

3. Economic Growth and Diminishing Returns

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Standard definition of Economic Growth

Amount of Goods and Services (= GDP) must be increasing

Goods and Services = GDP



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

If we believe Turchin, to avoid collapse, a “stronger” condition must hold

After tax income of common workers must be increasing

After-Tax Income of Common Workers



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

If after-tax income of common workers is decreasing

- ▶ Workers will have trouble paying for commitments
 - ▶ Food
 - ▶ Mortgages
 - ▶ Cost of raising children

- ▶ So would-be common workers
 - ▶ Need jobs available
 - ▶ Need pay at least equal to what common workers have received previously
 - ▶ On after inflation, after-tax basis

Let's look at an example of what goes wrong

- ▶ Based on problems noted by Peter Turchin in *Secular Cycles*

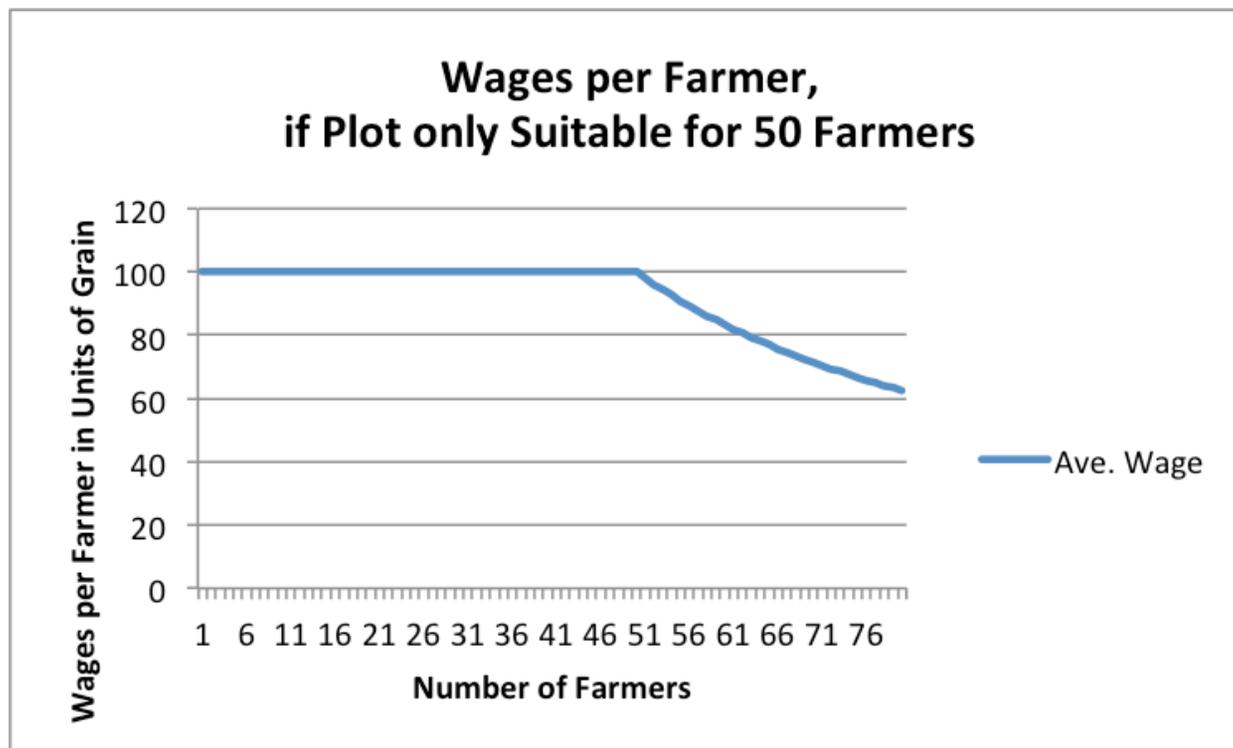
Suppose there is a plot of land that will provide work for 50 farmers

- ▶ What happens when number of farmers rises above 50?
 - ▶ Suppose 60, 70 or 80 farmers share the land



Land gets subdivided more ways

- ▶ Plots get smaller
- ▶ Each farmer grows less grain
- ▶ If paid in bushels of grain, wages drop



As practical matter, farmer situation might work out a little differently

- ▶ New farmers after 50 are only “helpers”
 - ▶ Get paid a lot less
- ▶ Or government sets up a program for older farmers to retire early, when problem of 51st farmer shows up
 - ▶ Cost of government program looks cheap, when only 1 extra farmer to pay for
 - ▶ Rapidly escalates, as more farmers need to be handled by government program
- ▶ Or maybe new “service” jobs that pay a lot less added

Any of these situations results in falling after-tax income for the common worker

- ▶ Result is clear based on bushels per worker
- ▶ Gets obscured with fancy moves to cover up problem

We call this condition “diminishing returns”

- ▶ Added workers or other resources no longer provide the same benefit
- ▶ Very often, the effect becomes apparent very suddenly
 - ▶ Adding the 51st farmer, for example
- ▶ The situation with oil supply is surprisingly similar

As you recall, oil is used almost everywhere

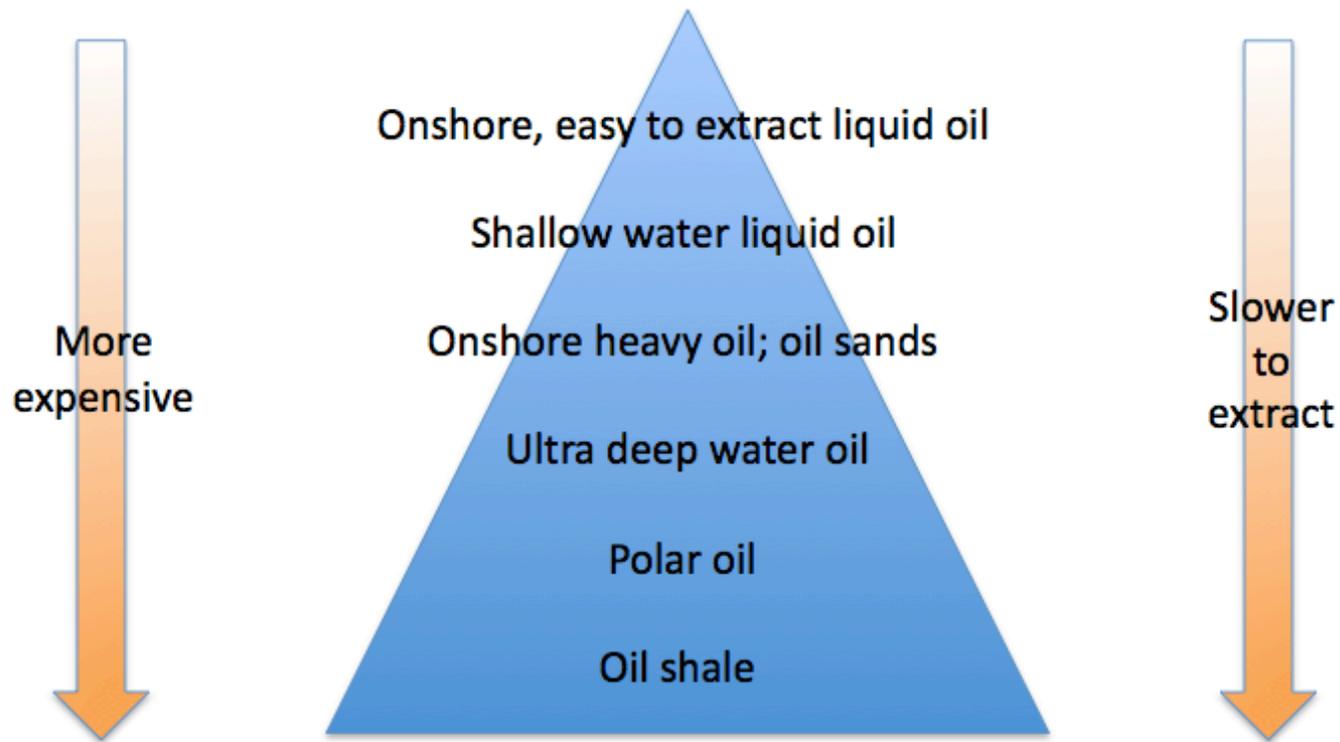
Food Uses

- ▶ Fertilizer transport
- ▶ Pesticides
- ▶ Herbicides
- ▶ Diesel for tractors
- ▶ Fast transport to market
- ▶ Diesel for irrigation
- ▶ Fuel for refrigeration
- ▶ Asphalt for roads

Other Uses

- ▶ Medicines
- ▶ Plastics
- ▶ Gasoline
- ▶ Synthetic cloth
- ▶ Building materials
- ▶ Easier metal extraction and working
- ▶ Diesel for earth movers

A huge amount of oil is available

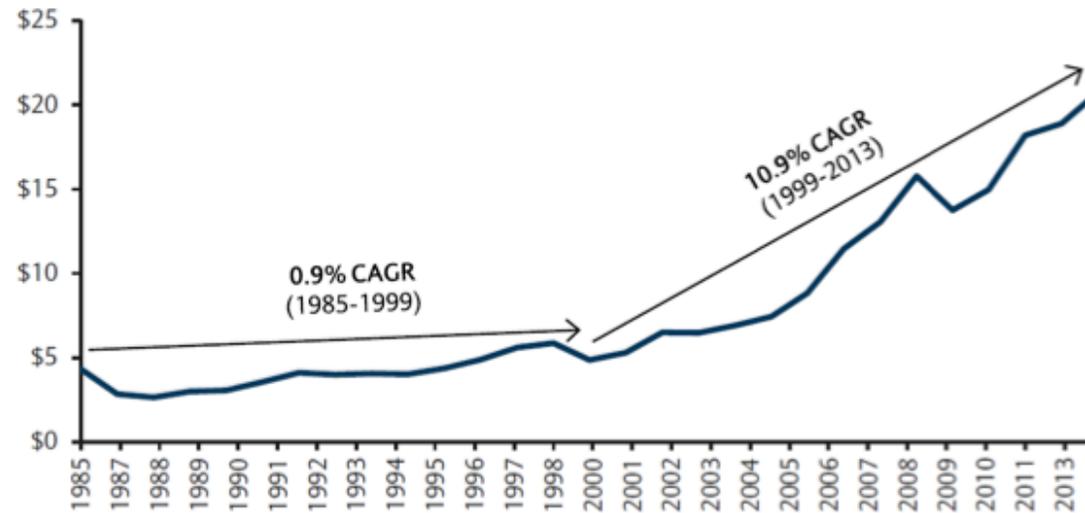


We have the same situation as with the farmers

- ▶ Initially, at the top of the triangle (previous slide), it doesn't take many workers (or many other resources) to extract 100 units of oil
- ▶ In fact, the situation stays pretty much the same, for a long time
- ▶ It is only as we are forced to move from “conventional oil” to unconventional oil that a big upturn in costs takes place
 - ▶ Need more workers and more resources per barrel of oil

Sudden shift in costs shown in data of oil companies, beginning in 1999

Costs are Rising



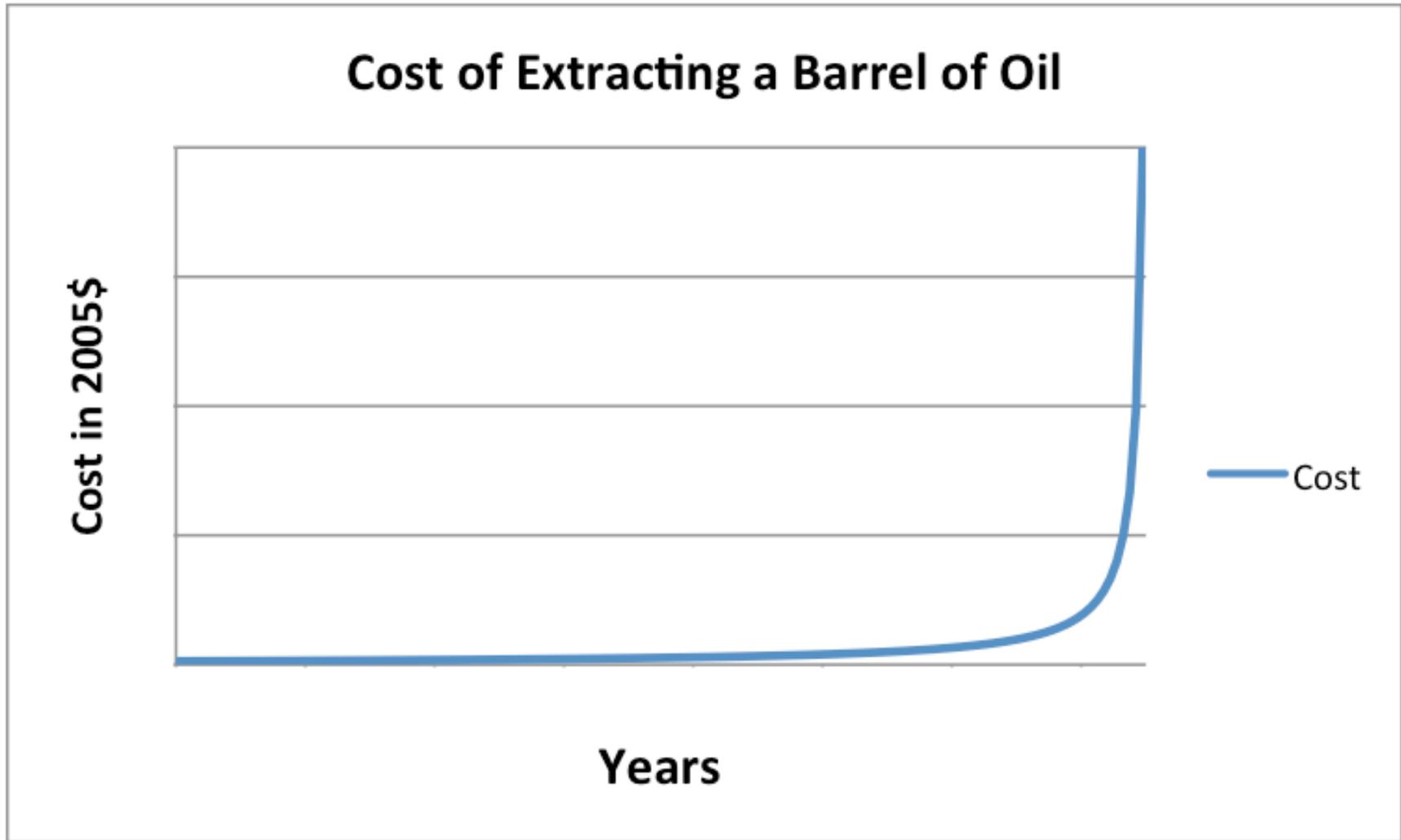
Source: IEA, Barclays Research

E&P Capex per Barrel

Source: Barclays Capital

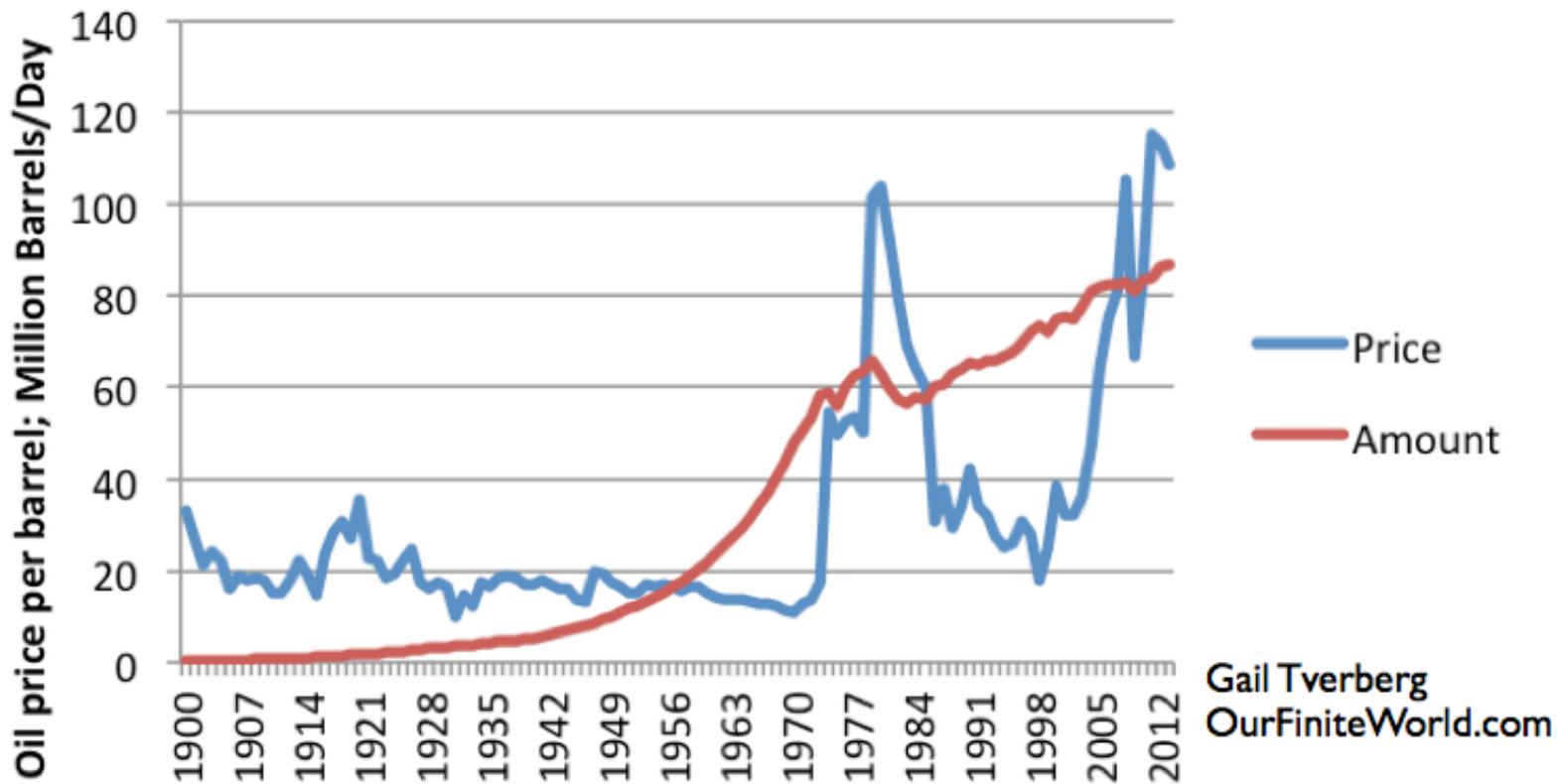
Source: Presentation by Steven Kopits at Columbia University, February 2014 <http://energypolicy.columbia.edu/events-calendar/global-oil-market-forecasting-main-approaches-key-drivers>

We usually see higher costs expressed terms of “higher cost per barrel of oil produced”



In fact, we have been seeing this problem with spiking oil prices since 1999

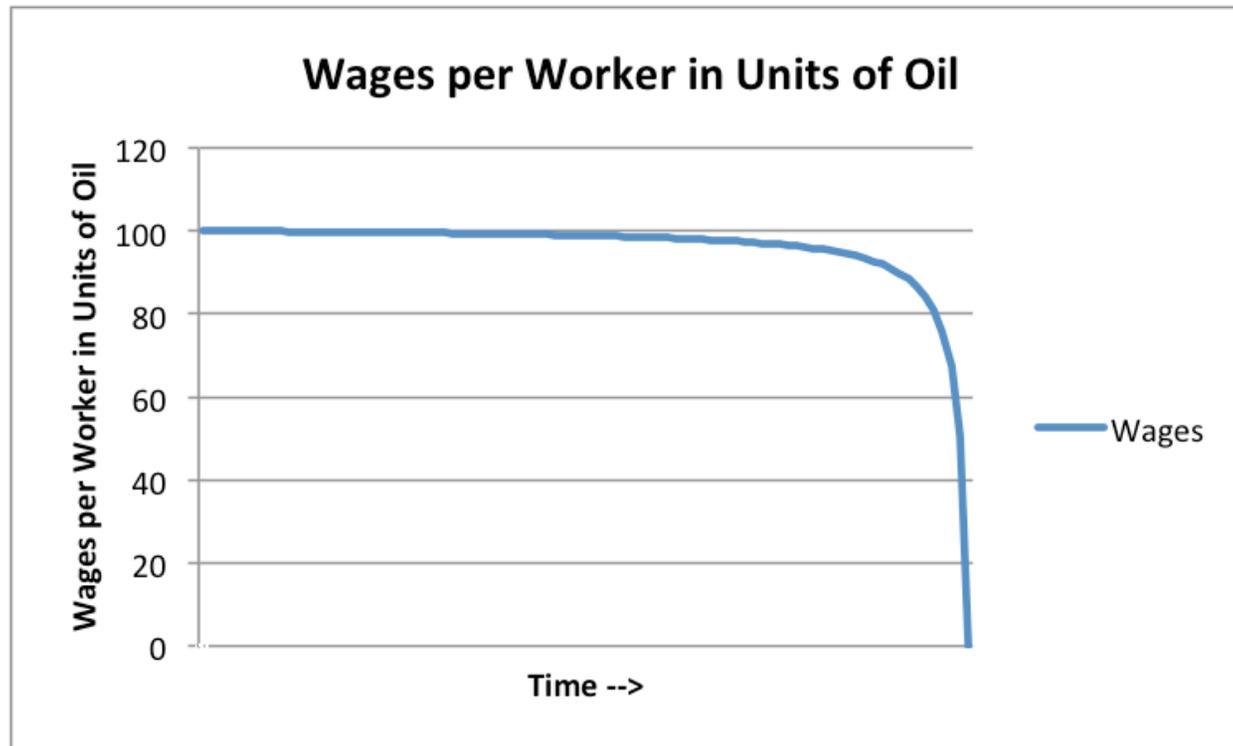
World oil consumption vs price (2013\$)



Based on data of Vaclav Smil and BP Statistical Review of World Energy 2014.

We could just as well flip Slide 15 chart over
– wages per worker in terms of oil produced

- ▶ (Part of oil would also have to go to pay for other resources used)
- ▶ Looks like the effect of adding too many farmers to field!

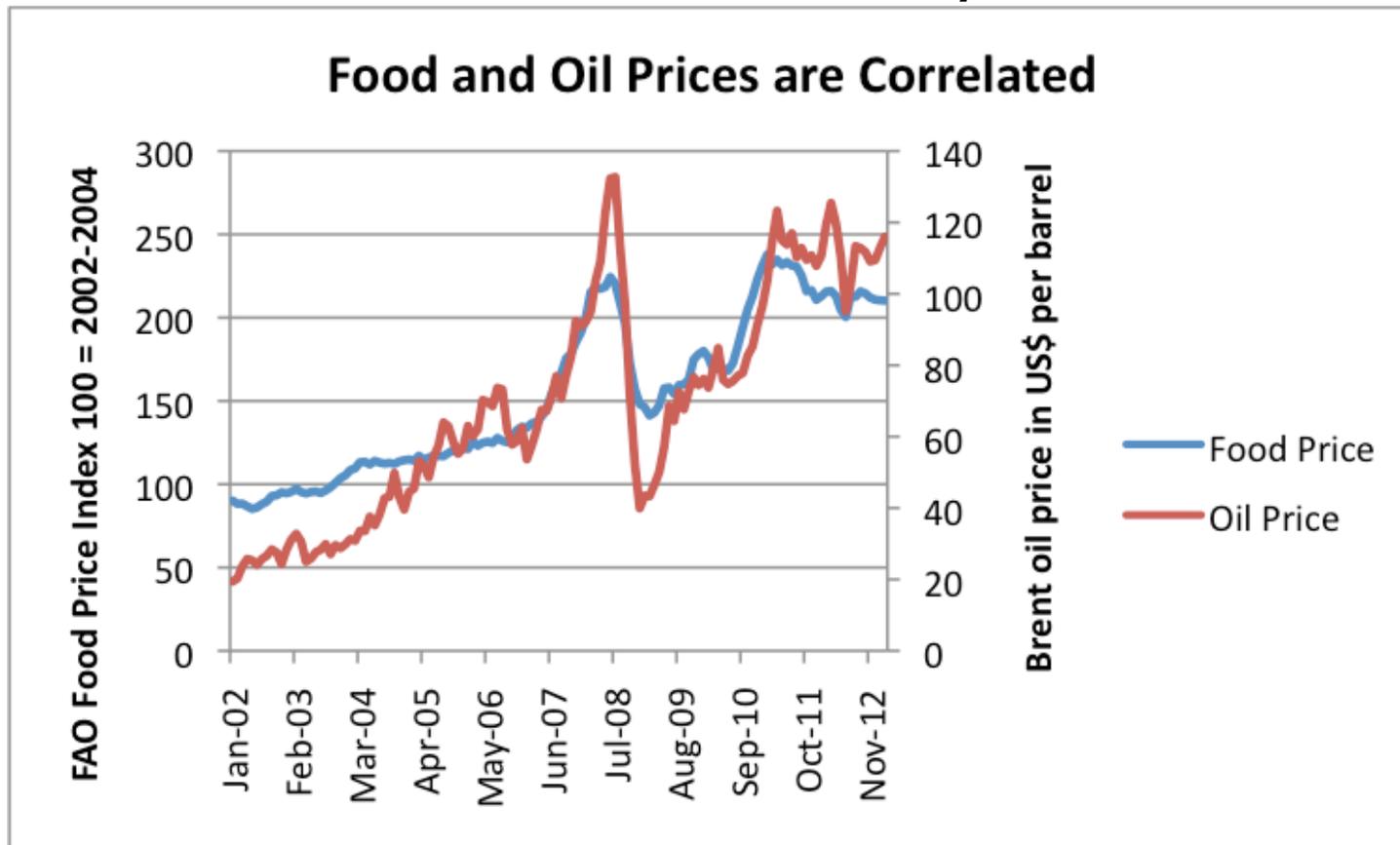


What would you expect impact of high oil prices to be

- ▶ Would wages rise at the same time?
- ▶ Would food prices be affected?
- ▶ How would countries that use a lot of oil in their energy mix differ from countries that do?
 - Examples: Greece—lots of oil in mix
 - United States – middle amount
 - China - much less

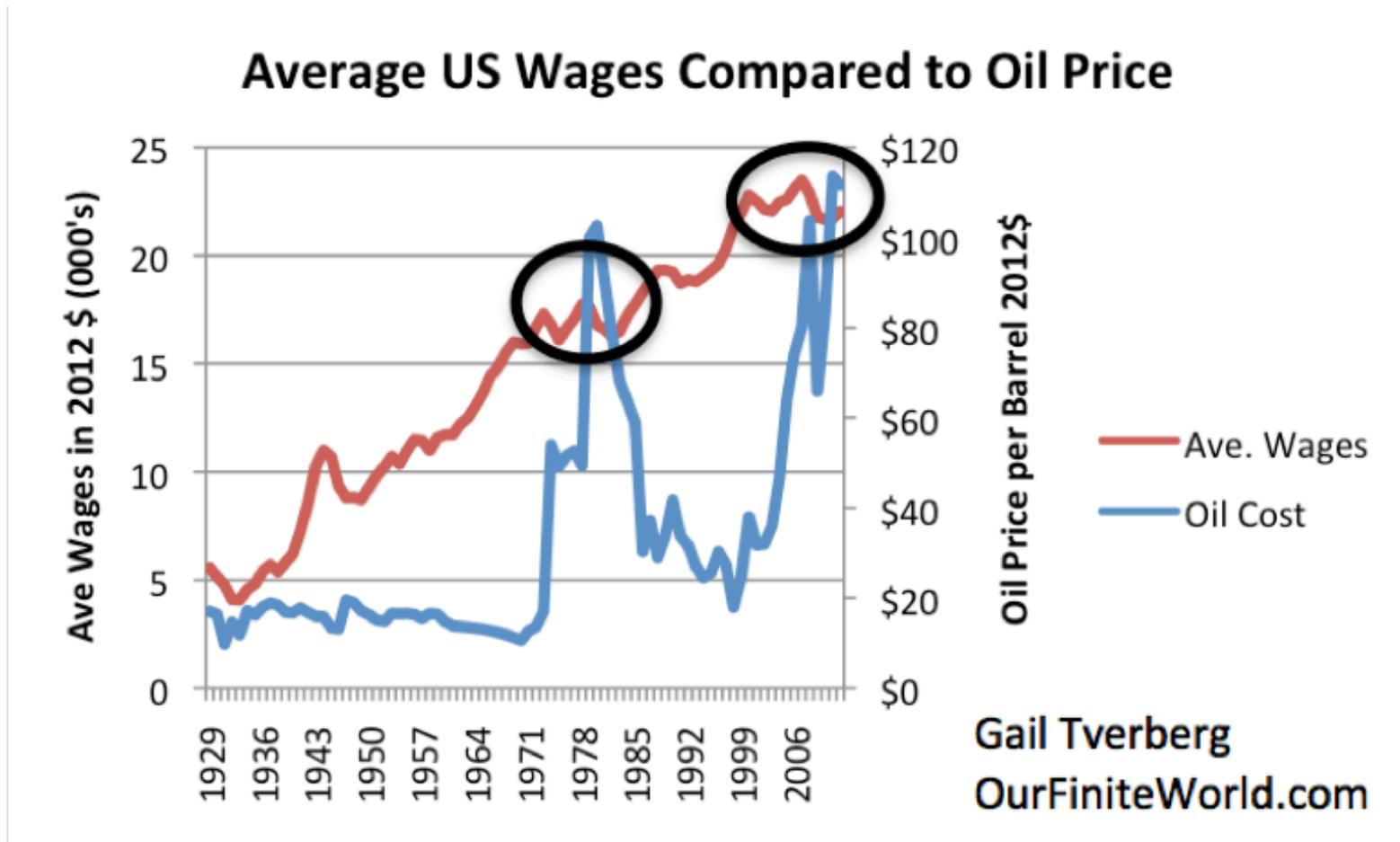
Food prices tend to rise with oil prices

- ▶ Common workers are most adversely affected.



Based on data of Food and Agriculture Organization of the United Nations and US Energy Information Administration.

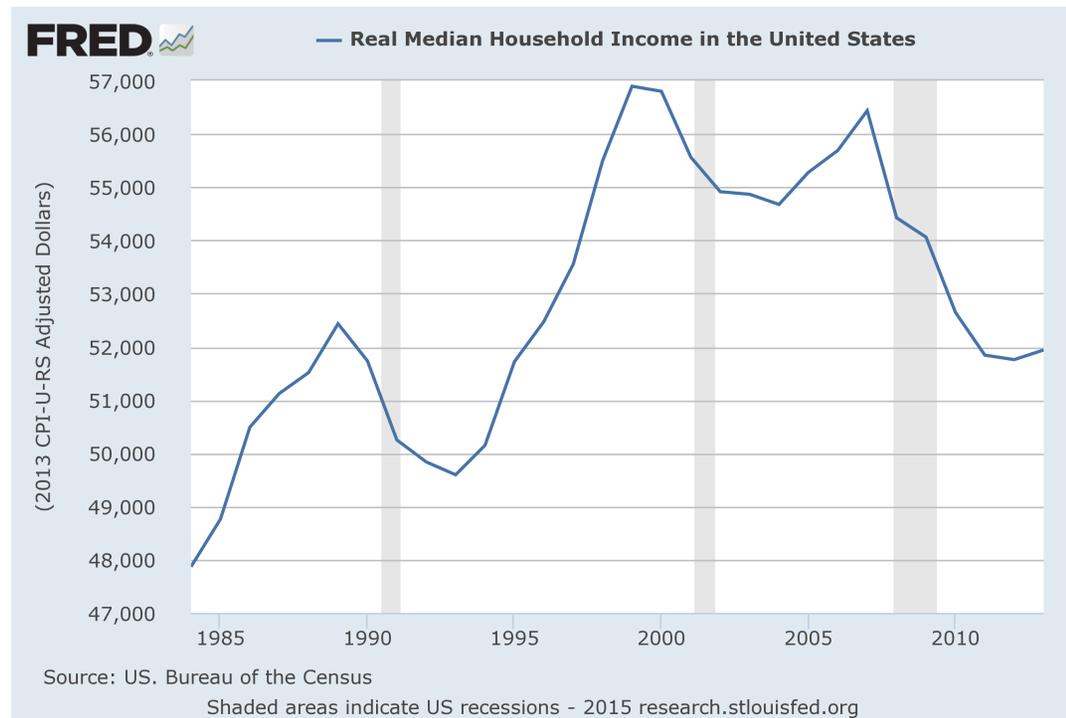
Wages don't rise as oil prices rise



Average wages in 2012\$ compared to Brent oil price, also in 2012\$. Average wages reflect wages adjusted using CPI-Urban, divided by total population.

In fact, US median wages have fallen since 2000, as oil prices rose

- ▶ Common workers are doing less well, both because of rising food prices and falling wages
- ▶ 1993-1999 period had low oil price (\$26), rising median wages

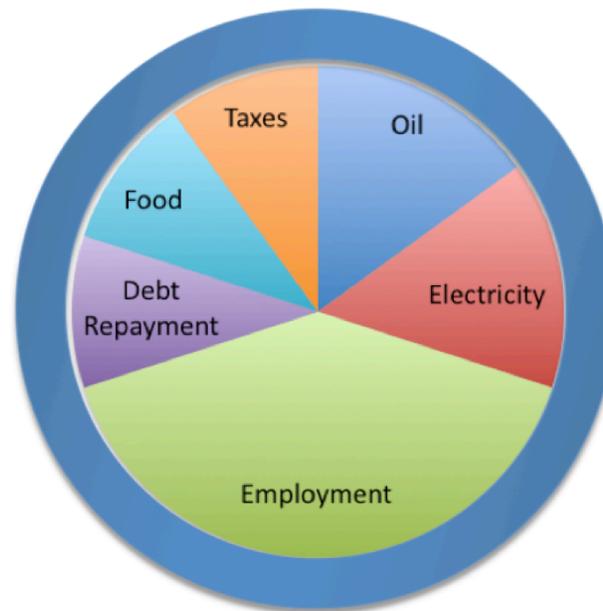


The spike in oil prices in 2005 – 2008 led to the 2007 – 2009 recession

- ▶ Impact greatest in countries that used the largest percentages of oil in their energy mix
- ▶ Recession = Contraction of the economy
- ▶ Economist James Hamilton showed that 10 out of 11 US recessions since World War II were associated with oil price spikes
- ▶ I wrote, “Oil Supply Limits and the Continuing Financial Crisis,” published in the journal *Energy*

Liebig's Law of the Minimum

- ▶ Agricultural yield is proportional to the amount of the most limiting nutrient
- ▶ Chemical reactions – output limited by the reagent with smallest quantity



- ▶ Recession seems to be similar-limited oil shrinks economy

What happened: Workers needed to buy food, and also fuel to get to work

- ▶ Workers cut back on things that aren't necessities
 - ▶ Examples: Restaurant meals, contributions, vacation trips
- ▶ Workers in these industries lost their jobs
 - ▶ Often could not pay their home loans
 - ▶ Banks got into financial difficulty
- ▶ Home building industry adversely affected
 - ▶ Fewer new homes built
 - ▶ Workers lost jobs in home building industry
- ▶ Recession ensued

Is there another way this problem of oil diminishing returns problem could appear?

- ▶ Could it lead to low oil prices?
- ▶ Also to low commodity prices in general?

Diminishing returns for oil can lead to low oil prices—and low commodity prices

- ▶ Reasoning:
- ▶ Common workers buy mostly goods, few services
- ▶ Large number of common workers means these workers buy a significant share of food, oil for commuting, and basic household goods
 - ▶ Not true for less basic goods and services
- ▶ If inflation adjusted wages of common workers are falling
 - ▶ Common workers have to cut back somewhere
 - ▶ Cut back on goods made from commodities
 - ▶ Leads to lower commodity prices
 - ▶ Also many young people without jobs
 - ▶ Can't afford cars, own apartment

Commodity prices tend to be variable to begin with

- ▶ Lack of affordability by common workers may be a big part of today's low oil and metal prices
- ▶ Effect is different from non-commodity prices
 - ▶ Also different from effect when diminishing returns is less of a problem for oil
- ▶ Economists have missed this point
 - ▶ Assume that prices will rise to cover the cost of oil extraction
- ▶ If prices don't cover the cost of oil extraction, we have a big problem!

How do we produce economic growth, then?

- ▶ We have talked about how to produce decline
 - ▶ Possibly even collapse

Answer: We need to produce the goods the common worker needs more cheaply

- ▶ Notice what common workers need is goods—not services
 - ▶ Things like cheap food, cheap housing, and cheap transportation
 - ▶ Not marvelous pixels in reports, or even high-tech goods
- ▶ Common workers also need to benefit from jobs manufacturing these goods
- ▶ Common workers cannot make these goods with their own hands cheaply
 - ▶ Need cheap energy to leverage their own hands

Leverage



Leverage increases the power of Person

<http://www.svtuition.org/2011/08/impact-of-leverage-on-risk-and-return.html>

Wages of the common worker last rose when oil prices averaged \$26 barrel (in 2013\$)

- ▶ A different cheap energy to leverage human energy might also “work”
- ▶ But has to work in today’s machinery
 - ▶ Most common job in America is “truck driver”
 - ▶ Trucks use diesel fuel, from oil
 - ▶ One role of oil is to provide jobs
 - ▶ Can’t switch quickly to something else

In general, we can expect wages of common workers to rise if

- ▶ Wages of workers are rising in inflation-adjusted terms, or alternatively
- ▶ Cost of basic goods (not high tech goods and services) is falling relative to wages
- ▶ To do this, we need “mix “ of human and supplemental energy to become increasingly inexpensive
 - ▶ If US workers to benefit, need increasing amounts of cheap energy in mix
 - ▶ May be some technological advances in this “package”
 - ▶ But US workers must participate in mix, to get the benefit
 - ▶ Moving jobs to cheaper wage locations is a problem

One take-away—Any new energy source must be very cheap

- ▶ Also work in today's machinery
- ▶ One reason energy must be cheap is the limited funds common workers have for buying energy products
 - ▶ If energy costs \$1 per unit and workers have \$100, they can buy 100 units.
 - ▶ If energy costs \$10 per unit, the same \$100 will buy 10 units
 - ▶ If energy costs \$100 per unit, the same \$100 will buy only 1 unit
- ▶ Rising quantity of energy is what creates economic growth
 - ▶ If energy is cheap, it is much easier to have a rising quantity
 - ▶ A small amount of expensive energy doesn't work!

Non-Energy Diminishing Returns

- ▶ Many other parts of the economy are affected by diminishing returns, including
 - ▶ Extraction of metals
 - ▶ Ores containing lower percentages of metals
 - ▶ Water supply
 - ▶ Need to use desalination; pipe from a distance
 - ▶ Pollution – and attempts to mitigate pollution
 - ▶ Workarounds for carbon dioxide and other pollutants are expensive
 - ▶ Cost of medical care
 - ▶ Increased specialization, more expensive procedures
 - ▶ Little change in outcomes
 - ▶ Advanced education – more and more needed, for all jobs

All of the diminishing returns act together

- ▶ Make it harder and harder to produce goods cheaply
- ▶ More and more workers needed for increasingly inefficient sectors
- ▶ Makes it hard to produce as much goods in total

