynamic, U.S.-style, integrated shale-oil and shale-gas market structure over most of the world.

Thus, if we narrow the definition of oil to conventional oil, then the term "peak-oil" is contingent on conventional oil production reaching the height of its potential, whereupon expensive alternatives, including non-U.S. shale-oil, can still adversely affect the world's economy. Looking only at conventional oil in Figure 1, based on BP's statistical data, but where tar-sands and shale-oil are removed from the statistics as thoroughly as possible, we notice that during the ten years before 2005, world conventional oil was increasing at close to 2% per year whereas during the ten years after 2005, it was almost on a plateau. And that was when post-2005 real oil prices were averaging over three times what they were in the pre-2005 time frame. This is typical of the extractive industries, as explained in Reynolds (2016a), where the *information effect* (of aggregating clues as to where the underground resources reside) is so dominant early on that even low oil prices do not hinder oil production increases, whereas once peak oil occurs, the (underground) *depletion effect* (of declining remaining reserves available to find) is so dominant that no matter how high oil prices are, production still plateaus and declines. It is not only about technology, but the resource base available.

Based on every conceivable Hubbert lambda trend from Reynolds (2009), as opposed to Hubbert's (1962), Campbell's (1997) or the recently departed Deffeyes' (2001) traditional mid-point trend, the world's conventional oil production looks to have ultimately recoverable reserves of

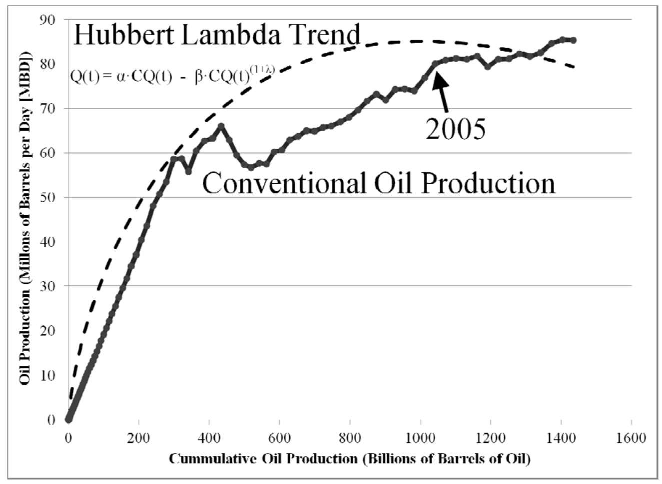

FIGURE 1. Trend and Production of Oil (MBD) versus Cumulative Production (BB)

Source: Data from BP Statistical Review, U.S. Energy Information Administration and the Canadian Energy Board

about 3 trillion barrels of oil. Otherwise, we would not have seen the relative plateau of conventional oil production, starting at the 1 trillion barrel cumulative production mark in 2005 that was ostensibly forecast in Reynolds (1999).

Nevertheless, upon close inspection of the trend, clearly the world's oil production goes above it, or any other potential Hubbert Lambda-type trend that can be devised and fitted into the data, after 2013, which could mean that the trend is meaningless or that some outlying increases in production must be more closely scrutinized. For example, since the rise in U.S. shale-oil production has helped to reduce prices over the last four years, along with demand side weakening, then the lack of oil revenue for OPEC members may have induced higher than normal production in order to cover budget short falls, which could mean Ezzati (1976), Cremer and Salehi -Isfahani (1991) and Teece's (1982) target revenue models are pertinent to the discussion.

However, normally, the trend should take into account changing producer institutions, just as Hubbert expected the trend would take into account all small incremental changes in technology, and therefore individual oil producer increases or decreases should all wash out. See for example Reynolds (2011), for more on institutions. If one producer increases production, others should decrease theirs, if the trend is to be believed. Indeed, the only time such a Hubbert trend has ever significantly changed was when there were either large changes in institutions or a revolutionary technology, such as Colonel Edwin Drake's oil wells. In this case, there would have to have been a worldwide change, along the lines of the changes in the former Soviet Union where both huge changes in technology available and huge changes in institutions occurred simultaneously (see Reynolds and Kolodziej 2009 and 2007). Such profound changes for conventional oil is not likely to have occurred all at one time for the entire world in 2013 and therefore, the Hubbert trend in Figure 1 should still hold true after 2013, but where the trend definitely looks to have been broken. Hence, the need for a tale.

There have been a lot of tales about various oil producers such as Russia (e.g., Gustafson 2012) and Saudi Arabia (e.g., Simmons 2005), although some of those may need revisiting. Still, new tales may be required to explain the glaring discrepancy. For instance, upon close inspection of the statistics of large producing countries, two peculiar countries jump out: China and the United States of America.

Interestingly, China's oil production increased by about 1.5 mbd from 2009 to 2017 according to BP statistics. The odd thing was that the production increased in 2015, just when according to Reynolds (2016b) China was probably in a recession and more importantly when world oil prices were falling, whereupon in 2016 China's production was curiously down to exactly 3.99 MBD. It could just be a fluke that the number is so precisely near an even number, but then there is another instance where from 2011 to 2012, again according to BP's worldwide oil statistics, China's oil production increased by 1.99%, which is almost exactly 2%. While it is possible to have two such fastidious numbers, it is unlikely, but what adds to the tale is that China has set up its own futures oil market, which suggests a need to purchase a lot of imported oil. Put together, China's oil production may be lower than the statistics suggest, and therefore one of the reasons for Chinas' new futures market, denominated in Yuan, is in order to prop up China's currency. The Chinese will undoubtedly need to buy increasing amounts of imported oil and not want to injure their foreign currency holdings. They would rather pay for that oil in Yuan than in dollars. That is, the new Chinese future's market is a currency enhancement mechanism rather than just a simple oil exchange.

However, China's peak oil situation is actually quite transparent compared to, of all countries, the United States of America. Reading "between the lines" so to speak is not just important for countries that are considered to be opaque, but it is even important for countries that seem transparent. Consider, then, both the U.S. conventional oil production and its tight sands (including shale) production, where one side of the U.S. story may be a part of the answer to the other side of the world story. Start with the U.S. shale-oil side of the story, which is important in its own right, but which will also lead to the conventional oil production side of the story.

Consider two contradictory headlines, "Permian Oil Production Requires Additional Pipeline Infrastructure," and "Permian, We Have a Gas Problem." The first headline suggests that the U.S. will have a lot more shale-oil available if only a pipeline were put in place, which is a curious concept in the history of the petroleum industry. Historically, there have been many instances of huge oil strikes in the U.S. where oil production was increasing quickly, even as fast as 10% per year, and with no pipeline access available, such as early Pennsylvania, Spindle Top, East Texas and even today's Bakken shale-oil. They all are instances where producers were able to increase their production quickly and without the need of pipelines, although certainly with a loss in value and safety. This is because oil's energy content is dense enough that trucks, trains or oil tankers can transport such a compact fuel easily and cost effectively enough that, even though there have been instances of a lack of pipelines, nevertheless, oil production was able to increase. So, the question is why the intense need for a pipeline to increase oil production in the Permian Basin, unless the oil we are talking about is not exactly a dense liquid? This brings us to the second headline which contrasts substantially with the first in explaining what may or may not be the problem with getting Permian oil to market: gas.

The whole issue with shale-oil is the question of what exactly the definition of a hydro-carbon is, where the American English term "oil" can mean a heavy liquid or solid of 55 carbon atoms (C55) or a light "liquid" with as few as two carbon atoms (C2), but where propanes, (C3) and butanes (C4) are very common light components. Then, there are natural gas liquids, those nebulous hydrocarbon components that intermingle with natural gas (methane C1) and that are just on the verge of being between oil and natural gas, but which technically belong in the oil family from about ethane (C2) to pentanes (C5). Well, the problem with natural gas liquids is that they are light enough to be a gas and transporting them is much easier within a pipeline. So, if you produce oil and natural gas, including natural gas liquids, and you only want to minimally process it at the wellhead, then a pipeline is needed to pressurize those NGLs with the heavier oil, and another pipeline for natural gas and some liquids, to cost effectively get all the products to market. Thus, the issue with getting oil out of the Permian is the issue of getting lighter oils and natural gas out of the Permian too, hence the absolute need for pipelines, although this could be a signal that U.S. mid-weight shale-oil is close to its peak.

Furthermore, upon close inspection of BP's oil statistics for the U.S. there is not just increases in shale-oil occurring within the numbers, but a substantial increase in natural gas plant liquids, which are light liquids separated out of wet natural gas. Some light liquids can be used to make gasoline, but most can be better used as a straight propane or butane fuel. So, a lot of the U.S. increase in the production of oil, according to the formulated BP statistics, is the increase in the production of light liquids that are coming, not from conventional oil and gas geological traps, but rather from shale-gas fields, and as such those natural gas plant liquids are not conventional oil at all but shale-oil. Therefore, another reason, besides the potentially high Chinese statistics, for the constructed conventional oil production breaking above the Hubbert tend in Figure 1 is that the statistics subtly include unconventional oil via the shale-gas information, which if subtracted from the overall oil production would put the conventional oil production down another one million barrels a day. Taken together, and possibly with meticulous tales of other countries and other unconventional oils, this suggests that the Hubbert trend may still be valid.

The other aspect of U.S. oil production is being able to predict the path and eventual peak of unconventional U.S. shale-oil production itself, which has been able to increase at the heady rate of 30% per year, not just for one year, but for 10 years, a phenomenal increase in the history of the petroleum industry and indeed in the history of human kind's extractive industries as a whole when considering how large of a regional area this involves. This suggests that an early and severe peak in shale-oil is in store for the U.S. However, the unstated secret to the phenomenal U.S. success is that the information effect for the shale-oil exploration process is being enhanced by the need for natural gas and the substantial natural gas pipeline system that already exists in the U.S., all of which is going to evolve quite differently for the rest of the world. So, the U.S. shale-oil/shale-gas interplay is creating a quickly rising Hubbert shale-oil production trend unmatched in history, and liable to include a much sharper decline than has happened in history, other than the incredible Soviet oil decline after 1989. Clearly, Russia and America have a lot in common. Although, I might give China the edge in infrastructure that can cushion any peak-oil effects.

Getting back to unconventional oil, the definition of oil as including natural gas plant liquids suggests that much of the shale-oil, or light oil produced with the shale-gas, is not particularly predisposed to be turned into gasoline and could more easily be sold as cheap propane or butane for automotive consumption. Although, by using propane or butane directly as an automotive fuel that will still incur transition costs to the world's economies even for the many countries that already use "auto-gas" (propane), and so as the U.S. moves ever closer to its own peak shale-oil maximum, the costs of getting and using liquid fuels will increase. In other words, there is a dichotomy between mid-grade and light-oil liquids production that requires its own tale, and which will affect the world's economy as conventional oil production continues its plateau and decline.

At any moment, then, we can expect an oil price shock and corresponding economic decline not unlike the 1970's stagflation. It might bring about a malaise like that of the Great Recession or Great Depression, but probably more on par with the Fall of the Soviet Union or Ancient Rome's Crisis of the Third Century, whereupon both Empires endured hyperinflation and economic decline simultaneously. Accordingly, to disapprove of the XL pipeline as not having followed the law reduces alternative liquids availability just on the verge of when substitutes for oil will be most required. However, at least tar-sands can more easily be transported by rail or truck, but at a correspondingly higher safety and environmental cost than if it were transported by pipeline and at a higher cost due to the need for liquid fuel to run the trucks and trains.

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