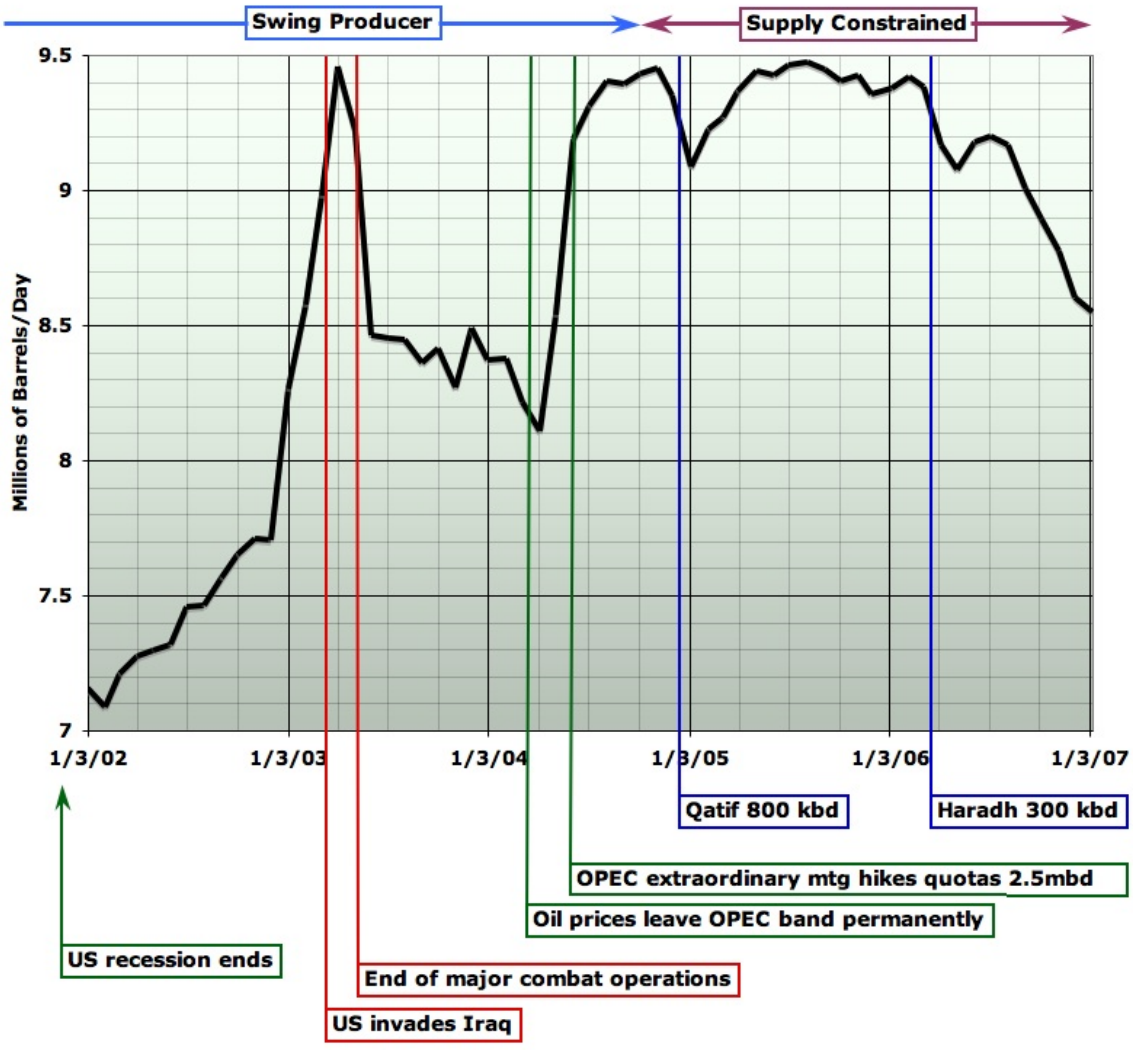
The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

A Nosedive Toward the Desert

Posted by Stuart Staniford on March 8, 2007 - 10:15am
Topic: Alternative energy
Tags: peak oil, saudi arabia [list all tags]

...Or, Why the Decline in Saudi Oil Production is Not Voluntary



Saudi Arabian oil production, Jan 2002-Jan 2007, average of four different sources. Annotations show

important events causally influencing production, including all documented megaprojects for new supply in the the time period. Graph is not zero-scaled to better show changes. Click to enlarge. Source: US EIA International Petroleum Monthly Table 1.1, IEA Oil Market Report Table 3, Joint Oil Data Initiative, OPEC Monthly Oil Market Report, Table 17 (or similar) on OPEC Supply.

[Update 3/13/07]. I changed the title of this post from "A Nosedive Into the Desert" to "A Nosedive Toward the Desert" to better reflect the conclusion of the post.

Summary

In this post, I extend my analysis of Saudi Arabian production backwards four years earlier than my post of last week. I explain in detail how the evidence strongly suggests that since late 2004, the Kingdom of Saudi Arabia (KSA) has entered rapid decline of their oil production, at least for the time being.

The headline graph summarizes my conclusions, which are as follows.

- Saudi production can be divided into two eras. In the first, prior to the third quarter of 2004, KSA had spare capacity and acted as the swing producer, making large voluntary changes in their production to stabilize the market. During this era, all major features of the production graph can be well understood based on demand side needs.
- Since late 2004, KSA have entered a new era where they cannot raise production in response to demand side needs, and instead the major features of the production curve correspond to supply side events.
- During 2002, KSA was increasing production to accomodate increasing demand as the world recovered from the recession of 2001.
- In 2003, there was a major spike in oil production immediately preceding and during the US invasion of Iraq: this was a voluntary action to stabilize oil prices in the face of the loss of Iraqi production. As combat wound down, and Iraqi oil production resumed, Saudi production declined back to levels slightly higher than before the war.
- Oil prices increased due to increasing US, Chinese, etc demand in the strong economy of 2003 and early 2004. Once it became clear that oil prices had risen pronouncedly above OPECs desired $22-$28 price band, KSA initiated a large voluntary increase in production in the spring of 2004 in an attempt to bring prices back into the band. They were not able to raise production by more than 1 million barrels per day (mbpd), however, and this was not sufficient to stabilize prices, which have never returned to the price band. The band was abandoned a year later.
- After continuing to increase production very slightly for several more months, Saudi production began to decline in late 2004. This was only arrested by the arrival of the first KSA oil "megaproject", the 800 thousand barrel/day (kbpd) output from the combined Qatif/Abu Sa'fah fields (690kbpd of new crude and condensate production). This 690kbpd arrested declines during early 2005, but never sufficed to raise production above the peak achieved in 2004. There was no sign of Saudi increases in production in response to the high prices of 2005 and since, nor to the loss of production from the Gulf of Mexico hurricanes in 2005.
- Production began to decline again in 2005, and at greater rates through 2006. This was only arrested briefly by the arrival of oil from the 300kbpd Haradh III development in late spring of 2006.
- If these trends were to continue, Saudi oil production would halve over the next five years. However, it seems more likely that KSA will find ways to bring smaller fields on line and start to mitigate the decline within this time period.

Let me justify each of these points in detail.

The Production Data

Saudi Aramco has not historically published detailed data on its oil production, and so data is inferred by third parties from a variety of indirect methods (eg counting tankers - but see below on JODI data). Here, I consider four data series that are published by various agencies, and none of which agree perfectly. The series are:

EIA International Petroleum Monthly Table 1.1

The US Energy Information Agency, in their monthly publication International Petroleum Monthly give a variety of data tables conveniently available in spreadsheet form. Table 1.1a provides monthly oil production estimates for OPEC countries, including Saudi Arabia. The EIA generally produces estimates about two months after the end of the month in question and revises them relatively little later. The data series includes crude oil, together with lease condensate, but not natural gas plant liquids (NGPLs). About half of neutral zone production is included. The EIA lists its sources as "Dow Jones, Middle East Economic Survey, Petroleum Intelligence Weekly, Monthly Oil Data Service from the International Energy Agency (IEA), Monthly Oil Market Report from OPEC, Oil & Gas Journal, Platts, and Reuters." It's unclear what algorithm the EIA uses to compute their final estimate from these sources.

IEA Oil Market Report Table 3

The OECD International Energy Agency produces a monthly Oil Market Report, available for free only as individual PDF files. Table 3 (Table 4 in older reports) contains a summary of oil production for a variety of countries, including Saudi Arabia. The IEA generally produces a preliminary estimate quite quickly after the end of a month, but then revises it multiple times in subsequent versions of the OMR, sometimes quites significantly. For Saudi Arabia, the production estimate *excludes* condensates and other NGLs. The exclusion of condensates probably makes the IEA's numbers systematically lower than the EIA's. The IEA does not document its sources or methods for its estimates of Saudi production, to my knowledge.

JODI

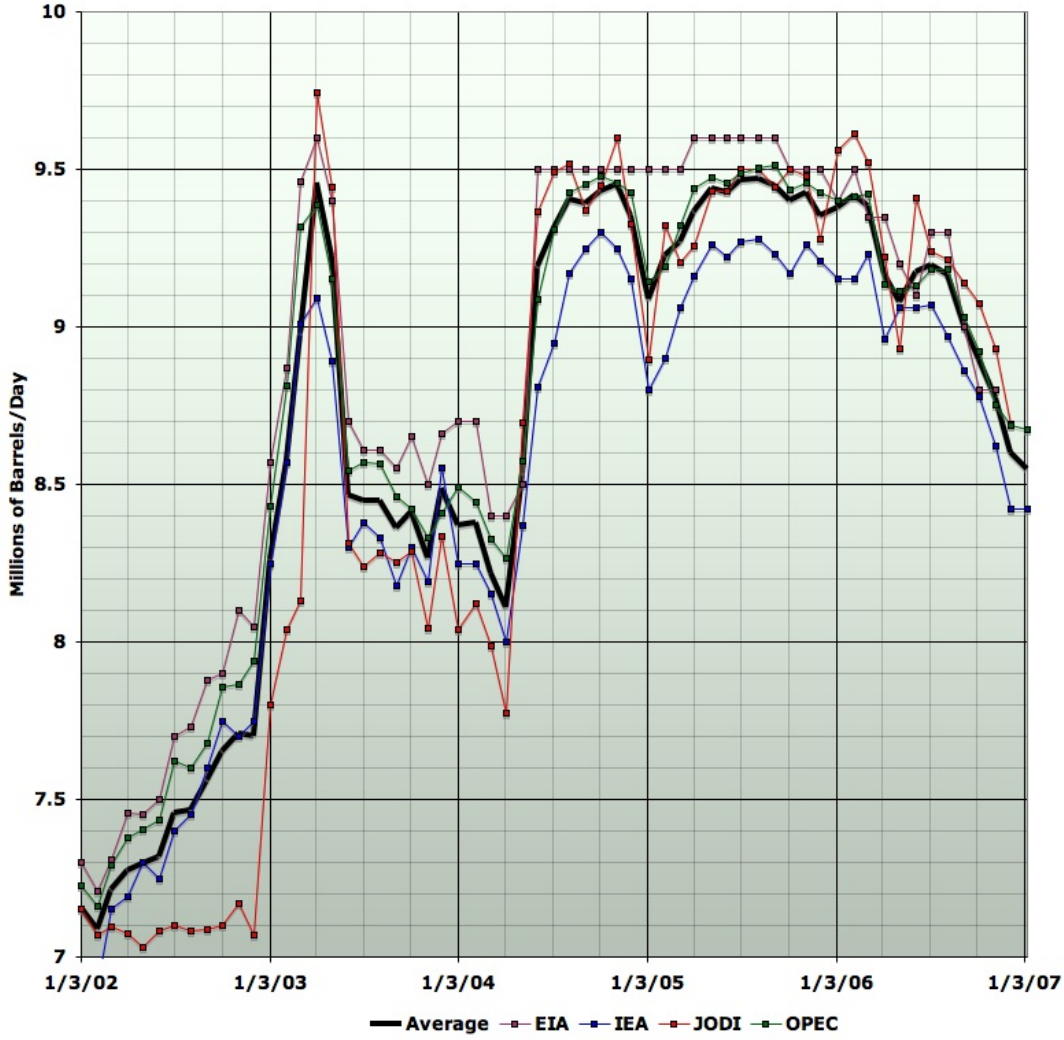
The Joint Oil Data Initiative is a global collaborative attempt to reconcile data from various agencies and improve transparency in the oil markets. They tabulate monthly oil production data, for many countries, including Saudi Arabia. Generally the data are a couple of months behind and do not get revised, but what is particularly interesting about JODI data is that it is based on self-reports by the countries. Thus since January 2002, when the JODI series begins, the Saudis have been making an assertion about their own production via the JODI process. This is of interest since the Saudis are in much the best position to know what their own oil production is. On the other hand, there is considerable reason to question the integrity of Saudi reports on their oil industry (discussed later), and they have incentives to distort their production data at times. JODI definitions of oil production includes condensates, but excludes other NGLs. In theory, the JODI data should thus be comparable to the EIA data. JODI data is available in convenient CSV or spreadsheet form.

OPEC Monthly Oil Market Report

The Organization of Oil Exporting Countries publishes a Monthly Oil Market Report (as individual PDFs) which includes data on OPEC member country production. This is in a table in the section on "World Oil Supply", but the table number varies from issue to issue. The sources of the data are listed only as "based on secondary sources", and OPEC does not document whether or not condensates are included, but apparently separately accounts for NGLs. OPEC data are generally produced within a couple of weeks of the end of the month,

but then are significantly revised.

The four production estimates are reproduced in this graph, together with their average:



Saudi Arabian oil production, Jan 2002-Jan 2007, from four different sources, together with the average of the sources. Graph is not zero-scaled to better show changes. Click to enlarge. Source: US EIA International Petroleum Monthly Table 1.1, IEA Oil Market Report Table 3, Joint Oil Data Initiative, OPEC Monthly Oil Market Report, Table 17 (or similar) on OPEC Supply.

Clearly the data situation is scientifically quite unsatisfactory. We have four data series which are undocumented, of uncertain veracity, do not agree, and yet the differences cannot rightly be interpreted as statistically independent noise. They do not measure quite the same thing, but lack the auxiliary information to make them commensurable.

Nonetheless, for lack of any other way to make progress, in this essay I take it that trends that appear in all or most of the data series are veridicial. Having no a-priori reason to favor one series over another, I generally take the average of the four as the best overall estimate. I also assume that the spread of the series is some kind of estimate of the uncertainty in the values.

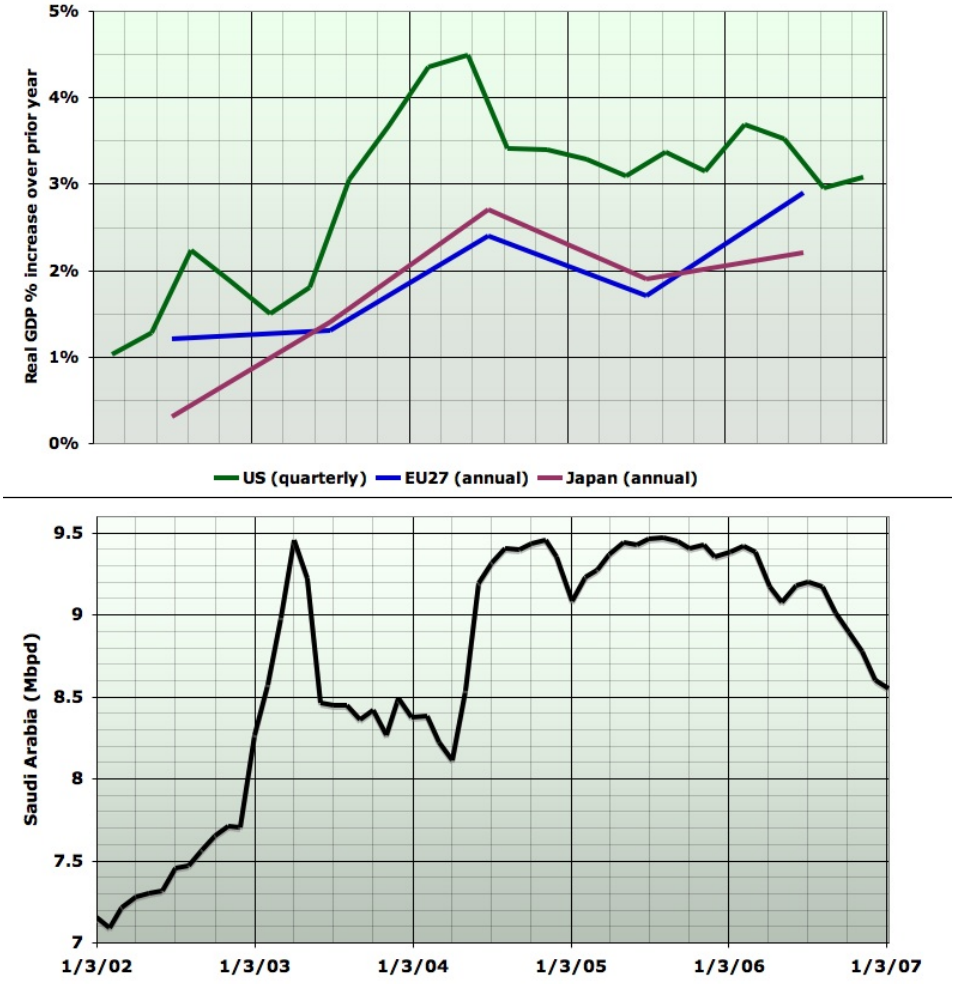
I now turn to justifying the narrative explanation of the data given in the summary.

Economic Growth

When economies grow well, people build more houses, take more vacations, and buy more goods and services. Businesses hire more workers, send staff on more business trips, and open new offices and factories. All these things increase the demand for oil to power cars, trucks, planes, heating systems, etc. Thus the usage of oil is highly sensitive to economic growth - indeed economic growth has a far stronger effect on oil demand than the price of oil (an economist would say that the income elasticity of oil demand is much larger than the price elasticity).

As the swing producer, historically Saudi Arabian oil production has varied widely based on oil demand - they reduce production the most when demand drops, and they were best placed to make very large increases in production when there was a sudden need in the market for more oil.

The next graph shows the history of real GDP growth in three key developed economies: the US (quarterly), the European Union (yearly), and Japan (also yearly), together with the Saudi production estimate for comparison.



Top: Percentage growth of real GDP over same period prior year for United States (quarterly) and the European Union and Japan (annual). Data are plotted as of the middle of the period. Bottom, monthly Saudi Arabian oil production, Jan 2002-Jan 2007, average of four different sources. Graph is not zero-scaled to better show changes. Click to enlarge. Source: see above for KSA oil production sources. US GDP growth from the Bureau of Economic Affairs. European and Japanese GDP growth from the European Commission.

In 2001, there was a recession in the US, and probably in the global economy, as a result of the bursting of the Internet stock bubble. The US recession officially ended in November 2001. So in

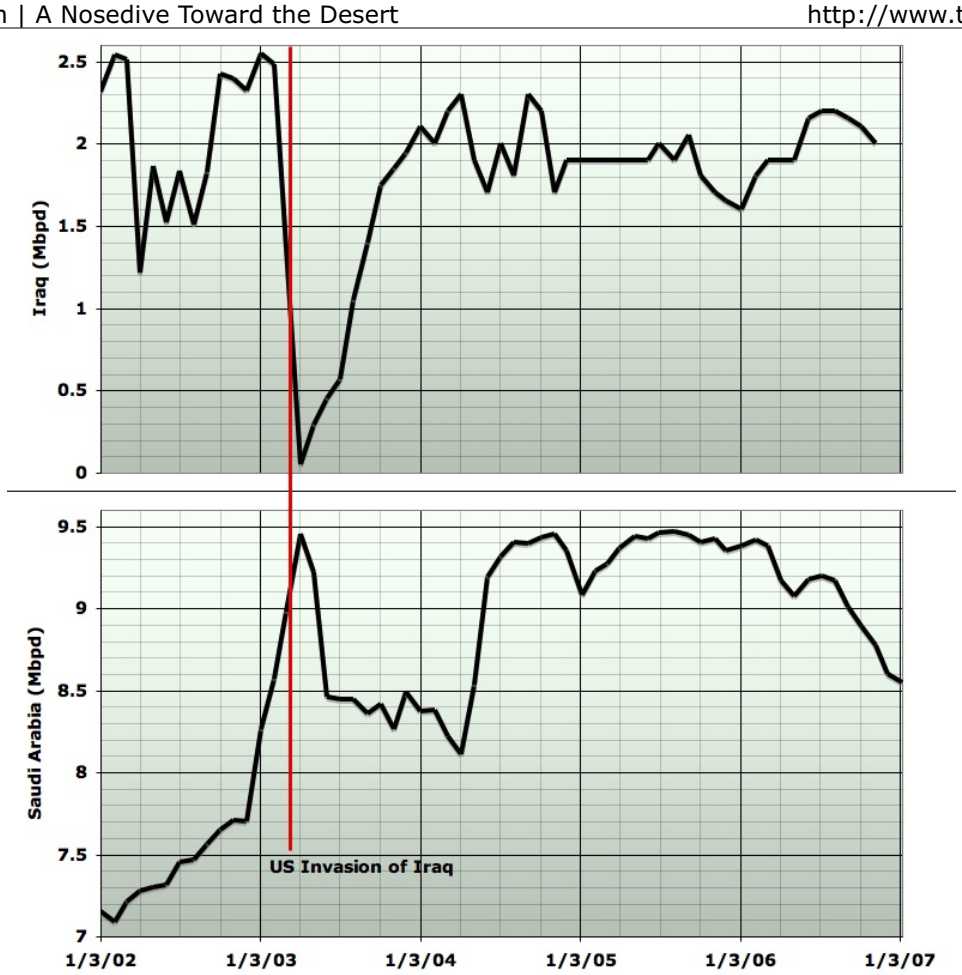
2002, economic growth resumed and gradually increased from a low base. Economic growth continued to increase until it reached a peak in mid 2004, after which it moderated, but remained overall healthy.

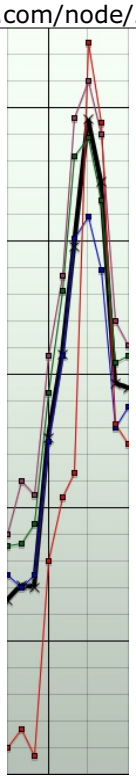
A-priori, in the face of steady economic growth like this, we would have expected world oil usage to increase several percent a year throughout the period of interest, and we might have expected Saudi production in particular to increase. The production increase in 2002 may well have this character, as may the increase from 2002 to 2004 and then to 2004 (though other factors enter the picture here as discussed in a moment). However it is striking that increases in production essentially ceased after a last step up in mid 2004, despite continued economic growth. This is surprising in the historical context. It is possible that the failure to increase oil supply (and resulting high prices) are the cause of economic growth being lower after mid 2004 - at any rate the two events coincide in onset. It is also likely, as discussed below, that the very strong economic growth of late 2003 and early 2004 led to the price increases which triggered the step-like Saudi production increase of mid 2004.

At any rate, it is important to note that there were no recessions during the study interval and no sizeable periods of low growth after 2002. Thus production declines in Saudi Arabia in the period of study cannot be due to weakness in global economic growth.

The Iraq War

The next graph is concerned with the large spike in KSA oil production in early 2003. It's fairly clear that this is due to the Saudi's increasing production to compensate the market for the loss of Iraqi production due to the US invasion, and to some extent the Venezuelan oil strike. Iraqi production is shown above Saudi production, and the spikes match up well.



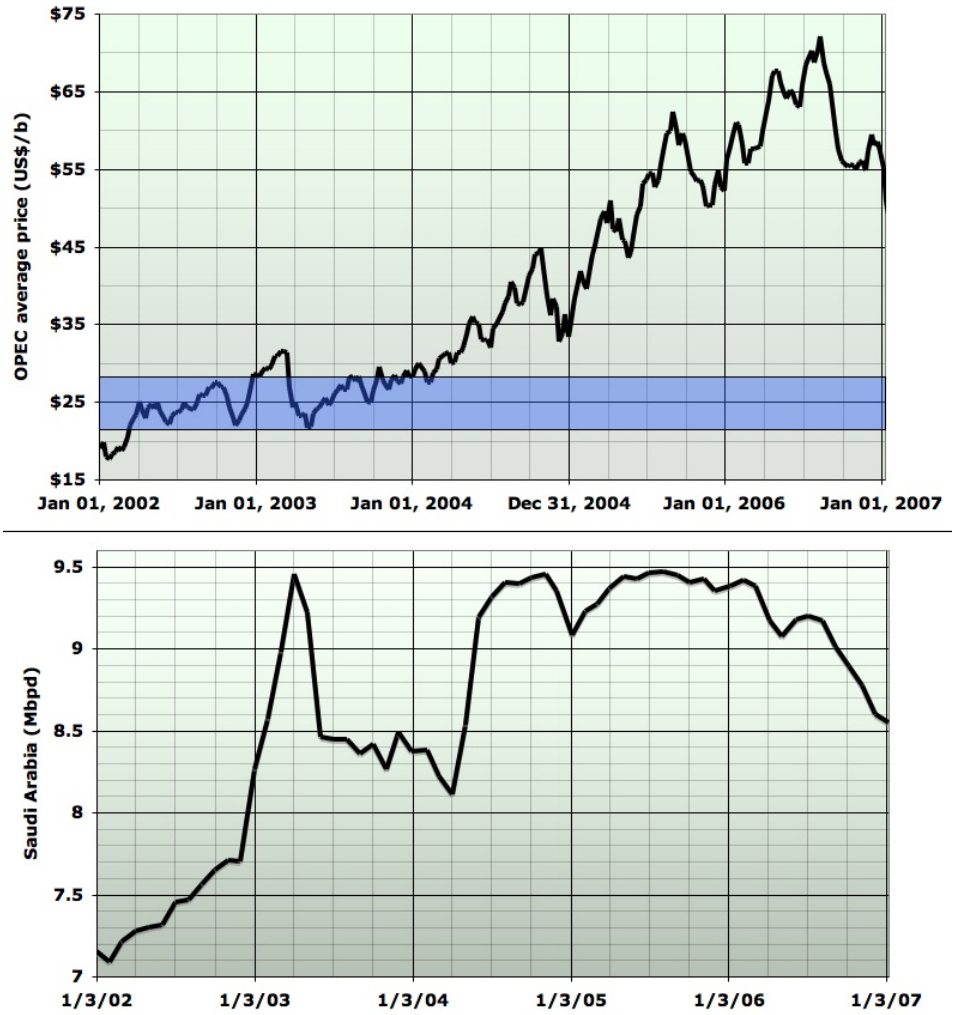


Top: Iraqi oil production Jan 2002-Nov 2006. Bottom: Saudi Arabian oil production, Jan 2002-Jan 2007, from four different sources. Saudi graph is not zero-scaled to better show changes; both graphs have the same vertical scale. Click to enlarge. Right fragment shows detail of all data sources for the early 2003 Saudi spike. Source: See above for Saudi production. Iraqi production is from US EIA International Petroleum Monthly Table 1.1.

All sources agree this spike began in January 2003 (the Venezuelan oil strike began in December 2002), peaked in April (the US invaded in March), and declined by June to a new, but higher level from which it sloped down through the remainder of 2003 (see the graph fragment to the right). Once the war was over and Iraqi production began to recover, the Saudis ramped down again - initially quickly, and then more gradually (OPEC was reducing quotas at the time). There does not seem too much to say about this interval. Clearly the Saudis were acting as swing producer and demonstrated an ability to raise production by 2mbpd in a fairly short interval to a total of somewhere around 9.5mbpd.

Breaking the OPEC Price Band

Now we come to what I think are the critical events in the story. With the very strong economic growth in late 2003 and early 2004, oil prices started to rise. The next graph shows oil price in the top panel - with OPEC's intended price band of $22-$28 shown in blue - and the Saudi production curve in the bottom panel. My price is the export weighted OPEC average from the EIA, not the official OPEC basket, but I don't think the difference matters too much.



Top: Export weighted average OPEC oil price. Blue box is OPEC agreed price band of $22-$28. Bottom: Saudi Arabian oil production, Jan 2002-Jan 2007, from four different sources. Graphs are not zero-scaled to better show changes. Click to enlarge. Sources: See above for production data. Price data are from the EIA.

We are going to focus now on explaining the large (roughly 1mbpd) rise in production in the May/June 2004 timeframe.

Reading through OPEC publications from the early 2004 timeframe is quite enlightening. In February 2004, the OPEC Oil Market Report gave the recent history of price, which was above the price band:

> The OPEC Reference Basket started 2004 on a firm footing, with an average of $30.33/b in January. The Basket gained 89¢/b over the previous month but dropped 1¢/b lower compared to the same month for 2003. On a weekly count, the Basket put in a strong performance early in the month gaining 55¢/b or 1.9% during the first week, followed by another rise of 67¢/b or 2.2% in the second. Then the Basket made a downturn losing 8¢/b to average $30.67/b in the third week, followed by a hefty loss of 85¢/b at the end of January for an average of $29.82/b. The fall extended to the first half of February when the Basket shed a substantial 3.9% of its value, averaging $28.67/b in the second week of the month, yet remained comfortably above the upper limit of the OPEC price band.

However, although technically above their policy, this is not a high enough price to alarm OPEC, and concerns are mainly about the risk of making stocks too large and causing prices to collapse:

> Therefore, despite the uncertainties inherent in any forecast of the supply/demand balance, the range of opinion among regularly published oil market reports points to the inevitability of a higher-than-normal build in stocks in the 2Q of this year to minimum 2.7 mb/d with a mean of 3.6 mb/d, close to OPEC's February figure of 3.4 mb/d. Moreover, no reasonable further upward revision in demand or a drop in non-OPEC supply is likely to change the consensus on the balance for 2Q 2004. If this surplus is not handled in a timely and effective manner, there is likely to be excessive downward pressure on prices. Such a development cannot be left unattended, as it would lead to a protracted spell of volatility in the market, something that is in no one's interest.

and, responding to these concerns, OPEC quotas were lowered and Saudi production in March and April fell slightly. However, this proved to be the wrong direction to move in: by May, prices had continued to rise, and we read,

> The $32.35/b April's OPEC Reference Basket price is second only to the all-time high monthly average of $34.32/b registered in October 1990. The constant strength of the Basket since the beginning of 2004, combined with the pronounced drop seen in March and April of last year, considerably widened the 2004 year's year-to-date average with respect to 2003. The Basket averaged $31.13/b to 30 April of this year versus $29.02/b during the same period in 2003. Early in May, following a surge in crude prices, the Basket added another 5% or $1.66/b to average $34.91/b in the week ended 6 May and rose by another $1.25/b to $36.16/b in the following week. As of 17 May, the Basket's daily average had risen to $37.72/b, or about $1.20 below the all-time high, driven primarily by geopolitics, security concerns, the gasoline situation in the USA, high demand for petroleum products and rampant speculation.

and OPEC is now worried - sneaking a few bucks above the price band was apparently viewed as a harmless good time for the membership, but $35 oil is worrying them. They are going to do something about the situation:

> OPEC crude oil production in April, based on secondary sources, is estimated at 28.05 mb/d, 0.26 mb/d lower than the revised March figure. However, May nominations and tanker movements indicate much higher volumes, and OPEC Member Countries are considering further production increases as part of their commitment to respond to market realities.

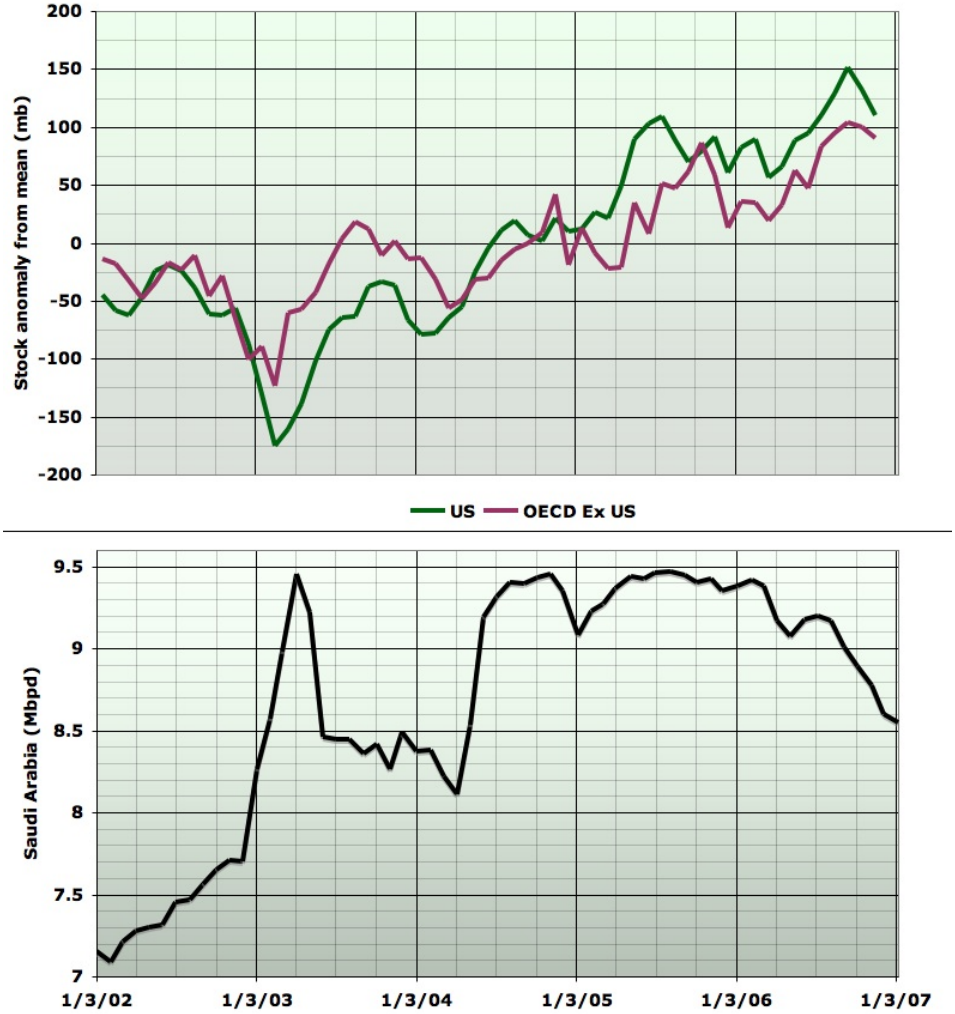
This is the lead in to the large Saudi increase - it goes up 1mbpd by June. By June 3rd, OPEC is having an extraordinary meeting to officially sanction what is being done, and consider what more to do. The meeting summary reports:

> Having reviewed market developments since its 130th Meeting, held on March 31, 2004, as well as the supply/demand outlook, the Conference noted with concern that, as a result of several factors, prices have continued to escalate, despite the efforts by OPEC Member Countries to meet market requirements. These factors are mainly the robust growth in demand in the USA and China, which had not been fully anticipated;

> geopolitical tensions; and refining and distribution industry bottlenecks in some major consuming regions, coupled with more stringent product specifications. Combined, these factors have led to unwarranted fear of a possible future supply shortage of crude oil, which has, in turn, resulted in increased speculation in the futures markets with substantial upward pressure on crude oil prices.
>
> Given current high and volatile prices and prevailing concerns regarding supply security, and in order to ensure continued, robust, global economic growth, especially in the economies of fellow Developing Countries, the Conference decided to increase the OPEC production ceiling (excluding Iraq) to 25.5 mb/d, with effect from July 1, 2004, and to 26 mb/d, with effect from August 1, 2004, in order to ensure adequate supply and give a clear signal of OPEC's commitment to market stability and to maintaining prices at acceptable levels to both producers and consumers. The Conference also decided to convene an Extraordinary Meeting in Vienna, Austria, on July 21, 2004 to review market developments.

Ok. So as of June 2004, OPEC and Saudi Arabia are doing all the right swing-producer things - flooding the market with extra oil to damp down prices and bring them back within reasonable range of the price band. However, as the price fragment to the right shows, it didn't work. Prices dropped a bit in May and June, and then shot up again. What went wrong?

I think the basic dynamic here is that futures market traders were essentially saying to Saudi Arabia: "show us what you got". This is six months after Matt Simmons gave his first presentation on his concerns about the future robustness of Saudi production, China and the US were both growing very fast, and prices were being bid up challenging the Saudis to show they could put enough oil on the market to rein prices in. Let's look at what happened. Here is oil stocks in the US, and the rest of the OECD, expressed as an anomaly relative to the average over the period.



Top: End of month oil stocks for US and OECD ex-US, Jan 2002-Jan 2007. Expressed as the anomaly in millions of barrels from the average over the period (1.64 billion barrels for the US, and 2.37 billion barrels for the rest of the OECD). Bottom, Saudi Arabian oil production, Jan 2002-Jan 2007, average of four different sources. Graphs are not zero-scaled to better show changes. Click to enlarge. Source: see above for KSA oil production sources. Oil stock numbers from EIA International Petroleum Monthly Table 1.5.

As you can see, in spring 2004, stocks increase a little, but then, critically, they stop increasing in the third quarter of 2004. This coincides with the Saudis stopping increasing production. The Saudis cannot pump any more, and it's not enough to drive stocks up further. The point is even clearer in this EIA picture Euan found:

As you can see, all through 2004, stocks were at a low, and the Saudis production hike was not enough to change that. Thus, the oil market bulls celebrate, bears retreat, and by August 2004, the OPEC OMR has this to say:

> No matter in which time-frame is considered — monthly, weekly, daily — the OPEC Reference Basket in July and early August broke records all across the board. On a monthly basis, the rise of $1.68/b in July brought the monthly average to an unprecedented level of $36.29/b. Besides the previous monthly high of $36.27/b reached in May this year, the Basket has never been above $34/b since October 1990. On a weekly basis, the $37.40/b average for the week ending 29 July constitutes an all-time weekly high, while the daily average of $40.08/b on 11 August now holds the

> Basket's daily record.

but the bulletin was, unusually, silent on what anyone should do. There was nothing to be done. OPEC had lost control of the price of oil.

They would effectively acknowledge this in Janauary 2005 when they suspended the price band. I think it's important to stress that OPEC had every reason in late 2004 to think that these prices would hurt the world economy. Their literature at the time says they thought so, and as recently as 2000, $35 oil had caused massive civil unrest and an economic crisis in Europe. This seems endearing looking back from the era of $60+ oil, but there's little doubt that people at the time believed oil prices above $35 were going to cause serious problems, and that's why Saudi Arabia made a real effort to contain them.

Entering the Supply Constraint Era

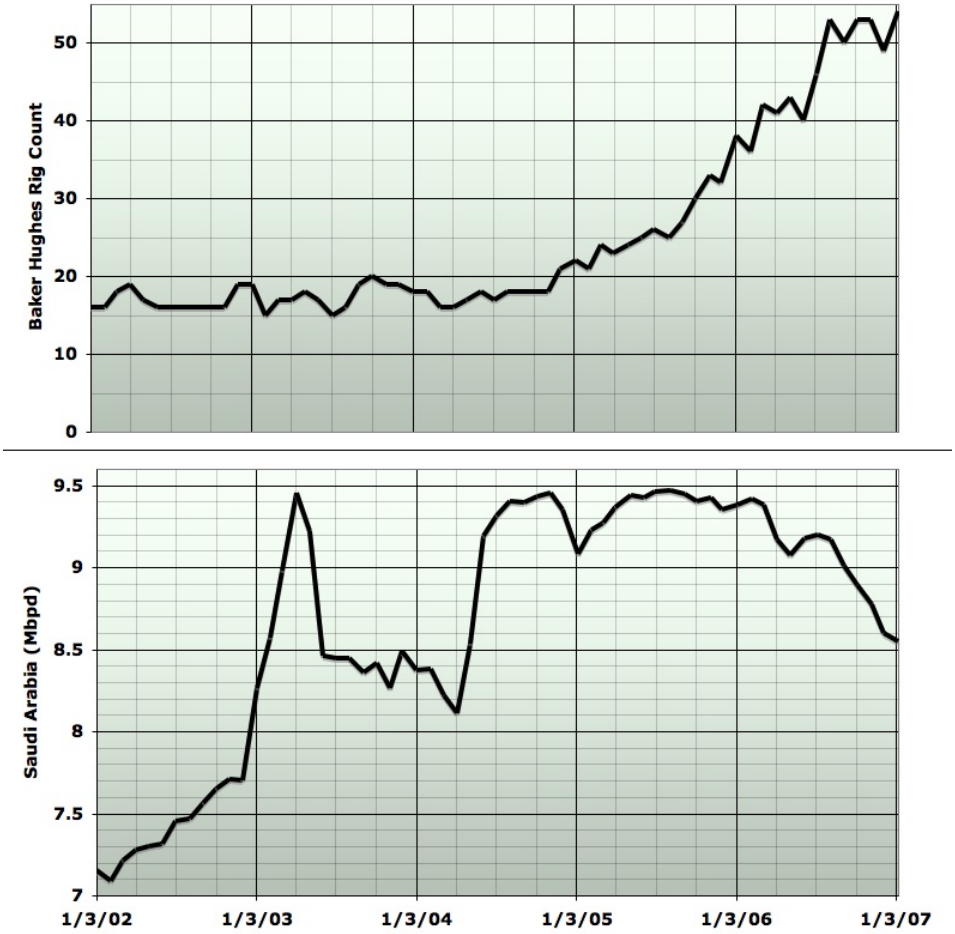
This third quarter of 2004 was the point when Saudi Arabia, and by extension OPEC, crossed from being a swing producer, to being supply constrained. And, as is typical of oil production in some region, once production cannot go up any more, it starts to go down. In the fourth quarter of 2004, Saudi production drops sharply: my hypothesis is that after nearly six months of running flat out, parts of the oil fields really needed to be rested to prevent water breakthroughs (producing a field too fast can allow water to find channels to the wells and then flow straight into them, instead of pushing the oil ahead of it). This is in the absence of any suggestion in the September OPEC OMR, or the press release from the 132nd OPEC meeting on September 15th 2004, that anyone should do anything but keep increasing production.

In fact, the meeting decided on yet another quota hike:

> In light of the foregoing, the Conference decided to raise the OPEC production ceiling (excluding Iraq) by 1.0 mb/d, to 27.0 mb/d, with effect from November 1, 2004, in order to bring prices down further to a more sustainable level, whilst, at the same time, vigilantly monitoring market developments. In taking this decision, the Organization reiterated its commitment to take action to stabilize the market at prices reasonable to both producers and consumers.

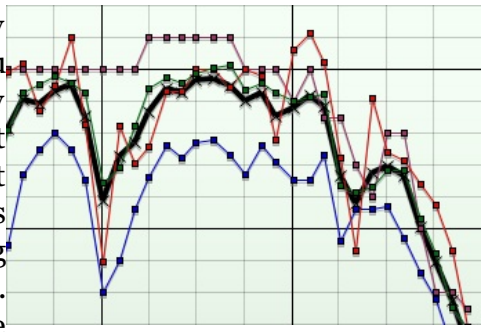
Saudi Arabia appears to have been obliged to do the opposite, dropping production by around 400,000 barrels per day between October 2004 and January 2005.

As the next graph shows, it was this quarter - the fourth quarter of 2004 - when the rig count began its rise above the long term very modest number of rigs that the Saudis had needed to maintain their production (given the extraordinary permeability of some of their large reservoirs - a point Euan helpfully reminds us of).



Top: Oil rig count in Saudi Arabia, Jan 2002-Jan 2007. Bottom: Saudi Arabian oil production, Jan 2006-Jan 2007, from four different sources. Graph is not zero-scaled to better show changes. Click to enlarge. Sources: See above for production sources. Rig count is from Baker Hughes.

It is at this point that megaprojects come into the story. After the initial development of the Shaybah field, which came on stream in 1998, the next major development the Saudis took on was the redevelopment of the Qatif and Abu Sa'fah fields. Qatif had been produced from 1951 to 1982, but was in serious decline at the end of that time and was mothballed during the low production years of the 1980s. It was then redeveloped using all the latest technology (horizontal drilling, multilateral completions) from 2002 to 2004, with official inaguaration in December 2004. A similar project rehabilitated the nearby offshore Abu Sa'fah field. Together, these were intended to produce 800,000 barrels per day of crude, plus 40kbpd of condensate, which was 690kbpd of new production, since Abu Sa'fah was already producing 150kbpd.



My suggestion is that the production bump that started in early 2005 should be interpreted as the new flows from Qatif/Abu Sa'fah being used to offset declines elsewhere. However, they did not allow Saudi production to rise above the almost 9.5mbpd attained in October 2004 - instead that level was just matched for a few months in the summer of 2005. This suggests that the rest of the production base was being produced 690kbpd lower than it had been 10 months earlier. That's about an 8% decline rate in the underlying base production, compensated for by the new field to give an overall roughly flat production profile.

By the end of 2005, beginning of 2006, the new projects were presumably fully in production and there was nothing to offset declines, which therefore show through into the top line production again. As I discussed at length last week, during 2006 we saw declines in the base production accelerate to 14%, offset to 8% as a net decline rate after addition of the smaller Haradh III megaproject.

Alternative Explanations

Next, I'd like to look at alternative explanations that have been proposed for what is happening, most of which stem from the Saudi's and OPEC's own explanation for what is occuring (with Euan and Robert Rapier adding wrinkles to this). It will be impossible to look at all variants, so let me try to string together the strongest possible narrative along these lines, and then point out why I don't believe it's plausible. That narrative would go something like the following:

> Due to long-standing under-investment in production capacity, Saudi Arabia did indeed temporarily fail to increase production as much as oil markets might have liked in the fall of 2004. This caused prices to rise very high, driven primarily by speculators in the futures market. However, KSA has now rebuilt significant spare capacity by utilizing more of their ample reserves. In the interim, it became clear that the world economy could in fact continue to grow with oil prices in the $60+ range, and so they realized that there was no point in increasing their production again to lower prices. In fact, as western oil stocks have been increasing since then, the market is overall well supplied, and in recognition of this fact, the Saudis have been lowering production voluntarily. If the onset of new megaprojects shows up in the production statistics, that is just because they waited to be sure that the new production was working before resting existing production. Nonetheless, they could increase production further if they really wanted to, eg. if oil prices became high enough to cause serious distress to the world economy.

Let me start with the idea that the visibility of the Qatif and Haradh megaprojects in the data is not significant. As Robert Rapier at one point put it:

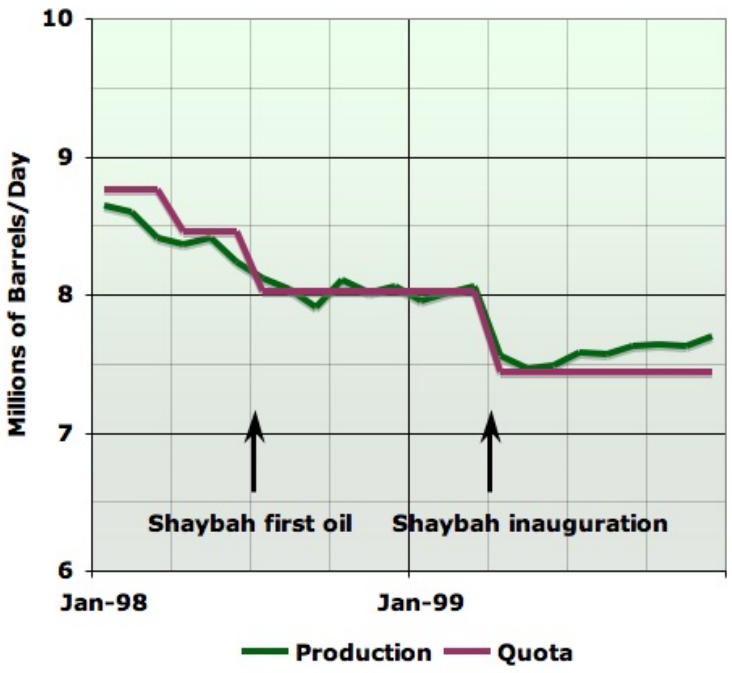
> That (Haradh III) probably is what it was. They probably brought that production on line. But, you want to prove your production rate before you take other production offline. You don't take the other production offline as you are bringing the new production on, because you don't know for sure if things are going to work out like you think they will.
>
> You can see this same pattern on their prior production declines. There will be a decline, and then a little step up, and then more declines.

I found this completely implausible from a theoretical perspective. Aramco, a very sophisticated high-tech company, has several decades of experience running the oil infrastructure for a swing producer that participates in political arrangments dependent on changing their oil output regularly. We have to assume that they would have made it easy to centrally control the amount of oil output. Indeed we see many occasions in the past when they've changed production by 1mpbd up or down from one month to another. So it has to be, from a technical standpoint, easy for them to adjust the level of their base production, assuming they are not operating at capacity. This means they can mask the effects of new production in the curve.

Furthermore, according to Robert's hypothesis, these declines (in 2006 for example) are voluntary. The declines occur every month according to the production statistics. Therefore, the level of production must be being adjusted *at least* every month under normal circumstance to implement the decline schedule. So again, if they are being adjusted every month, how can it be so difficult to change the adjustment to do a little extra ramping down on existing production when new production is coming on line?

And the failure to match the intended production has real consequences: extra tankers must be ordered and paid for to take the extra oil away, and that extra oil will affect prices in the marketplace. It's hard for me to believe that it's easier to face these consequences than just turn the base production down a little at the outset of turning on the new megaproject, and then turn it back up again if there's a problem with the new field.

However, in my modus operandi, empirical evidence trumps theoretical prejudice every time. So I went back and looked at the inauguration of the Shaybah field. This was a megaproject to bring on a brand new field, 500 kbpd, during the swing producer era. Specifically, first oil was in July 1998 and the official inauguration of the completed facility was in March 1999. Presumably the new oil came on to varying degrees between those dates, or perhaps a little after, but we don't know exactly how much when. I made a graph of the 1998-1999 period, and I plotted two things: the official OPEC allocations for Saudi Arabia, which is the schedule that production is supposed to be following. I also plotted the average of IEA and EIA production estimates (JODI didn't exist back then and I don't have the OPEC production series done back that far yet and it's particularly time consuming to compile).

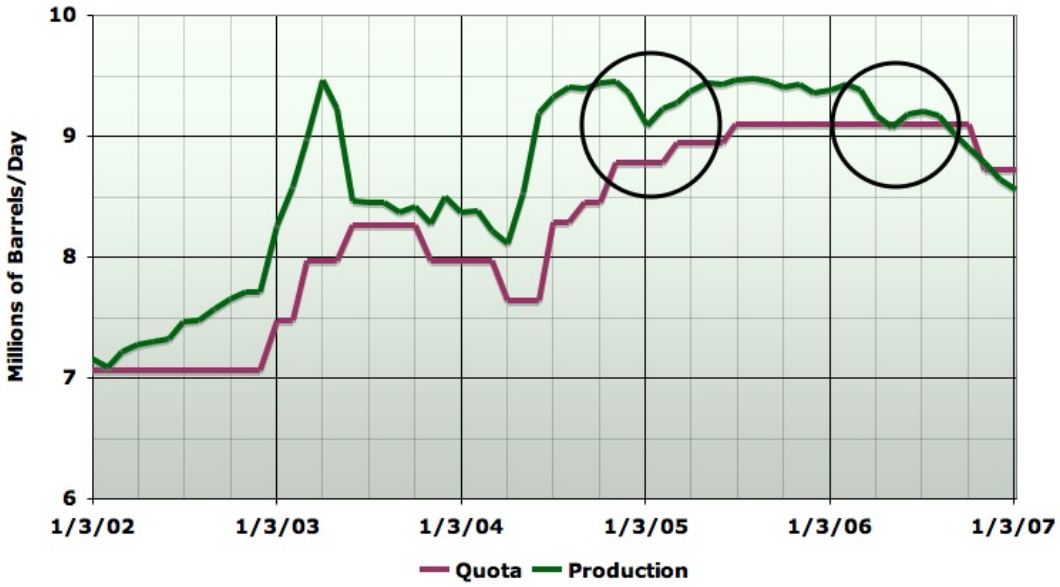


Saudi Arabian oil production, Jan 1998-Dec 1999, average of two different sources, together with official OPEC quota for Saudi crude oil production. Annotations show timeline of Shaybah field onset (500 kbpd). Graph is not zero-scaled to better show changes. Click to enlarge. Source: US EIA International Petroleum Monthly Table 1.1 and IEA Oil Market Report Table 3, for production data, and OPEC for quotas.

As you can see, at the time Saudi Arabia was tracking its quota pretty well. OPEC was ramping down production in response to the Asian financial crisis, and the Saudis were behaving as well-disciplined members of the cartel. The new megaproject has no apparent impact on their ability to follow the schedule - they are never more than a couple of hundred kbpd off, usually less, and

they are particularly close to the line during the interval whan Shaybah came on stream. (Note that it is just a coincidence that both first oil and inauguration of Shaybah are in the same month as OPEC production cuts).

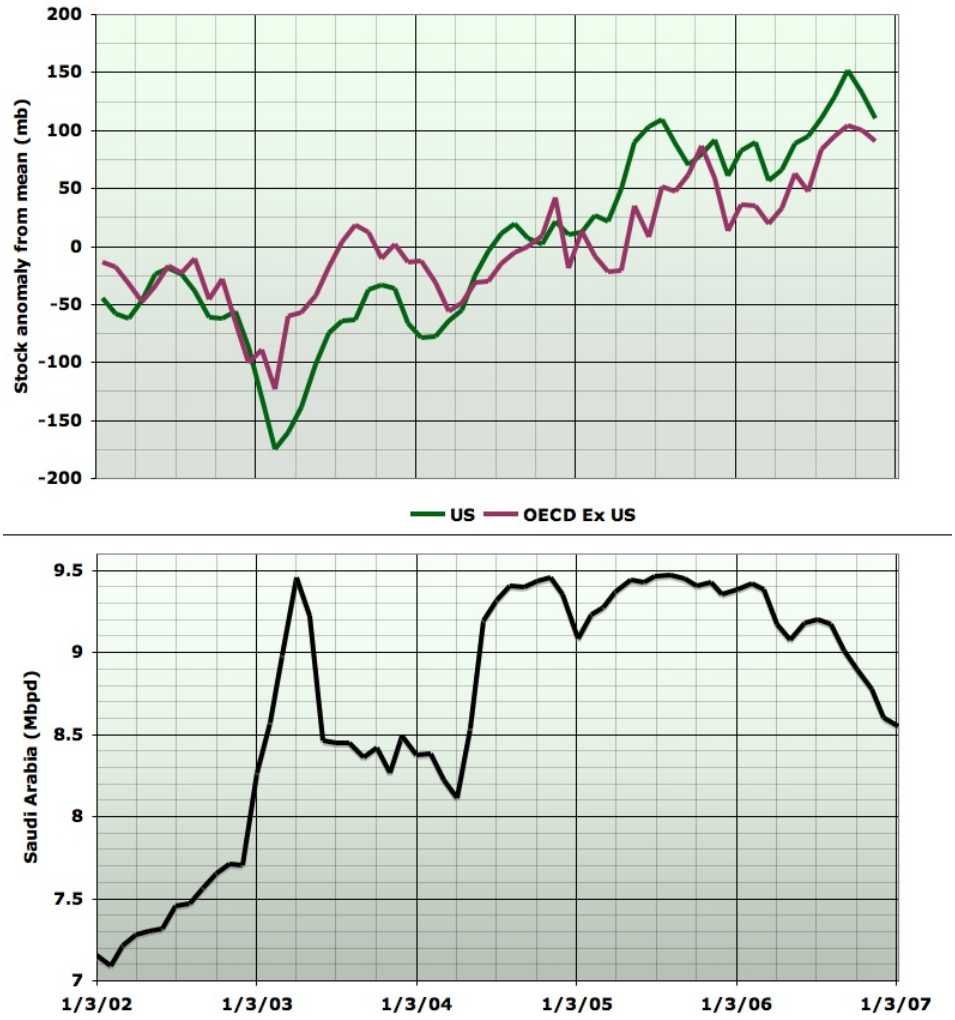
To me, this strongly demonstrates my contention: when KSA is not operating at capacity, they can control base production so that a new megaproject does not influence their total production level. Thus the fact that they did **not** achieve that control for the onset of Qatif and Haradh III continues to strike me as highly significant. For reference, here is the production profile and quota for the last five years (on the same vertical scale):



Saudi Arabian oil production, Jan 2002-Jan 2007, average of four different sources, together with official OPEC quota for Saudi crude oil production. Circles show timeline of Qatif field onset (690 kbpd) and Haradh III onset (300kbpd). Graph is not zero-scaled to better show changes. Click to enlarge. Source: See above for production data, and OPEC for quotas.

In general, KSA was not following its quota so closely during this era - in particular, they seem to have responded much more aggressively than OPEC required to the market need for more oil during the Gulf war, and also in response to the loss of control over prices in mid 2004. However, as the two circled regions show, there was nothing in the quota curve to explain these events.

Now, let's turn to the issue of rising OECD stocks:



Top: End of month oil stocks for US and OECD ex-US, Jan 2002-Jan 2007. Expressed as the anomaly in millions of barrels from the average over the period (1.64 billion barrels for the US, and 2.37 billion barrels for the rest of the OECD). Bottom, Saudi Arabian oil production, Jan 2002-Jan 2007, average of four different sources. Graphs are not zero-scaled to better show changes. Click to enlarge. Source: see above for KSA oil production sources. Oil stock numbers from EIA International Petroleum Monthly Table 1.5.

It's certainly true that stocks have been rising from 2004 until last summer, both on an absolute and a days of supply basis - though the rise is not historically outrageous. OPEC is fond of claiming this mean that the market is well supplied and so nobody needs any more oil. Clearly, the average minimum wage worker forced to cut short on driving because they can't afford the gas would have a very different perspective. The problem is in the supply constraint era, inventories just do not mean what they used to mean. The price rises of the last few years have frequently come from the long end of the futures market - the market has often been in contango in which the right to have a barrel of oil in five years is more expensive than the right to have a barrel today. When the far future oil contracts are driving up like that, two things happen: one is that it makes it more profitable to store oil, so stocks rise. The other is that the current price of oil has to rise too (because otherwise even more oil would be stored, which tends to drive the far future price and the current price towards one another). So the historical role of inventories as the main signal OPEC used to balance the market has broken down. But I find it hard to believe that OPEC doesn't know how the futures markets work.

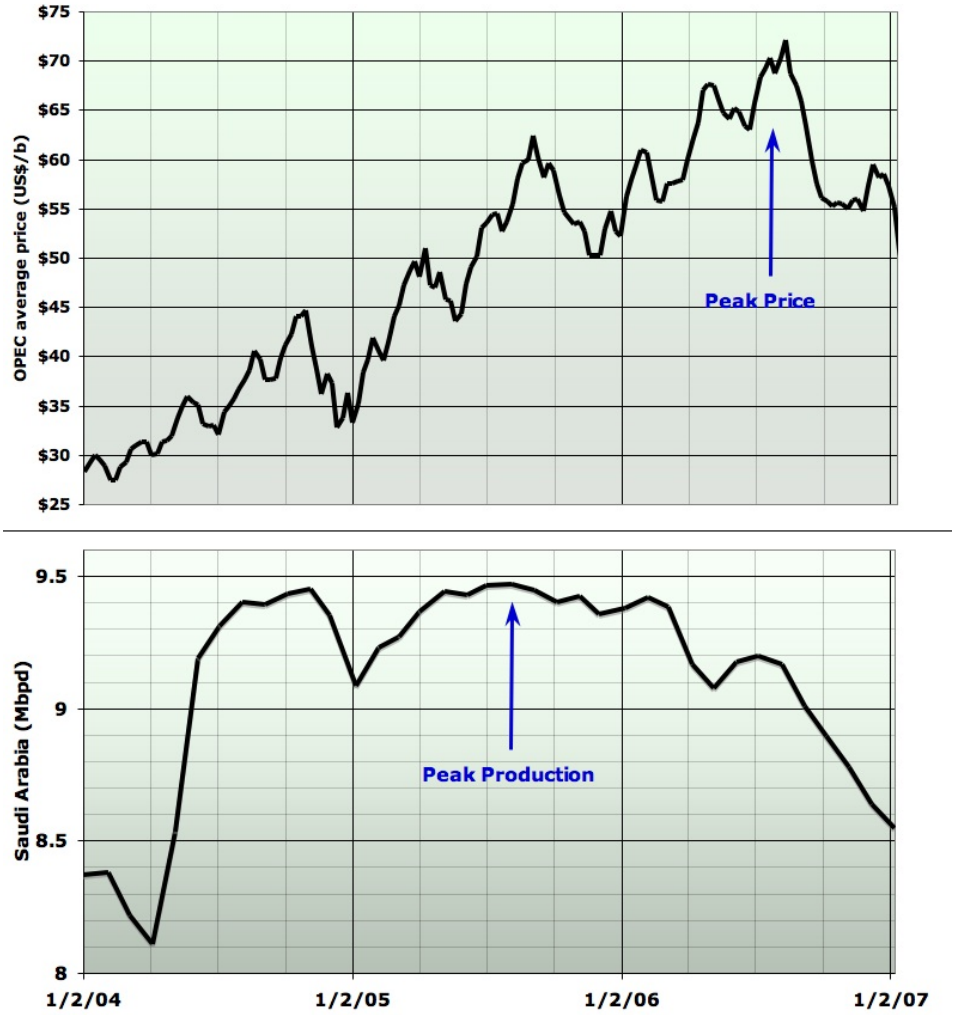
But obviously, none of this would happen if the futures markets thought that there was going to be ample oil in the future. $60 is high enough that demand has flattened out, despite decent

economic growth. Thus there are certainly additional customers who would drive further and turn up the heating oil thermostat if only oil was a bit cheaper and they could afford it. The fact that there's no-one available to supply it to them is why prices have remained so high. If OPEC had the capacity and convincingly demonstrated their ability to flood the market with all the oil anyone anywhere would pay for, oil market bulls would have no choice but to run screaming for the hills - selling their long positions cheaper and cheaper lest they be faced with the prospect of tankers heading up Long Island Sound trying to deliver to their hedge fund offices.

Ok, but what about the idea that the Saudis, having recognized that the world can cope with $60+oil, are now deliberately holding production down in order to maintain prices at that level. At one level, I think it's incontrovertible that OPEC has gotten very fond of the high prices. There does seem to be some evidence that some countries did actually make very small cuts specifically in response to the recent OPEC cuts. Could the Saudis simply have decided that being the swing producer is a mugs game, and they're just going to take all the money they can?

Well, that hypothesis has some problems, I think. One is, why don't they cut even further, and make even more money? Knock another few mbpd off, and oil will be $150, which is even better for the treasury. Ok, they can't do that all at once, or they'd throw the world into recession. But after prices peaked at almost $80 last summer, why did the newly greedy Saudis let them come down again. Why not have managed them slowly higher to find the point of maximum profitability, which is almost certainly higher than $60? Or if they aren't that greedy, and $60ish is the new price band, the new balance between the interests of producers and consumers, why'd they let the price go almost to $80 over the summer? Why not ramp up to 10.5mbpd for a few months and scare the markets back down to $65?

In short, if the Saudis had spare capacity, we'd expect the production profile to show *some* intentionality around managing the price in some way that they perceive to benefit them. But that's not what we've got. If we focus on price and production over just the last three years:



Top: Export weighted average OPEC oil price. Bottom: Saudi Arabian oil production, Jan 2004-Jan 2007, from four different sources. Graph is not zero-scaled to better show changes. Click to enlarge. Sources: See above for production data. Price data are from the EIA.

I just can't see Euan's contention that the peak in Saudi production and price coincide. From my perspective, declines in Saudi production start a year earlier than the peak price, gradually at first, and then accelerating.

Instead of some rational looking approach to price management, we see a profile of drops interrupted by each new megaproject.

Thirdly, if the Saudi's were indeed sitting on 716gb of ultimately recoverable oil, there's some serious risks in running prices so high now, so early in the history of their production. In particular, they are triggering a huge boom in investment in trying to find alternative forms of energy (this is going gangbusters here in the SF Bay Area). That's pretty risky for them - who's to say that Silicon Valley won't solve the electric car battery problem and the cheap solar panel problem? It's not usually a good business strategy to price your product so high that your customers are driven to furiously trying to invent an alternative. In the past, they understood this which was why they created a moderate $22-$28 price band which balanced the needs of producers and consumers. They had the experience of the 1980s when the price spikes of the 1970s caused a huge shift away from oil and contraction in demand, which absolutely killed their revenues for years. Why would they repeat that experience?

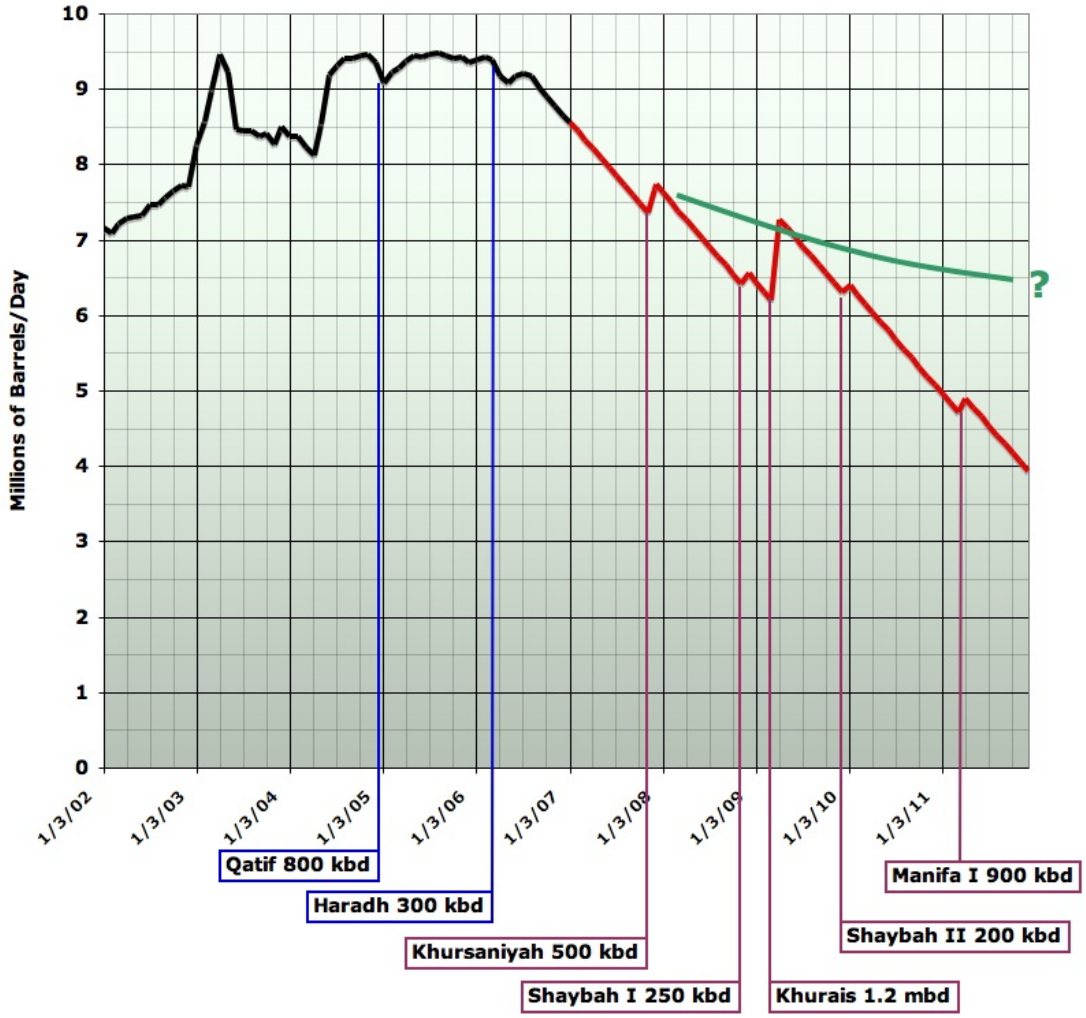
So, at this point, I'm pretty strongly persuaded that this can't be the explanation.

The Future of Saudi Production

The very near term future is generally agreed to be continued declines. The most recent IEA Oil Market Report (from Feb 13th, 2007) says:

> The Saudi Arabian crude supply estimate for December was revised down by 100 kb/d to 8.7 mb/d in light of updated tanker data and reported production levels. January supply is assessed unchanged, although Aramco has signalled to Asian term buyers that exports will be curbed by between 10-13% in February compared with 8-9% in January. Moreover, steep price increases for March exports suggest supply remaining constrained next month.

For the medium term, if you just project the underlying linear decline rate in 2006 out for the next five years and add in the known megaprojects, you get the red line in the following graph:



Saudi Aramco production 2002-Jan 2007 as before, together with a hypothetical scenario (red line) where base production declines linearly at 120kbd per month, but is augmented by production from all planned megaprojects starting on their currently intended date, and not changing thereafter. Click to enlarge. Source: see above for KSA oil production sources. Megaproject dates and amounts are from press releases from Saudi Aramco and Rembrandt Koppelaar.

If that were true, production would have halved by 2012. However, it's very hard to believe that declines would continue at that rate. Eg, if they continued all the way to zero after ten years, that would only be another 16 billion barrels of oil production. No-one is that sceptical of Saudi oil reserves. Eg Hubbert linearization suggests there's about another 80gb or so of oil there. ASPO estimates 170gb still to produce (though based on a fairly generous recovery factor).

So rather than declines continuing at the present rate all the way into the ground, more likely, I think, is that there are a large number of small fields, and pockets in big fields, which carry the remaining reserves. Hitherto, these have been beneath the attention of Saudi Aramco, which prefers to engage in massive heroic engineering projects - they haven't gone below about a 5gb field in recent publicly announced projects. Just as in other regions, the addition of increasingly large numbers of increasingly small fields to the backside of the production peak should serve to moderate the decline rate. How quickly Saudi Arabia will move to exploit the remaining smaller fields is anyone's guess, but the green line on the chart above is intended to suggest that the present decline rates should moderate at some point.

Parting Thoughts

No-one has taken me up on my bet, but since I feel even more confident of my conclusions, I'm raising the offered stakes to $2000. I need to go find some cornucopians to take the other side of it.

Which reminds me. For those of you doomers keen to see this as the end of civilization as we know it, it's going to take more than this for me to join you. While it's certainly worrying, we need to keep some perspective: 8% of Saudi production is 1% of global production, and as long as global declines are less than a few percent a year they are well within society's proven capacity to adapt. Probably the biggest potential issue is the political stability of the Kingdom of Saudi Arabia once this news becomes clear to everyone.