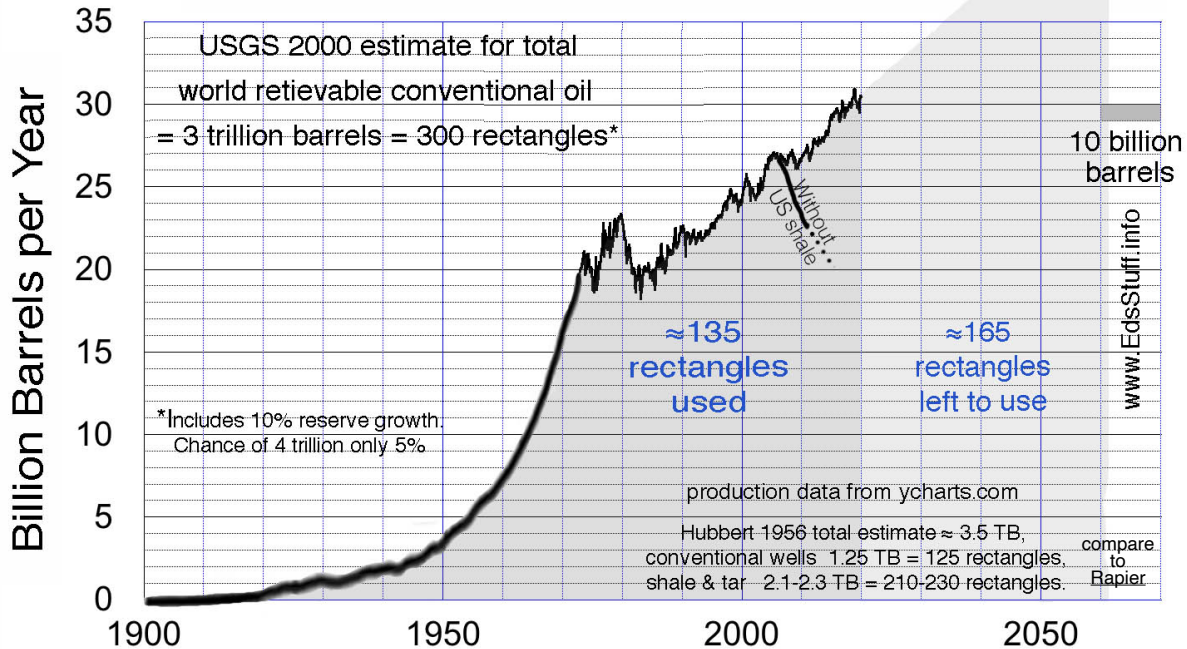


World Oil's 3-4 Trillion Barrel Limit

This is not a computer model. It is data + recent history.

The production curve has to come down with about 300 rectangles under it.

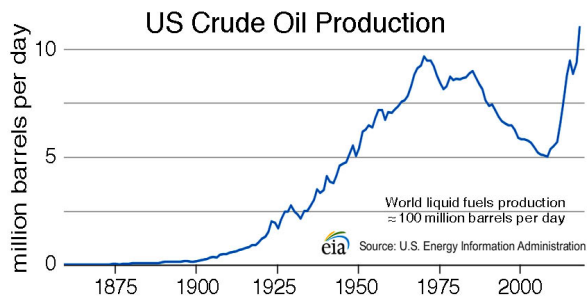
The 2020 trajectory could get to 2061 then totally crash, or if 4 trillion barrels to 2079.



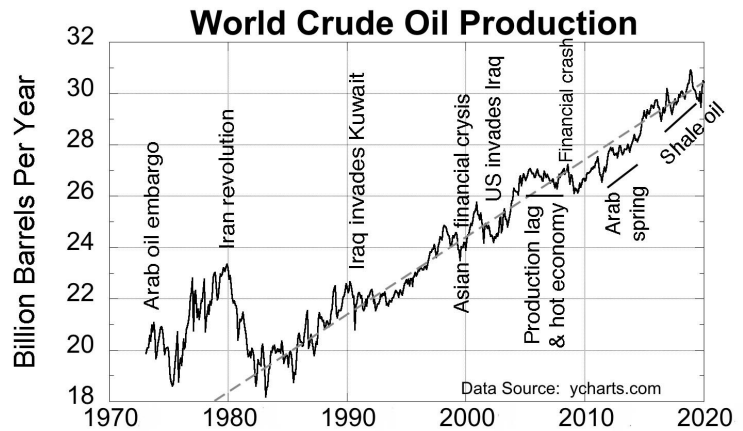
Recent Past Foretell Future?

The Arab oil embargo and Iranian revolution caused both short-term price jumps and long-term energy efficiency improvements by consumers. This slowed demand and so production. But more than that happened.

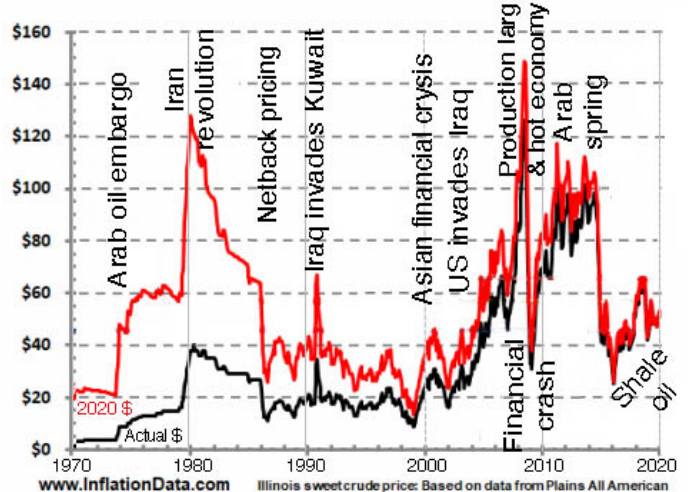
Growth in production changed from normal exponential to just linear. This seems to be reflected in the steady rise in price from 2002 to 2014. And perhaps relevant is Hubbert's observation that in all examples of local oil fields departure from exponential growth has heralded leveling off and decline with production shifting to other fields. The steady 2.5x price rise over 12 years and then price drop in 2015 reflects that shift from declining conventional wells to newer sources of tight oil. In 2019 63% of US oil production was from shale oil formations.



These shale finds are new technology confirmation of decades old geographic data, not new discoveries as fallaciously misrepresented by DOE. The century of rock classification mapping, including main shale and tar sands, was 1860-1960. The not fully known is efficiency of extraction from shale, not how much of that kind of rock there is.

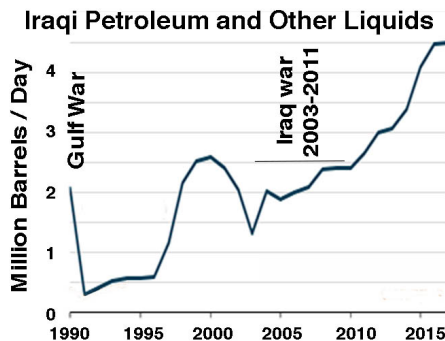


Crude Oil Prices and World Events

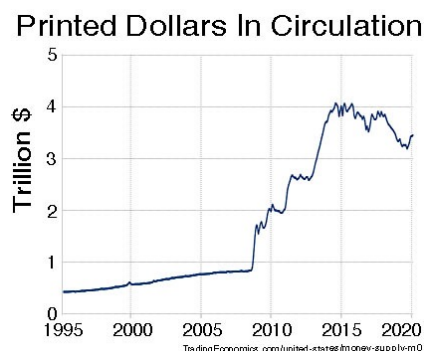


The financial crash of 2008 was not due to economic factors alone. Synergistic interplay with the supply and short-term inelastic price of oil was also involved. In 1999 Clinton's banking deregulation and Brooksley Born firing lessened restraints on financial leveraging, creating much prosperity on the basis of recirculating loan money—here called confidence money. Historic norm had kept the amount of money in circulation at about five times the amount of dollars in print, but in the era to 2008 this was significantly exceeded both in the housing and over-the-counter derivatives markets.

Starting in 2003, the Iraq war caused a slight drop in oil production at exactly the same time demand was increasing due to the credit-stimulated US economy plus purchases from China and India. Oil prices skyrocketed 25 percent in three months hitting an all-time high of \$144/barrel in July 2008. The suddenness and degree of change caused pain and panic, especially in transportation. So the 2008 financial crash was caused by a combination of three factors—failure of key banks, evaporation of confidence money, and fear of skyrocketing oil prices. The financial crash with oil dropping in 6 mo to \$32 was also the [solution](#) in 2008 for inability of conventional wells to meet demand.



Four government interventions prevented 2008 from becoming a major depression—replacement of failed private debt with trusted government debt, TARP funding by Congress (some of it leveraged by the Fed by insuring bank loans), classic Keynesian money pumped into the economy by deficits averaging about a trillion per year since 2008, and an astonishing amount of printing of US paper dollars technically called Quantitative Easing. From 2008 to 2015 the amount of printed dollars was increased by almost a factor of five from about 0.85 to four trillion. That's an increase in circulating money by about 15 trillion dollars. In comparison, the initial 1929-1931 drop in money supply that sealed the depression was 25%.



If it takes that kind of Herculean financial intervention to recover from the loss of confidence money in 2008, what happens, and can economies function, if panic sets in from fear of peak oil? The above data plot suggests that today's abundance in the shale oil supply chain will likely disappear well before 2061 and maybe by 2030 or 2040.

Jimmy Carter was crucified for trying to do something about this, and all administrations since have preached energy independence. Nuclear power is feared, but there are way too few renewables to support our population size. Yet, the petroleum production curve will come down. When and how?

April 2020, by Ed, a retired PhD research physicist

References for or relevant to world maximum extractible crude oil:

Hubbert 1956: [peakoil.edsstuff.info/hubbert1956.pdf](#) est 3.5 trillion barrels total world retrievable with shale & tar retrievable tight oil: US shale 1 + Non US shale .3-.5 + Tar sands .8 = 2.1-2.3 trillion barrels; based on three references & quotes

EIA 2000: [large.stanford.edu/publications/power/references/wood](#) 3 TB likely, 4 TB unlikely
EIA refers to USGS, but the world 3 & 4 trillion numbers can not be found in the USGS report.

Jared Diamond 2005, "[Collapse, How Societies Choose to Fail or Succeed](#)" In having no alien invaders, mankind today is similar to Easter Islanders and Incas. Population versus resources is key.

Wikipedia says that, "Global technically recoverable oil shale reserves have recently been estimated at about 2.8 to 3.3 trillion barrels," but that's not what is in the four references.

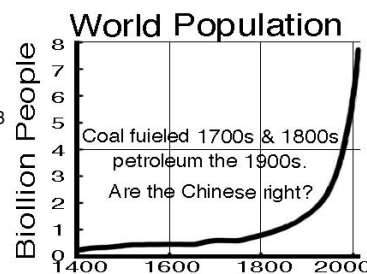
- ref#14, 2010 (USGS 2008, John R. Dyni) > 2.8 trillion barrels of in situ world shale
- ref#41, 2008 (CRS 2008) Three US states total 1.3 trillion barrels of in place shale oil
- ref#44, 2006 (EIA 2006) Gives US costs but no world petroleum production numbers
- ref#45, 2006 (DOE 2006) Wrong link?

World Energy Equiv Oil Use = 87 Billion Barrels 2013

Global warming more known, but lesser problem. Liquids Coal Gas Hydro Nuc Ren
US oil use/person = 2.1xEU, 4.8xWorld, 6.3xChina 33% 30% 24% 7% 4% 2%

Shale oil boom & bust

US Petroleum Consumption 2018
transportation industry residential commercial electric power
69% 25% 3% 2% 1%



Additional notes:

Club of Rome 1972: en.wikipedia.org/wiki/The_Limits_to_Growth, a computer model of everything

From 1929 to 1931 the money supply dropped \$11 billion or 25%. Rebound to 1929 levels was not until 1940. Adjusted for inflation (x24) and for size of GDP (x17) that's roughly equivalent to a drop of \$2.6 trillion in 2008 \$.

Wages increase from 1980 to 2016:

advanced degrees	41%	\$67K -> \$95K	(16% of full time workers over 25)
college graduates	17%	\$56K -> \$66K	(26% of full time workers over 25)
high school graduates	-12%		

Consumption relative to US per person per day

	EU	World	China
Petroleum	48%	21%	16%
Natural gas	41%	22%	7.7%
Coal	-	500%	1.4%
Nuclear	-	14%	7.2%

The US has most of the world's shale oil, and China most of the shale gas. Oil yield from shale by weight is anywhere from 30+% down to 3%. Extraction methods are still being improved, and the total amount of shale oil potentially available is still not well known.

Two Formulas For Growth: The relationship between fixed percentage growth of $\epsilon\%$ /year and number of years doubling time N is

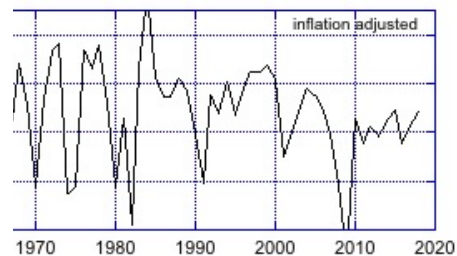
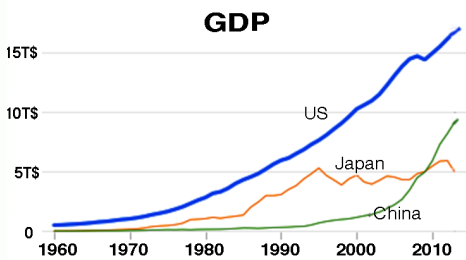
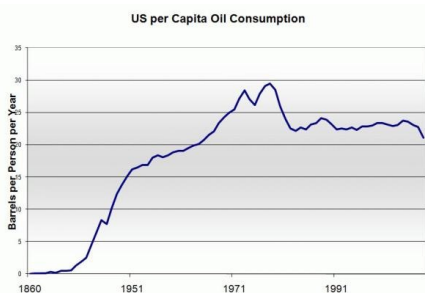
$$N = (69 \text{ years}) / \epsilon.$$

So 4%, 3%, and 2% growth mean doubling times of 17yr, 23yr and 35yr.

And a surprisingly profound aspect of doubling times is that the next doubling time involves essentially the same amount as all previous history. Take the classic problem, for instance, of kernels of grain allotted to squares of a checker board with one for the first square, two for the second, four for the third, and so on, doubling each time. The number of grains for the 64th square is 2^{64} , and with a little algebra, you can show that the sum of grains for all the previous 63 squares is $2^{64}-1$. These numbers are both twenty digits long starting with 184467440737....., so the 1 doesn't make any difference and the numbers are essentially the same. This much grain would fill dozens of the largest super tankers.

Now consider the real world problem of US economic growth, which is currently 2%/yr. If it had been that been holding for a while, the amount of goods and services to be consumed in the next 35 years would be equal to that consumed in all previous history. And actually since doubling time has gotten longer, the amount of goods and services to be consumed in the next 35 years needs to be more than that of all previous history.

Growth in US GDP was 4% from 1960-1970, about 3% for the next three decades and since 2010 has been about 2%, this decrease being part of the reason for so much voter discontent. Modern economies and governments must have growth to function. But world capacity for extracting oil being limited to 3-4 trillion barrels says this kind of growth in a prime energy sector will end soon.



Some Hubbert references

- US Shale: p.19 1TB USGS survey in The Oil and Gas Journal, Feb 13,1956, p.83 (900 billion barrels of shale oil in Colorado) Rubel, A.C., 1955; Shale Oil—As a Future Energy Resource, Mines Magazine, Oct 1955, p.72-76
- Other Shale: p.19 .3-.5TB quotes & guesses, but no reference
- Tar Sands: p.20 .8TB Ayres,Eugene & Scarlott, Charles A., 1952; Energy Sources—The Wealth of the World, McGraw-Hill, p.75-76