The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Hubbert Theory says Peak is Slow Squeeze.

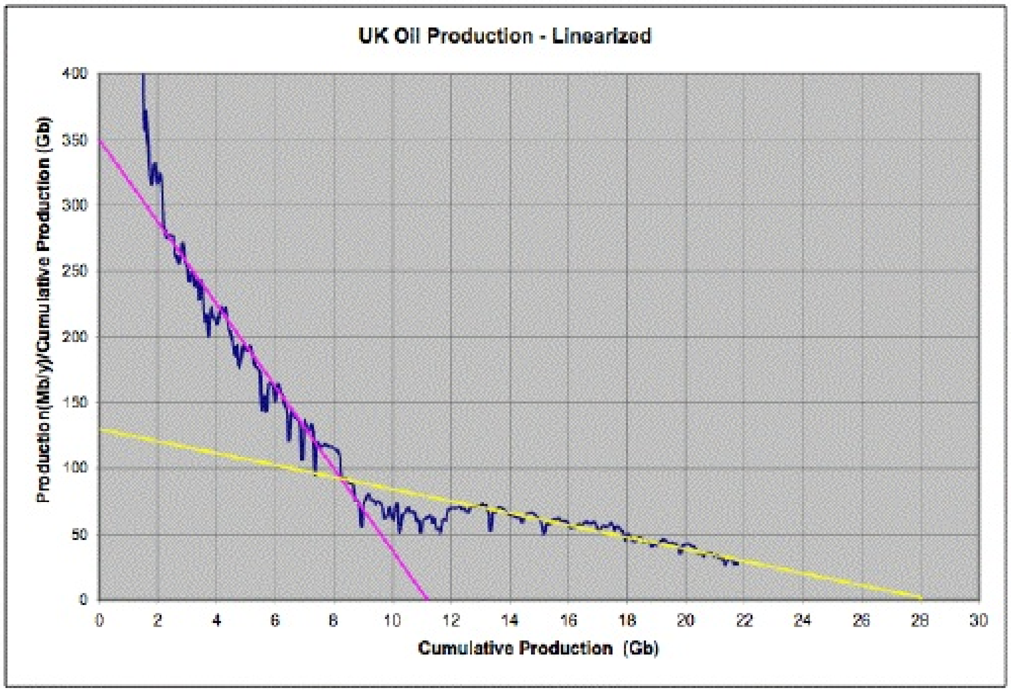
Posted by Stuart Staniford on December 5, 2005 - 8:35pm
Topic: Supply/Production
Tags: hubbert peak, oil prices, peak oil [list all tags]

I wanted to highlight and extend a very important point made by WesTexas the other day, which is that the Hubbert linearization method has a lot to say about future decline rates. And what it has to say is rather optimistic (at least by the admittedly low standards of the Peak Oil community). If you believe the Hubbert theory, average net decline rates in global production will be quite low for several decades.

Hubbert-style prediction of future global oil production decline rates, together with recent year-on-year change in BP production data (inc NGLs), and a linear fit to the BP data.

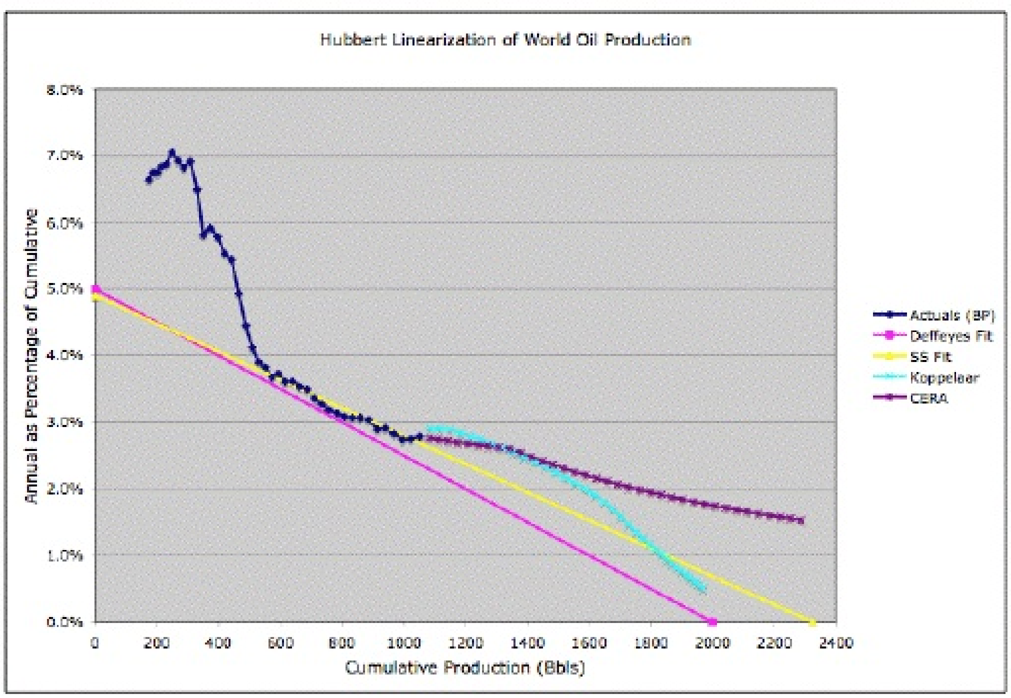
The reason a lot of us have been worried about high decline rates is the recent history in the North Sea, especially the UK. UK oil production has been undergoing dramatic 8%, 10%, and now even 15% year-on-year decline rates. The case is sometimes made that this is due to application of new technologies which suck oil out fast and then decline very rapidly. Since those technologies are being applied everywhere these days, maybe global production will behave like the UK, which would be extremely hard for the world economy to handle.

The important point WesTexas makes is that these high UK decline rates were predictable from the Hubbert theory. Recall that the UK has this strange dual peak structure in it's production history. But if you believe it has now settled down into a linear regime, the intercept with the yaxis of that regime is about 13% (correcting for the unit choice in this graph: 130/1000 is 13%):



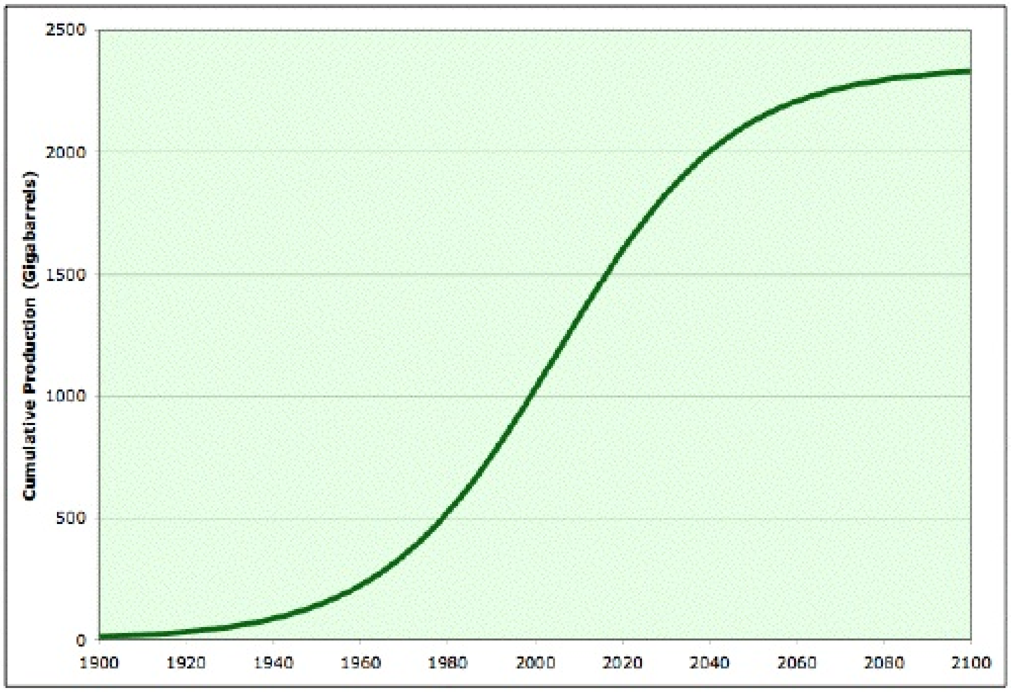
Hubbert linearization of UK oil production due to Nick Rouse, with yellow line added by me.

Let's develop some intuition for the meaning of that intercept in the P/Q linearization graph. It turns out it's the *K* parameter, in the URR*exp(Kt)/(1+exp(Kt)) equation of the logistic. That's the thing which mainly controls the width of the peak. For example, suppose we build a logistic curve with a URR (Ultimately Recoverable Resource) of 2350gb and a *K* of 5% (based on this picture from a few months back),



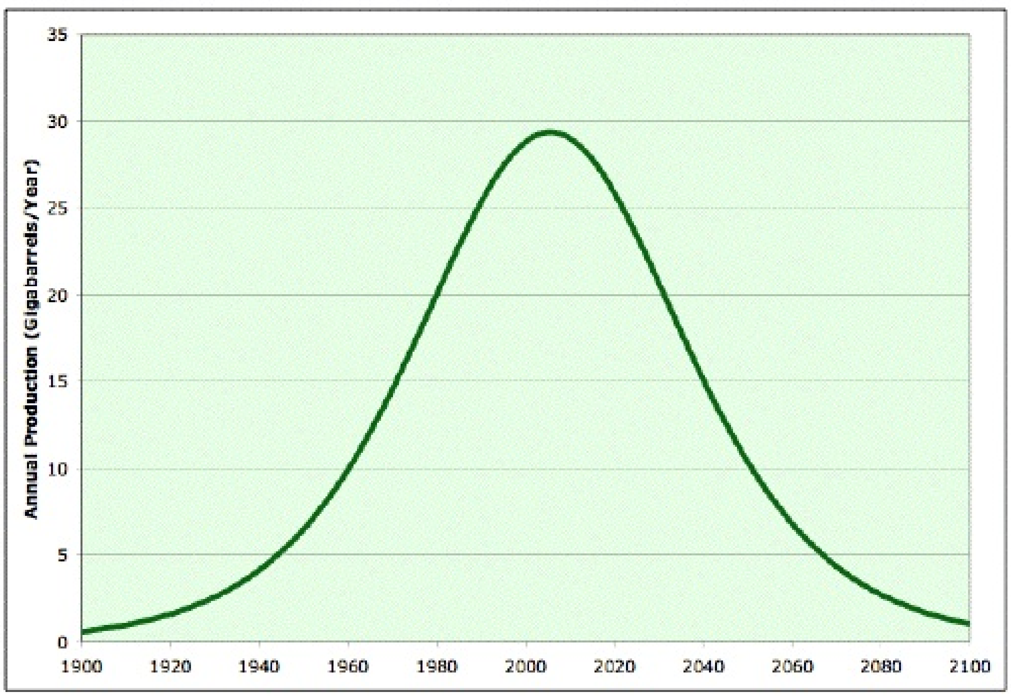
Hubbert linearization of BP production data (inc NGLs), Deffeyes fit, my fit, and CERA and Rembrandt Koppelaar projections.

Note the world value for *K* at around 5% is much lower than the UK's 13%. If we build the logistic, we get cumulative production as follows (I've set the peak in 2005, reflecting my growing, though not certain, suspicion that the peak is near).



Cumulative production logistic model with URR = 2350gb, K = 5%, and peak at 2005.

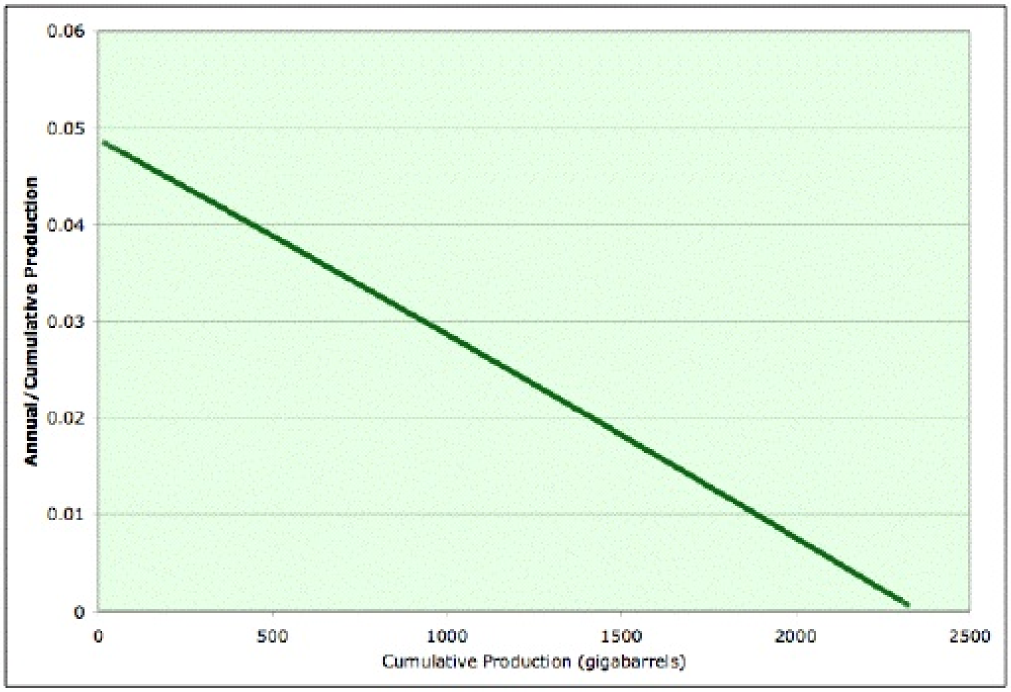
If we difference the cumulative production, we get the classic Hubbert Peak in annual production:



Hubbert model of global oil production with URR = 2350gb, K = 5%, and peak at 2005 .

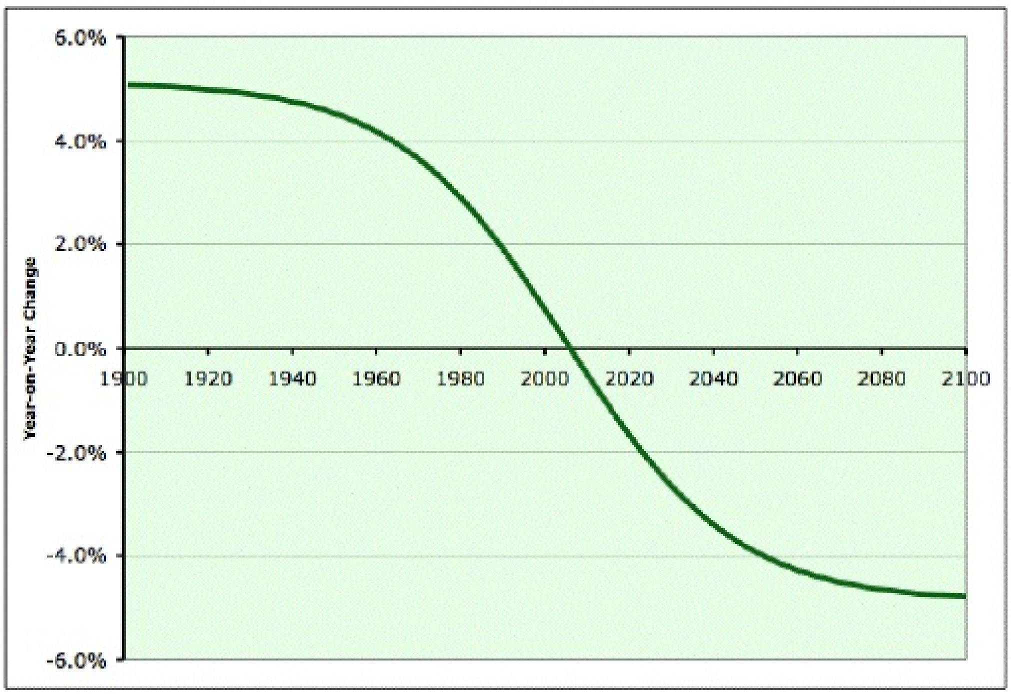
Note that the peak value is about right (30gb a year).

Now let's double check and make a linearization plot and just see that logistics really do give a linear P/Q versus Q plot, and that we get back the 5% and 2350gb we put into the scenario:



Hubbert-style linearization: annual/cumulative production versus cumulative production with URR = 2350gb, K = 5% .

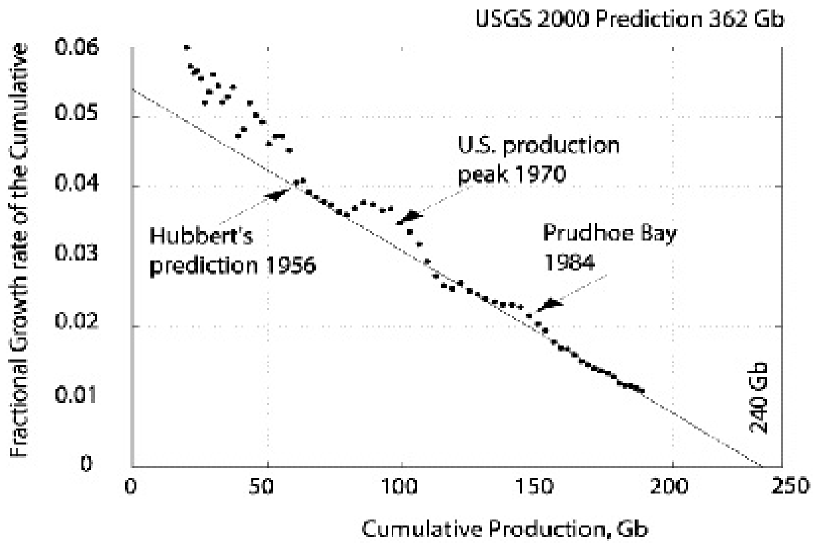
Yep, looks fine. Ok, now what happens with the decline rate? Well, here are the year-on-year percentage changes:



Year-on-year percentage changes in Hubbert model of global oil production with URR = 2350gb, K = 5%, and peak at 2005.

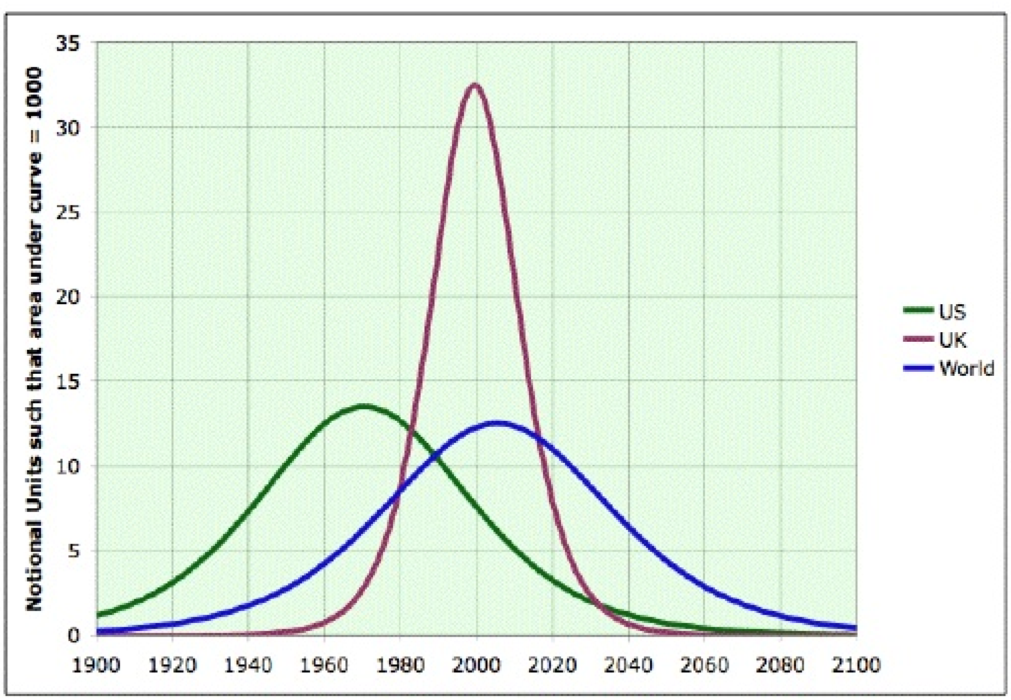
You see that what happens is, in the early years, production grows at the input rate of $K=5\%$. the growth rate takes a declining sigmoid form, and the line crosses the axis at the production peak in 2005. Then decline rates increase gradually till they reach the input K value again (5%). (There are some slight deviations from this story associated with using whole years rather than infinitessimal time intervals to make the graph).

To get a better feeling for the meaning of K, lets look at the US, with $K = 5.4\%$ (the intercept of this graph, remember:



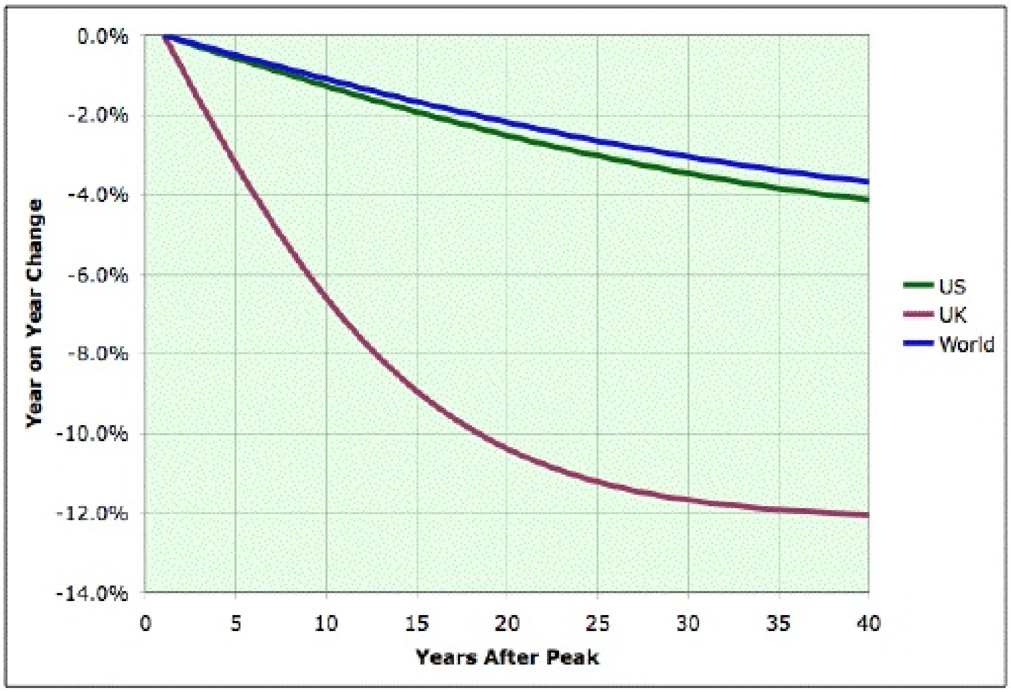
Credit [Seppo Korpela.]()

We'll take that, the UK number of 13%, and the world number of 5%. I made a plot of Hubbert peaks - the US centered on 1970, the UK centered on 1999, and the world centered on 2005. Note that I've rescaled them so they all have the same area under them (1000 notional units), so we can better compare the shapes.



Hubbert-peak model of US, UK, and world production. US has peak at 1970, and K=5.4%. UK has peak in 1999 and K = 13%. World has peak in 2005 and K = 5%. All three have been rescaled to have identical area of 1000 units under them.

Obviously, the good news is that the world would decline the slowest of all. In particular, if we plot the post-peak decline rate for the three regions as a function of years after peak, we get this:



Hubbert-style prediction of future decline rates as a function of years after peak, for the US with K=5.4%, the UK with K=13%, and the world with K=5%.

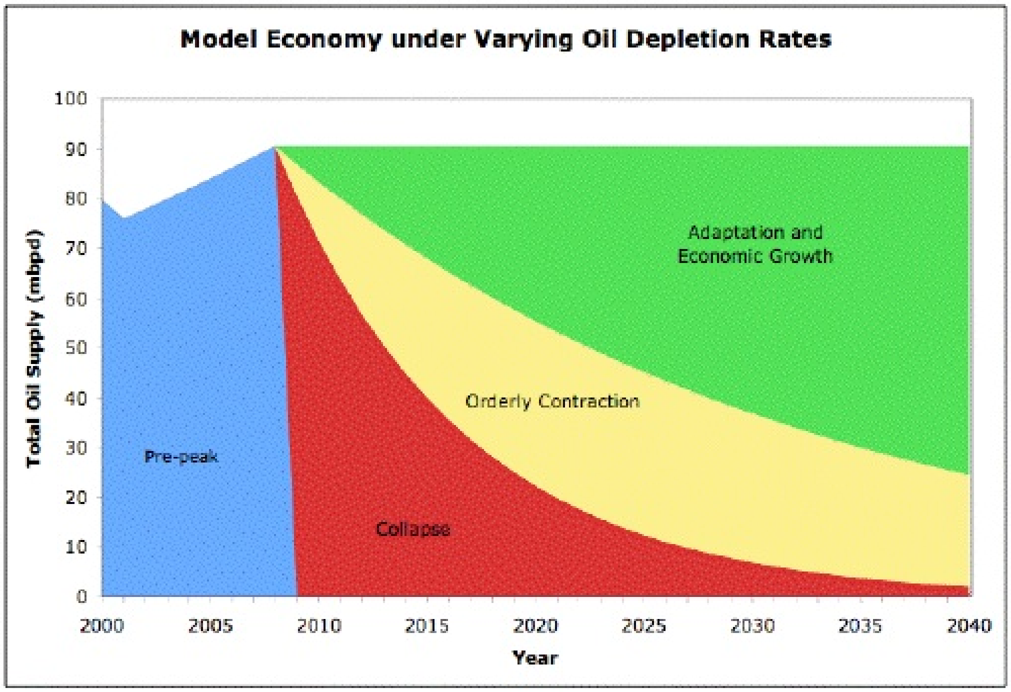
Clearly, the world only declines relatively slowly. To compare all this with some data, we can look at growth/decline rates in the BP annual data (which includes NGLs).

Hubbert-style prediction of future decline rates, together with recent year-on-year change in BP production data (inc NGLs), and a linear fit to the BP data. The last point in the data (2005) is provisional, and is constructed from the first eight months of the EIA monthly series for 2005 compared to the first eight months of 2004.

The dark green line is the same Hubbert model (2350gb URR, K=5%, and peak = 2005). The plum colored line is the BP data. Clearly, the data are very noisy - as the world economy goes through it's various gyrations, production goes above and below what the model would predict. However, the model trend is about right. To see this, I added the blue line which is a simple straight line regression to the data. The difference between the Hubbert theory and the straight line are likely comparable to the errors in the data.

I should say this somewhat matches my subjective sense as I continue to slowly plough through press releases of all the world's oil projects. I do have the sense that in a number of places, we are not seeing the kind of all-out aggressive exploitation of the resource that happened in the North Sea. Whether it's the tiny rig count in Saudi Arabia, or the disappearing independent oil sector in Russia, there are significant economic and political restrictions on near-term production. That's a bad thing from the perspective of the short-term price picture, but it does mean that there's some oil that will still be around to get used another day.

The good news is that we've got several decades of declines that are quite modest (no doubt interrupted by various nasty shocks and alternately periods when things go somewhat better). That makes adaptations much more feasible - be they more efficient vehicles, tar sands, coal-to-liquids, or windmills. You may recall my claim that the decline rate is the main thing that controls whether the economy can adapt or not:



Simple model of economic response to varying decline rates. If decline rate is low, adaptations and continued economic growth are possible. If decline rates are higher, sustained but orderly economic contractions occur. If decline rates were extremely high, adaptation would be infeasible, and society would collapse.

What this suggests is that for the next few decades we will mostly be in the green zone (shocks aside). The US economy can probably get 3-4% less oil intensive each year by slowly replacing the vehicle stock with more efficient vehicles. As Econbrowser has been noting, this has begun. I don't doubt growth will be affected - there is very unlikely to be enough oil for the developing countries to grow their economies as they would like. The fact that BRIC countries will continue to grow faster than the US and Europe will place more pressure on the western economy's oil usage than a global analysis might suggest. However, this theory does imply that some economic growth will be possible for quite a long time.

Whether that's a good thing for the long-term future of humanity is a different question.