

The economy is approaching near-term collapse,
not peak oil. The result is quite different.

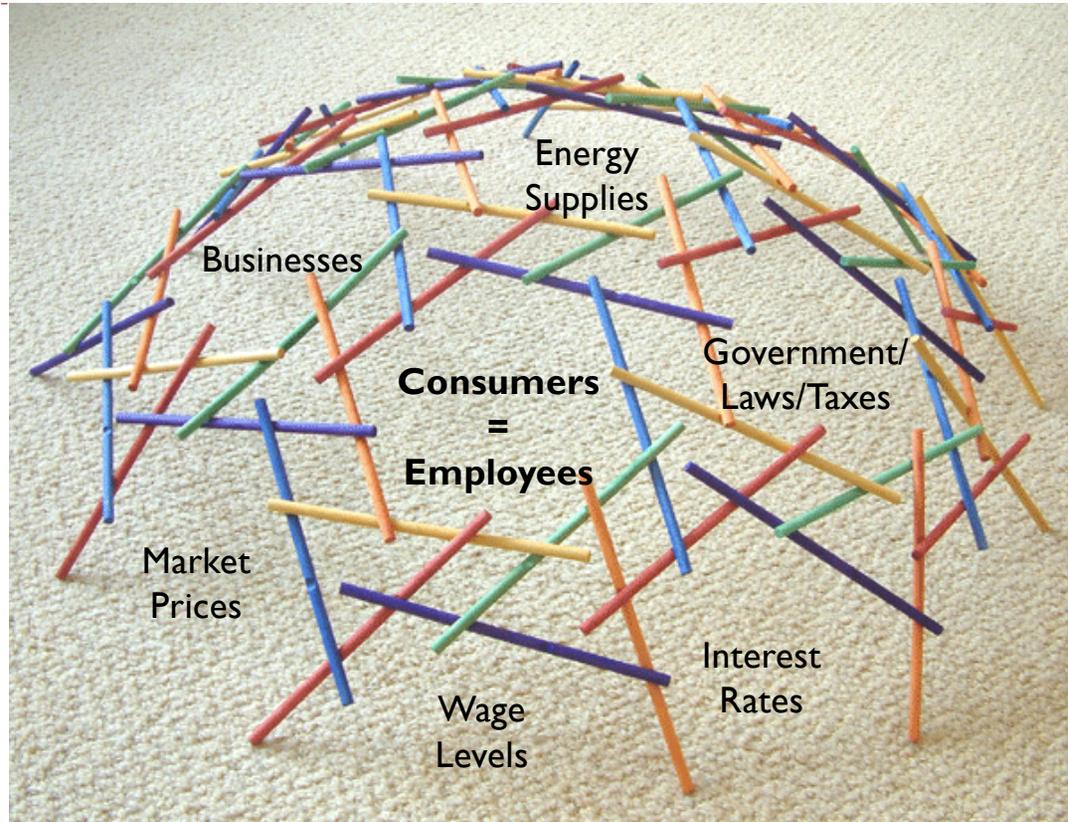
Gail Tverberg, February 23, 2021

Outline

- ▶ How economic growth leads to collapse
- ▶ What Peak Oil Theory misunderstands
- ▶ Where we are today, relative to collapse
- ▶ Implications for Biophysical Economics

How Economic Growth Leads to Collapse

The economy is a self-organizing physics-based system
(Y. Shiozawa, 1996; Chaisson, 2001; Roddier, 2017)

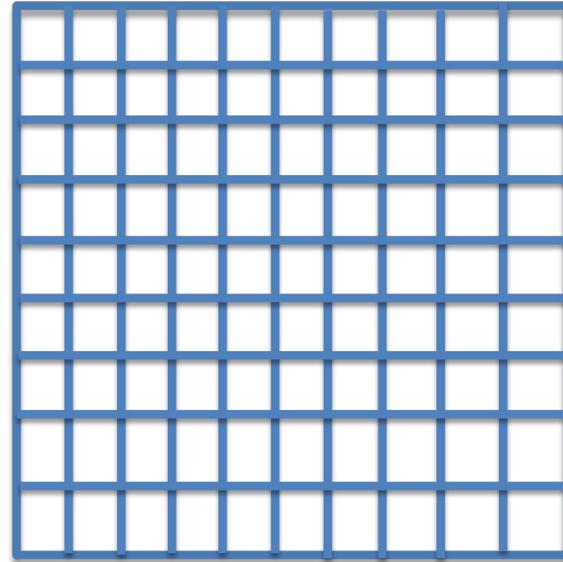
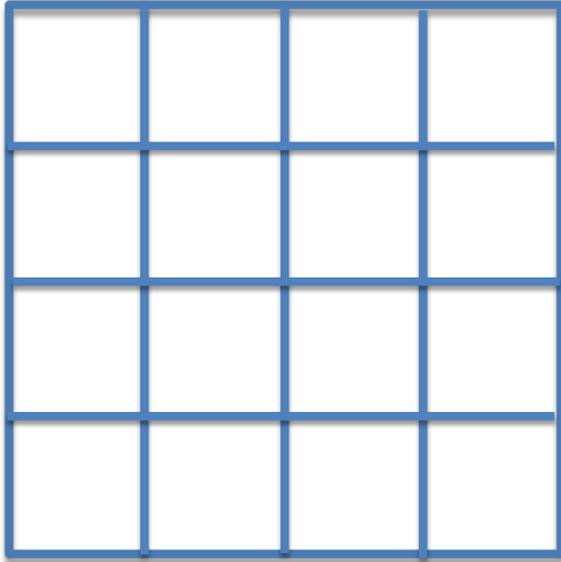


Economies seem to grow on their own

- ▶ New businesses are formed
 - ▶ Unneeded businesses close
- ▶ Governments add new laws, taxes
- ▶ Resources are very important
 - ▶ Metal ores, fresh water, adequate fertile farmland
 - ▶ Energy is needed for every aspect of GDP
 - ▶ Heating things, moving things
- ▶ Employees = Consumers play a very important role
 - ▶ Wages need to be high enough for even the low-paid
 - ▶ If not high enough, consumers may riot; try to overthrow governments
 - ▶ Or poor eating may make workers susceptible to epidemics

Biggest problem: *Population rises as resources deplete.*
Resources per capita fall.

- ▶ With farmland, smaller plots for all don't work – all would starve



Added complexity is a workaround for inadequate resources per capita

- ▶ Examples of more complexity:
 - ▶ More technology; greater efficiency
 - ▶ Longer, more tightly connected supply lines
 - ▶ Bigger business and governments
 - ▶ Growing international trade
 - ▶ Use of intermittent electricity
 - ▶ More complex financial systems
- ▶ But too much *complexity* leads to collapse because of diminishing returns to complexity (Tainter, 1988)
- ▶ Added complexity leads to wider wage/wealth disparity
 - ▶ Managers, technically skilled get higher pay
 - ▶ Little left over to pay non-elite workers

F. Roddier – Physics underlies the unequal distribution of resources; evolution is based on “survival of best adapted”

- ▶ Roddier says unequal distribution is like steam rising to the top and ice falling to bottom, as limits are reached
- ▶ Examples of added complexity in farming situation
 - ▶ Build dam so that farming is more productive
 - ▶ One farmer becomes owner; others are tenants
 - ▶ Some would-be farmers become craftsmen
- ▶ When there are not enough resources to go around, those with the fewest resources get squeezed out
 - ▶ Example: Two million children in Yemen are malnourished ([UNICEF](#))
 - ▶ 12.4 million Yemen children need humanitarian assistance

Added complexity leads to a need for a financial system for time-shifting purposes

- ▶ **Examples of time-shifting devices**
 - ▶ Bank debt, bonds, sale of shares of stock
- ▶ **Long-lasting goods provide their benefit over a long future period**
 - ▶ But workers need to be paid as goods are made
 - ▶ Business people need to build factories in advance
 - ▶ Even consumers get a benefit over a period of time
 - ▶ Homes, vehicles, college education
- ▶ **Existence of time-shifting devices tends to help rich more than poor**
 - ▶ **Poor pay high interest rates**
 - ▶ Ultimately helps the bankers
 - ▶ **Rich people can borrow at low interest rates and use loans to speculate**

Net impact is that non-elite workers find themselves worse and worse off, as complexity is added

- ▶ Rich become very, very rich
 - ▶ Own companies, with all of their high tech devices
 - ▶ Also get paid wages and bonuses
- ▶ Pensioners get a cut of the goods and services of the economy
 - ▶ Not currently making any of these goods and service
 - ▶ Take part of the output of the economy, nevertheless
- ▶ Non-elite workers get the left-overs
 - ▶ Still required to purchase health insurance
 - ▶ Compete with global workers, earning very low wages
 - ▶ Difficult to have enough left for home, family, vehicle
 - ▶ Often live with parents to save money

Collapse results from the very low wage situation faced by many workers

- ▶ Low wage workers become very unhappy
 - ▶ Uprisings likely; governments may be overthrown
- ▶ Workers cannot afford to pay very much
 - ▶ Debt defaults likely
 - ▶ Governments cannot collect sufficient taxes; may collapse
- ▶ Workers with low wages eat poorly
 - ▶ Vulnerable to epidemics
- ▶ Conflict among countries likely
 - ▶ Occurs because leaders covet each other's resources and jobs
- ▶ Commodity prices likely low
 - ▶ Revelation 18:11-13 talks about lack of demand for slaves in the collapse of Babylon

What Peak Oil Theory Misunderstands

Peak oil theory assumes that there is a different condition from collapse ahead

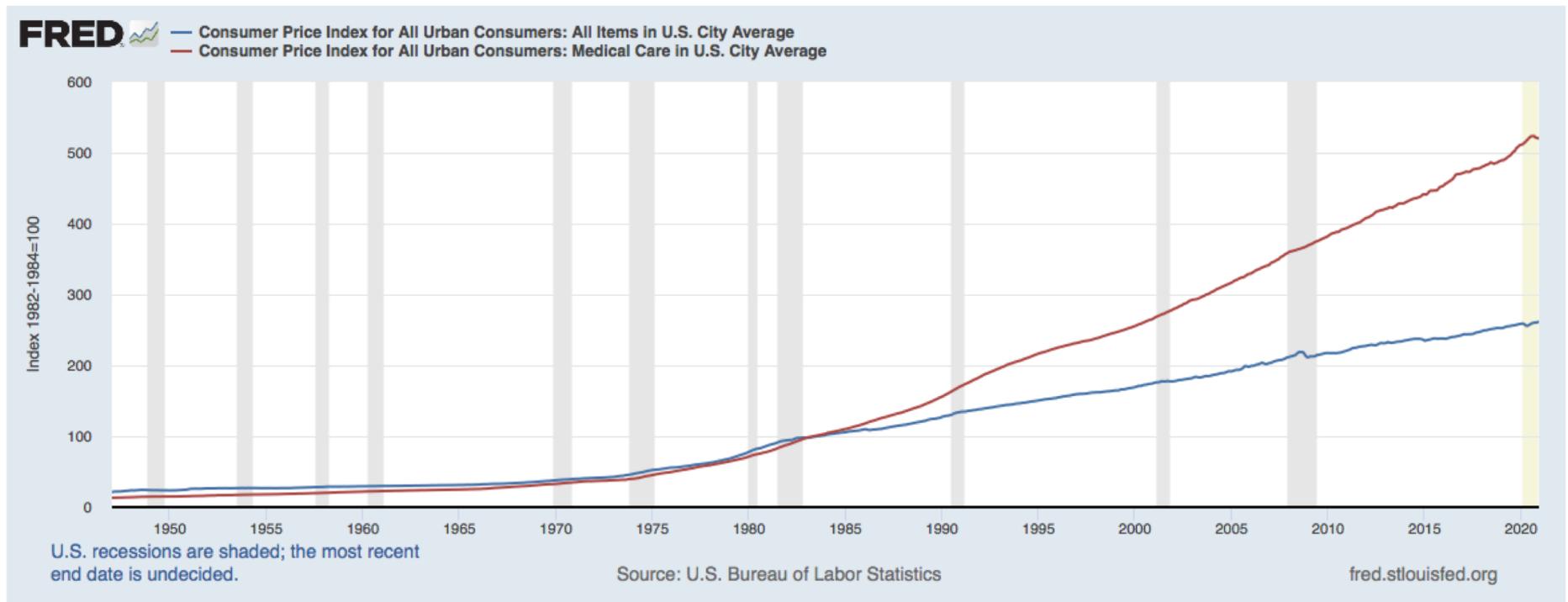
- ▶ Different condition might be called “Collapse light”
- ▶ In Collapse Light
 - ▶ A peak in oil supply can occur without the whole economy collapsing
 - ▶ Believe that the quantity of energy used by the economy is quite flexible
 - ▶ Oil supply can decline, but other fuels can take oil’s place
 - ▶ Oil prices will rise, allowing much extraction after peak
 - ▶ Resources in the ground for oil, coal, and natural gas determine future extraction
 - ▶ Climate change may be a huge problem
 - ▶ Financial system is not terribly important; man-made
- ▶ World leaders are believed to be able to control Collapse Light

Peak oil theory overlooks the very tightly knit nature of the economy

- ▶ Tightly knit nature is because the economy is a dissipative structure
 - ▶ Other examples: Ecosystems, hurricanes, all plants and animals, including humans
 - ▶ All require energy to grow; eventually collapse
 - ▶ Oil pipelines are like human arteries; cell phones are like part of nervous system
- ▶ All parts of the economy are reaching diminishing returns, simultaneously
 - ▶ Oil
 - ▶ Coal
 - ▶ Natural gas
 - ▶ Fresh water
 - ▶ Mineral extraction
 - ▶ Complexity

Problem: Widespread diminishing returns means the cost of many goods and services rises; wages don't rise *enough!*

▶ Health care costs rise without limit in the US



Why oil prices don't necessarily rise with scarcity

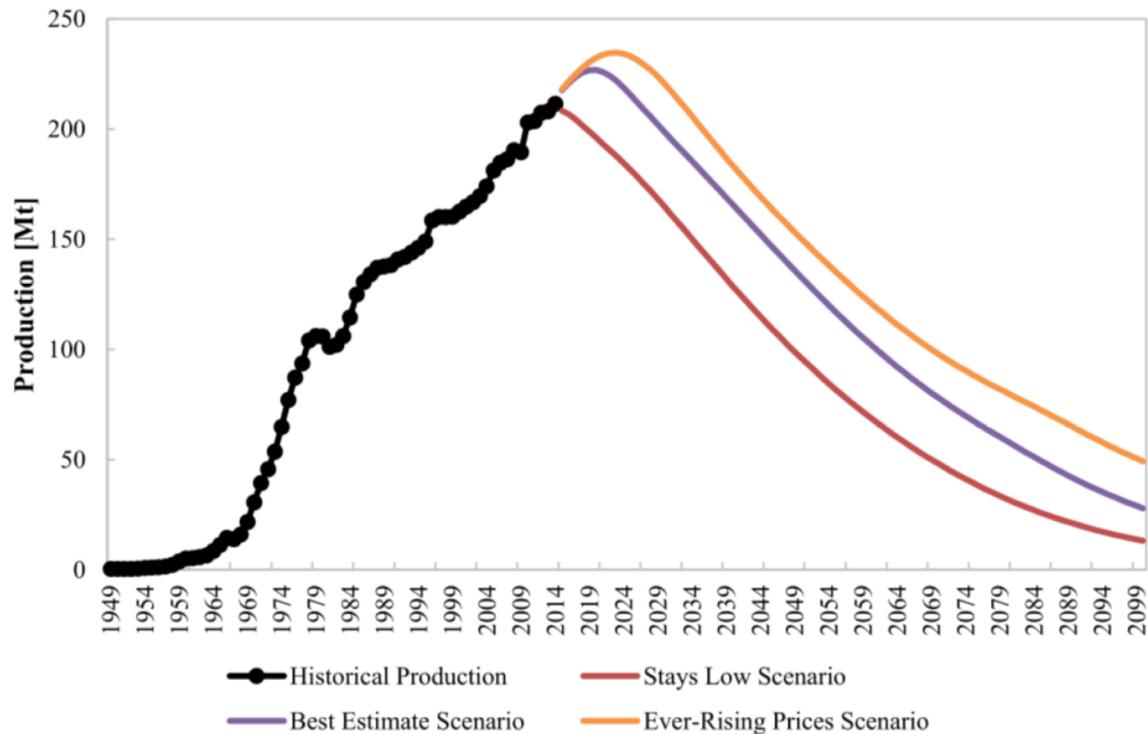
- ▶ Too many would-be oil consumers have low disposable income
 - ▶ Wages are low because of the wage disparity problem
 - ▶ Repayment of college loans comes first
 - ▶ Health care coverage is mandatory
 - ▶ Need to live with parents; can't afford car/home
- ▶ Government mandates
 - ▶ Can't travel to foreign country, may spread COVID-19
 - ▶ Work at home to prevent disease spread
 - ▶ Closed restaurants lead to laid-off workers

Why oil prices don't necessarily rise with scarcity (continued)

- ▶ Oil prices do rise, but they quickly get beaten back down again
 - ▶ Customers around the world cannot afford the higher prices
 - ▶ Cut back on their demand
 - ▶ Prices drop back down
- ▶ Debt bubble pops
 - ▶ Part of the demand for oil comes from availability of loans for vehicles, new homes, and new factories
 - ▶ Amount of debt seems to rise endlessly
 - ▶ Interest rates are manipulated lower and lower
 - ▶ If (when) this debt bubble collapses, oil prices can be expected to fall

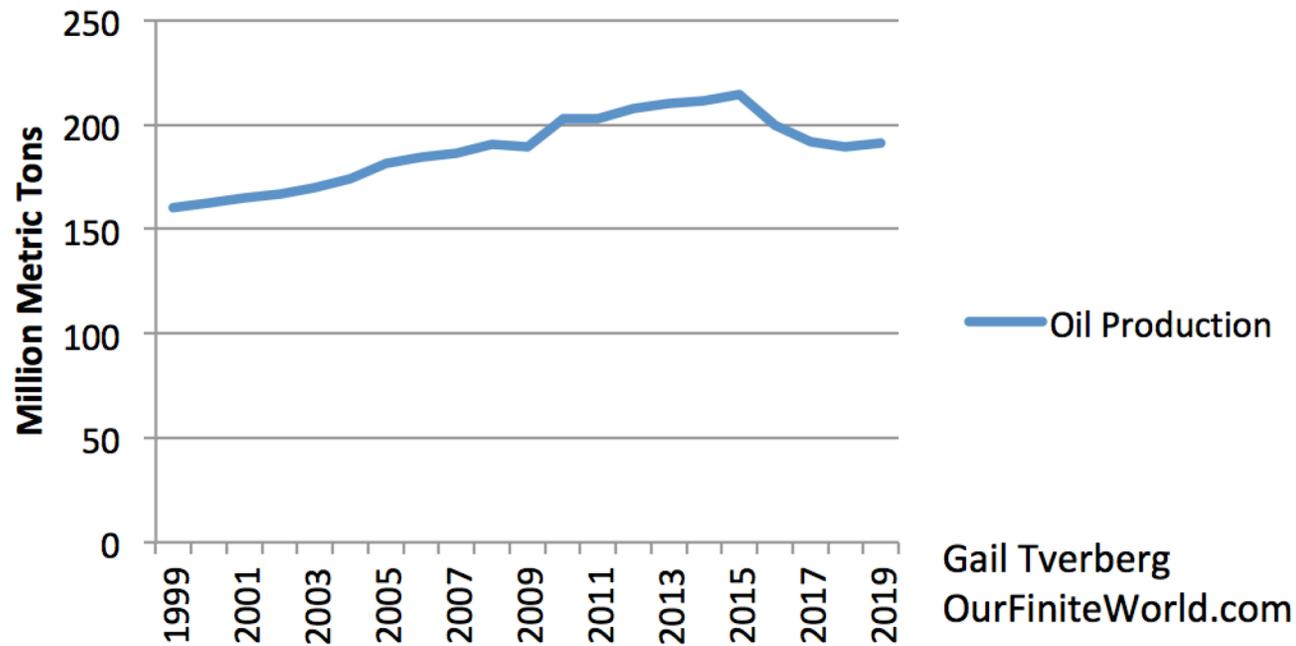
If oil prices stay low, oil stays in the ground. Reserves vastly overstate future production

- ▶ Ke Wang et al. *An oil production forecast for China considering economic limits*, 2015



Actual oil production of China has started declining, as expected in “Stays Low” Scenario

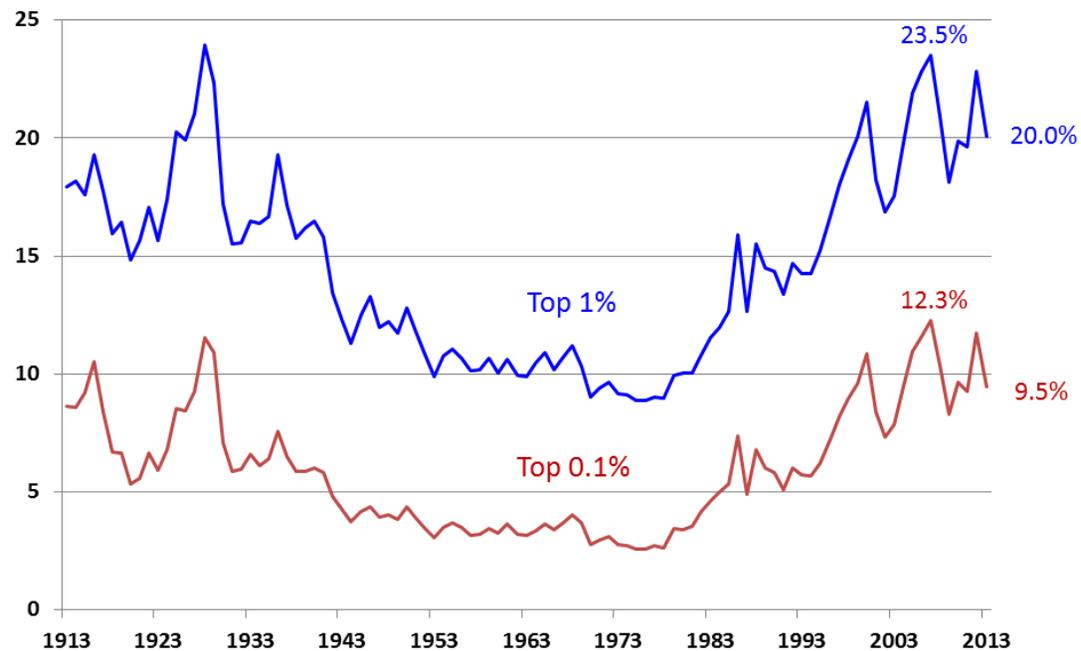
China's Oil Production



Where We Are Today, Relative to Collapse

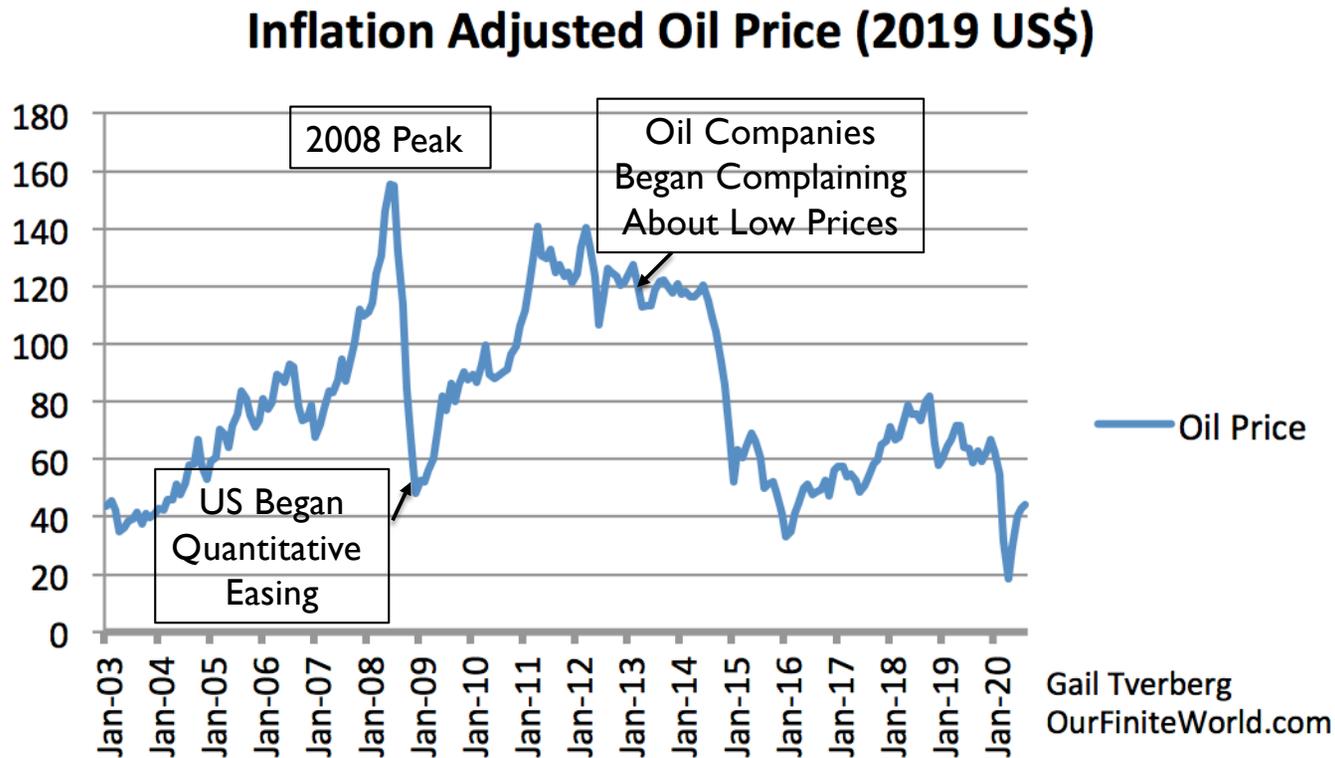
Wage disparity problem is very great, especially on a worldwide basis

U.S. Income Shares of Top 1% and Top 0.1% Households – Incl. Capital Gains (1913-2013)

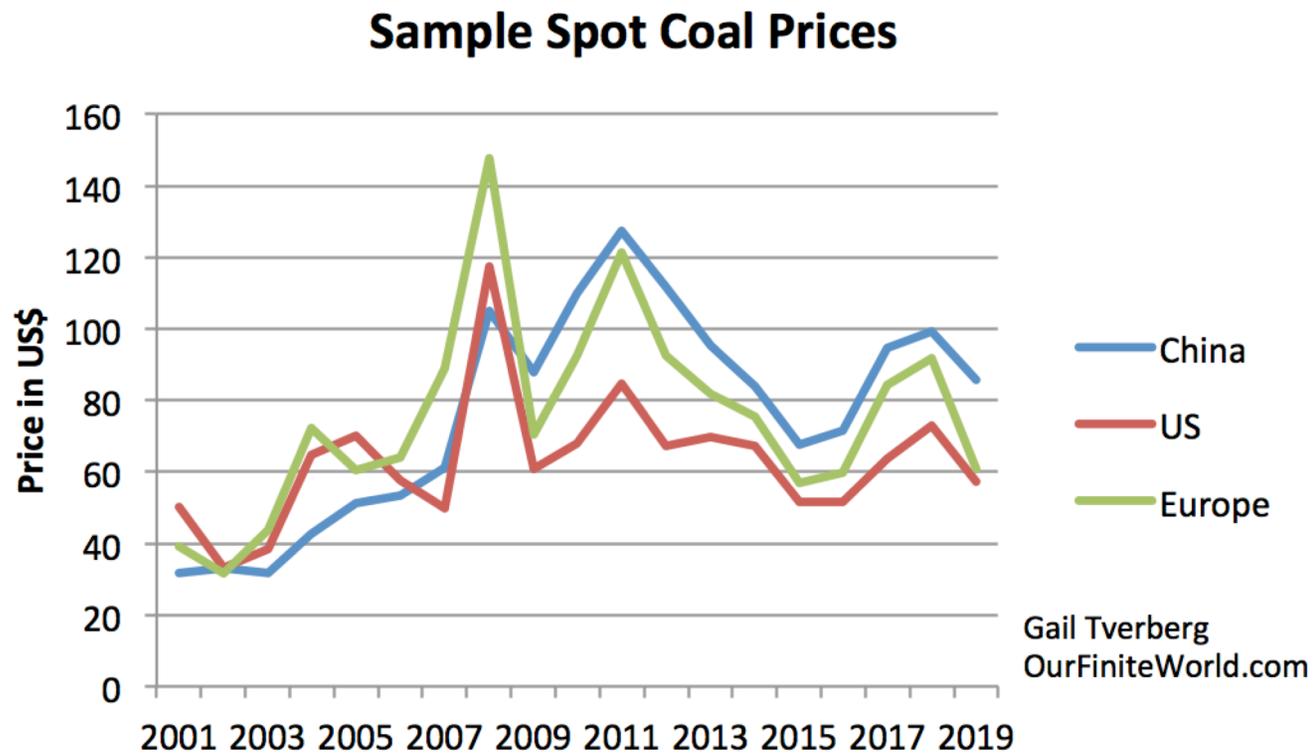


Source: Piketty & Saez – January 2015

Oil producers began complaining about too low oil prices at \$120 barrel. Financial manipulation can't get price to \$120!

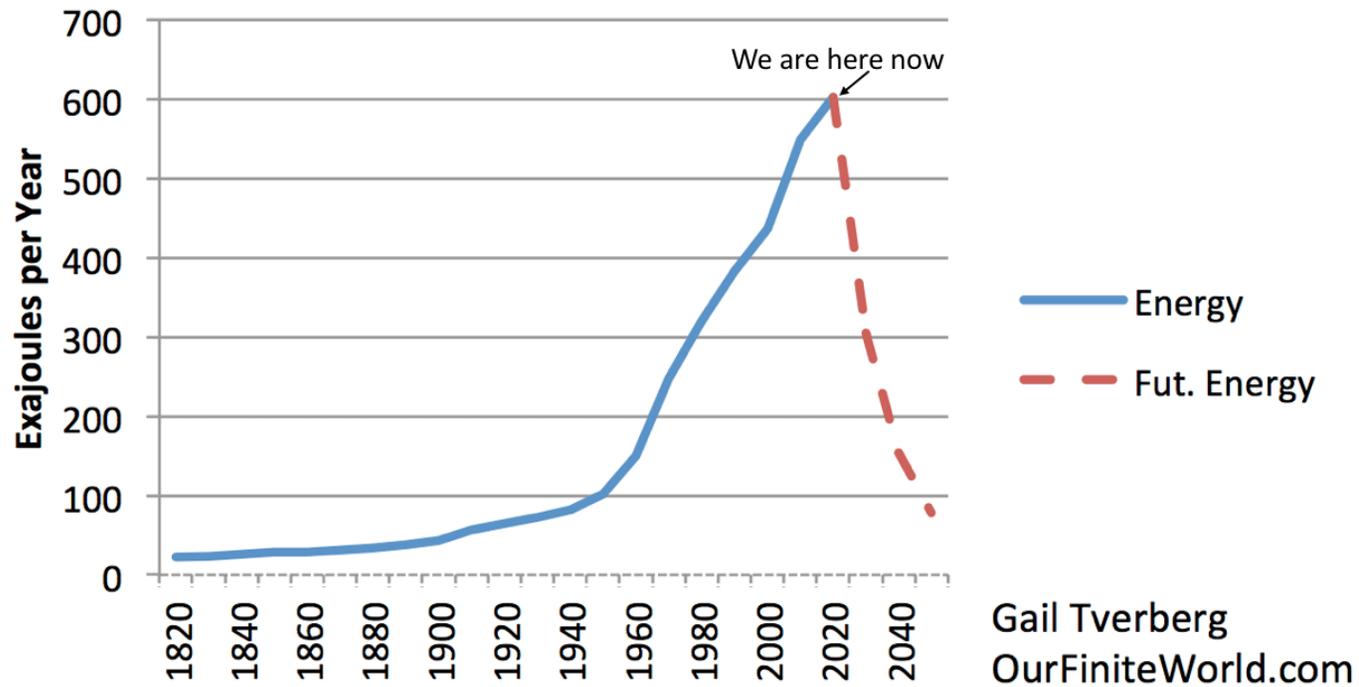


Coal has pricing problems as well. Many boats are waiting off China's coast, hoping China will allow more imports.



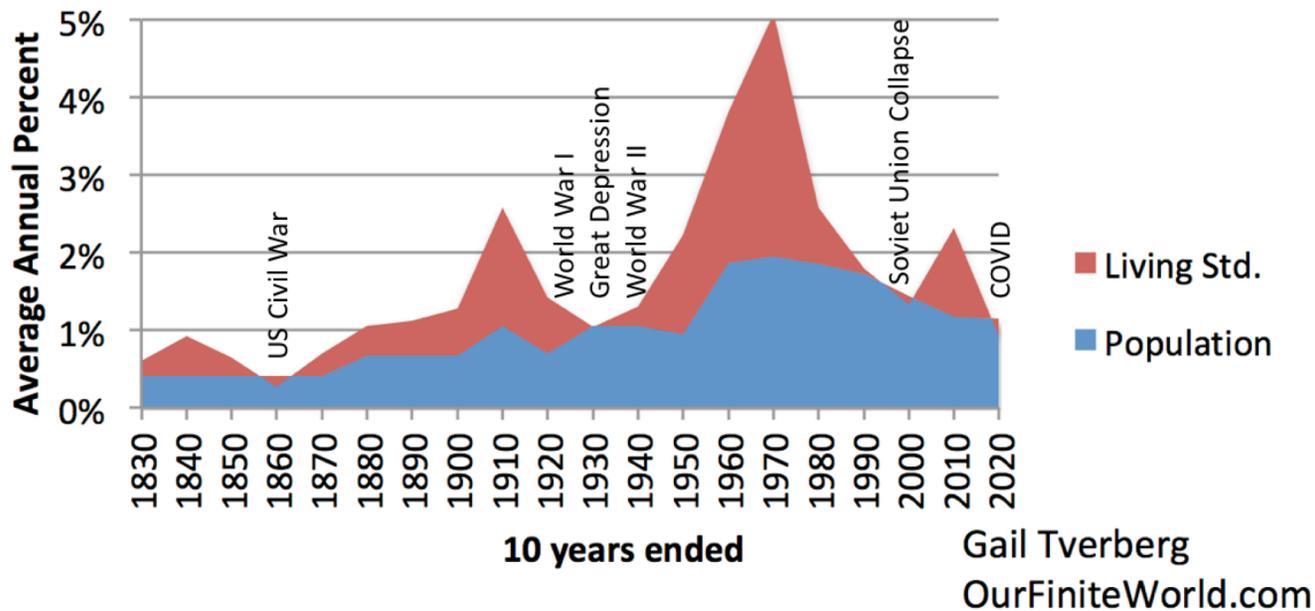
Future energy production looks like it may fall in a distressing way

World Energy Consumption to 2050



Even a slowdown in the growth rate of energy consumption has had a distressing impact, historically

World Energy Consumption Growth Population Growth vs. Standard of Living Incr.



Research by Turchin and Nefedov (2009) on the collapse of eight agricultural societies leads to a rough timeline

- ▶ **A group finds a new resource**
 - ▶ For example, group makes farmland by cutting down trees
 - ▶ Or, more recently, learns to use fossil fuel
- ▶ **Growth Stage: Population of group expands to use new resource**
 - ▶ Several generations – generally over 100 years
- ▶ **Stagflation Stage hits when carrying capacity is reached**
 - ▶ Lasts for perhaps 50 or 60 years
 - ▶ For fossil fuels, stagflation probably began in the 1970s
 - ▶ More debt added; wage disparity starts growing; efficiency in use of resources becomes important
- ▶ **Crisis Stage takes over after Stagflation**
 - ▶ We seem to be hitting this Crisis stage now
 - ▶ In the past, this stage typically lasted over 20 years
 - ▶ Governments overthrown or collapse; debt defaults; epidemics; wars; falling population

Parts of electric grid are surprisingly close to collapse

- ▶ *Pricing systems that are used to encourage wind and solar are detrimental to the overall system*
 - ▶ End up with inadequate pricing for the overall system
 - ▶ High prices when electricity is in short supply don't make up for low prices
 - ▶ Electricity prices end up too low for the system, just as fossil fuel prices are too low!
 - ▶ Infrastructure gets neglected
 - ▶ Tends to drive away nuclear and fossil fuel providers
 - ▶ True "value" of intermittent wind and solar may be negative
 - ▶ Really need "utility" model of pricing, to get adequate funding
- ▶ **Huge recent outage in Texas**
 - ▶ None of the electricity providers were prepared for cold weather
 - ▶ No water for homes and businesses
 - ▶ Electricity needed for oil and gas production was cut
 - ▶ Physical damage to the power infrastructure was narrowly averted
 - ▶ Damage could happen if human operators did not catch in time
 - ▶ Would take months to repair, with today's systems
 - ▶ Doubtful if damage could ever be repaired, with intermittent wind and solar alone

Implications for Biophysical Economics

1. Economies really need to add an *increasing quantity of net energy* over time, if they are not to fail

- ▶ The larger quantity is needed because the economy faces diminishing returns in many areas, simultaneously
 - ▶ Energy is needed to fight all of these diminishing returns
 - ▶ Situation is like a person with inadequate food
 - ▶ Humans can get along with less food for a while (lose weight), but eventually they die
 - ▶ Economy can cut back on non-essential travel, but it risks destabilizing the whole system
- ▶ In order for the quantity of energy to grow, it must be affordable
 - ▶ Likely that the average EROEI of the energy mix needs to be *rising*
 - ▶ Power density should be rising
 - ▶ Would fall with wind and solar

2. EROEI calculations should only be used to compare energy systems with similar complexity

- ▶ More complex systems are seriously detrimental to the economy because of the wage disparity and debt that they add to the system
- ▶ At least three different levels of complexity need to be distinguished
 - 1) Low: Burned biomass; power from animals
 - 2) Medium: Fossil fuels
 - 3) High: Nuclear; intermittent wind and solar electricity

3. Low oil prices rather than high should be expected as limits are reached

- ▶ Oil prices, and other energy prices, will bounce around, but will not rise high enough to meet the needs of most producers
- ▶ Big issue is consumer unaffordability, even at prices far below what oil producers require (\$120+ barrel)
- ▶ Oil exporting countries, especially, require high prices because of the tax revenue they make available
 - ▶ Without high tax revenue, OPEC countries cannot provide the food subsidies and jobs programs that keep their citizens from trying to overturn the governments
- ▶ Supply and demand curve of economists not appropriate for energy
 - ▶ Energy affects both Supply (goods and services created) and Demand (wages)

4. The economy is experiencing the historical phenomenon of collapse, rather than peak oil

- ▶ A tightly networked system works differently from a system where each resource behaves independently of the other resources.
- ▶ In fact, we should expect many parts of the economy to decline, close to simultaneously
 - ▶ Oil, coal and natural gas production
 - ▶ Electric grid and generation
 - ▶ International trade
 - ▶ Governmental organizations
 - ▶ Medical system; ability to fight infectious diseases
 - ▶ Higher education
 - ▶ Human population

5. Most fossil fuel resources will be left in the ground because of low prices

- ▶ Fossil fuels are already starting to be left in the ground, without any action on our part
- ▶ Humans need a “Happily ever after story.”
 - ▶ The supposed need to fight climate change helps to hide the worrisome fossil fuel situation that the world is facing