What happens when energy resources deplete?

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What happens when energy resources, such as oil, deplete? Many people believe that oil prices will just go up--but I don't see that to be the case. A more likely result is future dominated by recession and debt defaults--similar to what we have been seeing recently, but trending over time to be worse. In the midst of this recession, the view may be that there is plenty of oil, if only the price were higher.

Views of Oil Prices

One view is that energy prices will rise, substitutes will be found, and prices will come back down again, perhaps settling at a somewhat higher equilibrium reflecting the cost of producing the substitute energy source. The economy will continue to function pretty much as before. The catch is that we aren't finding reasonably-priced, scalable substitutes, so this isn't happening. Oil prices are down, but not because of substitutes.

Another view, popular among those concerned about peak-oil, is that oil and energy prices will just keep rising. If scalable substitutes aren't found, some expect that oil prices will rise from their current price of $75 barrel, to $100 barrel, to $200 barrel, to $300 barrel, and eventually to $1,000 barrel or more.

The problem with this view is that it doesn't take into account the amount of money people actually have available to spend. Just because oil or energy prices rise doesn't mean that people will get additional income to cover these higher expenditures. In real life, prices can't keep going up.

I expect that what really will happen is oil prices may bounce up, but they will soon come back down again, because of recessionary impacts and credit crunches caused by high oil prices. Most of the time, oil prices will end up in the uncomfortable middle--too high for the economy to buzz along, but too low to encourage much new oil production, or much new renewable production. The result is likely to be continuing recession, getting worse over time, because of what will be generally viewed as inadequate demand for oil.

What really happens when energy prices go up

Energy expenditures are not a big share of income for high income people, but they are for the many people getting along on minimum wage, or close to minimum wage. If oil prices go up, these folks find the price of food and gasoline going up, and perhaps the price of home heating and electricity (because the prices of the various types of energy tend to move together). They find their budgets stretched, and they either

1. Cut back on discretionary spending, or

2. Default on loan repayments.

A similar situation happens to the many people who earn more than minimum wage, but live paycheck to paycheck, and pretty much spend all the money they earn. As the prices of energy-related goods rise, these people too find a need to cutback. Some will cut back on discretionary goods; others will default on loan repayments; some will do both.

Thus, when oil prices rise (or energy prices in general rise), we end up with two main effects:

1. Banks find themselves in worse condition because of many loan defaults.

2. The economy starts feeling recessionary impact, because so many people cut back on buying discretionary goods.

These impacts are likely to lead to others as well:

1. Banks become less willing to make loans, because of the problem with defaults.

2. Many people are laid off from work, because of reduced demand for discretionary goods (restaurant meals, vacations, new homes, new cars, new home furnishings, for example.)

The cutback in the purchase of new homes, new cars, new home furnishings and the like leads to yet more impacts:

1. The price of homes drops (because fewer are upgrading to more expensive homes, and because loans are harder to get).

2. There is less demand for oil (because oil is used in making cars, new homes, and many other things. Also, if fewer people take vacations, and fewer people drive to work, this reduces oil usage).

3. There is also less demand for natural gas, coal, and electricity, because all of these are used in manufacturing discretionary goods.

The next round of effects then becomes:

1. Even more people default on their loans, because with the decline in home values, they owe more on their homes than their homes are worth. This may also happen if people have lost their jobs, and can no longer afford their homes.

2. The prices of all energy products drop (oil, natural gas, coal, uranium, ethanol) because of reduced demand. Many fewer solar panels are sold as well.

About this time, governments come in with stimulus funds, bails out for banks, and the problem appears to mostly solved. It isn't really solved though--it is mostly transferred from private citizens and from corporations to governments. But governments find expenditures vastly exceed revenues, and debt is rapidly rising. Something needs to be done--either raise taxes and cut services, or default on debt.

Before we talk about these options, let's talk about timing.

When does all this happen?

The popular myth among people concerned about peak oil is that difficulties do not really start until oil production begins its down-slope. In my view, the difficulties start much sooner--as soon as oil supply cannot be provided at close to a constant price.

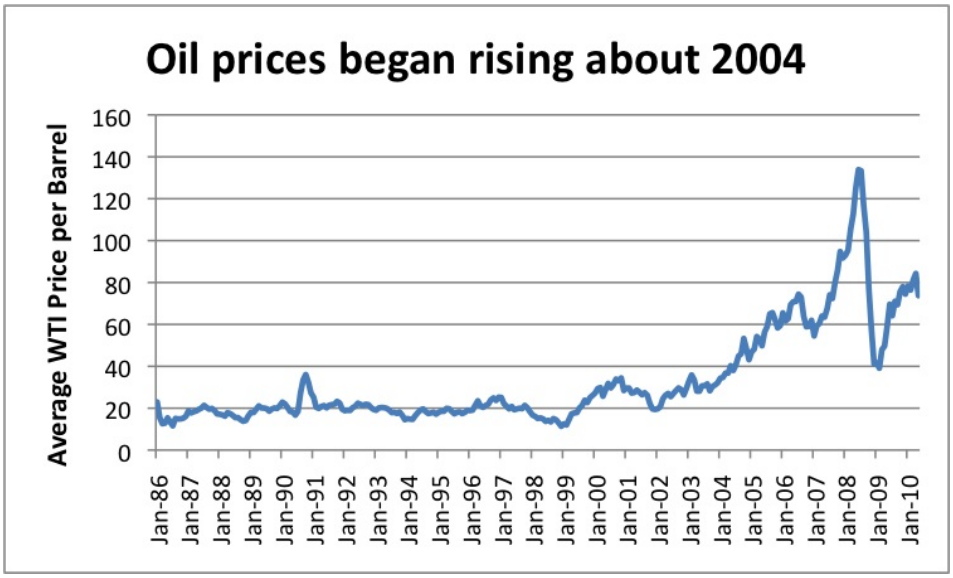

Figure 1. Average monthly West Texas Intermediate spot prices, based on Energy Information Administration data

Oil prices were in the $20 a barrel range for many years, but then started rising about 2004, as Chinese demand began rising. So this was really the first sign of problems.

A second measure of when this happens is when the growth in oil supplies starts to falter. The world had been accustomed to a close to 2% a year rise in world oil production, but slipped onto a production plateau starting in 2005. This production plateau has lasted until the present time (2010).

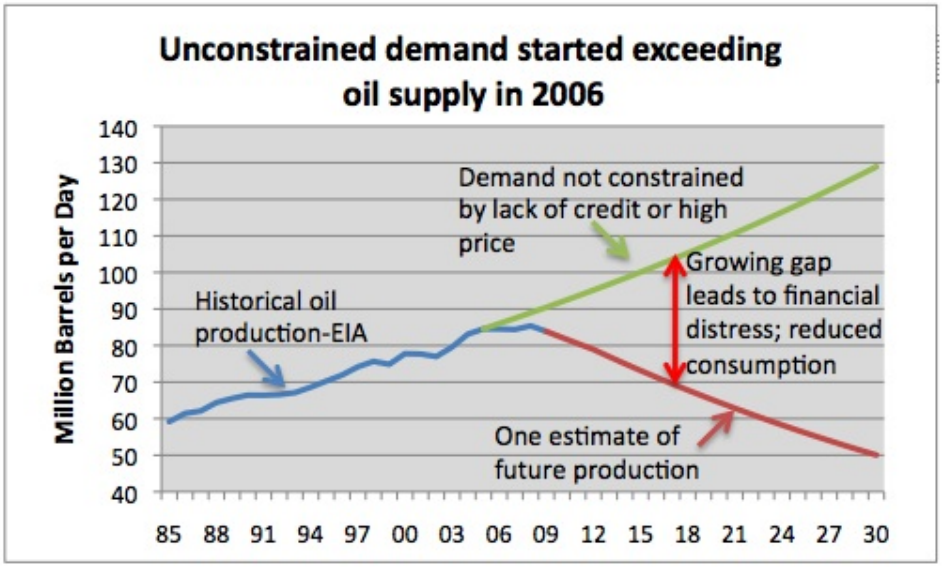

Figure 2. Diagram by author. Historical data from Energy Information Administration.

So if we compare what production we might have expected in the absence of higher price or credit problems (green line), to the actual production (blue line), a gap started to appear about 2006. This is another measure of when we would expect symptoms of energy shortages to start affecting economies.

I know many will say, "Oh, but while we had problems with sub-prime mortgages about then, and housing price drops, it couldn't have had anything to do with oil prices." I would point out:

1. Recessionary effects happened around the world, not just where there were subprime mortgages. Japan was affected even before the US, and didn't have subprime mortgages.

2. The effects that we would expect from higher oil prices had to be manifested somewhere. It turns out the greatest manifestation was with lower income people, living in distant suburbs where the commutes were longest. These are precisely the folks one would expect to be most affected by higher oil prices.

3. The impacts of recession and credit problems have gradually spread more broadly than subprime loans, as we would expect, based on the foregoing discussion of the expected impacts.

I should point out that saying that higher oil prices being instrumental in causing in recession doesn't mean that there couldn't be underlying weaknesses, that would allow the manifestations to be in particular parts of the economy.

Also, we know that higher world oil usage is closely linked with world economic growth. One would expect relatively lower oil use to therefore lead to recession--and that is precisely what seems to be happening in the real world.

What is ahead?

We are now at the point where the recession seems to be better, because governments have bailed out private citizens and companies (particularly banks). But this leaves the governments with a huge amount of debt, and with a big gap between revenues and expenditures.

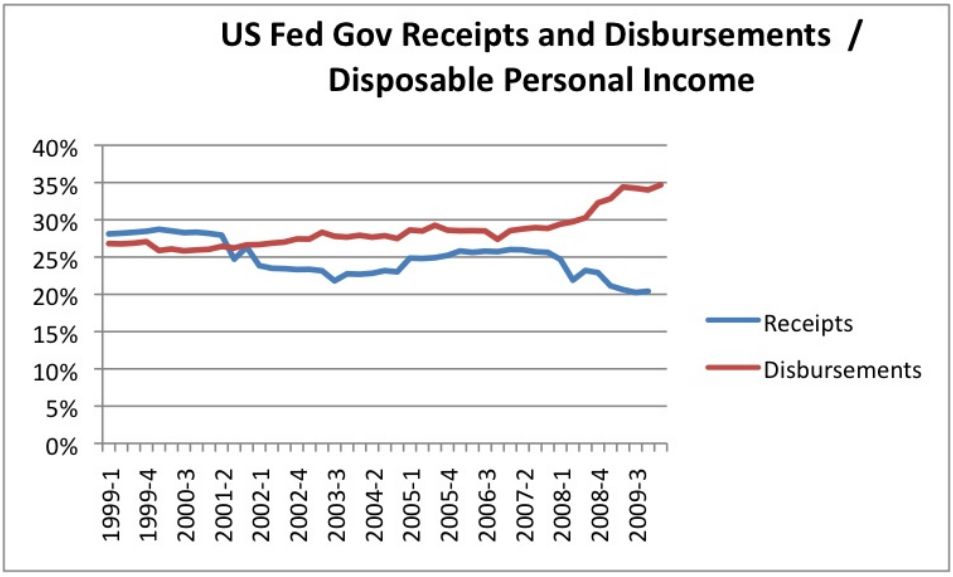

Figure 3. US government receipts and disbursements as percentages of disposable personal income, based on data of the US Bureau of Economic Analysis

Figure 3 shows what a huge shortfall the US government now has in revenues. There are many other governments around the world with similar issues. In addition, state and local governments have serious revenue shortfalls.

If recession continues, it is difficult for governments to continue to borrow more, as expenditures outpace income. Eventually, governments are left with two options:

1. Raise taxes and reduce services, so as to get revenue and expenses back in line.

2. Default on debt.

Either one of these things will make the situation worse:

1. If governments raise taxes, the effect on citizens is pretty much like higher oil (or energy) prices. Citizens react by cutting back on discretionary spending or defaulting on loans, and we are back to more of the problems recessionary problems, plus loan defaults we had before. If governments also layoff workers, this increases the recessionary effect.

2. If only one or two small governments default on debt, the world can probably accommodate the defaults pretty easily. But if problems spread to a large number of big countries (UK, United States, and Japan, for example), then international trade is likely to be disrupted, because many sellers of goods will find themselves without payment. To prevent this happening again, the sellers of goods are likely to set stricter terms--I will sell you so much oil if you will sell me so much wheat in return, for example. The amount of trade is likely to drop precipitously, because of the cumbersome nature of such trading.

If governments mainly raise taxes and reduce services, I would expect the result to be more recession, more debt defaults, and lower prices for all energy products. Everyone will say, there is plenty of oil (natural gas, coal, uranium) in the ground. If prices were only higher, we would extract it.

If there are major international debt defaults, the situation is likely to be somewhat the same (recessionary impacts and lack of credit), but some goods may cease to be available for import. If these goods are critical goods (computers, replacement parts for the electrical grid, replacement parts for automobiles), the economy could spiral downhill rapidly.

A variation on defaulting on debt is attempting to inflate it away. This still leaves owners of bonds very unhappy, and can cause many of the same problems as regular default.

What would it take to ramp up oil production (or a substitute) so production is again on a trajectory where it is growing at, say, 2% per year?

I can see several ways such a ramp-up theoretically could be accomplished. (Some of these are more ways of circumventing the problem. Note that these are all temporary solutions. In a finite world, it is not possible to continue exponential growth forever.)

1. If conventional oil production is flat to declining, one could ramp up unconventional oil production (oil sands, oil shale, ultra-deep, and arctic for example).

2. If conventional oil production is flat to declining, ramp up production of other liquids--ethanol, biodiesel from algae, and coal to liquids, for example.

3. If conventional oil production is flat to declining, one can try to convert a large share of the auto fleet to electric, and ramp up electrical production.

4. If conventional oil production is declining, one can theoretically engineer cars to be much more efficient, and ramp up production of these new cars.

Regardless of which approach one uses, one needs:

1. A lot of time. In 2005, Robert Hirsch was the lead author or a report for the department of defense called Peaking of World Oil Production: Impacts, Mitigation, & Risk Management. This report showed that **mitigation would take 20 years**. If one stops and works through the details of any of the three solutions proposed above, one can see that each of these require long lead times. For example, scaling up oil shale would likely require new coal fired power plants in the area, new coal mines, new train tracks from the coal mines to the oil shale area, and new water supplies piped into the arid US West, not to mention building the facilities themselves. Perfecting the technology for electric cars, and building a whole fleet of these, would be a similarly slow undertaking, as would replacing the current auto fleet with more efficient cars.

2. A lot of capital. Unless oil prices are higher--a lot higher--it is hard to justify large capital expenditures, in ventures such as this. We have just seen that consumers cannot afford high oil prices, without recession.

3. Long term subsidies. If the prices of the new fuels are too high for consumers to really afford, one needs long-term subsidies. We have just seen that high oil prices seem to hurt the economy badly. High prices for substitutes can be expected to have a similar effect.

It seems like any one of these issues is likely to be a deal-killer. Since we are already at a point where conventional oil is falling short of demand, the time requirement will mean that scaling up will be very difficult. Progress to date on renewables has been very small, as shown on Figure 4.

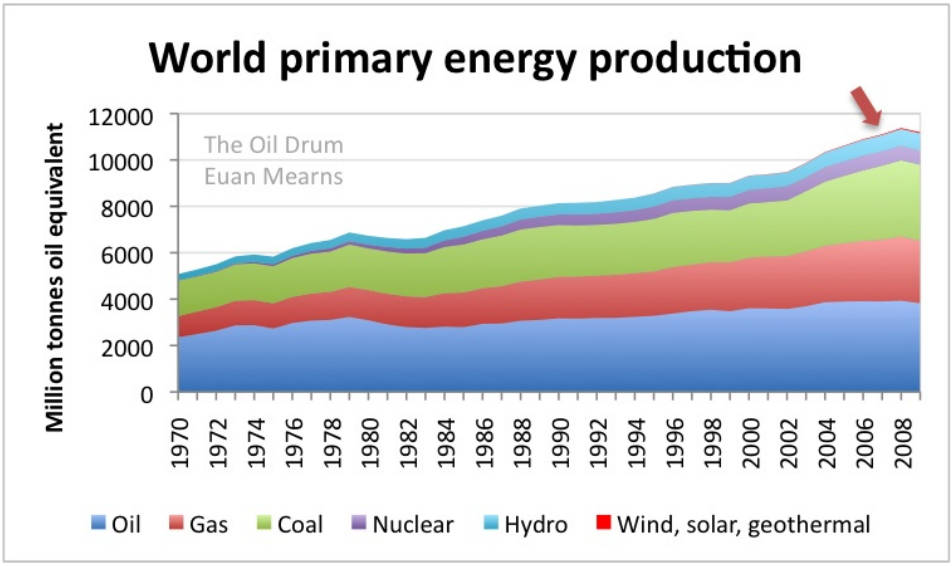

Figure 4. World primary energy production, based on BP 2010 Statistical Analysis – Graph by Euan Mearns

Wind, solar, and geothermal are combined in the tiny red line at the top of the chart. Since these all produce electricity, not a liquid fuel, they are not good substitutes for oil. Biofuels are not

shown, but are also a very thin line.

What is "Peak Oil"?

"Peak oil" is sometimes described as the time when conventional oil production begins to fall. There is still a lot of oil in the ground, though, but what is left is

1. Very slow to extract. It is necessary to ramp up huge amounts of production capability to mitigate the downslope of conventional production.

2. Expensive to produce. The easy to produce oil is gone.

So what peak oil really is, is a turning point. One can theoretically continue to produce the same amount of oil or more, **if one makes huge investment well in advance**. The problem is that it is really too late now. By the time new production finally gets started, conventional oil production will be down very substantially from its peak level. The fact that no one ramped up unconventional production (or alternatives production) before it was too late leaves us with precisely the problem that the peak oil community has been warning about--oil production capacity that can be expected to decrease over time, as individual fields deplete.

Peak Oil and Exponential Growth

Oil supplies are expected not just to level off, but to actually decline. Part of this happens because of the natural decline rate of conventional oil fields, as the finite amount of oil that is in the field is extracted.

The decline is likely to be more severe than historical decline rates (2% to 8% per year) would suggest, for two reasons mentioned earlier:

1. Declining credit availability, as high default rates continue among buyers. Lack of credit will tend to keep oil prices low, and discourage investment.

2. Higher tax rates on fossil fuels. Governments are short of funds and oil companies are temping targets. If tax rates are raised, this will likely cut back production, since oil companies base investment decisions on expected after-tax profit, and this will be lower for many projects.

Meanwhile, we have a huge number of variables growing exponentially:

- Economic growth
- Money supply
- Stock market prices (hopefully)
- Population

These variables are not independent of energy supplies. If nothing else, people need food to eat, and oil is used very extensively for food production. It is questionable whether these variables can continue their exponential growth if oil and other energy supplies are declining in quantity.

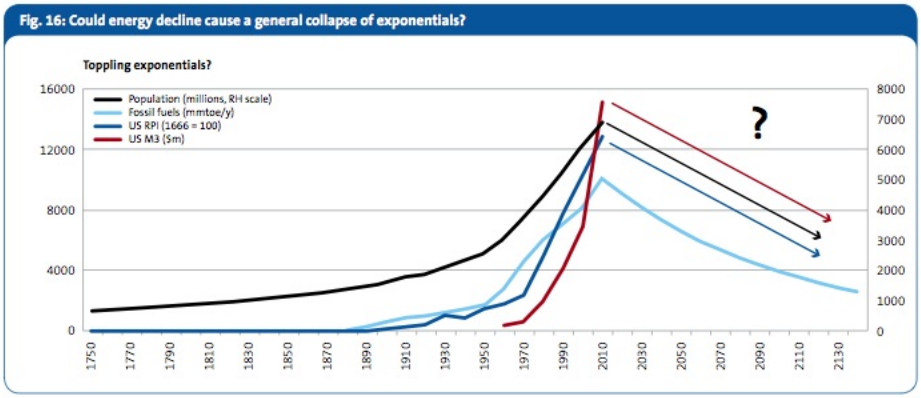

Figure 5. Graph from report Dangerous Exponentials by Tullett Prebon.

> "Anyone who believes exponential growth can go on forever in a finite world is either a madman or an economist". *Kenneth Boulding*

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