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Oil Prices, the Kondratiev Cycle and Peak Oil

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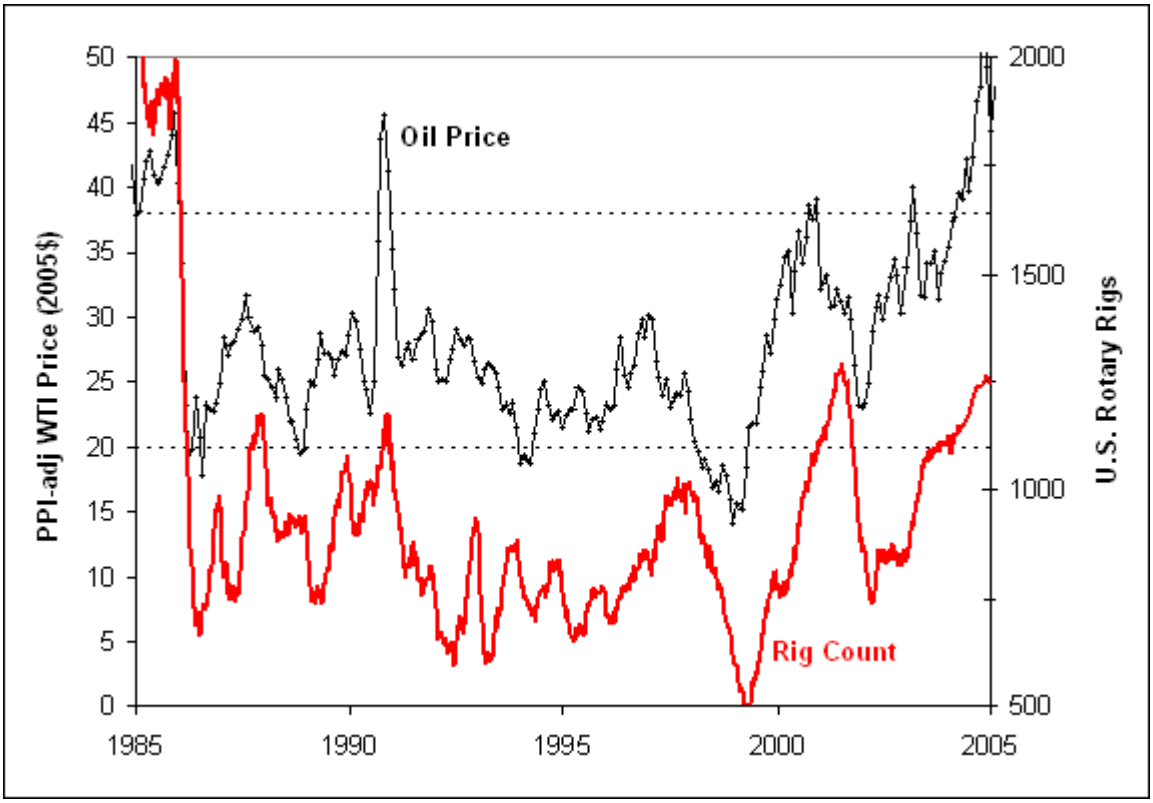
High oil prices are much on investor's minds today and a cycle-based examination of oil is well due. I discussed oil in my 2003 book *Retiring Rich* and presented an investment strategy for oil stocks that has since been not very useful. The strategy called for buying oil driller stocks or a suitable index when oil prices and rig counts reached certain (low) levels. Since late 2002 when I developed the strategy, prices and rig counts have remained well above these buy levels and the strategy has been irrelevant as a result.

The strategy was based on the assumption that the 1985-2002 experience during which oil traded in a broad range would hold into the future. As Figure 1 shows, almost immediately after I developed the strategy, inflation-adjusted oil prices rose to levels outside of this post-1985 trading range and today are far higher. The reason I believed that oil would continue to trade in this region was based on our position in a Kondratiev downwave. I interpreted the mid-1980's collapse in oil prices as a reflection of the "fall to plateau" event in the reduced price measure.

Figure 1. PPI-adjusted West Texas Intermediate (oil) price and drilling rig count since 1985

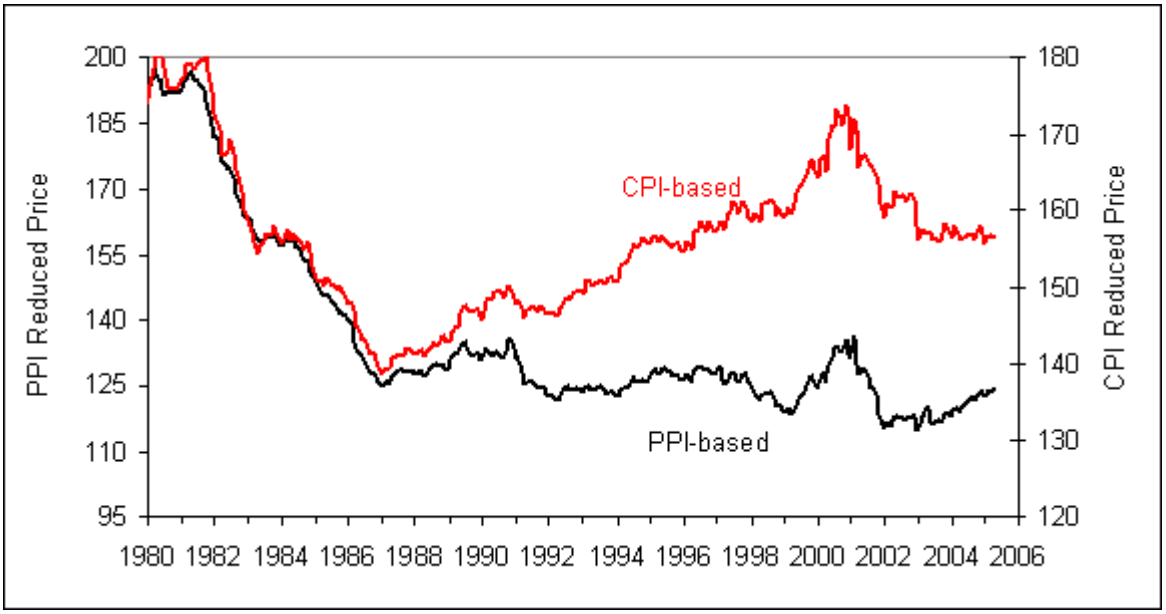


As described previously, the Kondratiev cycle can be expressed in terms of the reduced price[1] and interest rates.[2] The reduced price[1] is the ratio between a price index and monetary stimulation, defined as the sum of government debt and money supply divided by GDP. Reduced price shows an estimate of what price inflation might look like in the absence of stimulus from deficit spending and Fed interest rate manipulations. Figure 2 shows plots of reduced price calculated using the CPI and PPI-commodity price indices. The most recent Kondratiev peak occurred in 1981 and both CPI and PPI-based reduced price showed sharp declines after 1981. Their behavior after 1986 is different.

Prior to 1980, PPI and CPI-based reduced price showed the same broad behavior. In previous downwaves, reduced price using either index initially fell after the Kondratiev peak, leveled off for about a decade, and then fell further. The level region is called the plateau. The initial decline is called the fall *to* plateau and the later one the fall *from* plateau. After 1986, the PPI-based reduced price showed a flat trend characteristic of past plateaus, while the CPI-based reduced price did not. For this reason, in all my early work I focused on the PPI-based reduced price as my measure of the current progress of the Kondratiev cycle.

In the last downwave, the fall to plateau occurred in 1920-22 and the fall from plateau in 1929-32/3. That is, the fall to plateau occurred at the beginning of the 1921-29 secular bull market and the fall from plateau after the end of that secular bull market. If the analogy with the last downwave holds today, the 1981-86 fall to plateau should have occurred at the beginning of the 1982-2000 secular bull market (it did) and the fall from plateau should have followed the end of the secular bull market in 2000. Shortly after 2000 we should have seen a deflationary shift, typified by the PPI-based reduced price falling dramatically below the level where it has been since 1986. This did not happen. Instead, PPI-based reduced price remained more or less in its flat trend and is currently rising. The CPI-based reduced price has shown a deflationary shift, from a rising trend in the 1986-2000 period to a declining-to-flat trend since 2000. This signal might be considered as a weak version of the fall from plateau.

Figure 2. CPI and PPI-based reduced price 1980-present



The failure of the PPI-based reduced price to fall from the plateau is directly related to rising commodity prices (especially oil) in recent years. That is, the failure of oil prices to remain range-bound (keeping my strategy relevant) and the failure for reduced price to convincingly fall from the plateau (as I expected) reflect the same issue that I did not foresee in 2002. This issue is strong Asian demand for commodities to support strong export-led growth powered by extremely low long-term interest rates in the US. This same phenomenon is responsible for maintenance of low interest rates.

Low interest rates have fueled rising house prices, which through the mechanism of cash-out mortgage refinance have fueled strong consumer demand for imports, providing demand for Asian commodity-consuming production. Should housing prices stop rising, or consumers become too-overextended, demand for imports could sag, leading to falling commodity demand and falling commodity prices. If the US were to fall into recession, the US deficit would soar and PPI-based reduced price would fall dramatically, creating the fall from plateau. Sinking US stock and housing prices with likely financial crisis in Asia could result in a flight to quality into US government bonds,

or the Fed could slash interest rates, possibly even longer term rates. In either case the result would be continued low interest rates despite a highly inflationary deficit, creating the regime shift. Thus, if a recession were on the horizon, as many expect, all the features expected for this point in the Kondratiev downwave would materialize. The only reason why they haven't is the economic authorities have quite deliberately intervened in a way to modify the way the Kondratiev cycle plays out and so far have been successful. If they fail the outcome would be a deflationary recession, not stagflation.

I am not of the opinion that the authorities are going to fail and that a recession is likely. My reasoning is based on the observation that since 1960, business cycles have tended to span a full Juglar cycle.[3] As I described in my February 2004 article, the Juglar cycle is a cycle in business investment of 7-11 years length that was first noted by Clement Juglar in 1862. Since 2000, business investment has declined, then bottomed and has now begun to rise, suggesting we are mid-way through the Juglar. The 1960's, 1980's and 1990's business cycles all spanned a full Juglar and I expect this business cycle to be the same, implying that this expansion should last until 2007-2009 or so.

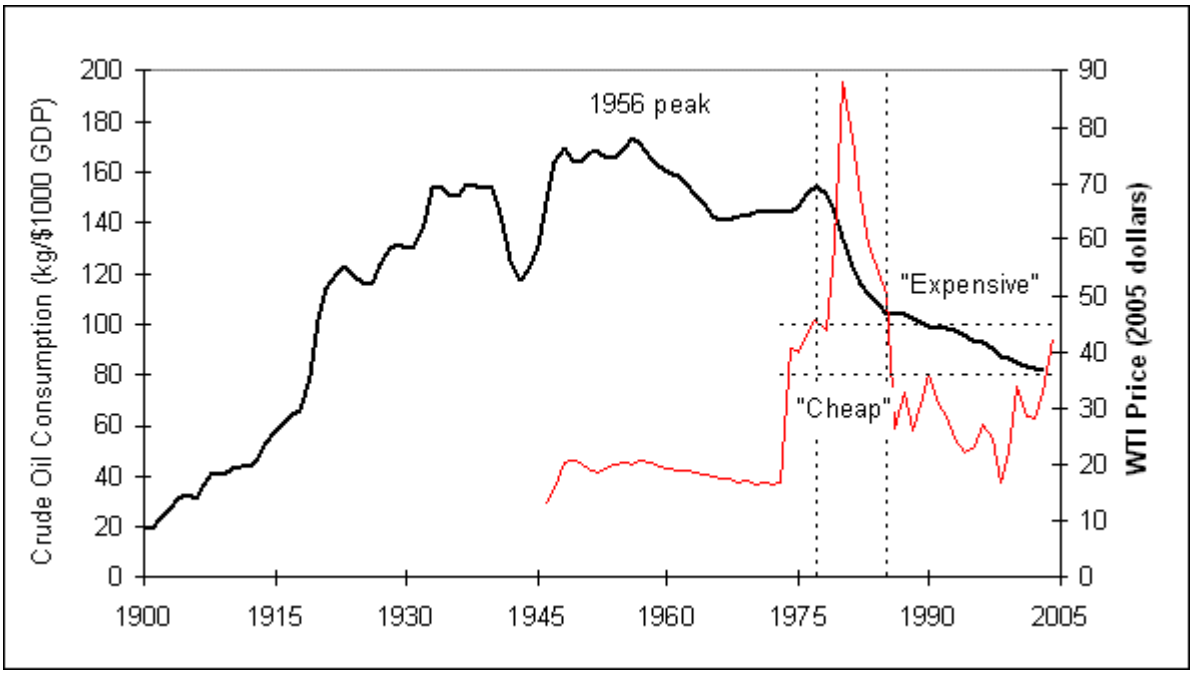
It is true that that the 1970's saw two shortened Juglar cycles because of the twin oil shocks from the 1973 oil embargo and the 1979 Iranian revolution. It has been argued that rising oil prices could produce a recession-causing oil shock like in the 1970's. I don't see this because, unlike in the 1970's, today's high prices reflect rising demand, not a restricted supply. A supply shock forces consumption down, reducing current economic activity into a recession. Rising prices because of rising demand can place constraints on economic activity requiring more consumption; they do not diminish current activity. If the economy can find other ways to expand that do not require increasing commodity consumption, it will.

Unlike almost all other commodities, gasoline (a major petroleum distillate) is primarily a consumer good rather than a producer good. The thing that is bought by gasoline consumers is not the commodity itself, but the transportation service it provides. The amount of transportation a consumer demands is limited by the amount of time they want to spend driving and the speed at which they travel. In the US, both are essentially fixed: the first by Americans' lack of desire to spend even more time driving and the second by the law and traffic congestion. This means that the amount of transportation a consumer demands tends not to rise with time. Increases in gasoline consumption by consumers then reflects changes in the efficiency of gasoline use for transportation and by increasing numbers of consumers (population growth). The growth in popularity of larger, fuel inefficient vehicles over the last decade is largely responsible for the 10-15% increase in US oil consumption over this time. Just as consumers can choose less efficient vehicles, so they can choose more efficient vehicles if the cost of fuel becomes onerous. What this suggests is the US economy should easily be able to find ways to grow that do not require increasing use of oil. Indeed, from 1978 to 1998 the US economy grew by over 70% yet oil consumption in 1998 was about the same as in 1978.

The situation for China and other developing nations is different. For these countries, oil consumption is still a leading sector of the economy as it was for the US before 1956 (Figure 3). Previously, I have described the innovation wave model in which innovations lead to new leading sectors which contribute disproportionately to economic growth.[4] Restriction of a commodity required for a leading sector would have negative consequences for overall economic growth. The economy requires increased supplies of these commodities in order to grow at its optimum rate. Because the rapid growth generated by a leading sector generates wealth, the growing economy will usually be able to pay whatever price is required to satisfy its demand for commodities. Once the leading sector has peaked, commodity demand becomes increasingly uncoupled from economic growth. In time the two can become completely uncoupled. For example, total railroad mileage in the US continued to grow until 1916, the year of the railroad leading sector peak. Afterward no further railroad expansion occurred, more railroads simply were not required for further growth, the nation's need for railways was satisfied. The

same thing happened with automobiles per worker, which reached a plateau in 1973 where it has been ever since. More cars per person are no longer needed once every worker (an average) has more than one car.

Figure 3. Innovation wave for oil and oil price over time



What this means is Asian growth in oil consumption is not going to decline (baring financial crisis) as prices rise. US oil consumption will. The reason is that once a market economy passes its leading sector peak, more of that sector is not required for growth. Additional oil consumption will not yield a proportionate growth in wealth sufficient to pay for it, it will merely be wasted on inefficient consumption. In a market economy, the resources that could be employed to acquire more oil will be deployed elsewhere, where they can still produce growth (profit).

A careful examination of Figure 3 will show when this might happen. Oil consumption per unit of GDP began a rapid decline in 1977 which lasted until 1985. This decline began when oil prices reached $45/bbl in today's (2005) money. During this period of decline, oil averaged $61/bbl. Based on this observation, $45 defines the lower limit of "expensive" oil. After 1985 oil prices fell dramatically and remained at low levels until 2003. Over the 1986-2003 period prices have averaged $28/bbl in today's dollars. Once oil had fallen below the $35 dollar level (see dashed line in Figure 3) it became "cheap". Oil consumption per unit of GDP continued to fall after oil became cheap, but at a greatly reduced rate. Absolute oil consumption, after reaching a peak of 18.8 million bbl/day (MBD) in 1978 fell to the 15-16 MBD level in the mid-1980's. After the price decline, consumption has slowly increased from that level to about 20 MBD today. Just this year, oil has ventured into the "expensive" region. If the leading sector model I am developing is correct, I should expect that oil consumption will start to decline assuming prices remain above $45 (in 2005 dollars) on an annual average basis.

This analysis suggests that high oil prices do not have to derail economic growth, allowing the current expansion to last the full Juglar cycle (i.e. until ~2008) as it has in three of the past four decades. Oil prices can stay high, Asian demand can continue to grow (barring financial crisis or recession there) and US interest rates can stay low. US oil consumption will fall in response to high prices, creating demand for more efficient vehicles and appliances, which will help support economic expansion. High oil prices should also stimulate interest in alternate energy technologies which could serve as additional leading sectors to enhance US economic growth.

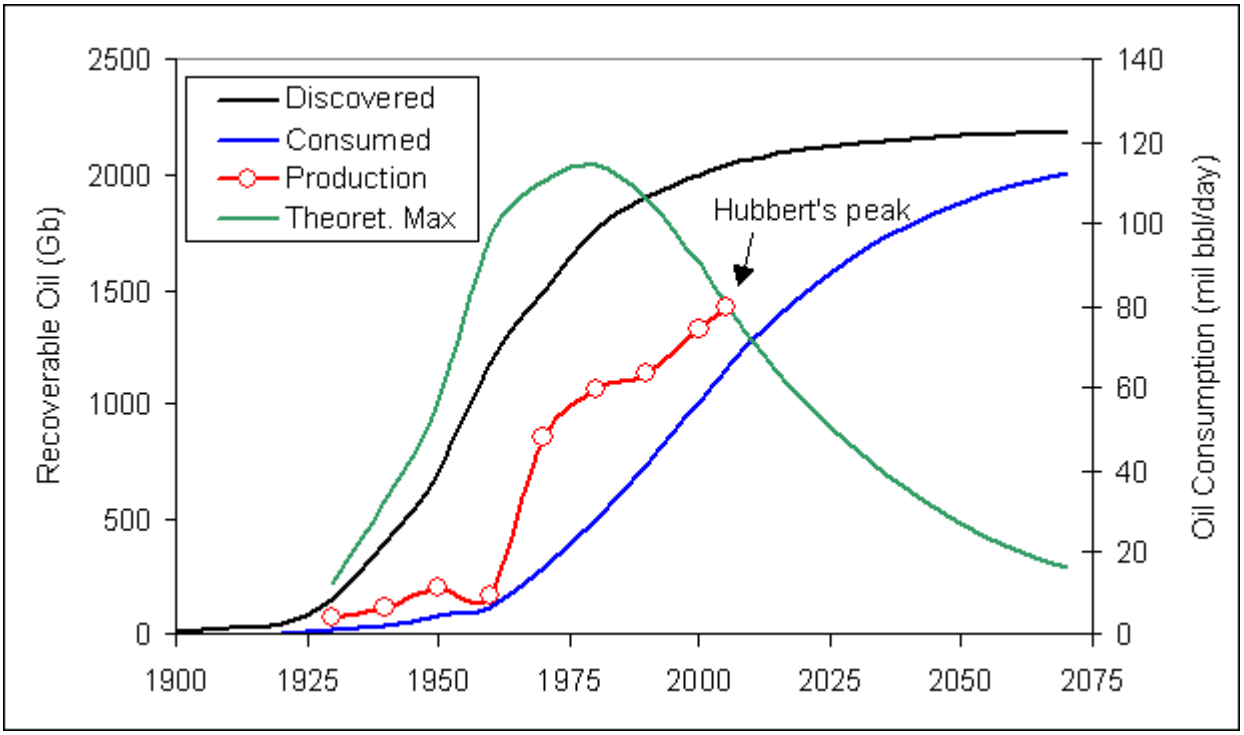
So far I have described a virtuous cycle from rising oil prices. Such a scenario could unfold as long as there is no oil supply restriction. Of course, there exists the potential for disruptions in oil supply from a variety of causes, not least of which would be a US-Iran conflict over nuclear proliferation. But the biggest threat to this scenario is something called peak oil.

Peak oil, or Hubbert's peak, refers to the point in time at which world oil production reaches a maximum. A geophysicist named Marion King Hubbert is credited with the idea, which is very simple. Hubbert proposed that the theoretical maximum production rate from a collection of oil fields is proportional to the amount of recoverable oil that remains in the ground. Since oil must first be discovered before it can be produced, the maximum theoretical production rate should then be proportional to the difference between the total amount of oil discovered and the total amount that has already been produced. Figure 4 shows curves for all three of these quantities.

Initially, before much oil has been pumped the amount of oil produced will be fixed by demand and will be much less that the theoretical maximum given by Hubbert's relation. Eventually a time will come when the rate of discovery falls below the rate of production. When this happens, the Hubbert maximum will begin to fall. At some point the rising production curve will intersect the falling Hubbert curve. This point is the maximum achievable production rate or the Hubbert peak. After this point in time, actual production will follow the declining theoretical line. Using this approach, King forecast that US production should peak in the 1966-1971 period. The actual peak was in 1970. King's method worked.

Figure 4 shows a calculation for the entire world based on data obtained from the Association for the Study of Peak Oil (ASPO). Oil discovery peaked in the 1960's and by now it is clear we have discovered most of the oil we ever will. Thus we can, in principle, estimate how much is there. In reality such estimates are very difficult to make because of unavailability of data. Colin Campbell projected the Hubbert peak for the entire world to be around 2010 in an article in Scientific American in 1998.[5] Since then, with the recent acceleration of Asian demand for oil, he has moved the date up to 2008. Some experts are forecasting that the peak will be this year. The data in Figure 4 reflect a 2005 peak.

Figure 4. Projected future oil production according to "peak oil is now" hypothesis



If peak oil will actually happen this year, it will rule out my rosy scenario. Peak oil will provide the necessary supply shock to curtail this business cycle and send much of the world into recession, with the deflationary outcome described earlier. If peak oil does not happen this year and instead occurs in 2010 as Campbell projected or even later, then oil prices can continue to rise and economic growth along with them.

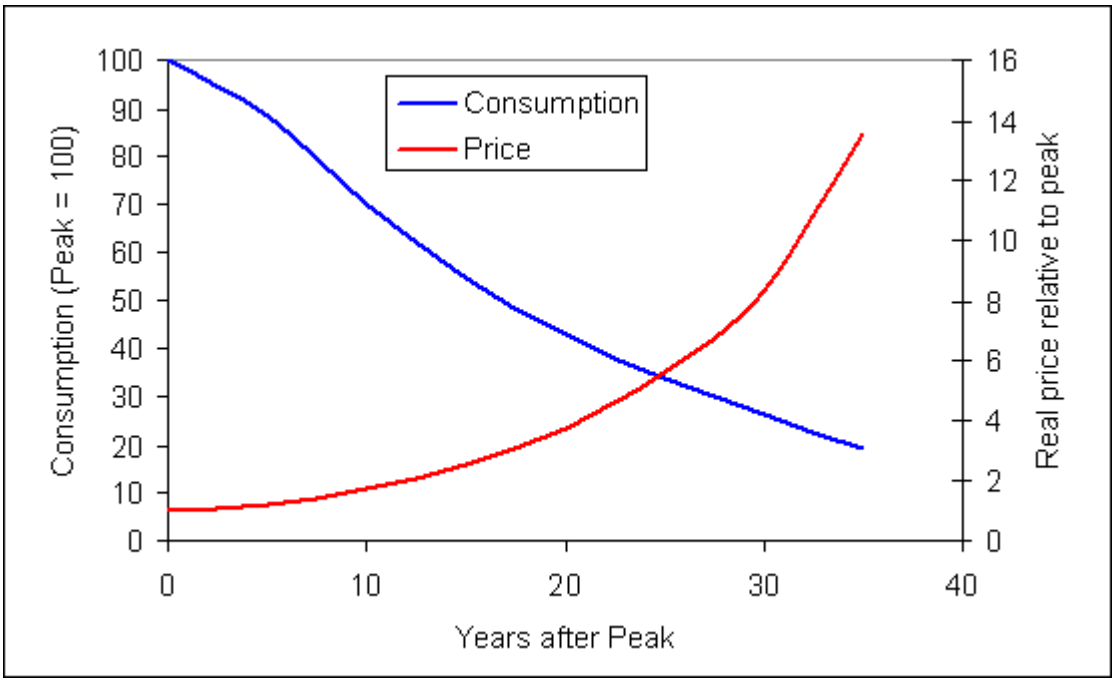
An estimate of the effect rising prices will have on US oil consumption can be obtained using the late 1970's, early 1980's experience. Before oil prices reached $45, there was no impact on consumption, the ratio of oil consumption to GDP grew. Once oil prices rose above this level the ratio started to plummet. Actual consumption fell to 82% of the 1978 peak in consumption by the mid 1980's. An average oil price of $61 did this. A simple power-law relationship can be constructed from this observation as follows:

1) Relative consumption = $(P_{CRIT}/P)^{0.63}$

Here P_{CRIT} is the critical price, above which price affects demand. Given P_{CRIT} = $45, a value of P = $61 gives 0.82, which is what happened in the 1977-1985 period. Oil prices of $61 were capable of reducing oil consumption to 82% of its peak value. This model should not be taken literally, my purpose here is illustrative. Some sort of power law relation with an exponent less than 1 will work, whether this exact model will do a good job cannot be known. The exponent must be less than one because the mechanism by which price cuts demand is the unwillingness/inability of consumers to pay more for a commodity. Say the price rises by 20%. If no change in consumption occurs then the consumer simply pays 20% more. This is the situation when oil price is less than P_{CRIT}. Once oil rises above P_{CRIT}, further price increases *must* cut consumption because some consumers cannot pay more and others are unwilling to. Above P_{CRIT} a 20% increase in price will cause a decline in consumption of *less* than 20%. The reason it is less is because not all consumers will be constrained by the higher price. As a whole, consumers will be willing to pay somewhat more, but not 20% more. How much more is reflected by the exponent. The closer to 1.0, the more constrained the average consumer is by oil prices. The 0.63 exponent says that, once the price is above the critical level, if price doubles, Americans would be willing to pay only about 30% more for oil, meaning they would be able to buy only 65% of what they did before the price increase.

Based on this model we would expect that today's oil price of $55, if maintained long enough, would eventually reduce US oil consumption by 12% from 20 MBD to 17.6 MPD. Recently Goldman Sachs forecast a peak price of $105. Based on the 1980 peak of $94, this projection implies an average price of $68 (= 105/94 x $61) going forward and a decrease in consumption of 23%, back to the 15.5 MBD level of the mid-1980's. The technology necessary to do this (hybrids) already exists and it is just a matter of economic incentive, which the higher price provides.

Figure 5. Effect of peak oil in price



Equation 1 can also be used to forecast price once consumption becomes limited by Hubbert's relation. For example, five years after the peak year, consumption would be down about 10%. Equation 1 suggests that a price rise of 18% would be required to produce such a decline. Figure 5 shows similar calculations for later in the Hubbert decline. Because of the greater need (and ability to pay for) commodities used for leading sectors it is likely that prices would be higher than those shown in the figure. Higher prices would be necessary to obtain a greater reduction in consumption from those economies (like the US) for which oil is no longer a leading sector.

What Figure 5 suggests is that oil-consuming economies have perhaps 1-2 decades to make their adjustments to peak oil without significant declines in living standards. If peak oil is happening today, the situation is not good as the new hybrid technology has been adopted by well under 1% of the population and will require a fairly long time to become fully rolled out. On the other hand, if peak oil is still years away, with prices rising to expensive levels now, we can expect the new technologies to be partially rolled out before the peak arrives and adaptation will proceed without severe disruption to our lives.

As oil prices rise alternatives will come to market, but it must be stressed that these alternatives will not restore motor fuel prices to the cheap levels of the past. The reason why is there exist no infinite sources of "free" energy (like fossil fuel deposits) suitable for use in automobiles. Once about half of existing deposits have been produced, production rate must decline. Thus, new sources of petroleum like the Athabasca tar sands simply delay the arrival of Hubbert's peak, they do not prevent it. Once the peak arrives motor fuel will become dear forever afterward, whether it is petroleum-based or not. Energy for automobiles in the post-peak era will have to be *manufactured*. As a result, it will have to command a price that makes manufacture worthwhile. Manufactured fuels cannot compete against extracted fuels like petroleum that have already been manufactured for us by Nature "for free". Only when shortages of "free" fuels drives up the price will manufactured fuels make sense. That the current price is too low for manufactured fuels to compete is shown by the fact that such fuels are not widespread in Europe, where petroleum prices are far higher than in the US. In a future article I plan to review some alternates.

In summary, I maintain a cautiously bullish view on stocks and the economy based on P/R valuation, continuation of low interest rates and the Juglar cycle. This view is critically dependent on assumptions that there are no disruptions to oil supply in the

near future and (especially) that peak oil is still some years off. Not all disruptions would be bearish. Financial crisis in China could well play out positively, as the Asian crisis in the 1990's did. But factors such as a showdown with Iran have the potential for serious market declines and recession.

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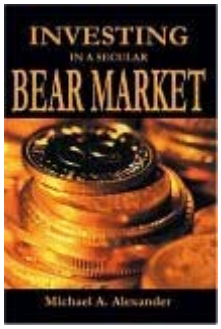

Mike Alexander is the author of four books: (2000) *Stock Cycles: Why stocks wont beat money market over the next 20 years*; (2002) *The Kondratiev Cycle: A generational interpretation;* (2003) *Retiring Rich: The ultimate IRA and 401(k) investing guide* (now available in paperback under the title *Investing in a Secular Bear Market*) and (2004) *Cycles in American Politics: How political, economic and cultural trends have shaped the nation*.

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