The World's Fragile Economic Condition

Gail Tverberg, OurFiniteWorld.com, September 17, 2018

Outline

1. Introduction
2. Energy consumption history
3. When energy consumption growth is rapid, all segments of the economy benefit
4. The miracles that added debt can produce
5. What really happens when economies hit energy limits
6. Conclusions

Introduction

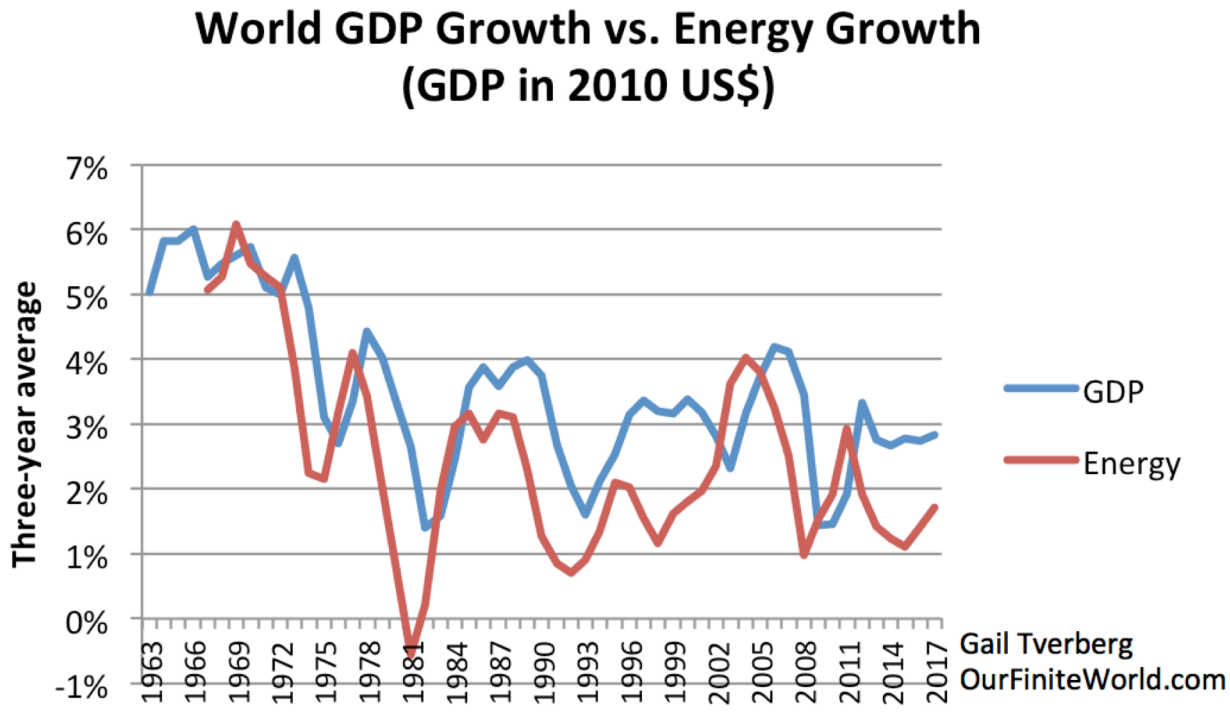
Two questions:

1. What is the role of food with respect to the human body?

2. What is the role of energy (coal, oil, natural gas, wood pellets, electricity) with respect to the economy?

The laws of physics require energy consumption for heat and for motion.

- The world economy *requires* energy for GDP growth. Energy change comes first!



Other things affect the growth rate/health of the economy, besides energy

- Situation analogous to human health
  - Food choices/ amounts are not the only things that affect human health
  - Exercise matters
  - Exposure to microbes matters
  - Risky behavior matters
  - Consuming poisonous materials matters

- For the economy, two examples
  - Efficiency gains increase growth rate
  - Diminishing returns in obtaining resources reduces growth rate
    - In other words, growing inflation-adjusted cost of producing resources

Recently discovered: The world economy is a self-organizing structure, powered by energy

- So is the human body
- Many other examples
  - Hurricanes
  - Stars
  - Plants and animals
  - Ecosystems

- In physics terms, all are "dissipative structures"
  - They "dissipate" energy
  - This allows them to grow and change over time
  - Dissipative structures are not permanent

More questions:

1. Do medical authorities agree on diet advice for humans?

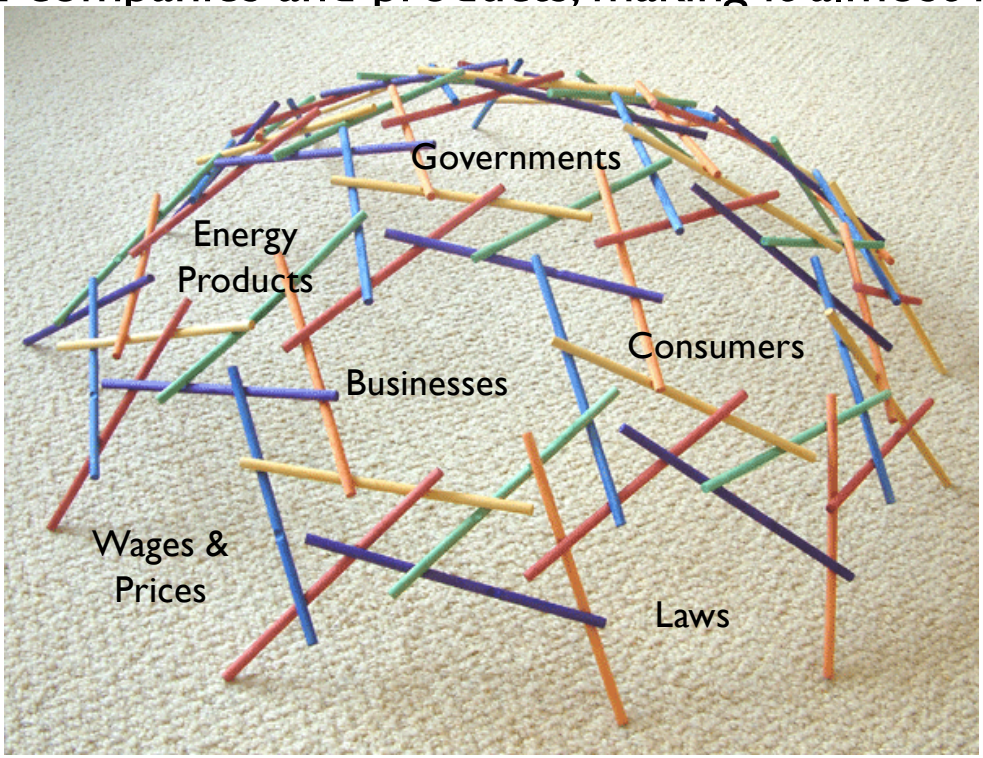
2. Do energy advisors agree on how much energy, of what kinds, is needed to solve our energy problems?

3. If a person doesn't understand that the ***economy requires energy***, how might that influence his view of possible solutions to today's energy problems?

The economy is a complex self-organizing structure that builds up over time – somewhat like a child's toy

- It deletes unneeded companies and products, making it almost impossible to "go backward"

Not being able to go backward makes the system ***fragile***



Leonardo Sticks toy http://www.rinusroelofs.nl/structure/davinci-sticks/gallery/gallery-01.html

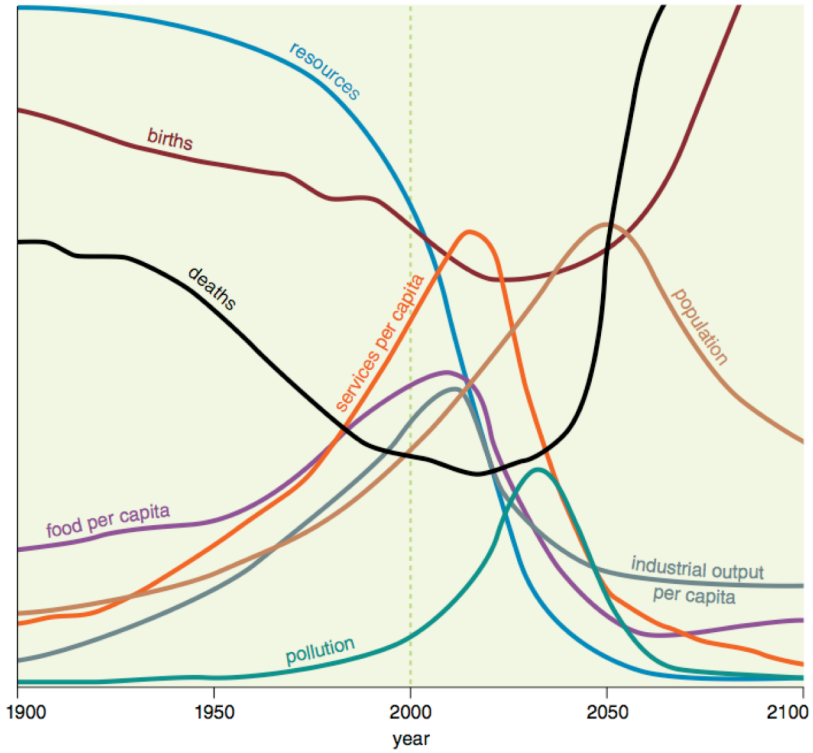
If there is inadequate energy supply, what signs should we expect?

- Naïve answer:
  - High prices

- Answer by person who understands the strange ways of networked systems:
  - Sometimes scarcity will lead to high prices
  - But scarcity can also lead to other problems throughout the system
    - More conflict among countries; even wars
    - Low wages for less skilled workers; wage disparity
    - Low interest rates
      - Asset price bubbles, reflecting low interest rates
    - Inadequate tax revenue for governments
      - Some central governments may collapse

My theory can be thought of as being related to that modeled in the 1972 book, "*The Limits to Growth.*"

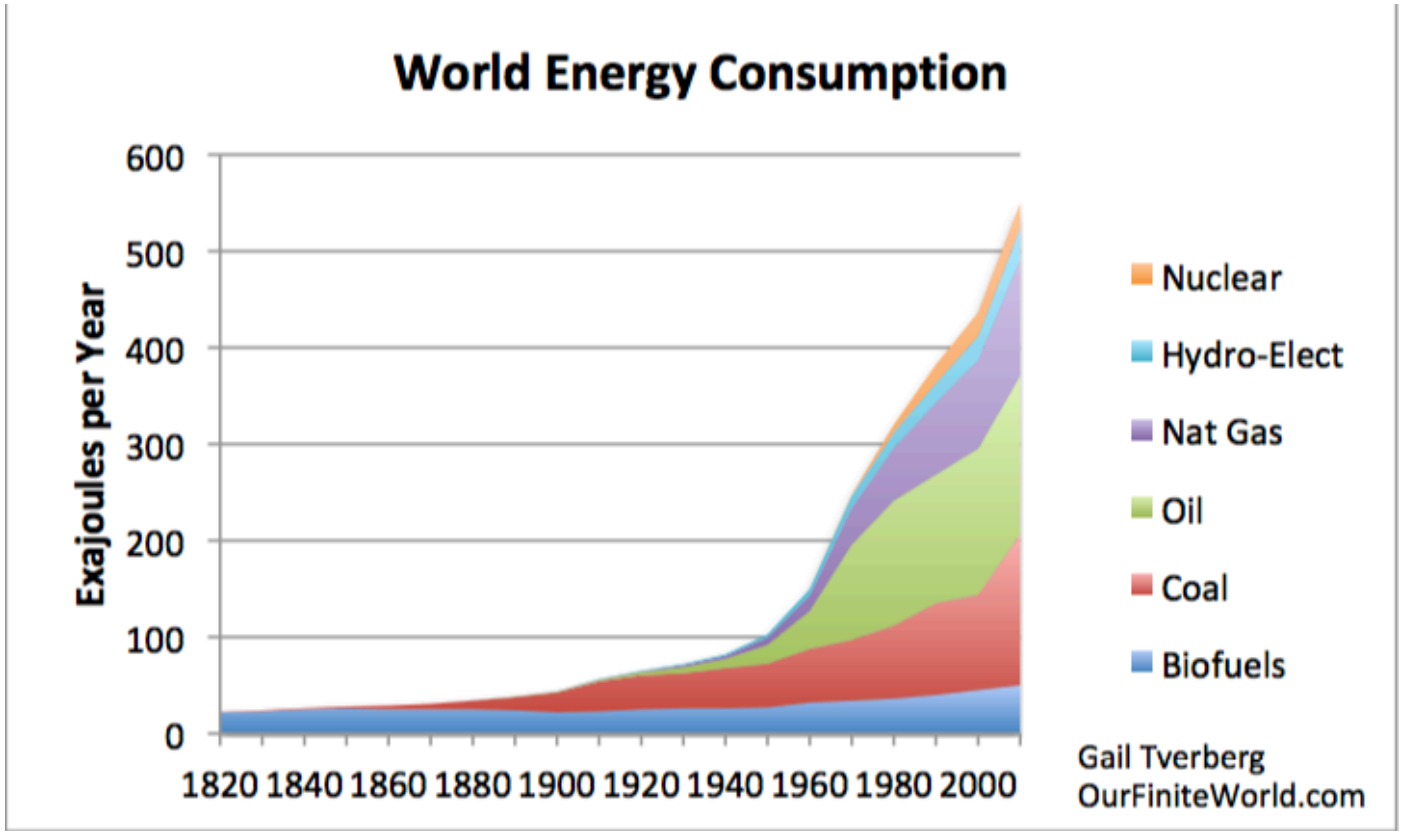
- Model suggested limits might come about now



Base scenario from 1972 The Limits to Growth, by Donella Meadows et al., printed using today's graphics by Charles Hall and John Day in "Revisiting Limits to Growth After Peak Oil" http://www.esf.edu/efb/hall/2009-05Hall0327.pdf

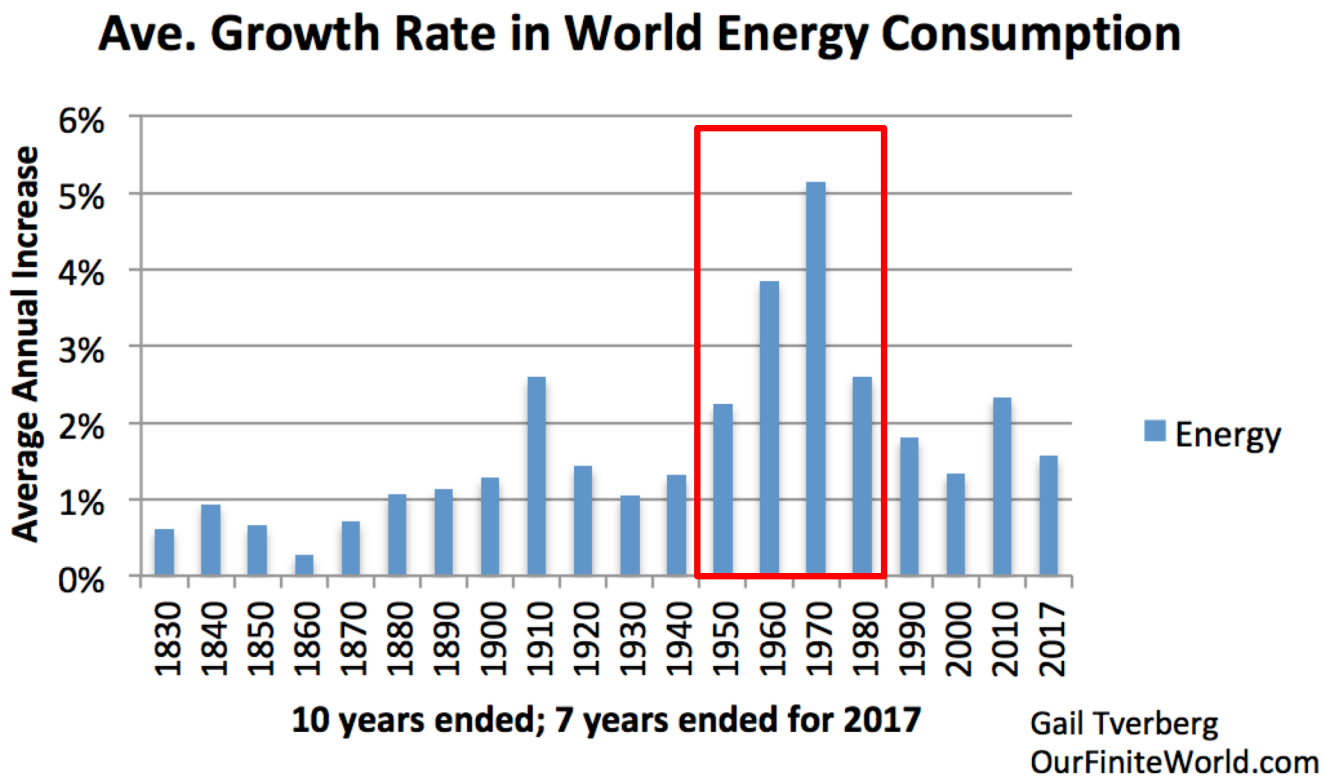
Energy consumption history

Total world energy consumption has grown greatly since 1820

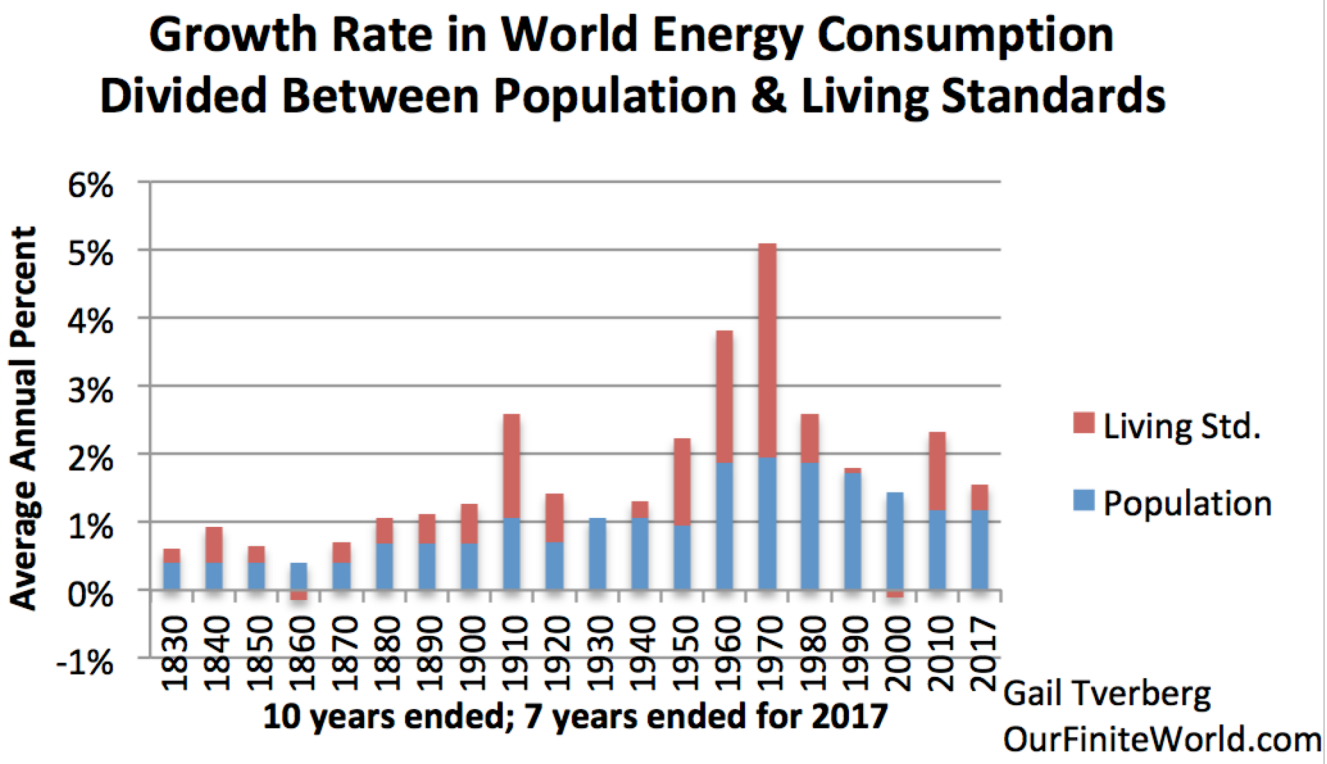


Based on Vaclav Smil data for earlier years combined with BP Statistical Review of World Energy data since 1965.

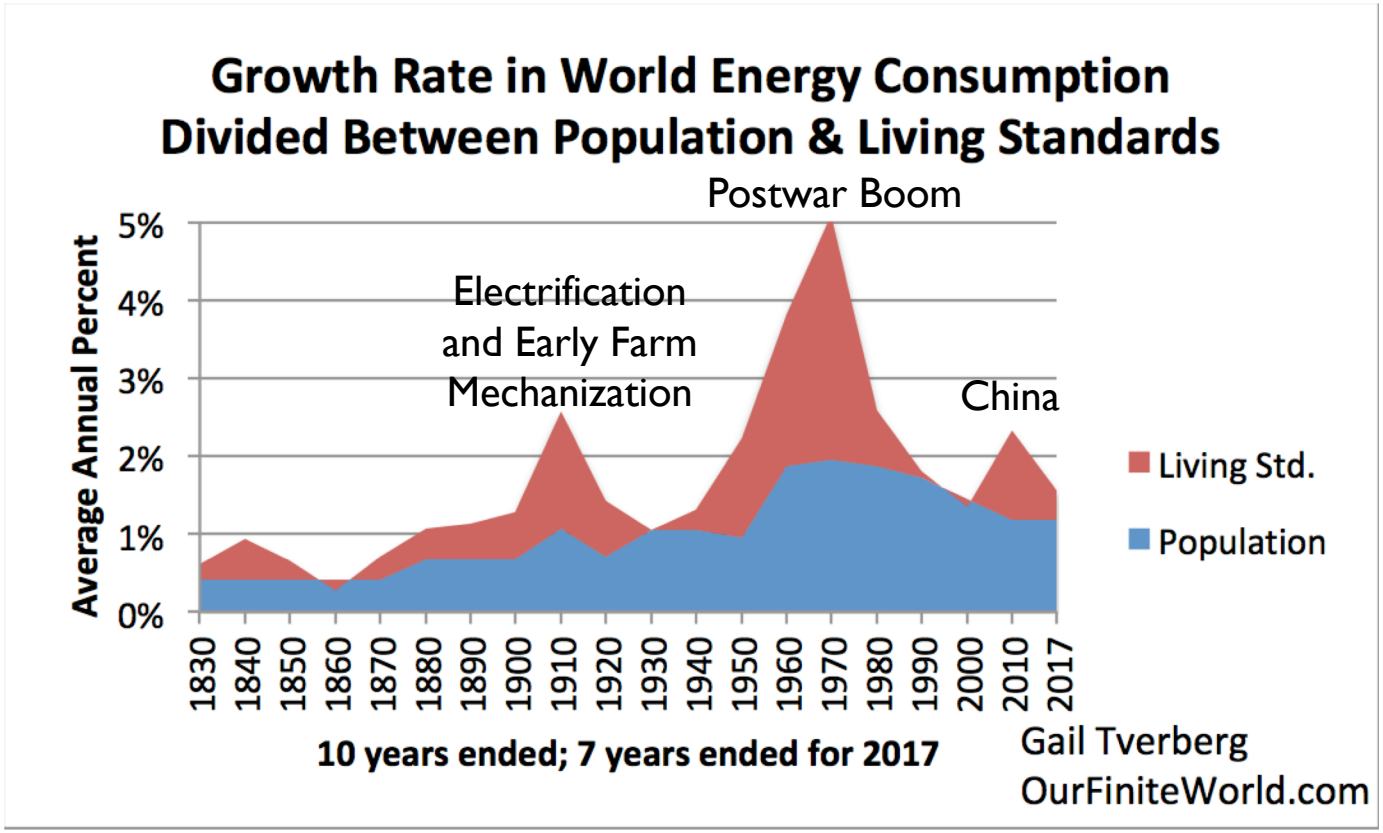
Energy growth rates vary by decade. They were particularly high in the 1940s through 1970s.



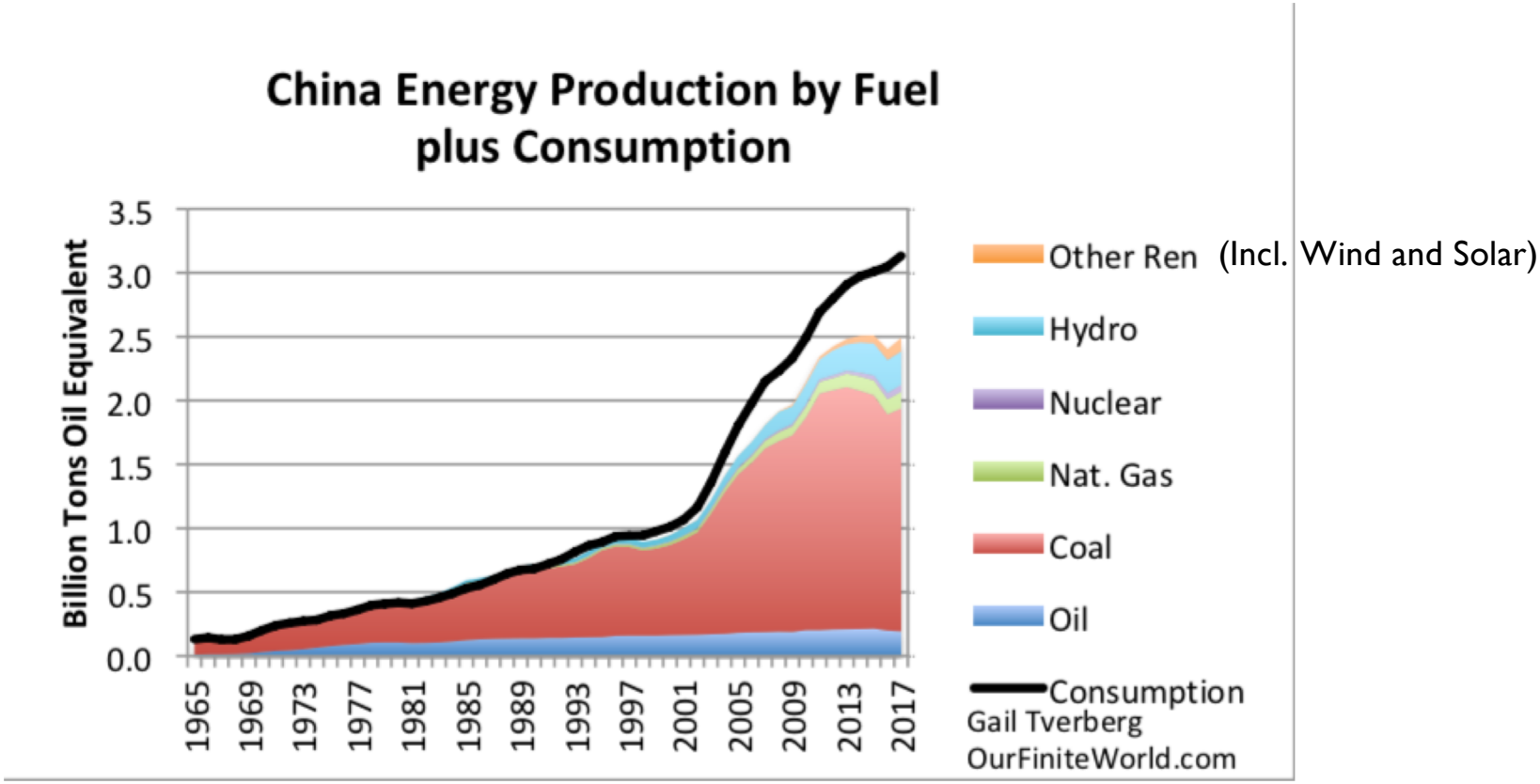
We can separate energy consumption growth into population growth and standard of living growth



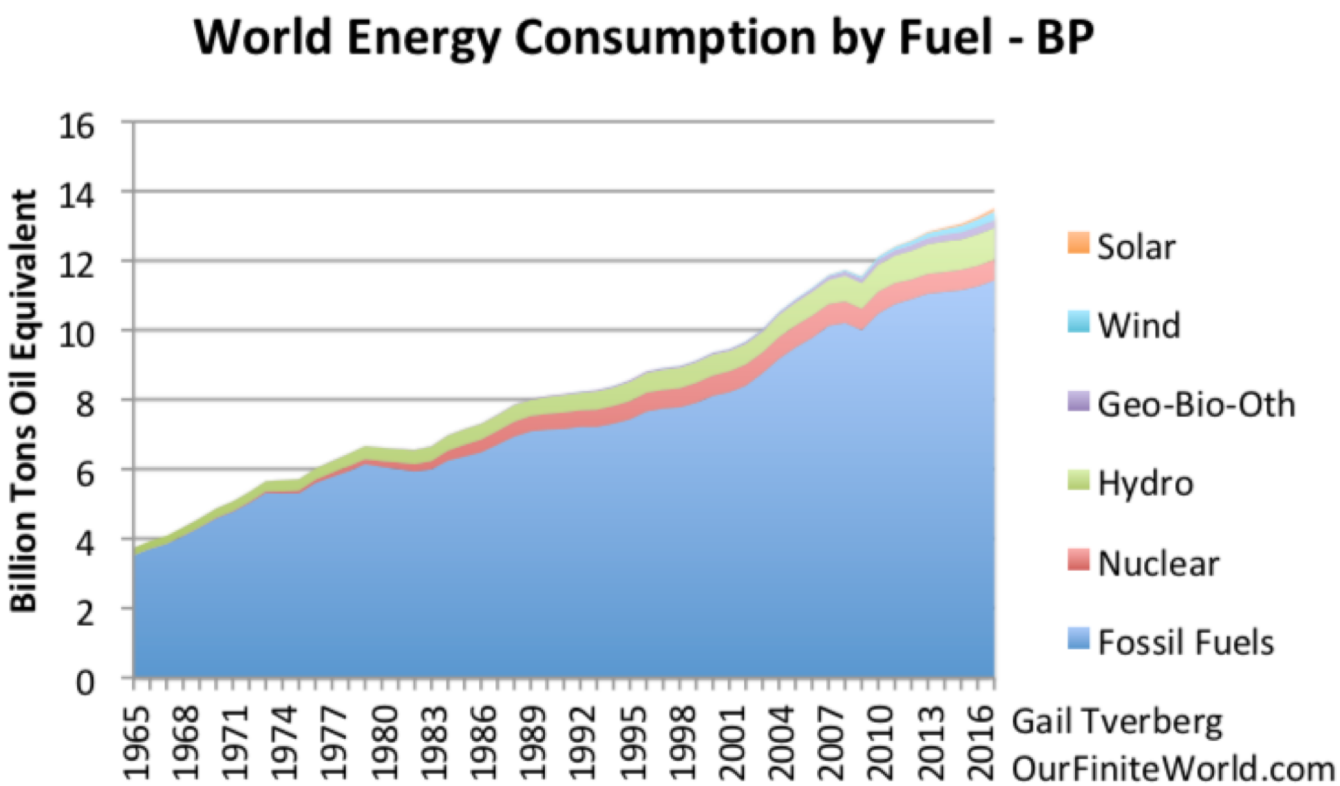
An area graph makes it easier to see the uses of energy growth



China's coal production seems to have peaked; imports tend to be more expensive

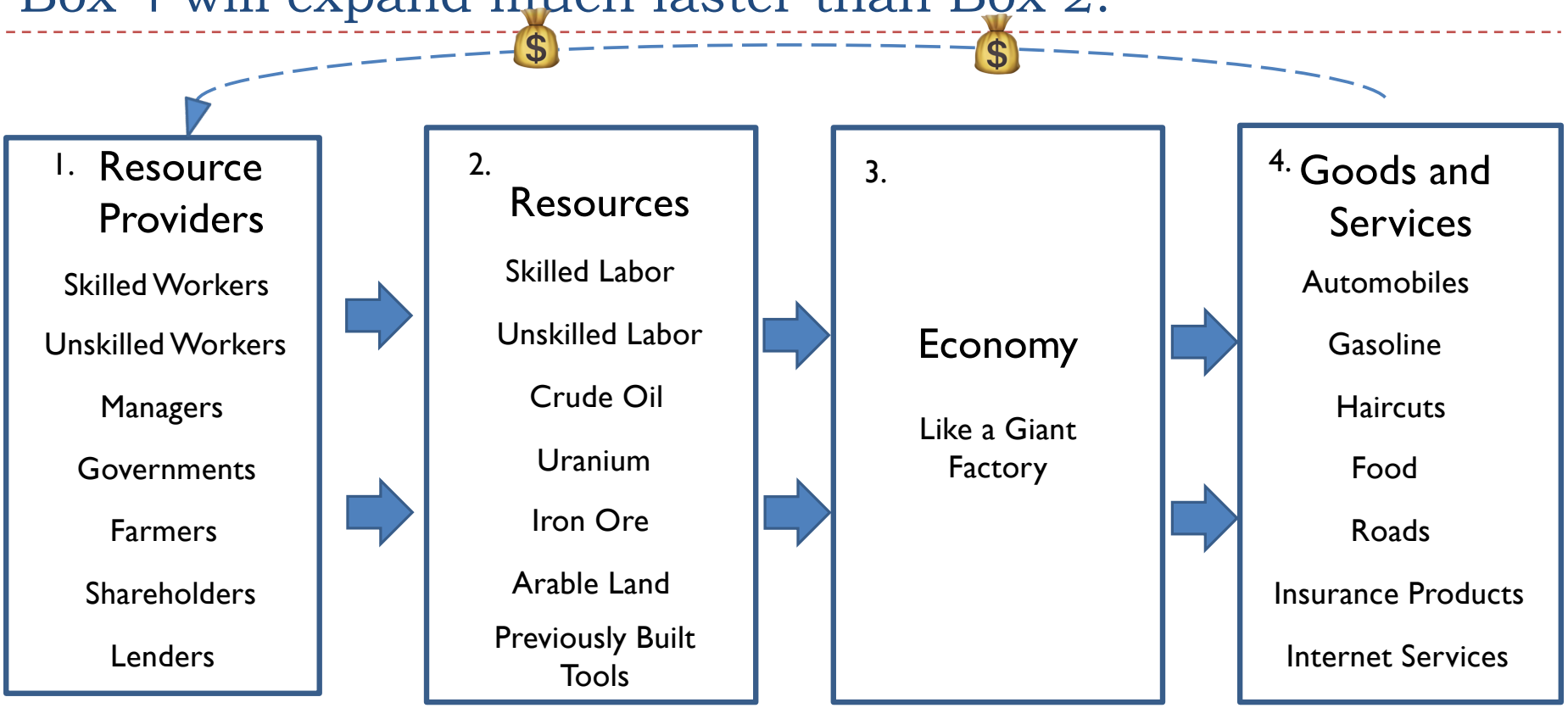


Worldwide, wind and solar are very small



When energy growth is rapid,
all segments of the economy benefit

Economy is like a giant machine. With very rapid growth, Box 4 will expand much faster than Box 2.



Everyone in Box 1 seems to benefit when the world economy is growing rapidly.

- Previously noted: 1940s to 1970s was the period of rapid energy consumption growth
- This is the period when we would expect returns to Box 1 to be highest
  - Interest rates rising
  - Inflation rates high
  - Less wage disparity because bottom 90% of workers get more adequate wages
- This is what we see in practice, in the next slides

1. **Resource Providers**

Skilled Workers

Unskilled Workers

Managers

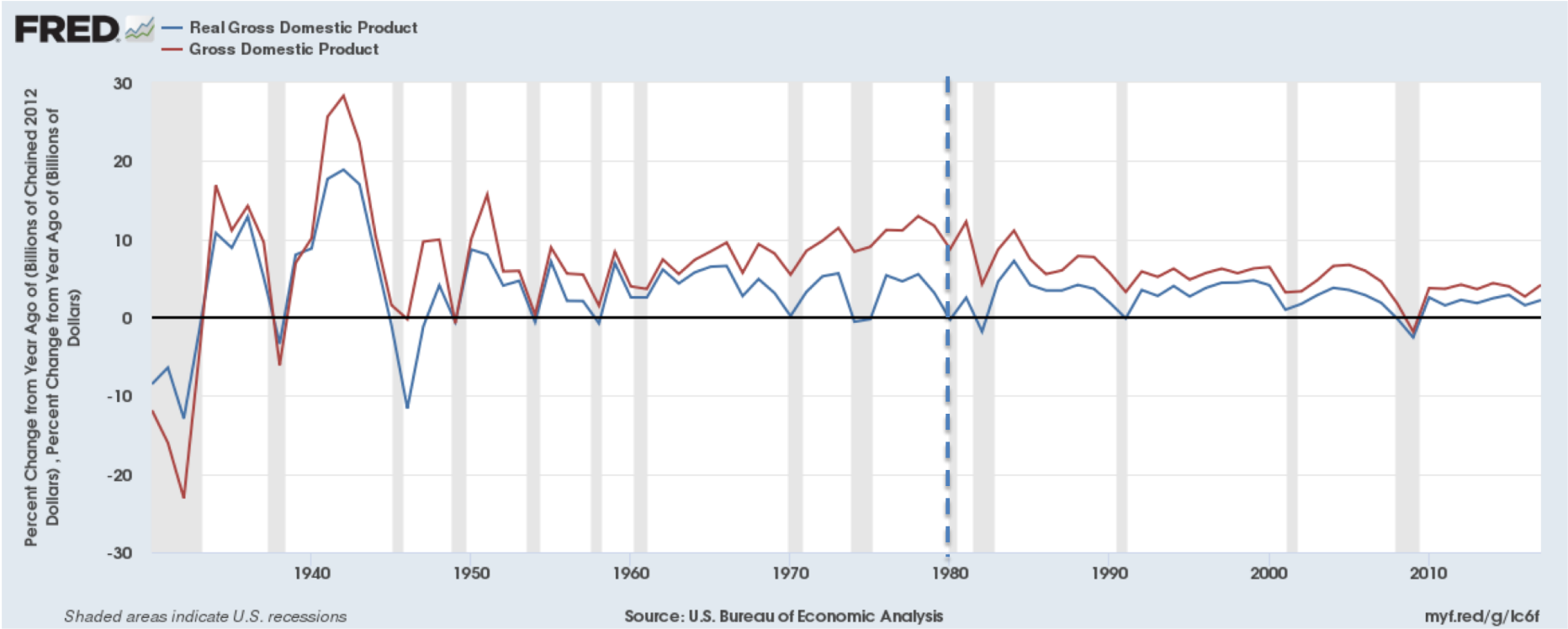
Governments

Farmers

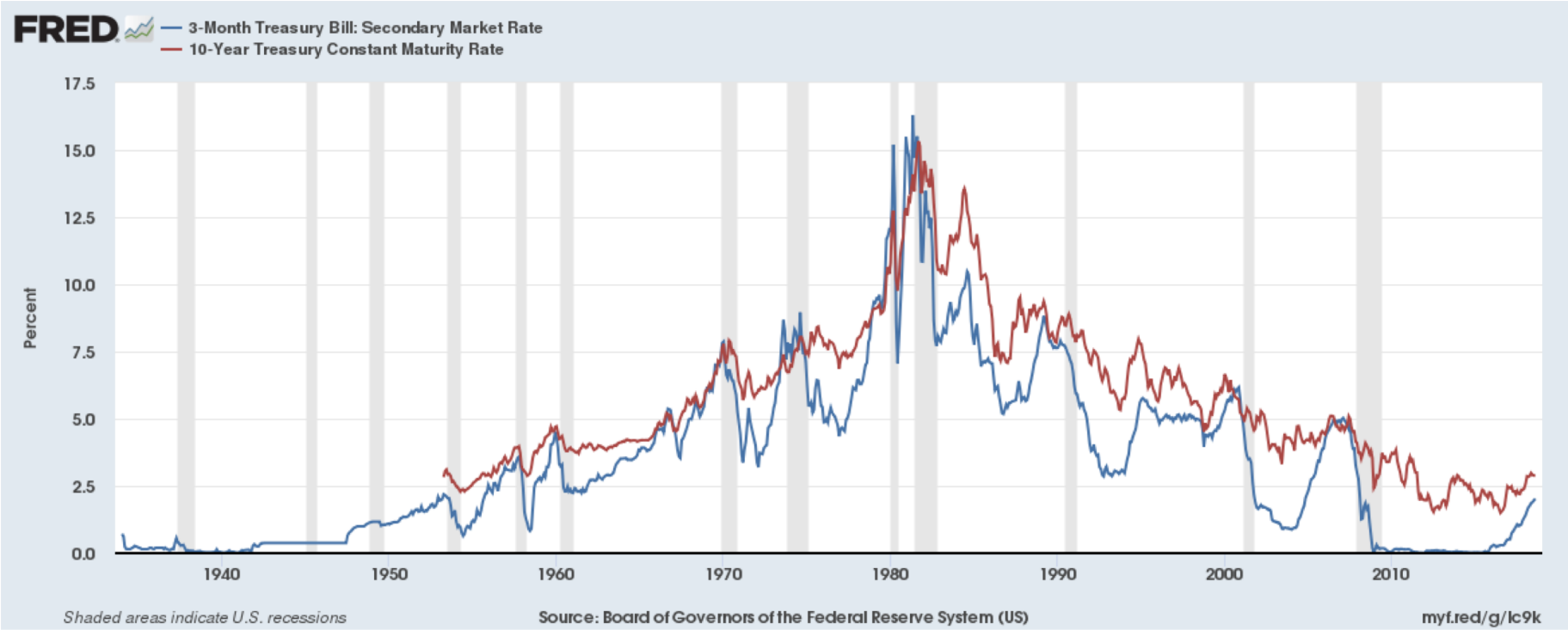
Shareholders

Lenders

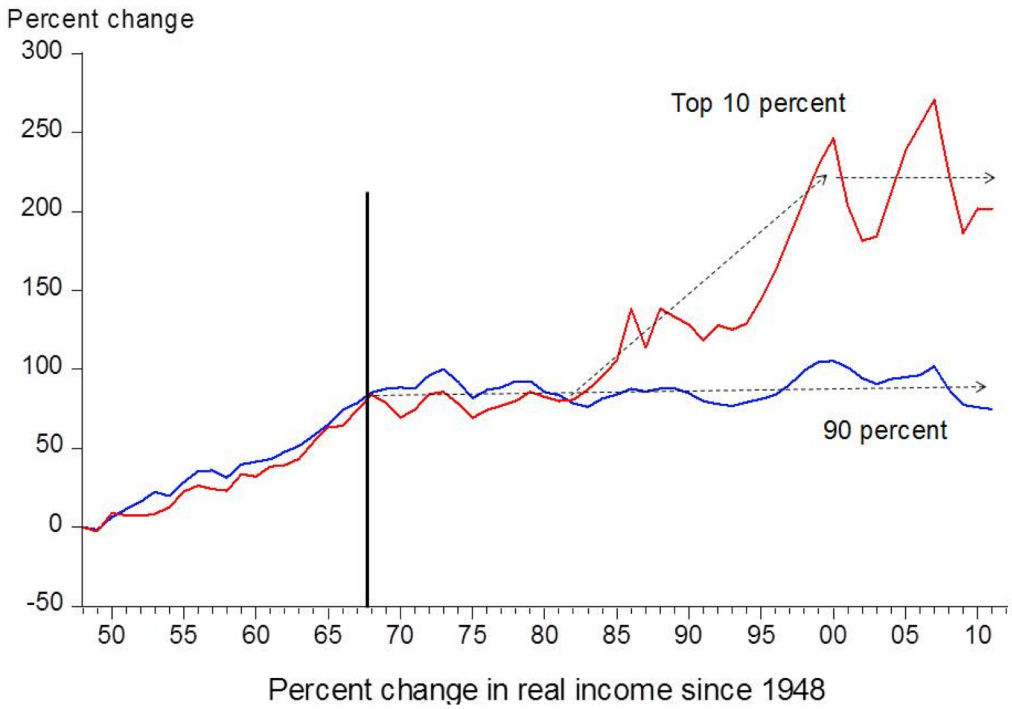
After 1980, both real GDP growth and inflationary changes (red line minus blue line) were much lower



Short and long-term interest rates increased until 1981, then declined.

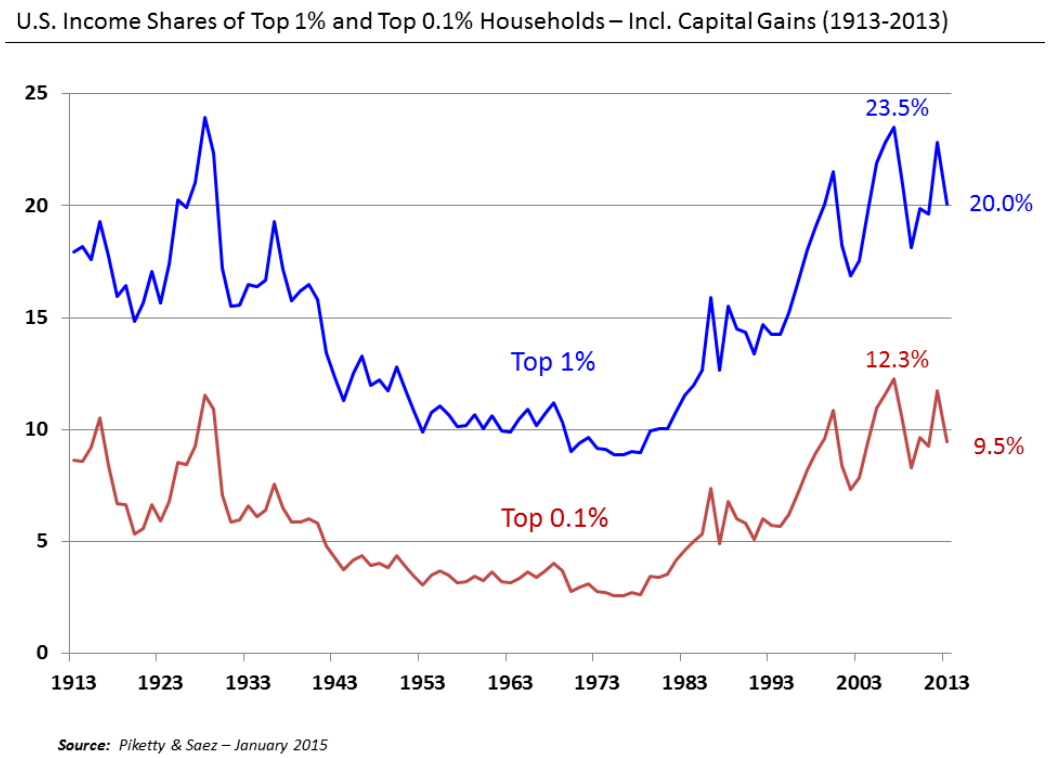


Inflation-adjusted wages of the bottom 90% of workers rose prior to 1968; growth fell behind the top 10% after 1980



Source: Emmanuel Saez, based on an analysis of US Social Security data. https://www.forbes.com/sites/louiswoodhill/2013/03/28/the-mystery-of-income-inequality-broken-down-to-one-simple-chart/#3846850919ea

Today's wage disparity seems to be reaching that of the 1930s



https://en.wikipedia.org/wiki/Income_inequality_in_the_United_States
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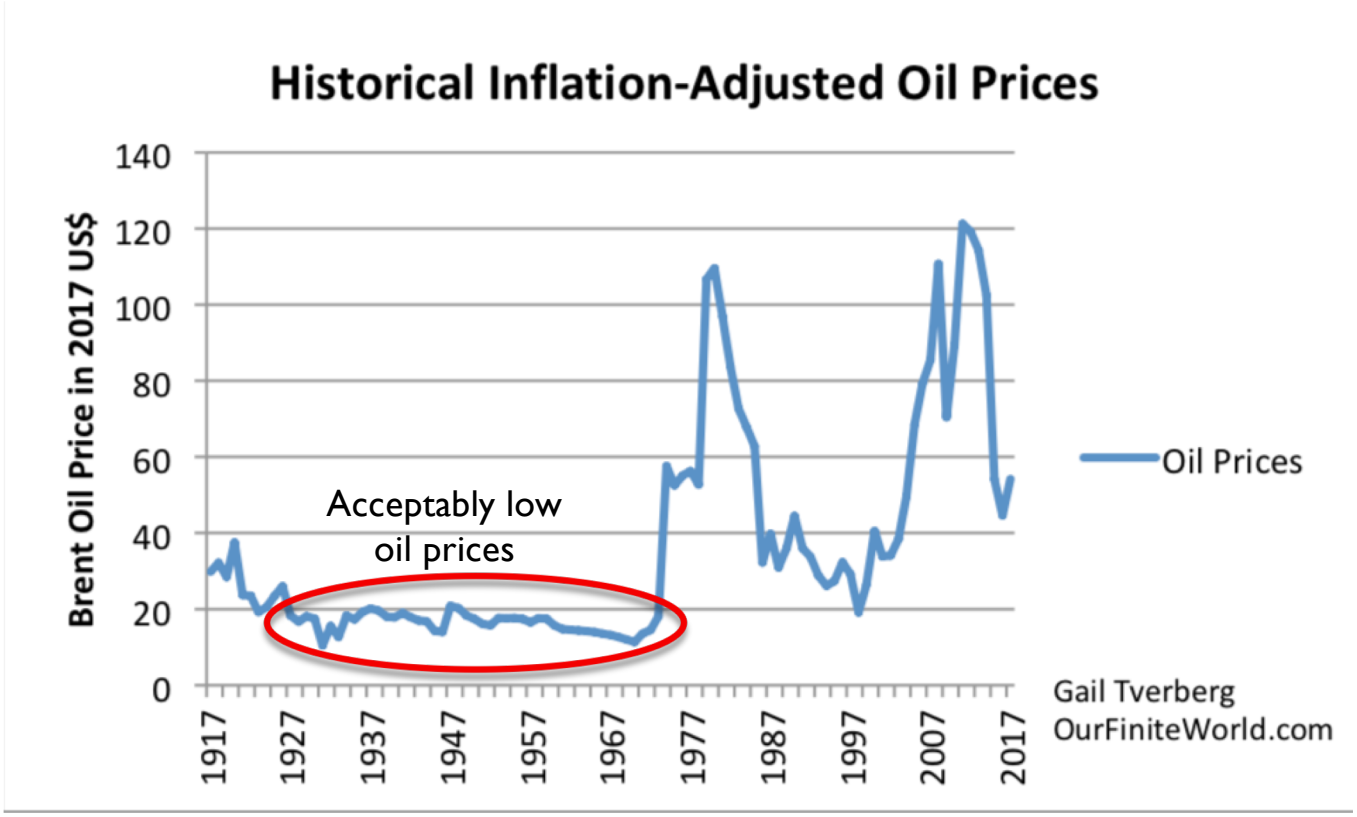
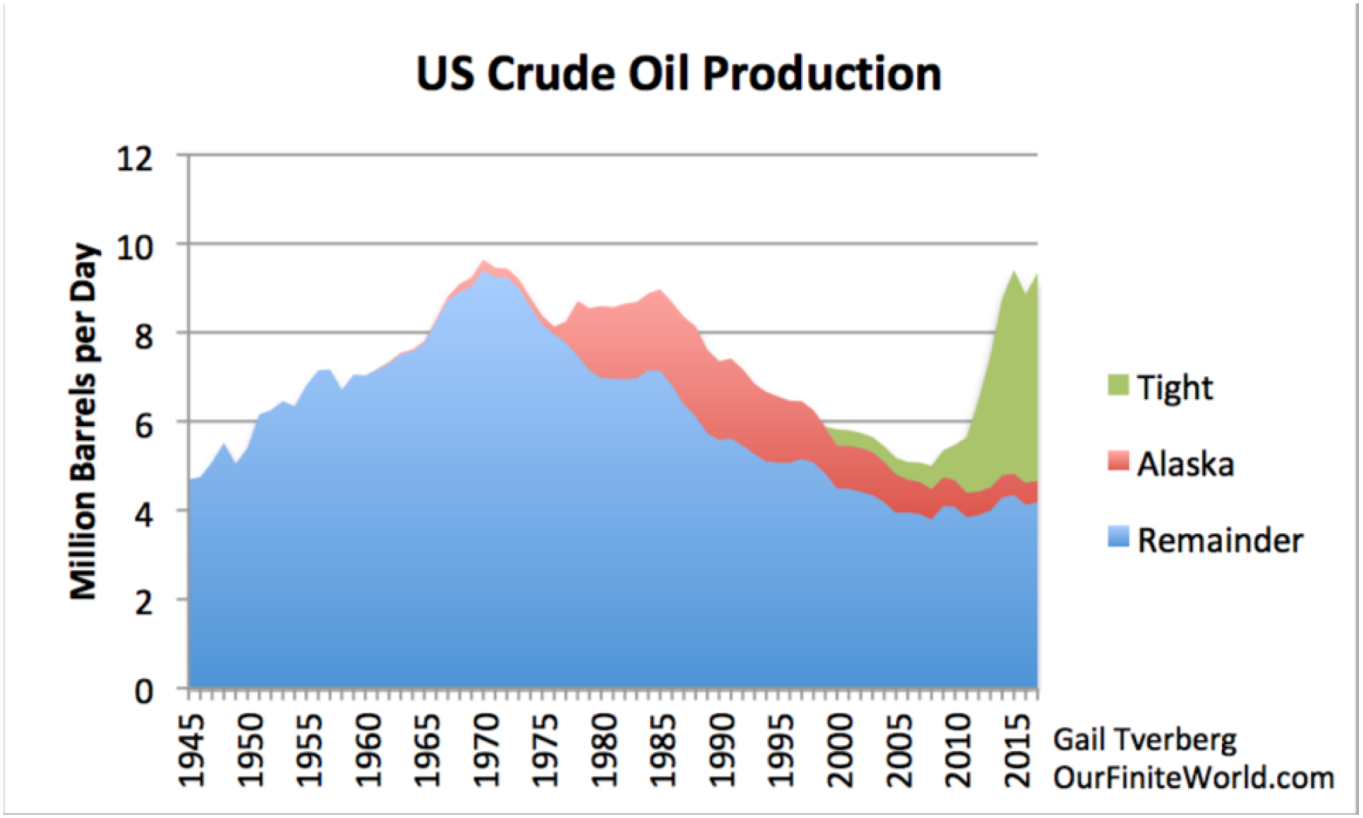
In the 1970s, oil became unaffordable. Its use couldn't grow without lower interest rates and growing debt.



Based on US Energy Information Administration data.

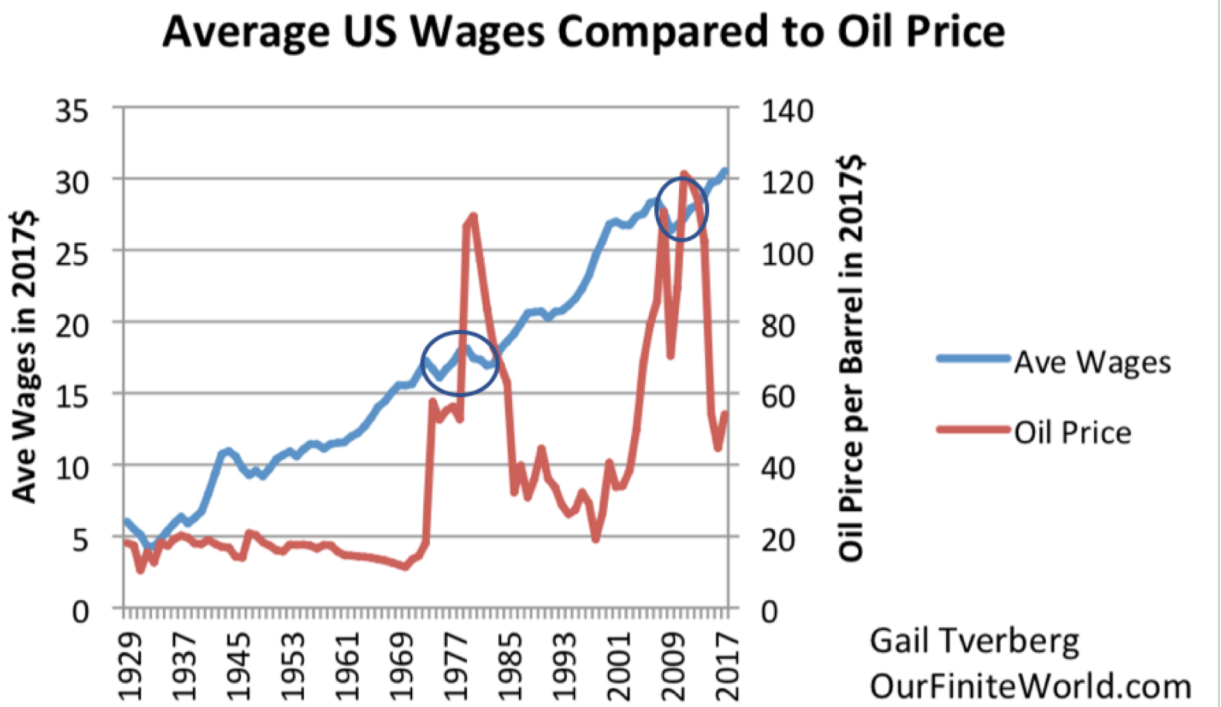
The higher prices came about because very cheap US oil supply depleted and new sources were more expensive.



Based on US Energy Information Administration data.

Inflation-adjusted wages didn't rise with oil prices because the higher costs represented diminishing returns

- Recession occurred instead; lower average wages reflected impact of layoffs



Compares inflation-adjusted wages using BEA data with inflation-adjusted oil prices from 2018 *BP Statistical Review of World Energy*

If energy/food prices rise, but wages do not, this strongly suggests that the economy is becoming ***less*** efficient

- Many assume that energy/food prices will rise, even if wages don't
  - Energy price increases likely to be temporary, before recession begins
- Energy companies and farmers can endure low prices for a few years
  - Take on more debt
  - Delay new investment
  - Eventually lack of new investment reduces production
- Current situation: Too low prices for too long, even with recent price run-up
  - Eventually, likely to lead to lack of production
  - May collapse governments of exporters, as with the Soviet Union in 1991

Geologists created a narrow view of what was wrong

- Geologists felt that we were ***running out of easily accessible oil***
  - Their solution: Find substitutes, regardless of cost
  - Belief was that oil prices would rise if there were a shortage Often False
  - Higher oil prices would eventually make higher-cost substitutes attractive False

- Measuring true costs and benefits of one type of energy is virtually impossible, in a networked system
  - Metrics such as "Energy Return on Energy Invested" or "Energy Payback Period" used
  - Such approaches consider only ***part*** of the costs of a networked system
  - Tend to give misleading results for renewables

My view is that the energy problem is an ***affordability problem***

- Oil and other energy prices tend to move together
  - Even food prices are in this grouping
  - Prices of metals are strongly influenced by energy prices
  - Even if oil is not a big share of people's spending, the total package is
  - Affordability quickly becomes an issue, especially for workers with low wages
- Any country with a high-priced energy mix tends to become non-competitive in the world economy
- Businesses have motivation to cut costs, any way they can:
  - Send jobs to China where wages are lower
  - In China, "energy mix" is also cheaper – mostly coal, less oil

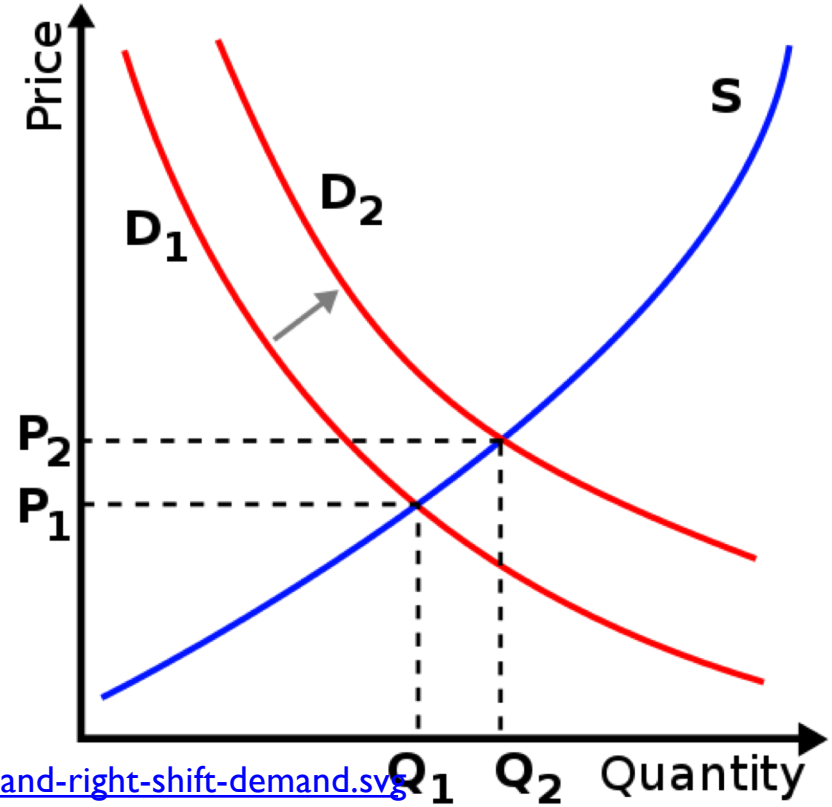
Energy limit is not the quantity of resources in the ground

- Energy limit is the amount that can be ***extracted, profitably***
  - Thus, the energy limit depends upon ***how high the oil price will stay***

- In the next section, I will explain why the maximum oil price depends upon ***how high a debt bubble can be blown***

Low energy supply affects both Supply and Demand, so shortages don't necessarily lead to high prices

- Result is system that does not behave as most people would expect
- Analysis of historical data confirms that the energy system acts in this strange way



From: https://commons.wikimedia.org/wiki/File%3ASupply-demand-right-shift-demand.svg
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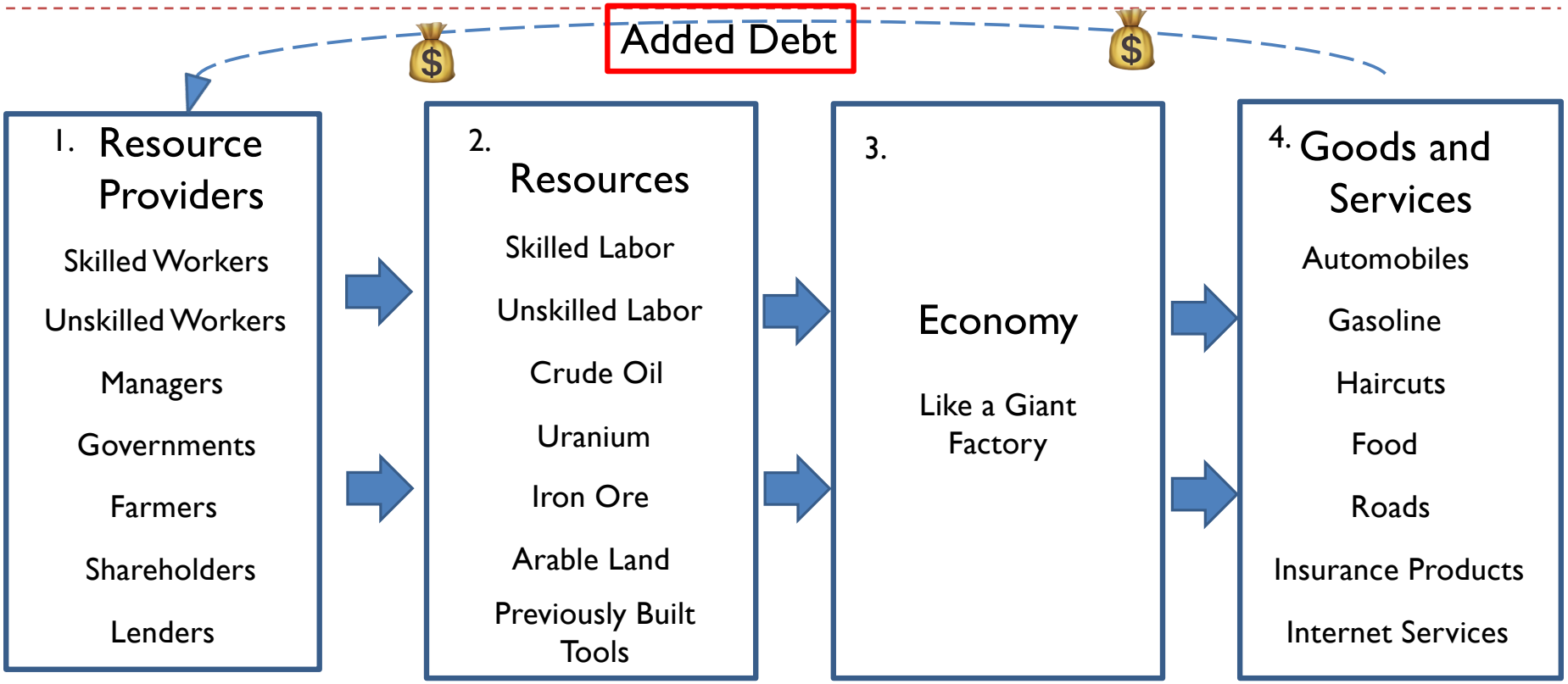
The miracles that added debt can produce

The secret of debt: It acts like a ***promise for future goods and services***

- Our problem in the last section was slowing growth in the production of goods and services (Box 4), relative to inputs
  - With the help of growing debt, the problem of inadequate goods and services can be fixed
  - The promise of future goods and services indirectly acts as a ***promise of low-cost future energy supplies*** to make these goods and services

- No one ever stops to question whether these promises can actually be fulfilled!
  - Promises have mostly worked in the past
  - Clearly (or not so clearly), they will work in the future

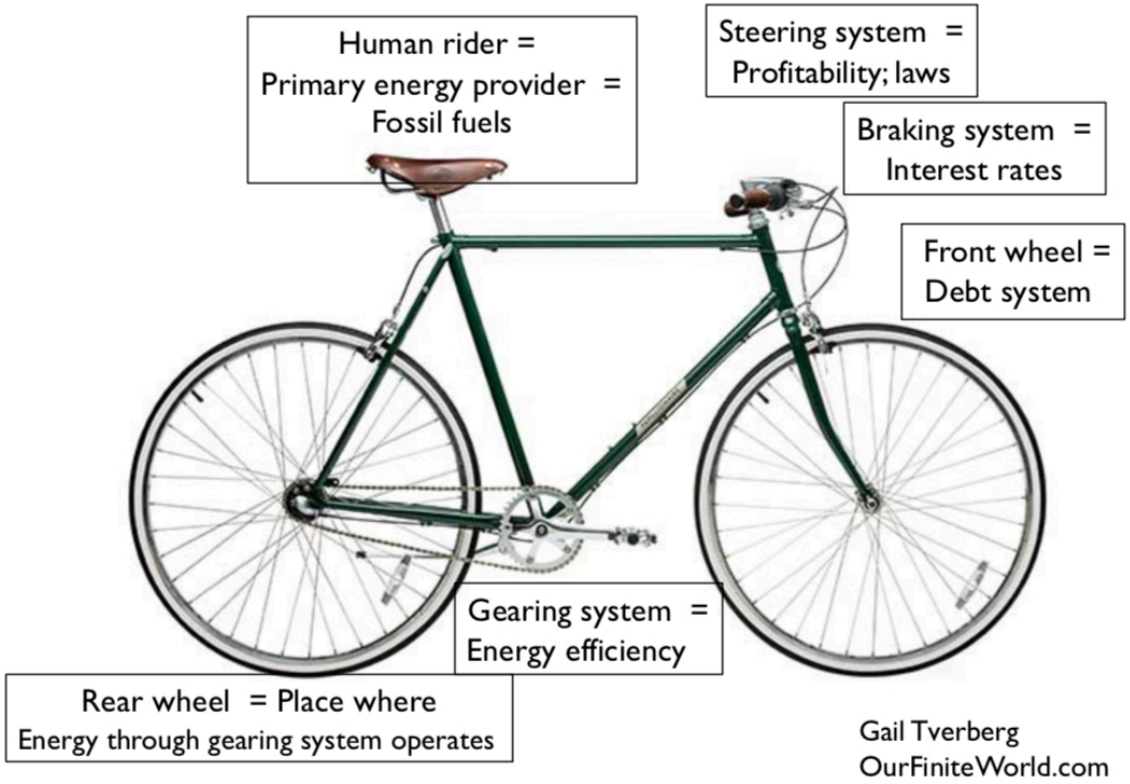
With added debt, we can miraculously pay resource providers with growing debt, not simply goods and services



With added debt, resource providers can think that they are being adequately paid

- Even if the payment is a promise for future goods and services
  - Payment can be in debt or in debt-like promises, such as shares of stock
- The shortfall of not having enough ***actual*** goods and services to pay everyone in Box 1 can be fixed
  - Growing debt provides a true miracle
- With growing debt
  - Businesses can afford to buy new machines, financing them with debt
  - Consumers can afford to buy cars, homes and college educations, financing them with debt
  - Governments can add new programs, financing them with debt

Debt with its time-shifting ability helps pull the economy forward—but it only works if the economy is moving fast enough



If interest rates are falling, the situation is even more helpful for propping up oil prices

- If interest rates are falling, monthly payments on mortgages are falling
- Monthly payment for 30-year mortgage of $300,000
  - At 10% - $2,633
  - At 6% - $1,799
  - At 4% - $1,432
  - At 3% - $1,268
- Allows more people to afford homes, at a given price level
  - Home prices tend to rise
  - Builders build more homes
  - Commodity prices, used in building homes, rise (includes oil, wood, and metals)
  - Encourages the development of oil and other energy products at higher prices

Falling interest rates enable asset price bubbles

- It is easy to see how home prices can be bid up with low interest rates
- Many other "investments" can be bid up to high prices with low interest rates
  - Prices of shares of stock
  - Land prices
  - Values of businesses
- If interest rates are very low, many marginal investments seem to make sense
  - Example: Oil investments in shale deposits look like they might make sense
    - Even though they are cash flow negative
    - Everyone assumes that oil prices will rise, sometime
    - Life insurance companies seem to be big investors in these, because of their high yields

Asset bubbles give a false sense of security

- Assets are reported to be worth rising $$$
- OK to borrow against them, to buy more goods and services
  - Acts to increase demand for goods and services
  - Indirectly, increases energy prices and other commodity prices
    - Encourages more marginal investments in oil, coal, gas, renewables, metals, etc.
- It is these asset bubbles that hold oil prices above $20 per barrel
- The limit to energy extraction depends upon **how high the debt bubble can be made to rise**
  - Higher debt => Higher commodity prices => Higher extraction

Unfunded government pension plans are also debt-like in nature

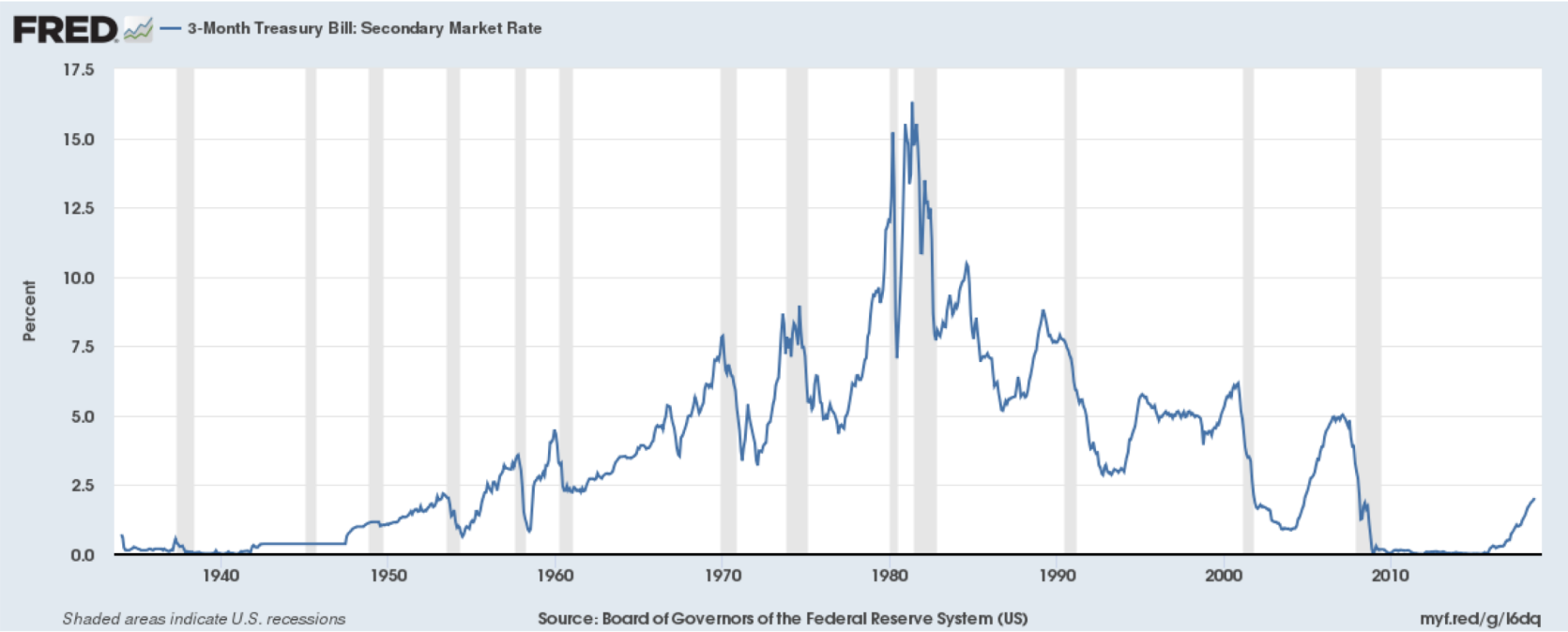
- Pensions indirectly promise workers future goods and services
  - These goods and services can only be made using energy
  - Indirectly, these promises are ***promises of inexpensive future energy supply***

- Without pensions, citizens need to fund old-age care themselves
  - Tend to have many children
  - Hope some outlive parents

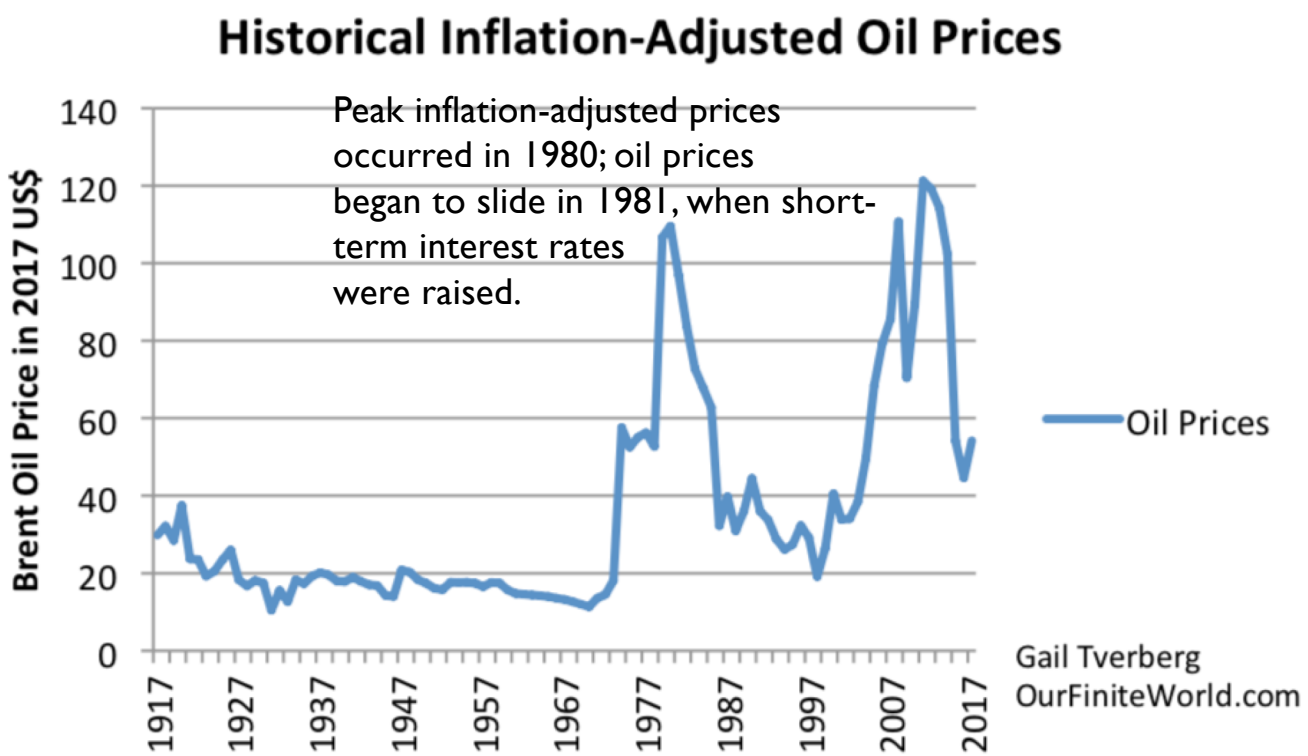
- Pensions allow mothers to have fewer children
  - Early years: Pump up production of goods and services as women enter workforce
  - Later years: **Reduce** goods and services production as population ages and fewer elderly ***need*** to work

Governments are aware of the power of short-term interest rate adjustments

- Often raise interest rates to pop debt bubbles and to reduce energy prices!

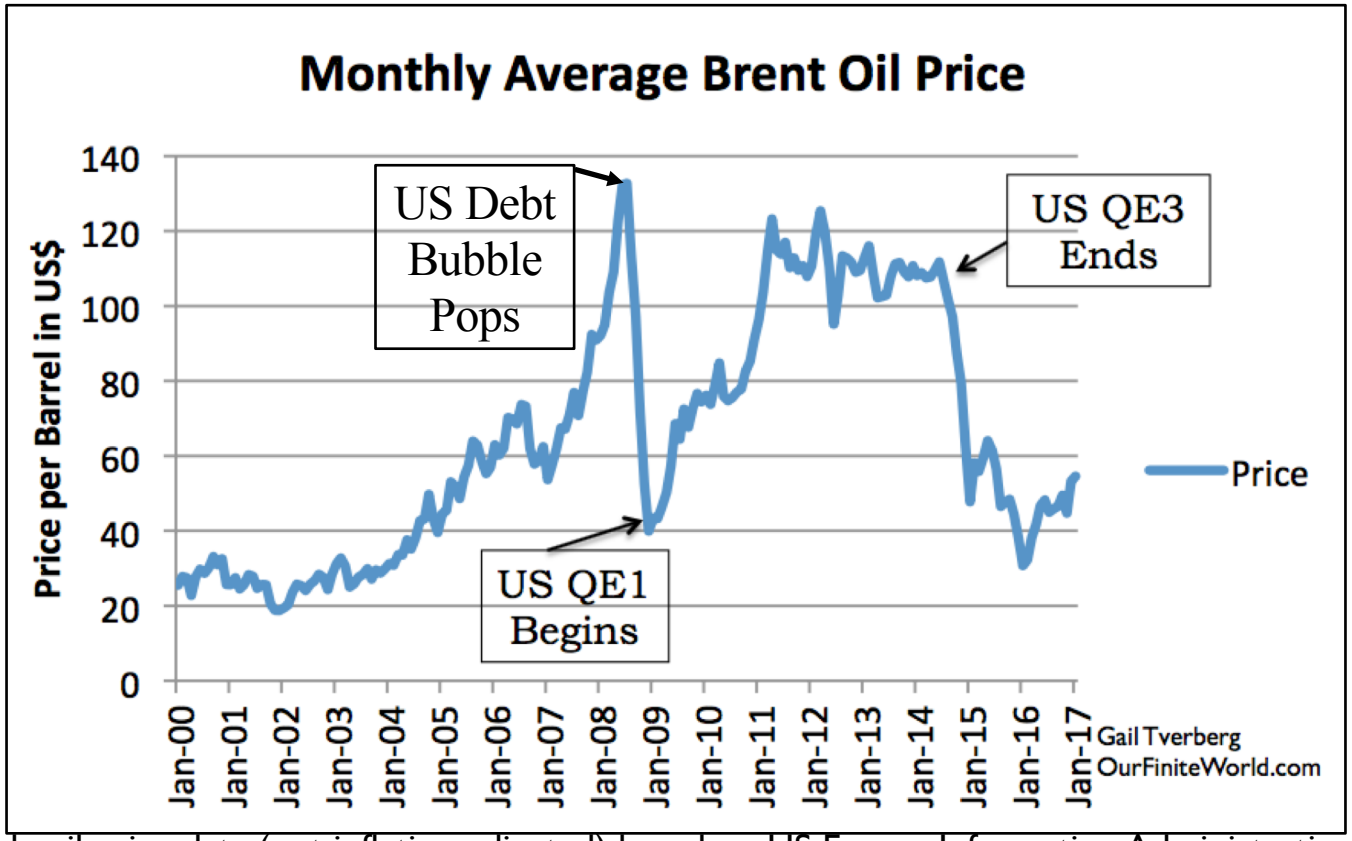


If we look at historical oil prices, we see that these prices are very much influenced by interest rate adjustments



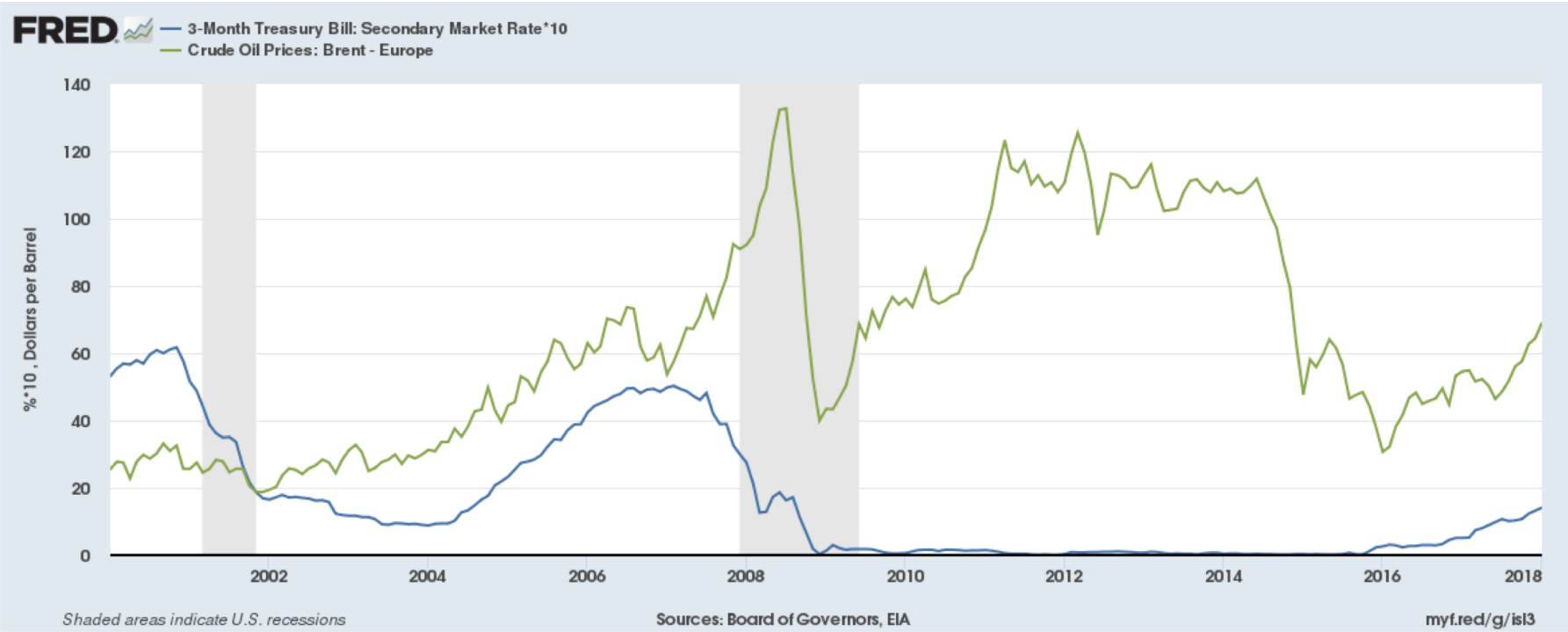
Based on inflation-adjusted oil prices of 2018 *BP Statistical Review of World Energy*.

We also see that interest rate changes tie in with recent oil price changes. Oil price peaked in July 2008.



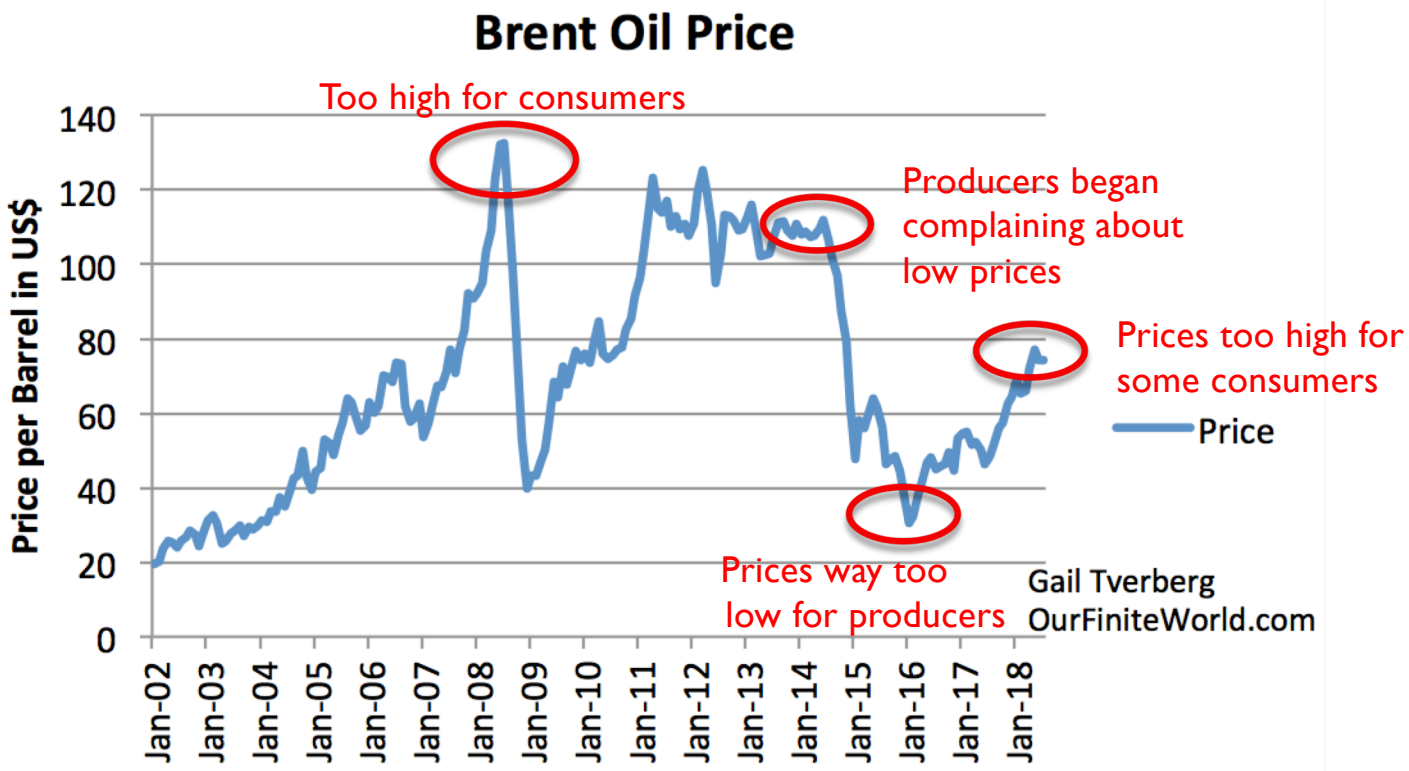
Monthly oil price data (not inflation adjusted) based on US Energy Information Administration data

The Federal Reserve seems to have induced the Great Recession by first lowering, then raising, interest rates



(Also see Slide 43)

Current predicament: No oil price works for both buyers and sellers



Oil prices are monthly averages, without inflation adjustment, based on US Energy Information Administration data.

Current US interest rate direction is concerning

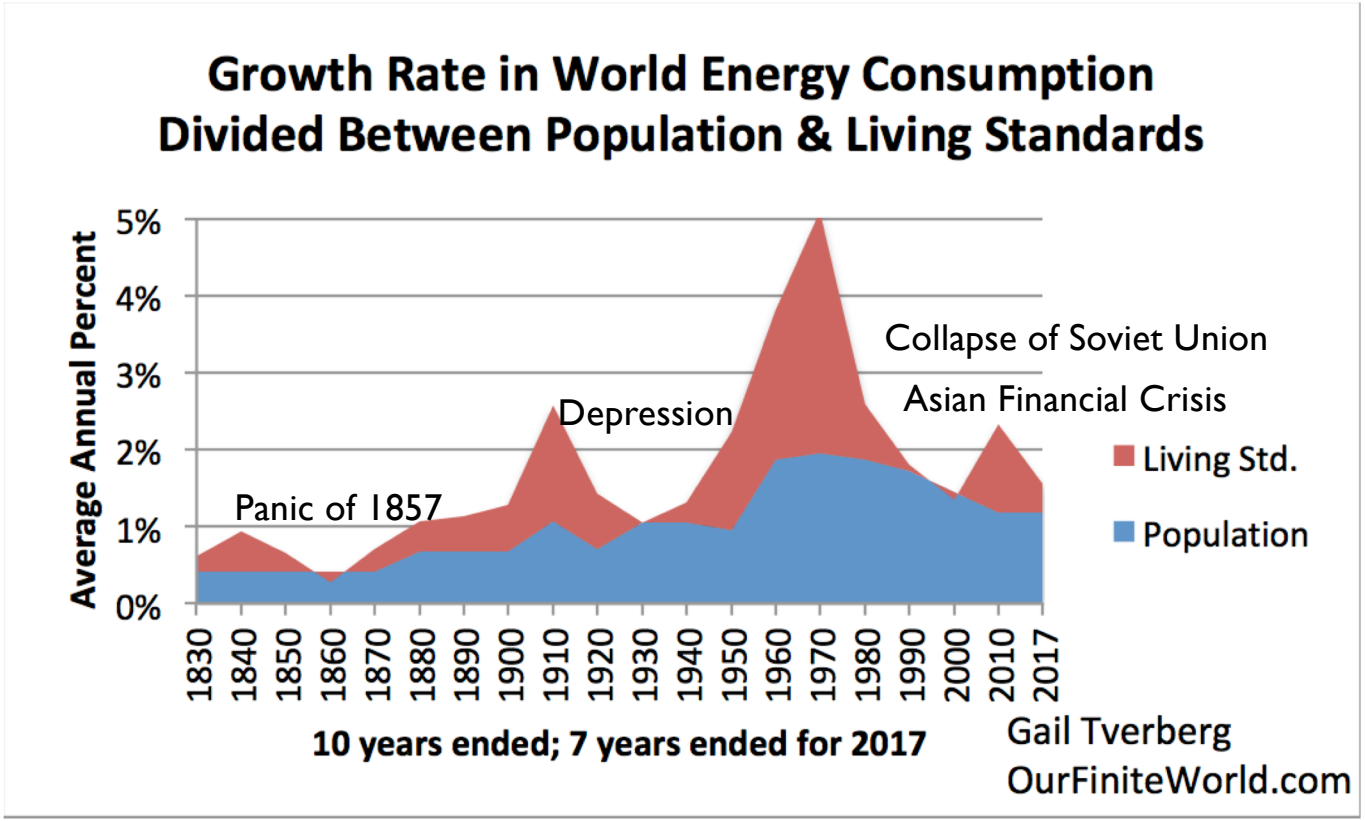
- Federal Reserve officials are taking two actions simultaneously
  - Raising short-term interest rates
  - Selling securities previously bought with Quantitative Easing
  - ***Doubles up impact***

- Effect is likely to pop the world debt bubble
  - May somewhat spare the US, at least temporarily
    - Reason: Rising US interest rates attract investment

- Likely outcome
  - Severe recession, starting especially outside the US
  - Lower oil and other energy prices
  - Lots of debt defaults; falling asset prices

What really happens when economies hit energy limits

We earlier looked at what happened when peak increases in energy consumption took place. We can also look at troughs.



All of these troughs are associated with ***low demand*** and low energy prices

- Panic of 1857: Successive failure of banks and businesses following unwinding of a debt bubble. Many bank and business failures. Seems to have been one of the causes of the US Civil War.

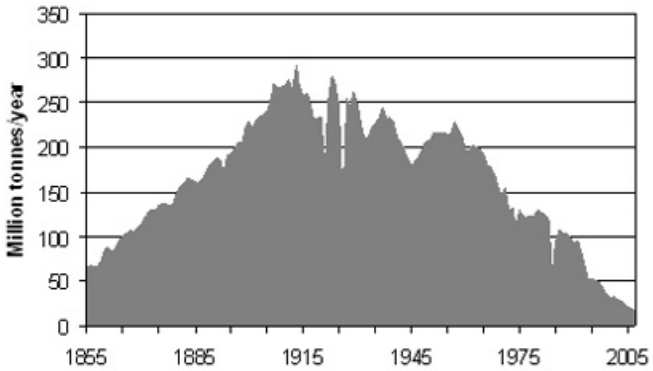
- 1920-1940: Early mechanization and growing immigrant population led to wage disparity. Also, loss of stimulus from WWI. Tariffs added in 1920s. Debt bubble popped in 1929. Low oil prices and oil glut. Depression of 1930s, finally eliminated with WWII.

- 1990-2000: Collapse of central government of Soviet Union in 1991. Japan real estate debt bubble unwound. 1997 Asian Financial Crisis.

Peak coal in UK occurred at time of World War I, and Peak Coal in Germany at time of World War II. Led to Wars?

Peak Coal in UK, at time of WWI

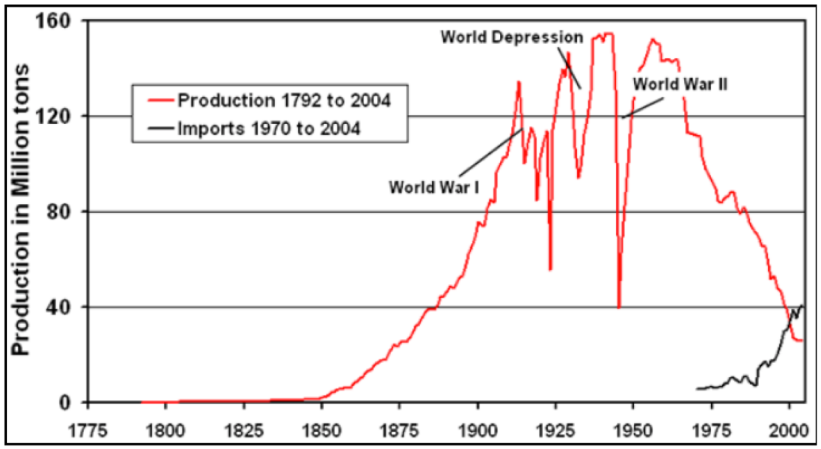
Coal Production in the UK by David Strahan



Source: http://www.davidstrahan.com/blog/?p=116

Peak Coal in Germany, at time of WWII

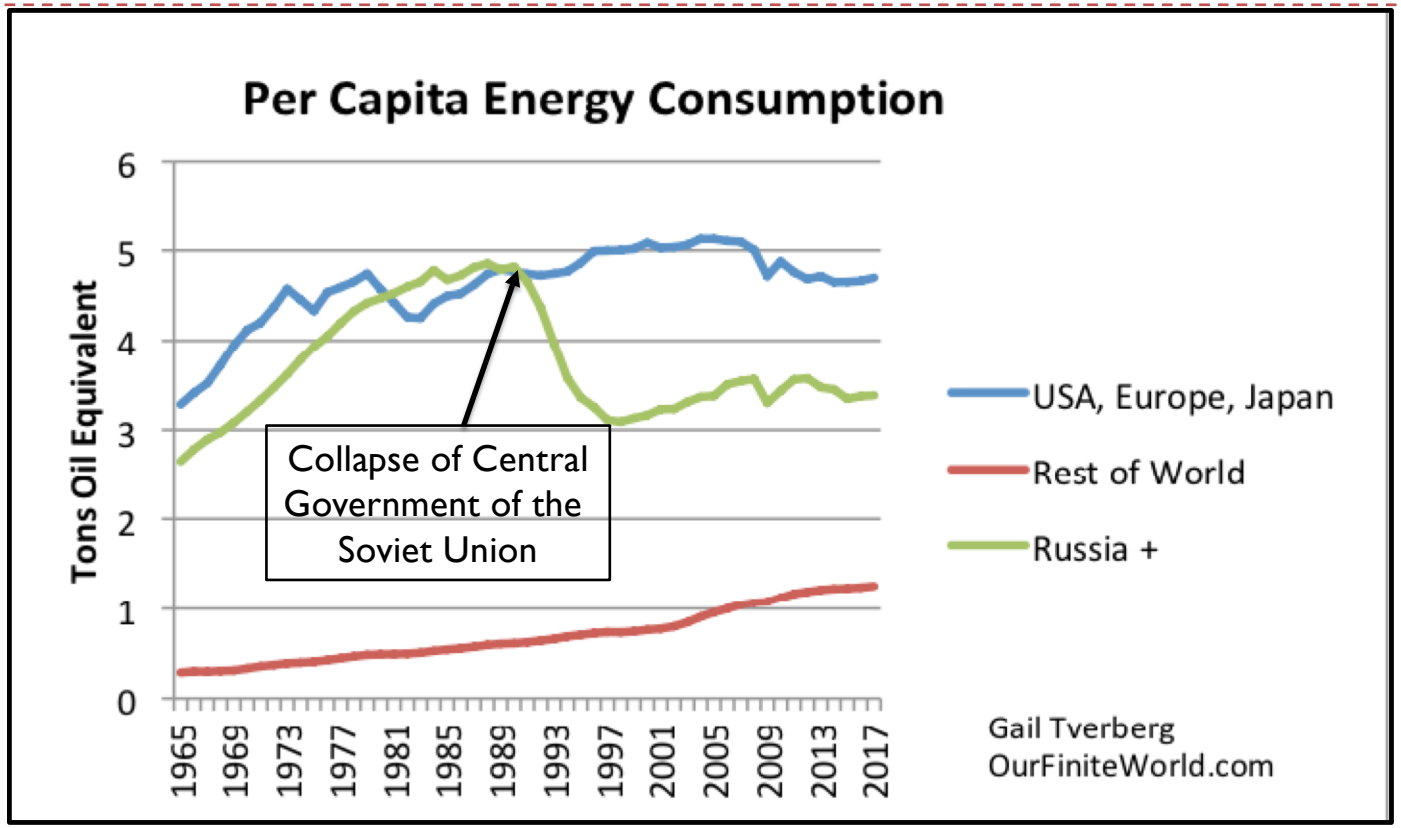
Hard Coal production in Germany (today's borders) 1792-2002 and imports 1975-2002.



Hard Coal production in Germany (today's borders) 1792-2004 and imports 1970-2004 Source: *BGR*

Source: BGR https://www.bgr.bund.de/EN/Themen/Energie/Bilder/Kohle_Reserven_Bild1_g_en.html?nn=1547280

Collapse of central government of Soviet Union had a dramatic impact on its long-term energy consumption



Based on 2018 BP Statistical Review of World Energy data.

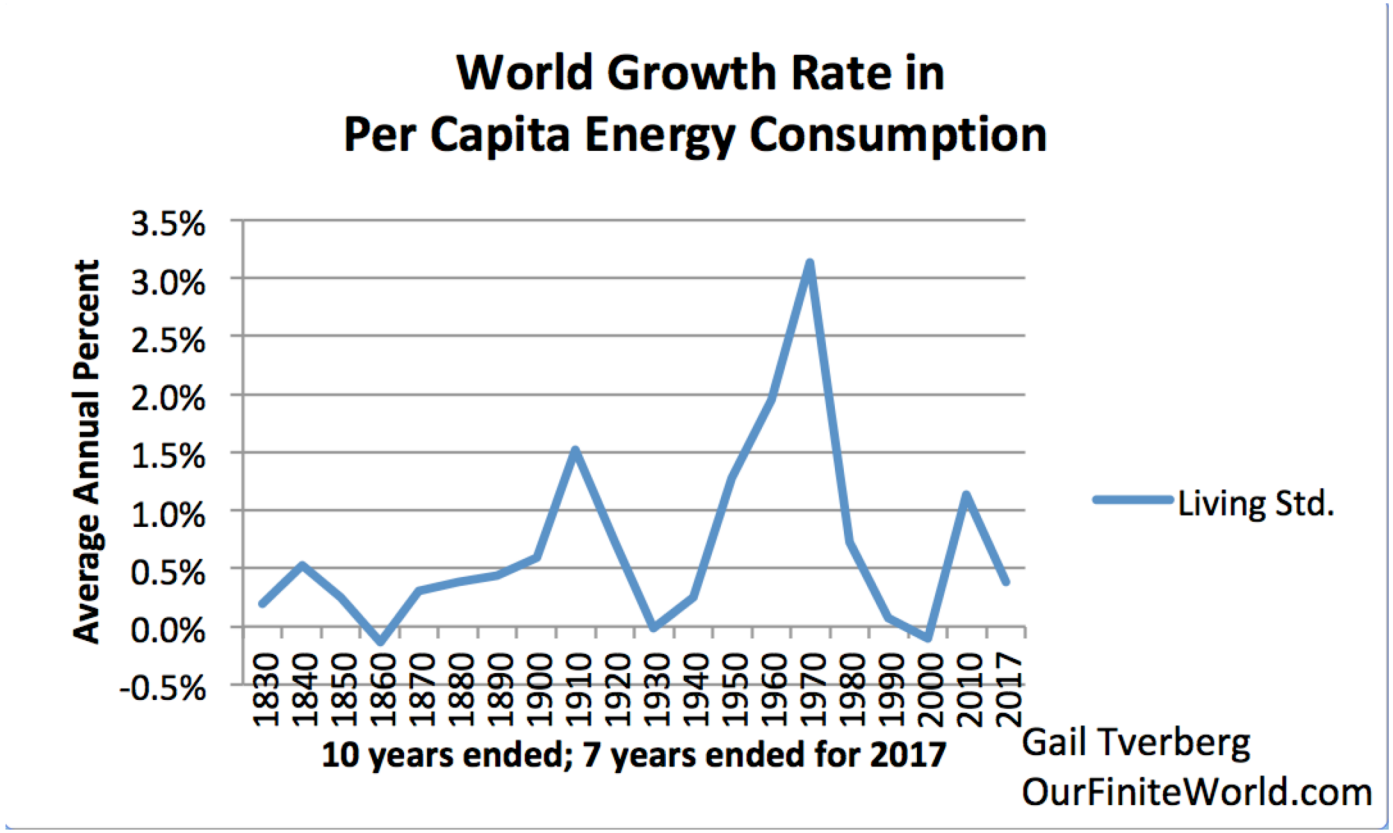
Analyzing ***energy consumption per capita troughs***, we don't see high prices. Instead we see

- Discord and fighting, sometimes leading to wars (Civil War, WWI, WWII)
- Added tariffs (1920s)
- Commodity prices that fall too low, rather than rise too high
- Government collapses (Soviet Union in 1991)

The problem is an ***affordability issue***, not a "running out of supply" issue

- Since it is an affordability issue, it tends to affect all commodities simultaneously
  - This is why the US government talks about "volatile food and energy prices"

There is also no evidence that energy consumption per capita can be made to go negative, due to efficiency gains



Conclusions

Conclusions

1. The energy story most of us have heard is very distorted. Most of the fossil fuels that seem to be available are likely to be left in the ground, because oil and other ***energy prices cannot be made to rise high enough***.

2. The critical factor in keeping our economic system operating is keeping the debt bubble rising. The primary way this is done is by lowering interest rates.

3. At some point, raising the debt bubble further becomes impossible. The US Federal Reserve seems to be intent on bubble popping. This can be expected to cause recession.

Conclusions (continued)

4. The desire to pop debt bubbles is concerning because doing so could lead to a substantial drop in oil and other energy prices. These lower prices could lead to lower oil and other energy production and to very adverse impacts on the economy.

5. The chain reaction started by popping debt bubbles holding up asset prices could have a seriously adverse impact on financial institutions, including insurance companies.

6. In many ways, we are now in a situation that is similar to 2007, when things still looked good, before the debt bubble popped. Today also looks a lot like the bubble days of 1929. If the debt bubble is popped, the economy could spiral downward to serious recession or depression.

Conclusions (continued)

7. The United States might be somewhat protected from interest rates manipulations, if the result is to send financial and economic problems to other countries because of changes in currency relativities. Longer term, the interconnectedness of the system strongly suggests that our current worldwide economy cannot continue indefinitely.

8. Even though the indications appear dire, somehow the world economy has been saved through a huge number of (seemingly) chance occurrences. The growth of China and the rest of Asia has kept the world economy operating since 2000 by reducing overall manufacturing costs, using coal and low-waged workers. We now need another comparable solution. Wind and solar do not work well enough to qualify.

Insurance companies are in the business of providing certainty

- The more closely we look at the situation, the clearer it becomes that this certainty cannot really exist
- This is related to the fragility of the system

Implications for Property and Casualty Insurers

1. Don't expect long-term interest rates to rise materially. The problems causing low long-term interest rates are systemic.

2. Insurers may, in the next couple of years, start seeing problems with the asset side of their balance sheets. Bonds may start to default; stock prices may drop substantially.

3. Insurance companies may revisit similar problems to those of the Great Recession, or even worse, if a new major recession occurs. For example, laid off workers may choose to file Workers' Compensation claims. Financial guarantee insurance may see a large increase in claims.

Implications for Property and Casualty Insurers (cont.)

4. Supply chains are likely to become more fragile. Necessary spare parts for repairs may not be available. Standard medicines may also be lacking.

5. Electrical problems seem quite likely. The whole discussion of "running out of oil" is based on a flawed understanding of the problem. We may have electrical problems sooner than oil problems, in part because of the difficulty in maintaining transmission lines.

6. Governmental programs, such as Flood Insurance, Social Security, and Medicare may be cut back, because of difficulty in collecting adequate tax revenue. In some cases, programs may be handed over to the states.

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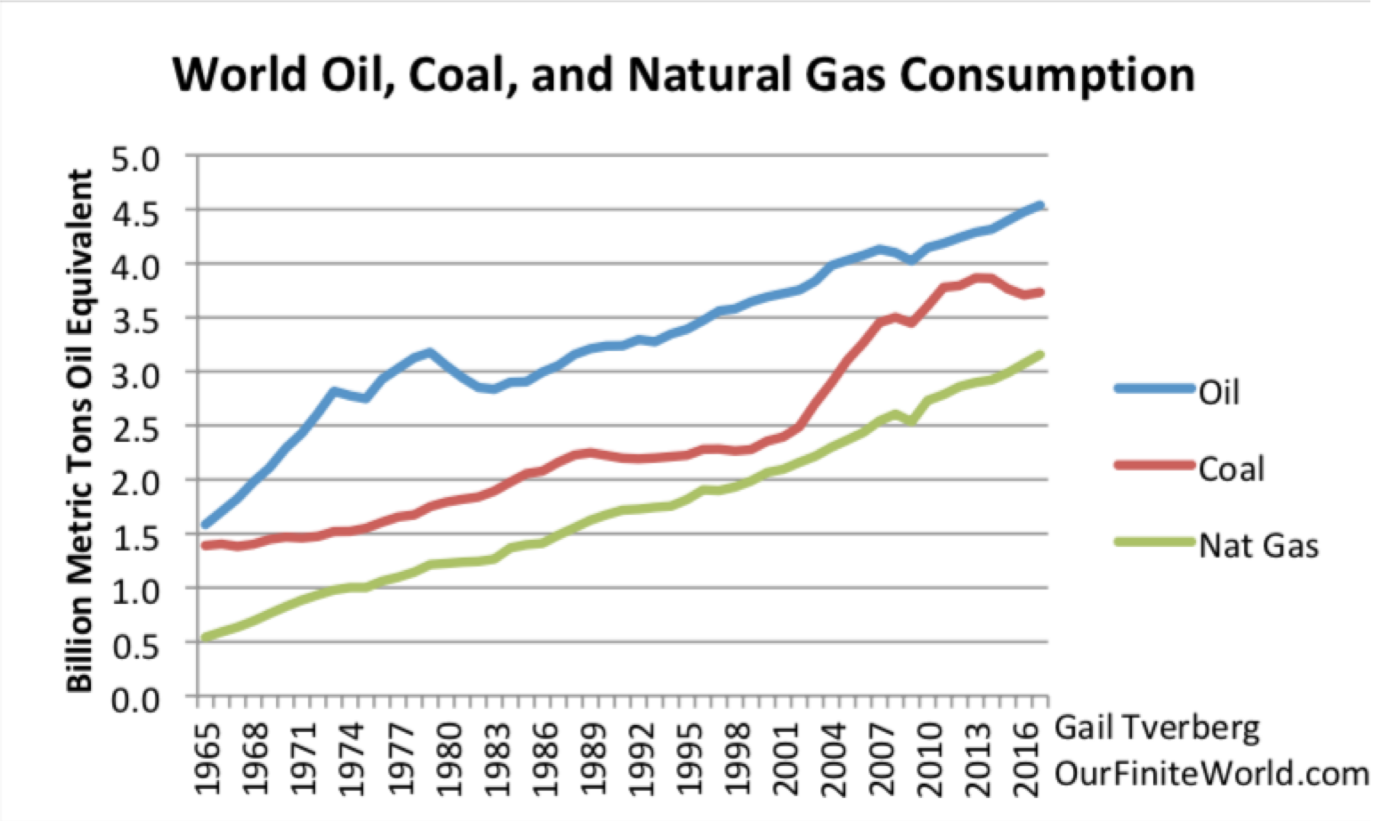
Odds and Ends of Other Slides

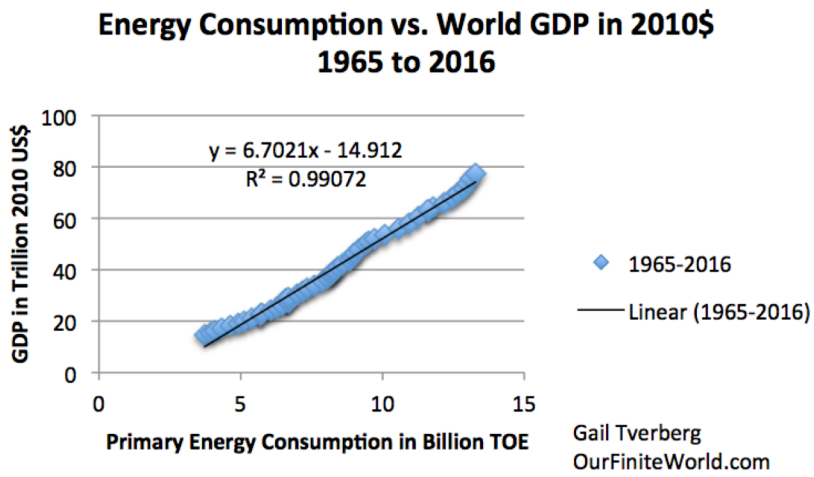
What kinds of ***energy***? The big three are oil, coal and natural gas.



Economic growth requires energy growth because of the laws of physics

- It takes energy "dissipation" to heat objects and to make them move

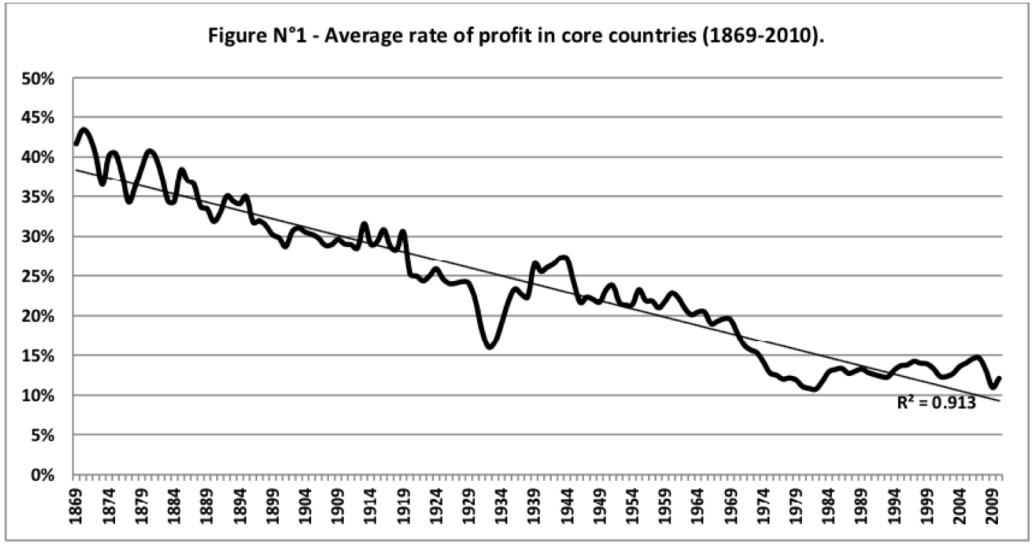
- Allows many important changes
  - Cooking of food
  - Smelting of metals
  - Elimination of unwanted microbes
  - More food per acre
  - Fewer farmers
    - More workers in other parts of the economy



Growing complexity/technology has limits, too

- One limit is diminishing returns
  - Example: First road added provides more benefit than later roads
  - Example: Early antibiotics provided more benefit than later drugs

Total Profits / Capital Invested



Esteban Ezequiel Maito: The historical transience of capital: the downward trend in the rate of profit since XIX century

https://mpra.ub.uni-muenchen.de/55894/1/

Another limit to growing complexity is wage disparity

- Wage disparity occurs for several reasons
  - Extra education for some, but not all
  - Extra administrative responsibilities for some, but not all
  - Globalization adds competition from low-wage countries
  - Mechanization substitutes for more routine jobs

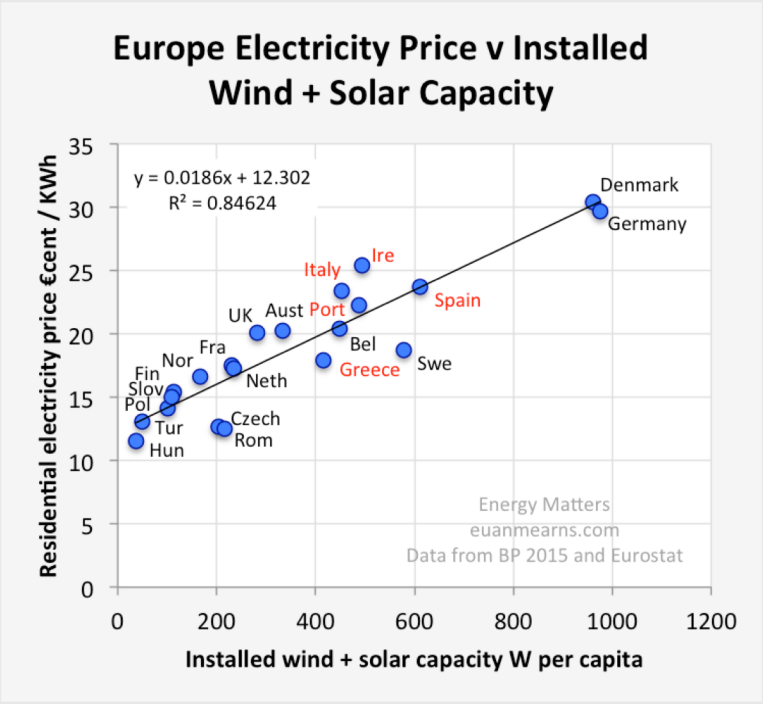
- Wage disparity tends to reduce the share of the population ***who can afford to buy the goods and services*** that the economy produces
  - How many young people in the US can afford to buy a new home?
  - How many workers in India can afford to buy a car?

Humans' domination of planet came about using burned biomass as a tool

- Over one million years ago, pre-humans learned how to burn biomass in a controlled way
  - Allowed cooking of food; more nutrition with less effort
  - Allowed larger brain; smaller teeth, jaws and guts
  - Now humans are adapted to consuming some cooked food
- Allowed humans to kill large animals for food
  - Cave evidence
    - Lower level: No evidence of fire; bones showed big "cats" in charge
    - Upper level: Evidence of fire; humans clearly eating the big cats, based on bone evidence
- Current huge use of fuel is an extension of what humans learned very early
  - Because of need to eat some cooked food, humans require some supplemental energy

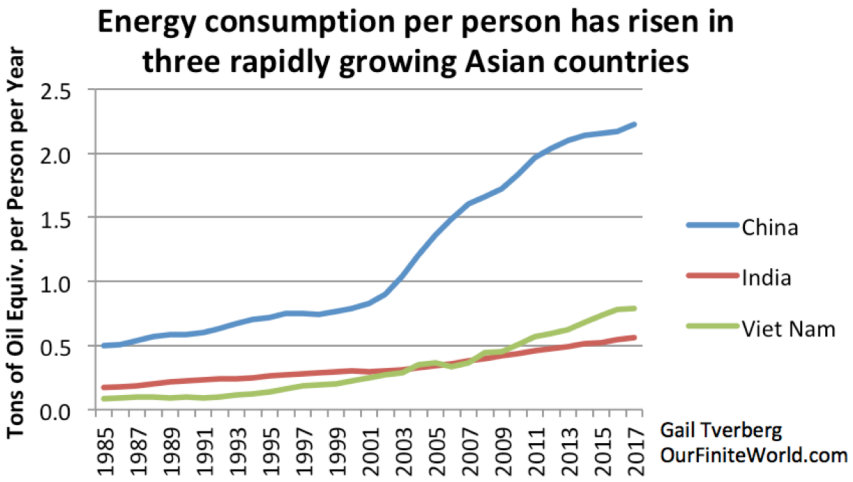
Wind and solar tend to be disruptive to the grid and expensive, when installed costs are counted

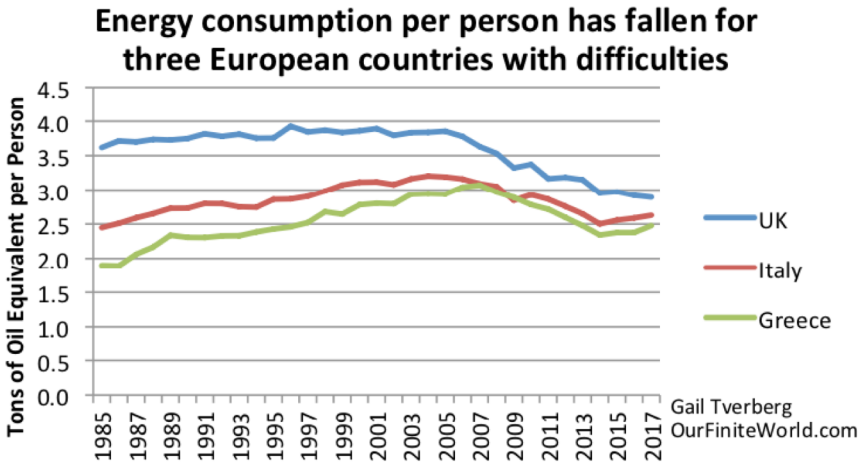
- Allowing wind and solar to "go first" is a major subsidy
  - Disrupts normal pricing
- W + S generally need other subsidies, besides going first
  - Politically popular
  - Appear to use less carbon, if costs are not counted too carefully
  - Act like leaches, sucking energy from the rest of system



Source: http://euanmearns.com/an-update-on-the-energiewende/

If energy consumption per capita is flat, growth of winners doesn't really offset slowdown of losers





My view of the economy as a dissipative structure

- Acts much like a rocket, thanks to "Other Energy"