

An Economic Theory of Limited Oil Supply

We seem to hear two versions of the story of limited oil supply:

1. The economists' view, saying that the issue is a simple problem of supply and demand. Substitution, higher prices, demand destruction, greater efficiency, and increased production of oil at higher prices will save the day.

2. A version of Hubbert's peak oil theory, saying that world oil production will rise and at some point reach a plateau and begin to decline, because of geological depletion. The common belief is that the rate of decline will be determined by geological considerations, and will roughly match the rate at which production increased.

In my view, neither of these views is correct. My view is a third view:

3. An adequate supply of cheap (\$20 or \$30 barrel) oil is no longer available, because most of the "easy to extract" oil is gone. The cost of extracting oil keeps rising, but the ability of oil-importing economies to pay for this oil does not. There are no good low-cost substitutes for oil, so substitution is very limited and will continue to be very limited. The big oil-importing economies are already finding themselves in poor financial condition, as higher oil prices lead to cutbacks in discretionary spending and layoffs in discretionary industries.

The government is caught up in this, as layoffs lead to more need for stimulus funds and for payments to unemployed workers, at the same time that tax revenue is reduced. There can be a temporary drop in oil prices (as there was in late 2008), as recession worsens, but eventually demand rises again, oil prices rise again, and the pattern of layoffs and increased governments financial problems occurs again.

Without substitutes at a price that the economy can afford, economies will adapt to lower amounts of oil they can afford by worsening recession, debt defaults, and reduced international trade. There may be tendency for international alliances (such as the Euro) to fall apart, and for countries to break into smaller units (Catalonia secede from Spain, or countries break up the way the Soviet Union and Yugoslavia did).

At some point, probably not too many years in the future, the amount of oil extracted from the ground will drop, reflecting a combination of geological and economic

factors. The fall may very well be quite steep. While we can't expect to extract more than geology will allow, there is nothing to say that political and economic factors will allow extraction of this amount. If civil war breaks out in an oil producer, production may drop quickly. Or if oil prices drop because of severe recession, drilling of new fields and wells may drop off quickly, leading to lower production as existing wells deplete, and not enough new supply as added. There may also be disruption in international sales of oil.

What the Economists' View Misses

The economists' view misses the fact that it is external energy that makes the economy operate the way it does. (See my earlier posts, [here](#), [here](#) and [here](#).) If energy products are higher priced, energy importers can *afford less of them*, and there is a tendency of their economies to shrink back to what their economies can afford—fewer employed workers and fewer government programs. I talk about the connection between employed workers and energy consumption in [The Close Tie Between Energy Consumption, Employment and Recession](#).

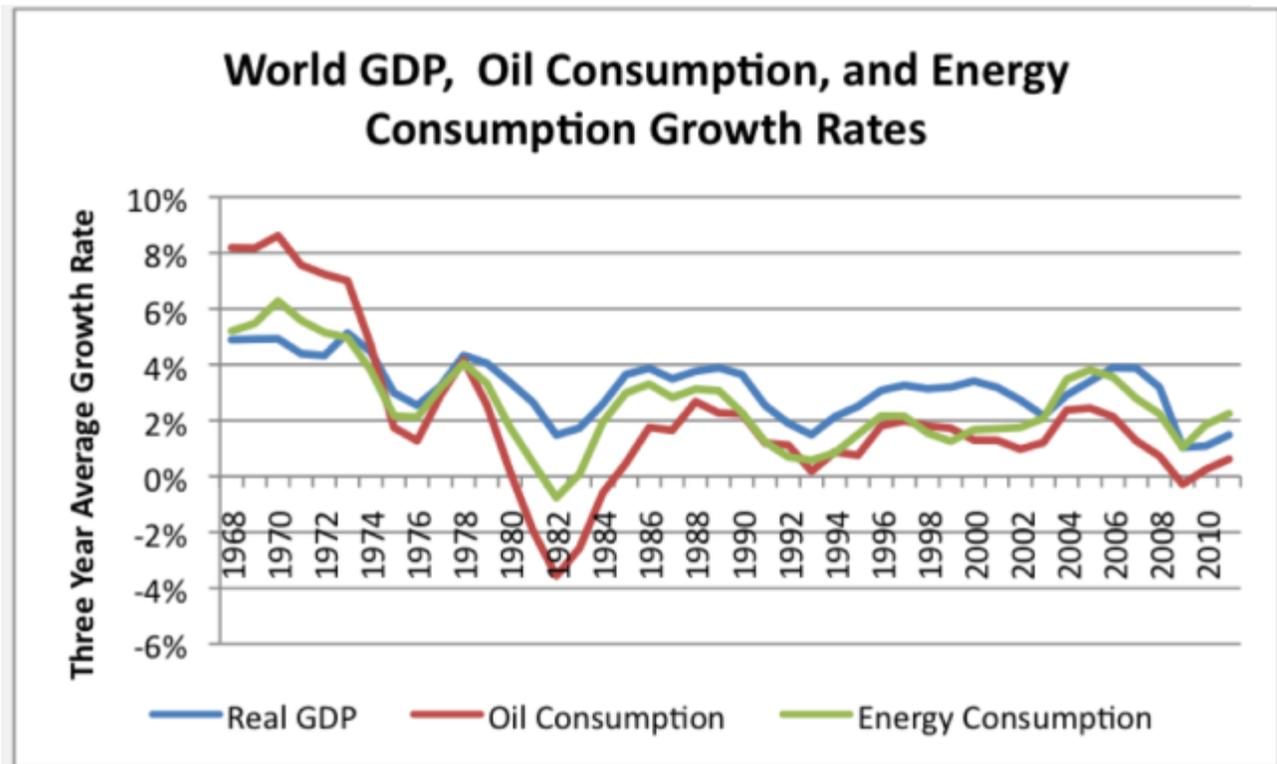


Figure 1. World GDP, oil consumption and energy consumption growth rates, based on data of USDA, Angus Maddison, and BP's 2012 Statistical Review of World Energy data.

As the growth rate in energy supplies decreases (oil by itself, or in total), the economy tends to shrink back. Initially (in the 1970s and 1980s), the economy shrinking back looked like it was slowing down – no longer undertaking big new initiatives like interstate highway systems and major electrical grid expansions, and adding new initiatives for taking care of the poor. Then the economy shrinking back morphed into a bigger emphasis on debt financing; less concern about keeping up infrastructure the way it had in the past; and switching from manufacturing of goods to production of services, to keep energy needs lower.

Another way of keeping down energy use was by keeping wages down. Since wages translate to purchase of things that energy can make, lower wages allow an economy to “get by” with less energy consumption. In the US, the quest for lower wages has manifested itself in many ways—the failure of men’s median wages to rise after the mid 1970s, the increasing use of women (at lower average wages) in the workforce, and later outsourcing of jobs to countries overseas with lower wages (and thus less energy consumption by workers).

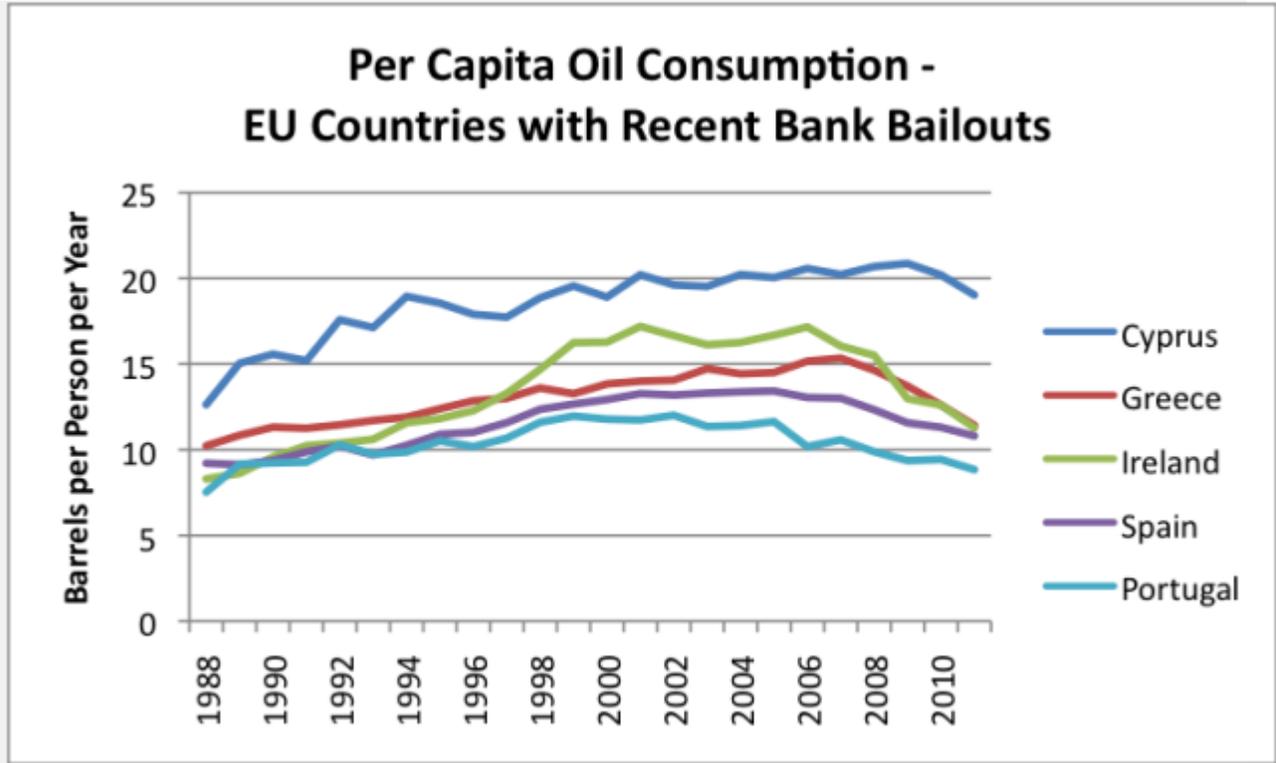


Figure 2. Per capita oil consumption in countries with recent bank bailouts, based on data of the US Energy Information Administration.

Eventually, the economy shrinking back has become more disruptive. It looks more like recession, with job layoffs, debt defaults, and serious government funding problems. Governments find themselves going deeper and deeper into debt, as tax revenue lags, and there is more need for stimulus funding and benefits for unemployed workers. In such an atmosphere, government stability is at risk. This seems to be where quite a few of the European countries are right now. The United States is not far away either, with many of its problems hidden by deficit spending, “quantitative easing,” ultra low interest rates, and the fiscal cliff.

The Myth of Substitution

A big part of the economists’ problem in figuring out the problem with limited cheap oil supply is their assumption that energy is not very important. It doesn’t cost very much, so why worry about it? Certainly, there should be substitutes. For example, if we can’t afford to make goods, we should be able to switch to the production of services, since these don’t require as much energy to produce. This might be a method of substitution.

But think about this. In our own life, our own energy comes from food. If someone told you that we were having a problem with food supply, but the economists said not to worry, we would find a substitute, how convinced would you be that economists really knew what they were talking about? Do you feel less hungry after a haircut, or a trip to get a loan at a bank (two standard types of services)? Perhaps they were underestimating the importance of food.

Something like that happens with other forms of energy as well. It is virtually impossible to substitute away. There is a little substitution over time of one form of energy for another, just as there is substitution of wheat for corn. But in general, each type of energy has its own uses, and it is hard to substitute one type for another. A car runs on gasoline. It is possible to substitute up to 10% or 15% corn ethanol in the gasoline, but unless significant changes are made, it is not possible to run the car on natural gas or on coal.

A big part of economists’ problem with overestimating the role of substitution is their missing the adverse impact of high oil prices (or other high energy prices) on the economy. As I have explained previously, when oil prices rise, both the cost of food and cost of commuting tend to rise. Workers cut back on discretionary spending, so as to have enough money for commuting and food expenses, leading to layoffs in discretionary industries. Housing prices stagnate or drop, as people cut back their

expectations of moving to a higher priced home. Governments find themselves in increasingly poor financial condition, trying to fix these problems, with lagging tax revenue. All of this creates substantial economic problems, which cannot be overlooked.

The comment a person often hears is, “As soon as the price of oil rises high enough, _____ will substitute for it.” This doesn’t work for a couple of reasons: (1) By the time the price rises that high, the economy will be “in the tank” anyhow; a high-priced substitute doesn’t fix the problem. (See my post [High-Priced Fuel Syndrome](#)) (2) Substitutes generally use oil in their production, either directly or indirectly, so when the price of oil rises, the price of the substitutes tends to rise as well, although probably not as much as the oil price rise.

Substitution to date is not taking place very quickly. On a worldwide basis, 87% of current energy use comes from fossil fuels, based on BP’s 2012 Statistical Review of World Energy Data. The remainder is divided as follows, in the year 2011:

- Nuclear amounted to 5% of the total;
- Hydroelectric amounted to 6% of the total, and
- Renewables (including wind, solar, biofuels, wood, waste, geothermal, and others) come to a **total** of 2% of world energy supply.

There has been some substitution away from oil for a long time, because oil is high priced. Often, this occurs through electrification of various processes. The electricity used in this process is today mostly from natural gas and coal, with lesser amounts from nuclear, hydroelectric, and other renewables.

The speed with which substitution of electricity for oil is taking place varies, with stationary applications working best, and transportation being slow to change. According to the [US Energy Information Administration](#), in 2011, only 0.3% of US transportation fuel was electricity. The rest of transportation was divided as follows: Oil, 92.7%; Biofuels, 4.3%; Natural Gas, 2.7%.

Another application which is a significant user of oil, but for which little substitution toward electricity is readily available, is in food production. Oil is used in operating farm machinery, in making herbicides and insecticides, and in transporting food to market. This is a reason why many people are interested in local food production, using techniques that use less oil.

What the Peak Oilers Missed

If a person goes back and looks at M. King Hubbert's 1956 paper, [Nuclear Energy and the Fossil Fuels](#), they will discover that Hubbert talks about a very optimistic scenario: the use of nuclear energy rising, before the use of oil and other fossil fuels begins to decline. See my post, [Will the decline in world oil supply be fast or slow?](#)

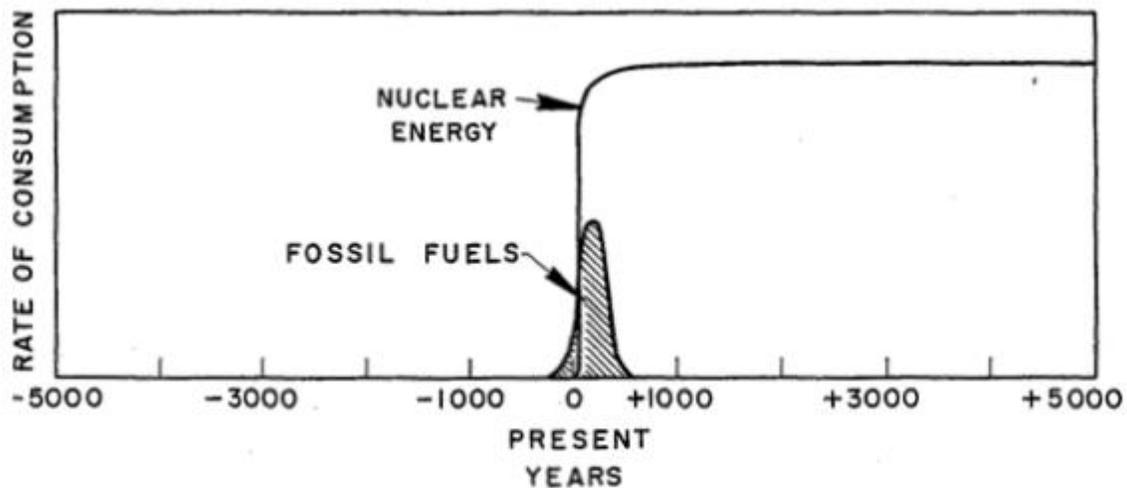


Figure 30 - Relative magnitudes of possible fossil-fuel and nuclear-energy consumption seen in time perspective of minus to plus 5000 years.

Figure 3. Figure from Hubbert's 1956 paper, [Nuclear Energy and the Fossil Fuels](#).

Elaborating further on this idea, Hubbert, in his 1962 paper, [Energy Resources - A Report to the Committee on Natural Resources](#), writes about the possibility of having so much cheap energy that it would be possible to essentially reverse combustion—combine lots of energy, plus carbon dioxide and water, to produce new types of fuel plus water. If we could do this, we could solve many of the world's problems—fix our high CO₂ levels, produce lots of fuel for our current vehicles, and even desalinate water, without fossil fuels.

The problem that arises if we don't have such a substitute for fossil fuels is a severe one. How do we keep our current economy operating, if oil prices, or fossil fuels in general, become high priced, and start interfering with the economy? At some point, the interference will become so great that recession will set in, in many major oil importing nations. Oil prices will drop, and oil producers will not be able to extract oil at those prices. There may be major financial impacts as well—governments dropping out of the Euro, the US government facing a financial cliff, and other countries (Japan, Britain, and China, for example) facing difficulties as well.

In my view, the shape of down slope in oil production is likely to be steeper than the pattern by which oil supply increases. Geology determines the maximum amount of extraction, but it doesn't determine how much will actually be extracted. Economic conditions need to be right for the extractions to take place. Low oil prices by themselves could cause political upheaval in some oil exporting nations. If there are huge international trade problems, this could reduce demand as well.

Why International Trade Can Be Expected to Contract

Huge economic growth since World War II has been enabled by increased international cooperation and increased globalization. It is now possible to make many high-tech goods using trained specialists who travel around the world and raw materials imported from countries that will put up with high levels of pollution. These high-tech goods can be very cheap, if they are assembled in a country such as China with cheap labor.

Once countries start operating in a mode of "not enough energy to go around," the model of global cooperation starts disintegrating. If unemployment becomes an increasing problem, then countries are no longer be willing to let in cheap labor from lesser-developed countries. We can see this happening in the United States, with respect to workers from Mexico.

If oil is becoming a problem, we will see more spats, of the type recently occurring between Japan and China, leading to lower trade. There may even be more resource wars. Large countries encountering financial problems will see individual units wanting to go their own way, with the parts that are doing better economically wanting to disassociate themselves from the have-nots.

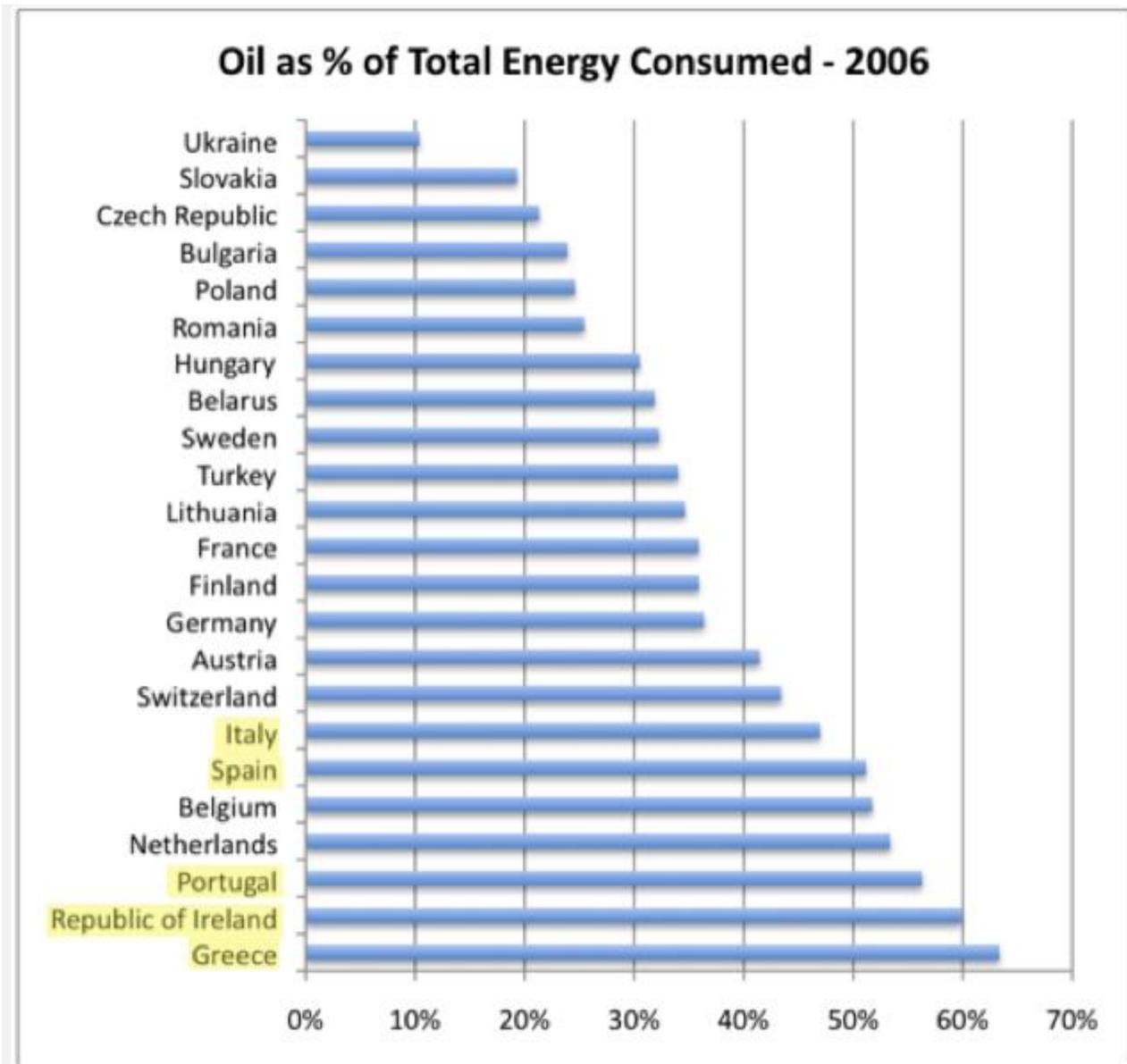


Figure 4. Oil as a percent of total 2006 energy consumption for European countries, based on BP's 2012 Statistical Review of World Energy

High oil prices are likely to lead to more defaults on loans. In fact, Figure 4 shows that the countries most at risk of defaulting tend to be the ones that imported the largest percent of their energy from oil in 2006, before the recent crisis began. As the world encounters more and more loan defaults, this too can be expected to erode interest in foreign trade. Such trade will likely not disappear, but may be carried on to a greater degree between trusted partners, or on more of a barter basis. For example, a certain quantity of oil may be traded for goods that the oil-producing country can use.

Businesses, Governments and Consumers form a Networked System

The way the world operates today, each business is added to the existing web of governments, businesses and consumers that exists today. Some businesses succeed, while others fail. Success or failure depends the laws that are in effect, the resources that are available, what competition there is, and the purchasing power of customers.

If energy is in short supply, more and more governments and businesses will fail, and increasing numbers of consumers will find themselves without jobs in the traditional economy. Banks may be overwhelmed by debt defaults. At some point, supply chains will become so disrupted that it will be hard for anything other than small local businesses to succeed.

This will correspond to what Joseph Tainter talks about as moving to a state of lower complexity. We don't know exactly when or how this will happen, but it appears that we are already moving in this direction. The next years seem likely to be challenging ones!

Source: <http://ourfiniteworld.com/2012/10/25/an-economic-theory-of-limited-oil-supply/>