The Economics of Oil, Part II: Peak Oil and the Energy Supply Curve

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This is the second (the first can be found here) in a series of guest posts by Robert Smithson, a portfolio manager at a London based investment fund.

Introduction

The world's oil supplies are not unlimited. Unless the abiogenic theory of oil is correct, then reserves will one-day dwindle, and production will decline. New barrels cannot be "magic-ed" by some trick of economics. Extraction of any fossil fuel extraction is limited. Peak oil is inevitable. Of course, there is debate about when production hits its highs; it may have already happened, perhaps it will come in the next few years, and just possibly, it will be in 2020 or later. But make no mistake about it, we are not endowed with infinite amounts of the stuff.

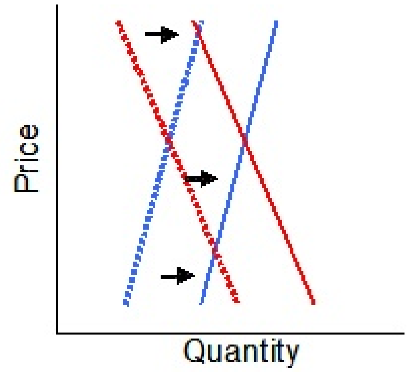
Sceptics rightly point out that this bell has been rung before. In the mid 1980s, world oil reserves were forecast to last about 20 years; and yet here we are in 2007, with near record production levels. Historically, we have always found new sources of oil – in Alaska, in the North Sea, in the Gulf of Mexico, and off the coast of Africa – to satisfy our addiction. There are prospects in the future too: there may well be (very substantial) new discoveries in the Middle East, ultra-deepwater drilling holds promise, as does the development of new areas such as the South Atlantic, and increased enhanced oil recovery will certainly play a role. **This misses the point: finding new oil reserves may push out peak production, but it does not invalidate the concept. Our planet does not contain an unlimited amount of oil.**

Many – particularly on this site - argue that economics has little that is intelligent to say about peak oil. Yet the very definition of economics is the study of scarcity, and in particular, the study of the efficient allocation of scarce resources. What more relevant subject could there be for studying the effects of peak oil?

Peak Oil and Micro-economics

Over the past fifty years, mankind has prospected for and found enormous quantities of oil. These discoveries and their development have relentlessly pushed the oil supply curve to the right. That is, at any given price point, more oil will be supplied. Simultaneously, we have seen economic growth; people have become richer, and with more money comes greater levels of demand for oil (petrol for their new cars, kerosene to fly them to their second homes in Florida or the South of

France). The demand curve has also been pushed to the right. The result is that – until the last few years – we have seen constantly rising oil supply and demand, while pricing has remained broadly stable in real-terms.



This process appears to have broken down in the last few years. Oil prices have risen, while the quantity supplied has not. In other words, the demand curve has moved to the right, while the supply curve has stayed broadly in the same place. Economic theory suggests this should lead to greater investment in prospecting and development. Yet persistently high oil prices – by historical standards – have not led to any increase in capacity.

There are a number of reasons why this might be: suppliers might be waiting for evidence that the demand curve has moved sustainably to the right (those who invested in oil shale projects in the 1970s did poorly), or projects might simply take long-periods before new oil comes to market (the Sakhalin II project was signed in 1996 for instance). Alternatively, we may be at or approaching a peak in global oil production. This may be Hubbert's Peak.

Are We There Yet?

Oil watchers tend to discount the evidence of the market, often accusing it of being "blind". But they would do well to keep an eye on one of the more interesting indicators, the oil forward curve. This measures what people will pay for a barrel of oil to be delivered at various points in the future. These forwards are the only way to bet on long-term movements in the price oil. The two charts below show forward pricing for oil (NYMEX) futures, and are taken from Bloomberg:

In August 2002, the markets forecast oil prices would fall, and keep on falling. You could buy oil for August 2007 delivery for under $23 a barrel. That would have been quite a trade. The current chart is more interesting; it sees oil prices trough at the end of 2010 and then begin to rise. For the first time in all my experience in looking at oil forward curves, there is a long-term upward bias. As recently as February of this year, the long-term curve pointed downward.

These charts do not, of course, show that peak oil has been reached. (The market was woefully wrong in August 2002, so its predicative power should not be over-stated.) What they do show is that the market does not expect new sources of oil – be they from oil sands, or from ultra-deepwater – to move the supply curve sufficiently to the right to mitigate rising demand from China and India. In other words, the market is forecasting a period when oil becomes less abundant.

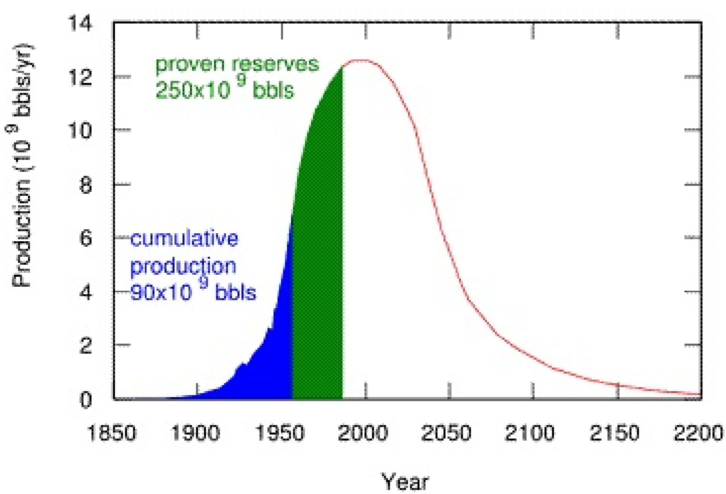
What Does it Mean?

Let us be bold: let us assume that the market is not only right that oil will become less abundant, but that overall supplies will start falling. (This is not an unreasonable assumption: after all, production in Mexico, in the US and in North Sea is declining.) What does this mean?

Well, firstly, it does not mean oil stops being pumped! On the contrary, it merely means that the supply curve stops moving to the right. For any given price there will be less oil supplied. In the short-term, demand curves will not change: the pressures from economic growth in India, China and the like will not have abated. In other words, prices will rise.

But they will not spike due to some sudden “realization”, because the price dynamics have not fundamentally changed. Realization means nothing to the spot price of oil. That price will continue be the level which causes (slightly diminished) supply and demand to meet. (The argument that speculators would or could use large underground “reservoirs” to store oil is spurious: the cost of doing so, once one includes the capital charge for owning the oil, would be enormously prohibitive. If you wanted to bet on rising longer-term oil prices, you’d simply buy the 2012 futures.)

The other thing worth noting is that the decline in total oil volumes produced suggested by Peak Oil is relatively modest, at least initially. The chart reproduced below is from Hubbert’s 1956 Paper “Nuclear Energy and the Fossil Fuels”, and suggests that production will only have fallen 20-25% by 2030 (although it does fall off more steeply after that).



As we described in the reaction of the world to the 1970s oil shocks, increased awareness of higher long-term oil prices, will cause the demand curve will change. Before going into the details, let us not forget that between 1973 and 1985 (just 12 years), world per capita oil consumption fell from 5.45 to 4.40 – a 19% reduction, a period during which world GDP still increased at a 2%+ rate.

The Price Elasticity of Oil

There is still a great deal of skepticism about whether demand for oil is price elastic. Much is written about “Minimum Operating Levels” of oil, below which a modern economy simply cannot function; and while there may be a minimum level of oil required – although I suspect there is actually more of a minimum level of energy – it is well below current levels, particularly for developed economies like the US. This can be demonstrated by looking at the “oil intensity” of various developed nations.

According to the CIA World Factbook, the United States currently uses 68.8 barrels of oil a day per 1,000 people. This compares to 43.8 in Japan, 32.2 in Germany, and 30.1 in the UK. While some of this might be explained by the greater distances people have to traverse in the US, it can hardly be the only reason - after all, there are large distances to cover across Europe. **The point of this data is that the US and Canada are anomalies: their economies use more oil per person, and more per unit of GDP than comparable countries. There is ample opportunity to become more energy efficient without causing significant economic damage.**

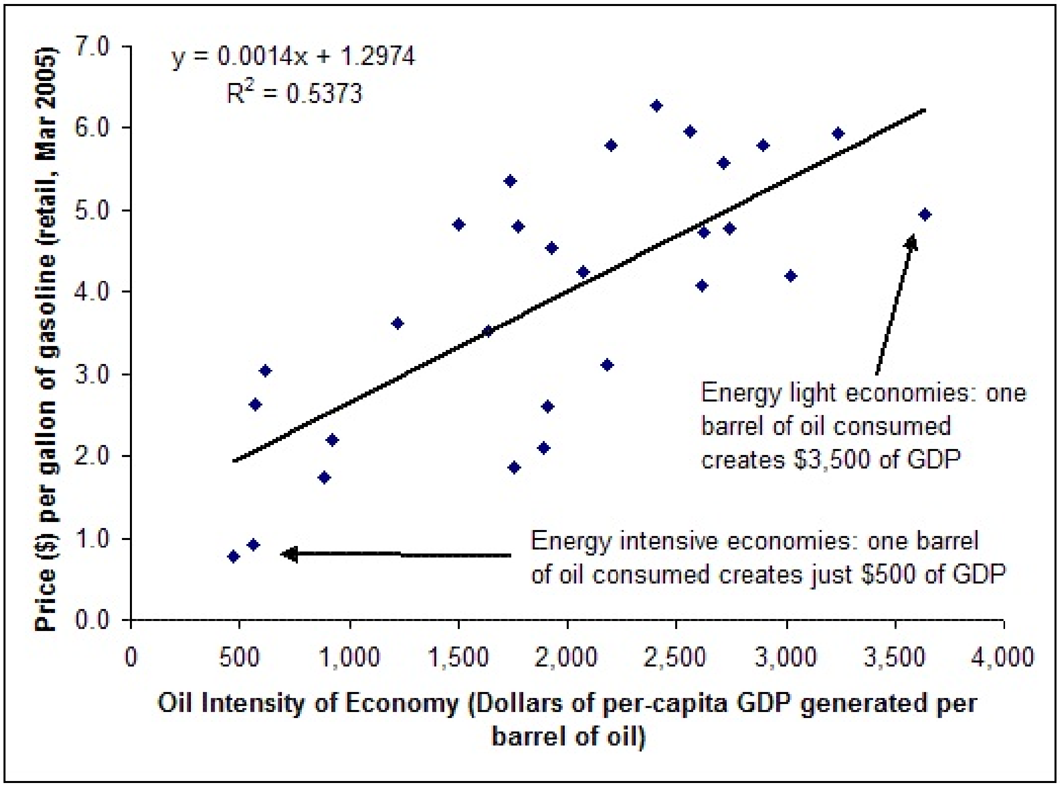
The other interesting piece of the puzzle is the driver of oil usage. Looking at countries with similar GDPs and population densities, but different oil per capita oil consumption, it is clear that gasoline pump prices are the largest determinant of oil usage. In other words, where the price of oil (gasoline) is high, consumers use less. And this difference in consumption (which can be in the order of 40-50%) has little to no effect on GDP. The following tables (based on 2004 data) illustrate this:

Developed Countries
Price per Litre Oil Consumption per Person
UK 156 30.1
Germany 146 32.2
Spain 121 38.9
Ireland 129 44.4
Greece 114 40.7
US 49 68.8

Developing Countries
Morocco 110 5.0
Tunisia 68 8.7
Russia 55 17.7
Saudi Arabia 24 66.8
Kuwait 21 133.7

(There are some countries – although surprisingly few - which clearly do not fall into this pattern: The Netherlands has some of the highest petrol prices in the world, but also has high per-capita oil "consumption". This is due to the Port of Rotterdam, and its associated petrochemical industries.)

For those who think these numbers are somehow cherry-picked, or contrived, the chart below tells the tale in a different way. On the x-axis is the GDP at purchasing-power parity created by each barrel of oil, and on the y-axis is retail price of gasoline (US$, March 2005). Countries where gasoline is more expensive, use it more efficiently. Or, to put it another way, consumption reduces surprisingly efficiently in response to higher prices.



The evidence is clear: people respond to higher prices of petroleum products with reduced consumption, and this reduction does not necessarily result in economic catastrophe. Consumers are rational; their consumption of oil depends on its price. And oil products are surprisingly price elastic – at least over long-periods. Reducing world oil consumption by 25% in the next 25 years, with the price mechanism as the driver, can and will happen. It may not be pleasant, and it may well result in lower economic growth and higher unemployment, but it will not be a disaster.

The Energy Supply Curve

Do we really demand oil? Or do we really demand usable energy? Oil is not the only source of energy in the world. There are alternatives. Forty years ago, oil was commonly used to generate electricity. Today, outside oil exporting countries and the occasional peaking power plant, it is virtually unknown. It is just not economically efficient to generate electricity from oil. Electricity generators are rational consumers: when the price of one input got too high, they switched to another. Of course, this happened over a long-time, but the impact was relatively modest.

When we think of oil as something unique and irreplaceable, we make a great mistake. Oil is just a store of calories, in the form of long chain hydrocarbons. When it is burnt, it releases those calories as heat, which can be harnessed to turn a turbine for electricity, move a car, or fly a plane. But it is by no means the only store of calories. Even just taking other hydrocarbons (so-called fossil fuels), there are supplies of coal, tar, oil sands, methane, gas hydrates, and other gases. The total calorific value of these supplies outweighs that held in traditional crude oil. In addition, there are alternative energy technologies: wind, biomass, geothermal, nuclear, solar. Mankind can extract calories from each of these, and in the case of the latter two, there is the possibility of almost limitless supplies of energy.

We think of the oil market as monolithic, as standing on its own. It's not. Oil is just an incredibly convenient source of calorific energy. It has an infrastructure already in place, and a reasonably efficient mechanism (the internal combustion engine) for translating its energy into motion. If the oil price exceeds the price of alternatives (and it already has in baseload electricity generation), then alternatives will substitute it. **The long-term price of oil is determined by the price of alternative energy supplies.**

That said, this convenience should not be underestimated. In terms of energy density, there is nothing – except nuclear power - to match oil products. Gasoline has 47m joules of energy per kilogram, and 35m per litre. Even the best batteries are an order of magnitude worse. (Interestingly, liquid hydrogen has fairly good characteristics from an energy density perspective, and can be generated – albeit not particularly efficiently – from electricity. This is why there is so much focus on hydrogen power – whether fuel cells or a straight hydrogen burning engine. There is, of course, no infrastructure in place for the distribution of hydrogen.)

Living in an Oil Constrained World

According to forecasts from the Energy Information Administration, world consumption of oil will rise from a little over 150 quadrillion BTUs in 2003 to almost 250 quadrillion in 2030. While anything is possible, this would require extraordinary discoveries; indeed even assuming continued improvements in recovery rates, the world would need to discover the equivalent of all the oil extracted ever in the next 20 years. Good luck.

That won't happen. **We're going to live in a more oil constrained world. But we're also going to discover that this isn't the end of the world.** These articles have focused on demand destruction caused by higher prices; perhaps it is more helpful to think in terms of more efficient use of energy. People will drive less. When they do drive, they will use more fuel efficient cars. 100 miles per gallon is not unachievable. More energy will be consumed from the grid (where nuclear will make up an ever greater share of generation). When we go off-grid, we'll use batteries more, and fuel oil less.

Public transport – particularly buses and trains - will look better value, while airlines will look for more fuel efficient ways of flying. (Ultra-high bypass engines – aka Propfans – which have 20-30% fuel savings over traditional jet engines may enter widespread use as fuel efficiency becomes more important than speed.) Even so, the price of air travel, which has been on a downward curve for the last quarter century, looks set to rise. People will respond by traveling less.

Consumers will react in predictable ways. If getting to out of town shopping malls is difficult, they will instead head into towns for their consumer goods. Likewise, businesses in cities will have an advantage (it is easy to commute into cities by public transport). Indeed, the demise of the high street is mostly the consequence of cheap personal transportation; i.e. the car. So Cities will look more like they did 70 years ago, with central areas preferred over suburbs.

We will become more reliant on telecommunications networks, and the economy will become more service focused. It is fortuitous that video conferencing and the Internet are maturing and improving at the same time our oil supplies are beginning to dwindle. We will need to spend on grid infrastructure: on HVDC lines to reduce transmission losses. There will be investment in nuclear power stations, with commercial fast breeder reactors, and a move from Uranium and towards Thorium. Biofuels, from sugarcane, will become more prevalent. There may be commercial algae farms in the next decade.

Oil will not stop flowing just because peak oil has been reached. We are fortunate that the downward curve of production will probably be as gentle as the upward one. Even in a hundred years time there will probably be commercial production; it will just be an irrelevancy as a percentage of global energy usage. We are given an awful lot of time to adapt to an oil constrained world.

More important that what will happen when we pass peak oil is what will not happen: there will be no queues at the gas station (why should they: we have rationing by price), the electrical and water networks will not cease to function (they were there before we got our present oil dependence), and some people will continue to buy gas guzzling SUVs and Ferarris (there will just be very few of them, and they'll pay extraordinary sums for the privilege). The government will not collapse. Democracy will not come to an end. Economic growth will not end. Our lives will not look so very different to how they do: or at least they'll look no odder than our lives would to those who grew up two generations ago – in an age before the automobile was ubiquitous.

Economics does not provide an answer to declining oil supplies. Its models try and explain – however imperfectly – how people will react to a scarce commodity becoming scarcer. **The price mechanism is a powerful thing: it forces people to prioritize and choose, and it performs a rationing system. This is not to say a transition away from oil as a primary energy source will be painless. But we must avoid the trap of thinking there are no alternatives, and we must avoid the conceit of thinking these alternatives are costless or easy.**