The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Economic Impact of Peak Oil Part 1: A Flashback

Posted by Gail the Actuary on September 23, 2007 - 11:00am
Topic: Economics/Finance
Tags: debt, industrial revolution, robert ayres, robert solow [list all tags]

This is the first part of a three-part series providing my ideas on the economic impact of peak oil.

What happens when peak oil collides with our economic system? It seems to me that there is a high probability of a major discontinuity of some type. What exactly happens after the discontinuity is likely to vary from country to country. It seems to me that the United States is especially vulnerable to a drastic drop in the amount of oil available for import because of the large amount of oil we import and the relatively small amount of goods we export.

Many people when analyzing the world oil situation focus on the relatively small drop in overall world supply in the first few years. From this, they conclude that peak oil will primarily raise the price of oil and some related goods, but not have a huge effect otherwise. If the decrease in oil products is severe, some rationing may be required. I think this analysis misses the big part of the problem – the impact of peak oil on the overall economic system, particularly in the United States.

The world is very different now than it was before the industrial revolution, which began about 1800 when fossil fuels were first used extensively. It seems to me that there is a significant chance that over the long term there will be just as big a change as we leave the age of fossil fuels. To start the discussion, let's start with where we are, and then take a look back.

1. What is our current economic system like?

We all recognize our current economic system. Goods are made in factories around the world. Food is grown on large farms, then processed and packaged before we buy it in grocery stores or restaurants. There is a huge amount of international and local trade that brings all of our goods and services to us.

Most of us have jobs and work for money to purchase the things we need or want. We expect to buy various types of insurance, such as life insurance, auto insurance, and long term care insurance. After we have worked for a number of years, we expect to retire and collect funds from various sources - social security, a pension, or perhaps a 401(k).

To finance all of this, there is a huge financial industry. This industry includes many players:

- Banks and savings and loans
- Insurance companies
- Hedge funds

• Markets that sell stocks, bonds, and a wide variety of derivatives and repackaged debt
• Large numbers of accountants, actuaries, economists, financial advisors, financial planners, quantitative analysts, and others associated with the financial services industry.

We know that this system includes a very large amount of debt. Almost any new factory is "financed". Businesses use debt to buy other business. Individuals use debt to finance college educations and to purchase homes or cars. In recent years it has become fashionable to refinance home loans as soon as some equity has built up, and use the funds withdrawn to pay down credit card debt.

Governments use debt to just as great an extent as individuals. State and local governments issue bonds to finance a wide range of projects. The federal government has both the debt that it reports, and unfunded programs such as Social Security and Medicare. USA Today reports that when corporate style accounting is used, federal liabilities amount to $59.1 trillion, or $516,348 for each US household. This compares to an average of $112,043 per household in personal debt such as mortgage loans, auto loans, and credit cards.

2. Have economies always been similar to ours today?

We all know that the answer is "No". Prior to the industrial revolution, most people were farmers, and businesses tended to be quite small. Governments funded big undertakings like roads or water systems (or pyramids). Farmers grew or made most of what they needed. What was left over was sold and traded for other goods. Cities tended to be quite small, because the amount farmers produced over and above what they needed for themselves was not sufficient to support very many additional people. While there was international trade, the volume was much smaller than today.

In businesses and governments, debt seems to have played a lesser role than today. When Lloyd's of London was formed in 1688 to pool insurance risk, it was formed by a group of wealthy individuals, each pledging a share of their personal wealth as backing for the venture. Thus, the emphasis was on assets rather than debt. The US government did not have significant debt until the Civil War. Its next increase in debt came with World War I.

The use of debt, particularly by individuals, seems to have been viewed quite negatively. The Catholic Church forbad debt until 1822, and Islam to this day forbids paying interest on debt. The Jewish Torah says debts should be erased every seven years and every 50 years. Those who could not repay loans were sometimes sent to debtors' prisons or became indentured servants or slaves.

Homes and barns were quite simple, and were often built with the help of friends or neighbors, so little debt was needed. Farms and other property tended to stay in families, and were transferred through inheritance. Many of the skills needed to run a farm or small business were learned through apprenticeship, often with the boy's own father. Retirement was unknown. People would work as long as their heath permitted, and lived with their children when they got older.

Since retirement was unknown, when people saved for the future, it was primarily savings for a "rainy day"--crop failure or ill health or burial. The stock market and even banks were viewed as risky. Panics, crashes and bubbles happened frequently, making it difficult to predict how markets would behave in the future.

3. How did this huge change in the economic system take place?

One of the big factors in the change was the greater use of fossil fuels, starting about 1800, when coal began to be used to power factories and the steam engine. This allowed for the production of many more goods, and resulted in greatly expanded trade.

Petroleum came into widespread use in the late 19th and early 20th century. Farmers were able to farm larger tracts of land with the use of tractors and other equipment. The green revolution between 1940 and 1960 further increased farm productivity through the greater use of fertilizers (natural gas), pesticides (oil), and pumped irrigation (oil).

4. Wasn't technology important in the change in the economy?

Energy and technology go hand-in-hand. Without energy, it is hard to have much technology improvement. Energy also goes hand in hand with productivity growth, since energy is what permits a machine to do the work a person previously would have done.

5. Have economists studied the relationship between energy and economic growth?

The standard model by which economists explain growth is the Solow-Swan neoclassical growth model, which is described in Robert Solow's 1956 paper A Contribution to the Theory of Economic Growth. This paper looks at the contribution of labor and capital to the growth of the US economy, using a model that assumes that the contributions of labor and capital are proportional to their respective costs. The paper finds that labor and capital in fact explain less than 25% of the actual growth of the US economy. The assumption is then made that "technology" must explain the huge residual.

With a model that explains so little (less than 25% of actual growth), it is not clear that the model is very helpful. The residual comprising over 75% of growth could just as well be energy as technology.

One economic growth model that explains growth quite well is Accounting for Growth, the Role of Physical Work by Robert U. Ayres and Benjamin Warr, *Structural Change and Economic Dynamics*, February, 2004). This model looks at the amount of work (in a physics sense) that is done by energy. Thus, it considers both the amount of energy used and how productive that energy is. For example, power stations in 1900 converted only 4% of the potential energy in coal to electricity, but by 2000, the conversion efficiency was raised to 35%. This model explains the vast majority of US real economic growth between 1900 and 2000, except for a residual of about 12% after 1975.

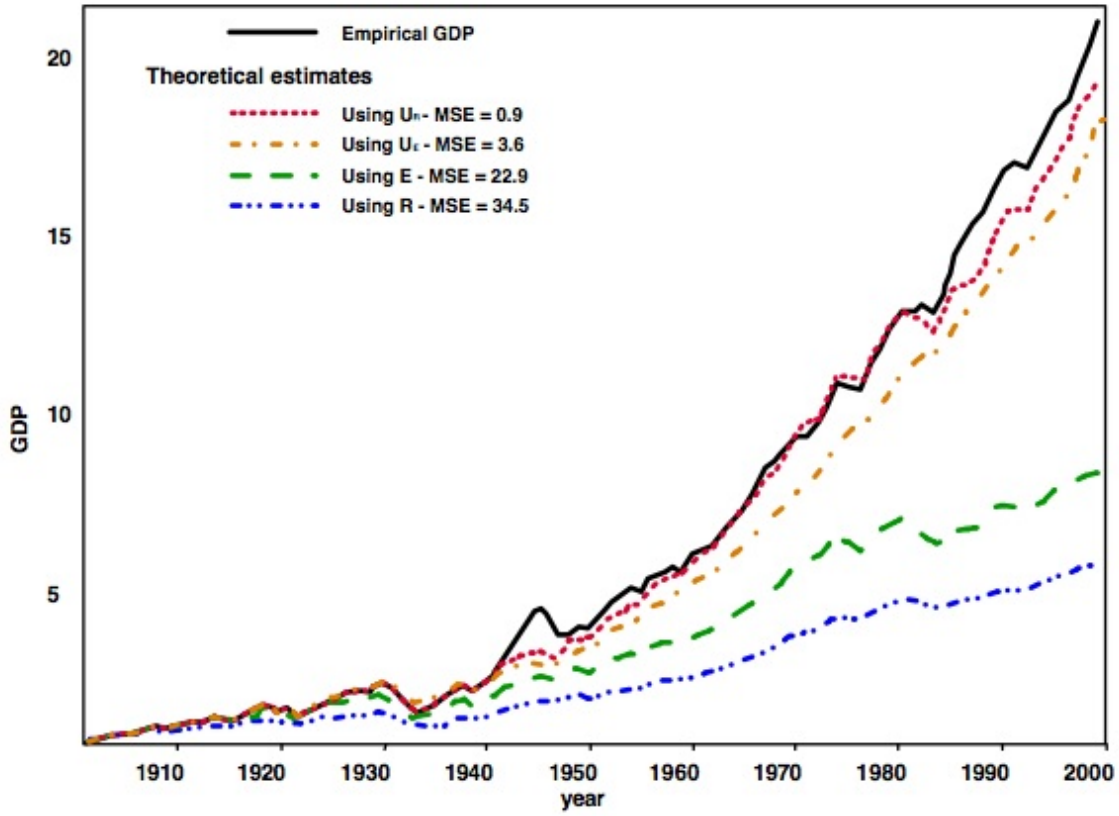

Figure 1: Results of model by Ayres and Warr. The selected model is the dotted red line, which includes biomass and animal labor, as well as other types of fuels (fossil and nuclear).

A closely related result from the Ayres and Warr paper is that declining real cost of energy, particularly electricity, and the rising use of the much cheaper electricity, fed economic growth in the 1900 to 1998 period.

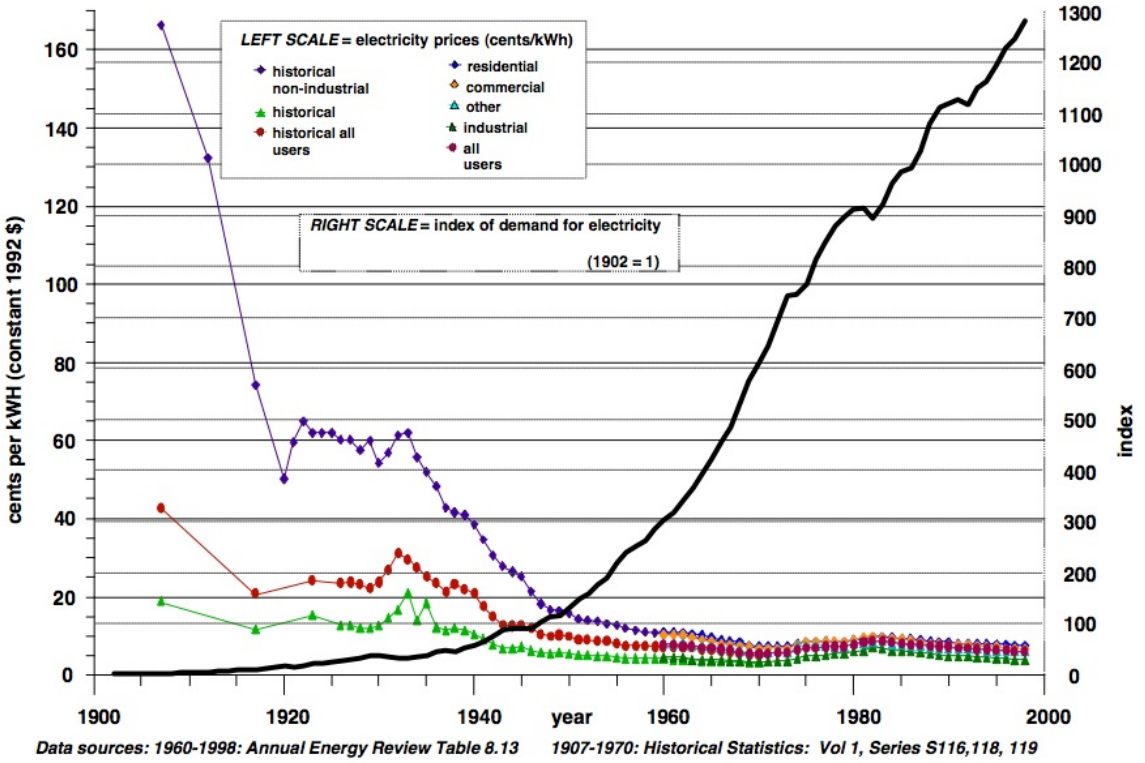

Figure 2: Electricity prices and electrical demand, USA 1900 - 1998

6. Has the real price of electricity and other energy products continued to drop in recent years?

Any of us, looking at our electric bills, our natural gas bills, and the cost of fuel for our cars know the answer to this one. Rather than talking about peak oil, perhaps we should be talking about passing the "trough in energy prices".

The Department of Labor shows this graph of changes in the Consumer Price Index for Energy.

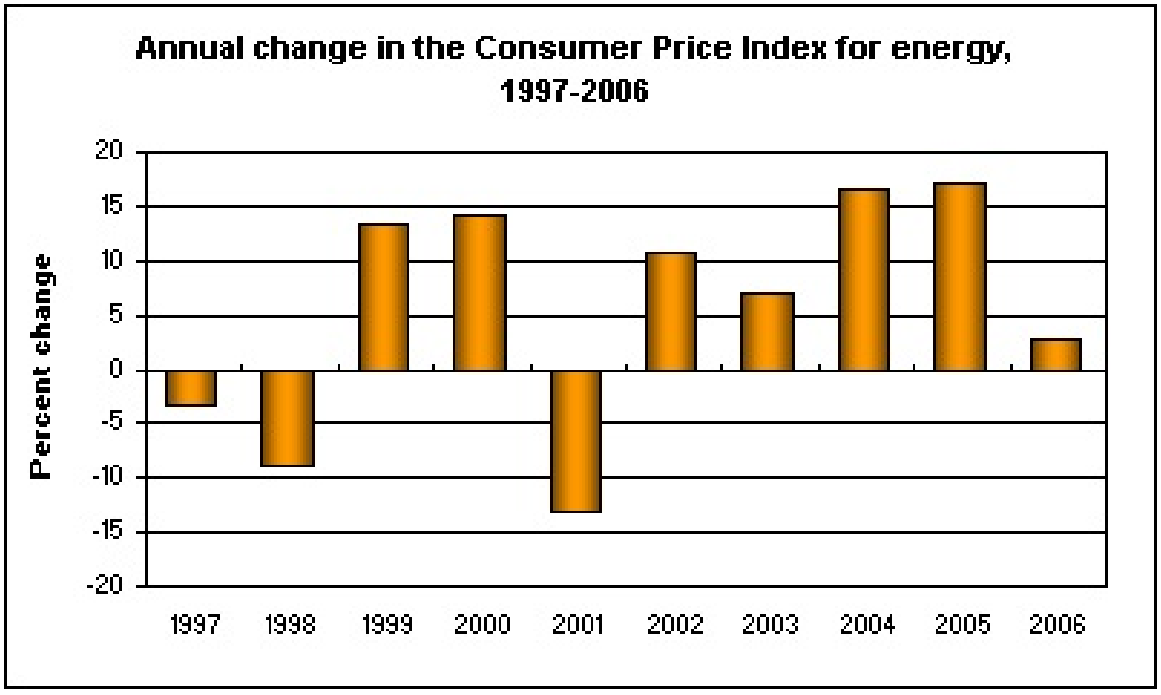

Figure 3: Changes in Consumer Price Index for Energy, from the US Department of Labor

The cost of electricity has also been rising since 1999.

Productivity is growing, but not nearly as rapidly as energy costs. The International Energy Association says that energy efficiency is growing at less than 1% per year in its 26 member countries. The US Energy Information Administration forecasts energy efficiency gains ranging from 2.2% to 2.4% per year between 2004 and 2030 in its various forecast scenarios.

One way of confirming the higher real cost of energy is to look at the trend in energy costs as a percentage of GDP. According to the U. S. Energy Information Agency, energy costs rose from 6.0% to 7.4% of US GDP between 1999 and 2004. We all know that since 2004, energy costs have likely risen further.

7. Were there any other factors besides the increased use of fossil fuels that caused a change in the economic system between early days and now?

Yes, there certainly have been many.

One that is important for our analysis is the fact that there was a real change in the way the markets and financing were viewed. Debt was viewed more positively. The stock market came to be viewed as a safe investment. The whole system came to be viewed as sufficiently stable that quantitative analysts could develop sophisticated models of the system and use these to price financial products.

We will look at how this change came about in Part 2. In Part 2, we will also look a little more at where the economy is now.