Energy and the Macroeconomy: 5 Propositions

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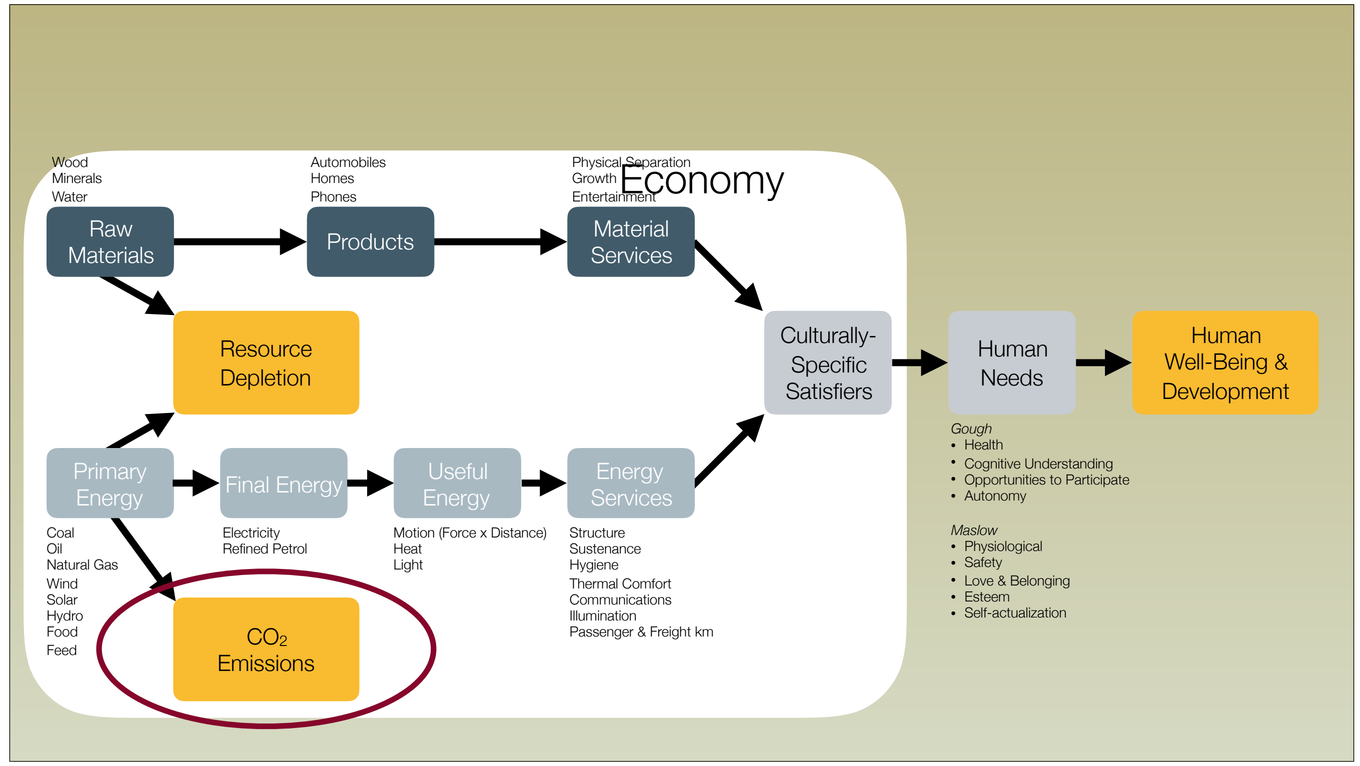
Thank you for that nice introduction, Wikus. It is an honor to be here today. My thanks to you and to everyone at CRSES for organizing this event and for hosting me this winter! And to the SI for hosting this event. I've chosen to speak today on the topic of Energy and the Macroeconomy. And I have five propositions for you.

Background is a gradient fill from Calvin color 4515 to Calvin color 453. See http://www.calvin.edu/admin/publishing/color.html for more details.

Why Should You Care About Energy and the Economy?

But first, let me address why I think you should care about this topic.



In his classic textbook, Paul Samuelson says that the purpose of economics is “to improve the living conditions of people in their everyday lives.” <space>
Human well-being and development is brought about by satisfying human needs <space> with culturally-specific satisfiers <space> such as different types of relationships and different types of homes, to name a few.
Material <space> and energy <space> services provide the culturally-specific satisfiers to meet those human needs.
Raw materials <space> and primary energy <space> provide services to meet human needs.
But, of course, consumption of raw materials and primary energy leads to resource depletion <space> and CO2 emissions <space>. And all of this is activity is mediated by the economy <space>.
So, why should you care about energy and the economy? If you care about human well-being and development <space>, if you care about resource depletion <space>, or if you care about CO_2 emissions <space> and climate change caused by global warming, you should care about energy and the economy.

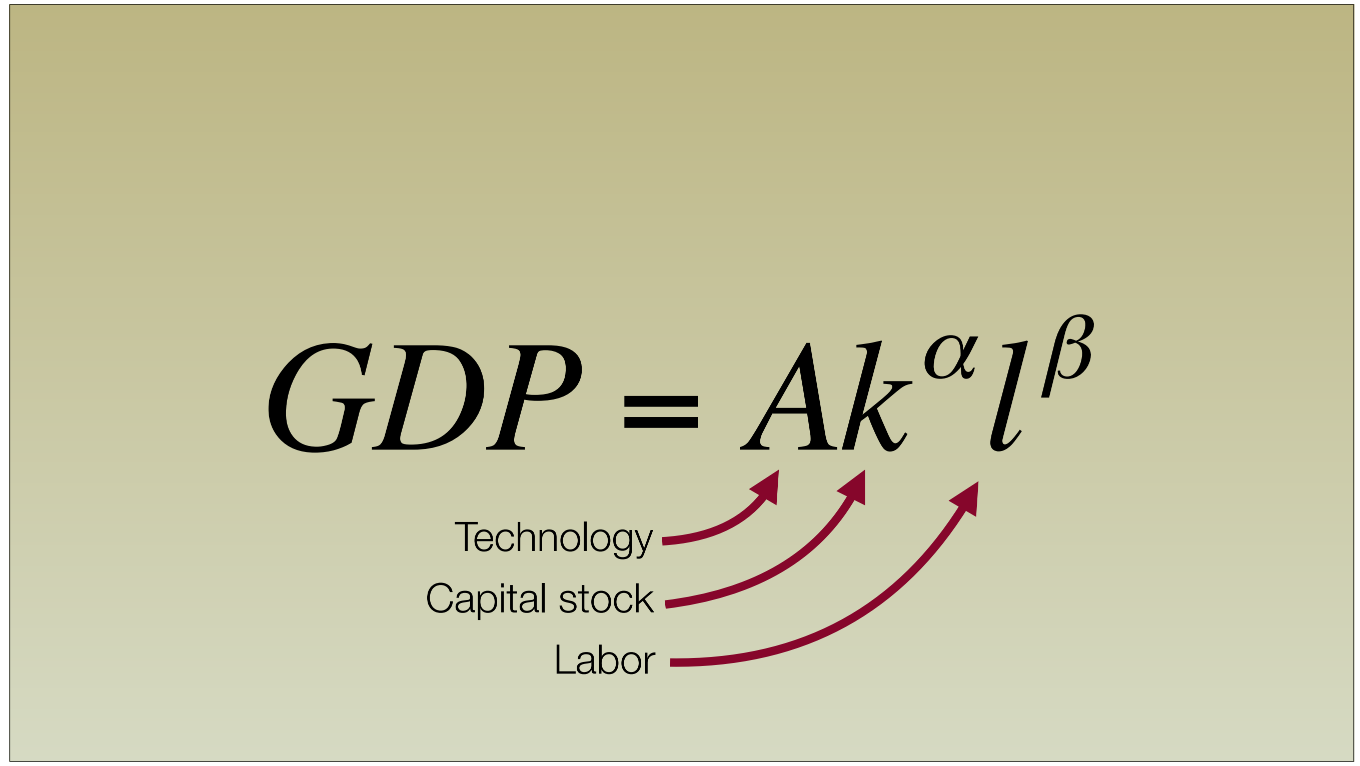
My initial concern was with CO2 emissions <space> and climate change. When you’re in that space, a transition to renewables is both necessary and slower than required. Every time I asked “why is that so?” the answer ran through the economy. Another factor that affects the economy is <space> resource depletion which I used as the framing for my recent book titled “Beyond GDP.” <space> I’m currently making plans for research on this entire chain through to human well-being.

This talk is a distillation of what I think I have learned from this journey.

http://www.amazon.com/Economics-Paul-Samuelson/dp/0073511293/ref=dp_ob_title_bk
The ultimate goal of economics is to improve the living conditions of people in their everyday life.
http://en.wikipedia.org/wiki/Economics

Mainstream Macroeconomic Growth Modeling

To provide context, I want to provide a very quick introduction to the mainstream approach to modeling economic growth and how energy fits into it.

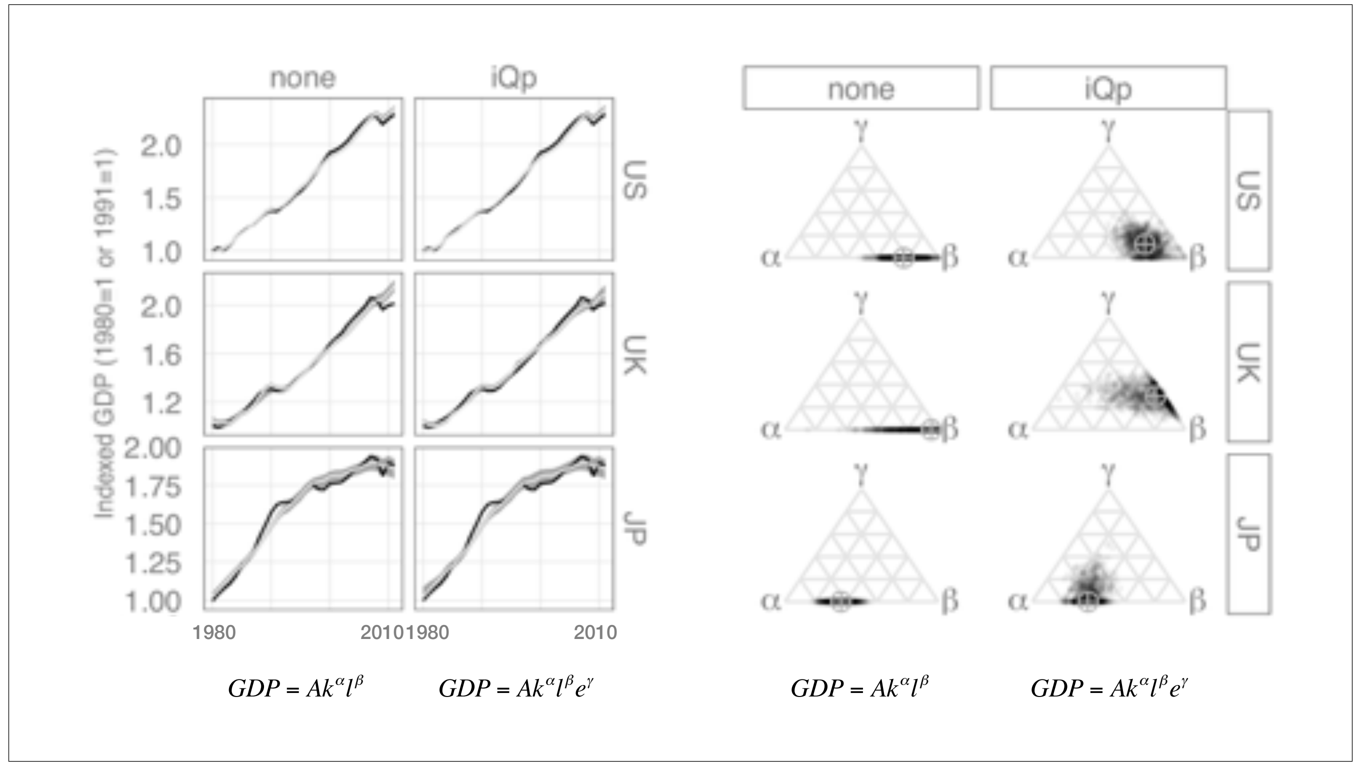


This is an example of an economic “production function,” the mainstream means of modeling macroeconomic growth. Production functions are mathematical models that describe aggregated, equilibrium macroeconomic performance as measured by GDP. This is the Cobb-Douglas function which was first formulated in 1927. GDP is related to factors of production, which are: <space> capital stock (machines and infrastructure), and <space> labor. <space> Technology augments or enhances capital and labor. Alpha and beta are the factor shares of production and indicate the importance of capital and labor, respectively, for a given economy.

$$GDP = Ak^{\alpha} l^{\beta} e^{\gamma}$$

Energy

After the energy crises of the 1970s, a very few researchers added a new term, energy (*e*).
The term represents a new constraint on economic growth. But, consideration of energy is definitely *not* part of mainstream economic thinking today.
To understand an economy, one fits an economic growth equation to GDP as a function of time by judicious choice of parameters for (in the case of this equation) A, alpha, beta, and gamma. To show how this works, I'll provide a few example graphs from a long-running project of mine.



This graph shows indexed GDP on the vertical axis and years on the horizontal axis for three different economies: the US, the UK, and Japan. Historical GDP is the black line, fitted GDP is the white line, and the gray band indicates uncertainty. The "none" column assumes energy is unimportant. The "iQp" column includes primary thermal energy in the production function. <space> These ternary graphs show crosshairs for fitted values of alpha, beta, and gamma. Uncertainty is shown by the scatter from 1000 fits to statistically resampled GDP.
I know that there are other models for economic growth and other quantifications for factors of production. But the points for now are
(1) mainstream macroeconomic growth theory endogenizes only technology, capital stock, and labor and
(2) these are aggregate, equilibrium models of the economy.

<Don't say> By the way, if you're expecting me to discuss other macroeconomic growth models such as CES, VES, Leontief, linear, or LINEX, or different energy quantifications such as primary exergy, final exergy, useful work, or energy services, we should talk later.

Five Propositions

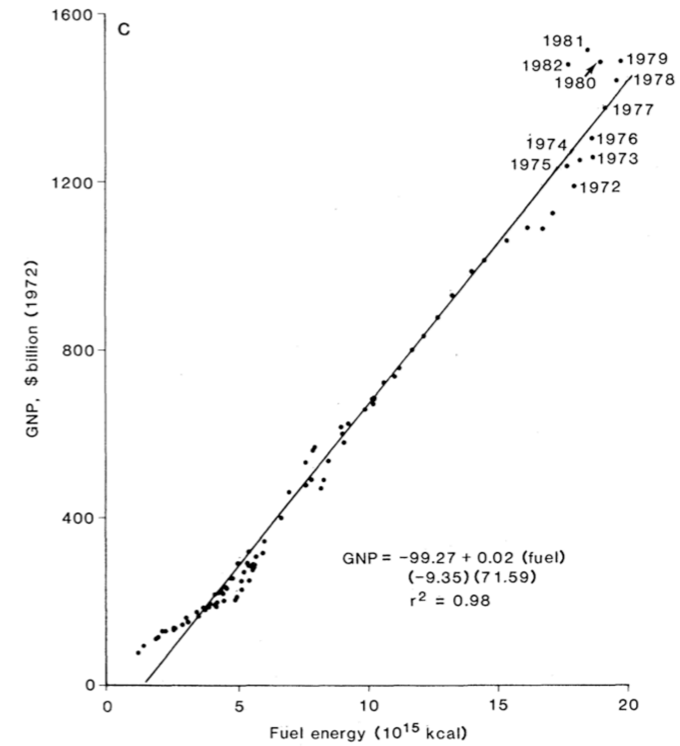
In contrast to, or maybe even as a challenge to mainstream equilibrium macroeconomic growth models, I'll discuss five propositions today. These are propositions about the energy-economy nexus.
I will argue that THESE propositions change everything and that we need to understand them if we want a transition to a stable economy run by renewable energy.

http://www.amazon.com/Economics-Paul-Samuelson/dp/0073511293/ref=dp_ob_title_bk
The ultimate goal of economics is to improve the living conditions of people in their everyday life.
http://en.wikipedia.org/wiki/Economics

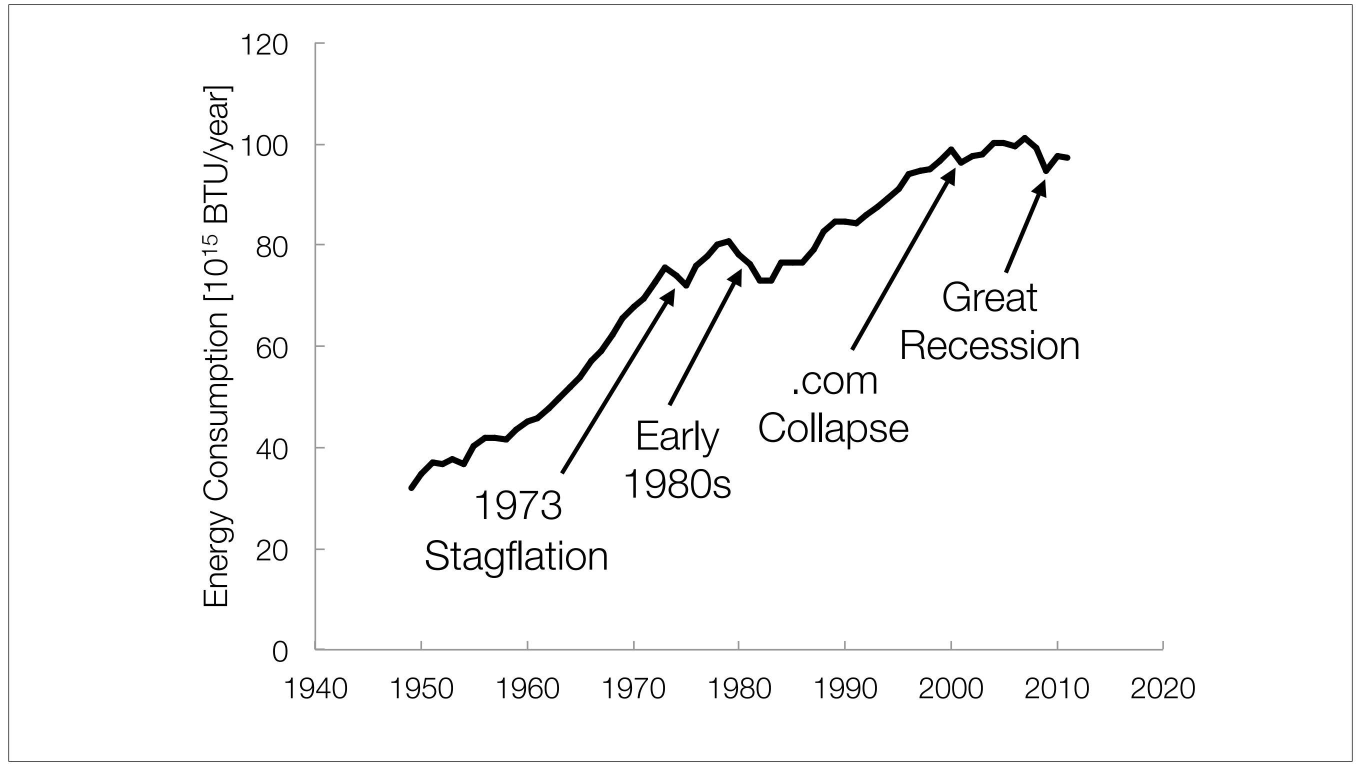
Proposition 1

Energy and the Economy are Linked

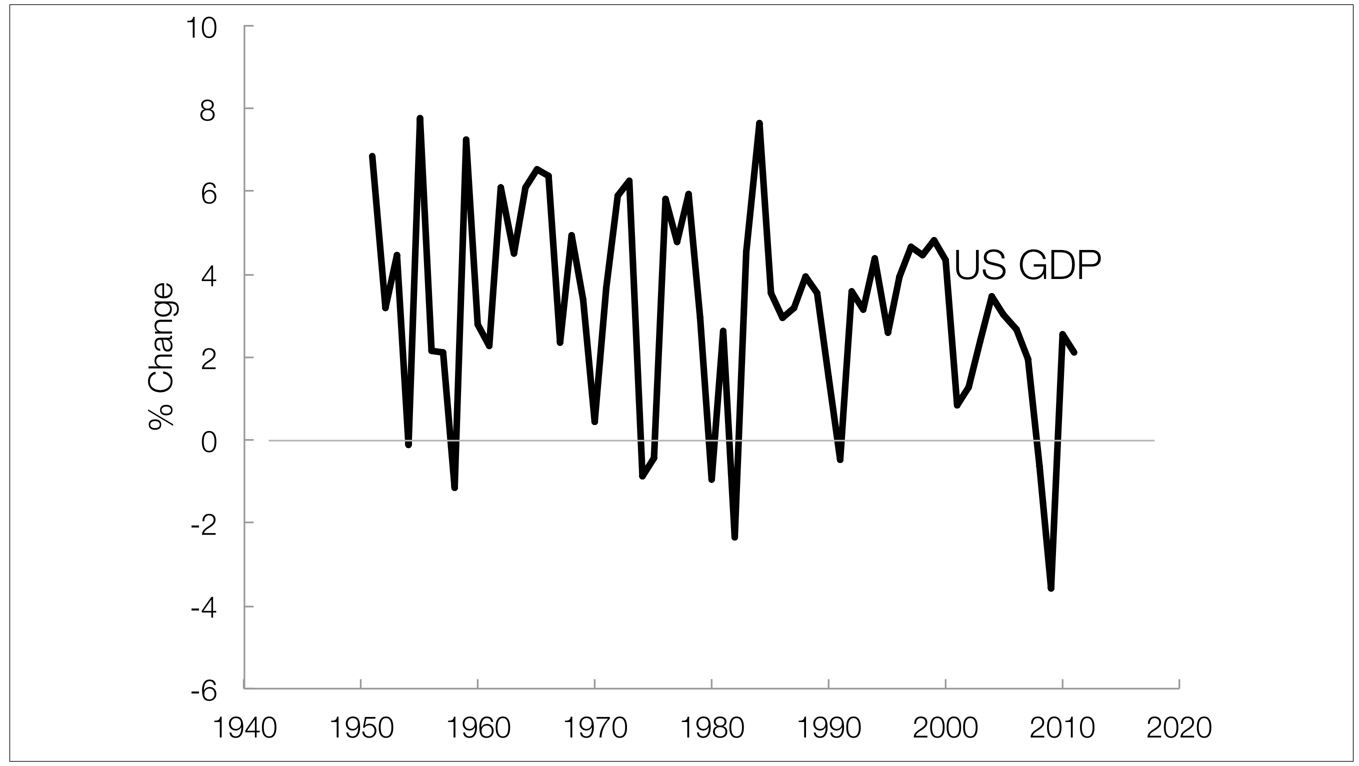
Let’s begin with Proposition 1: Energy and the Economy are Linked.



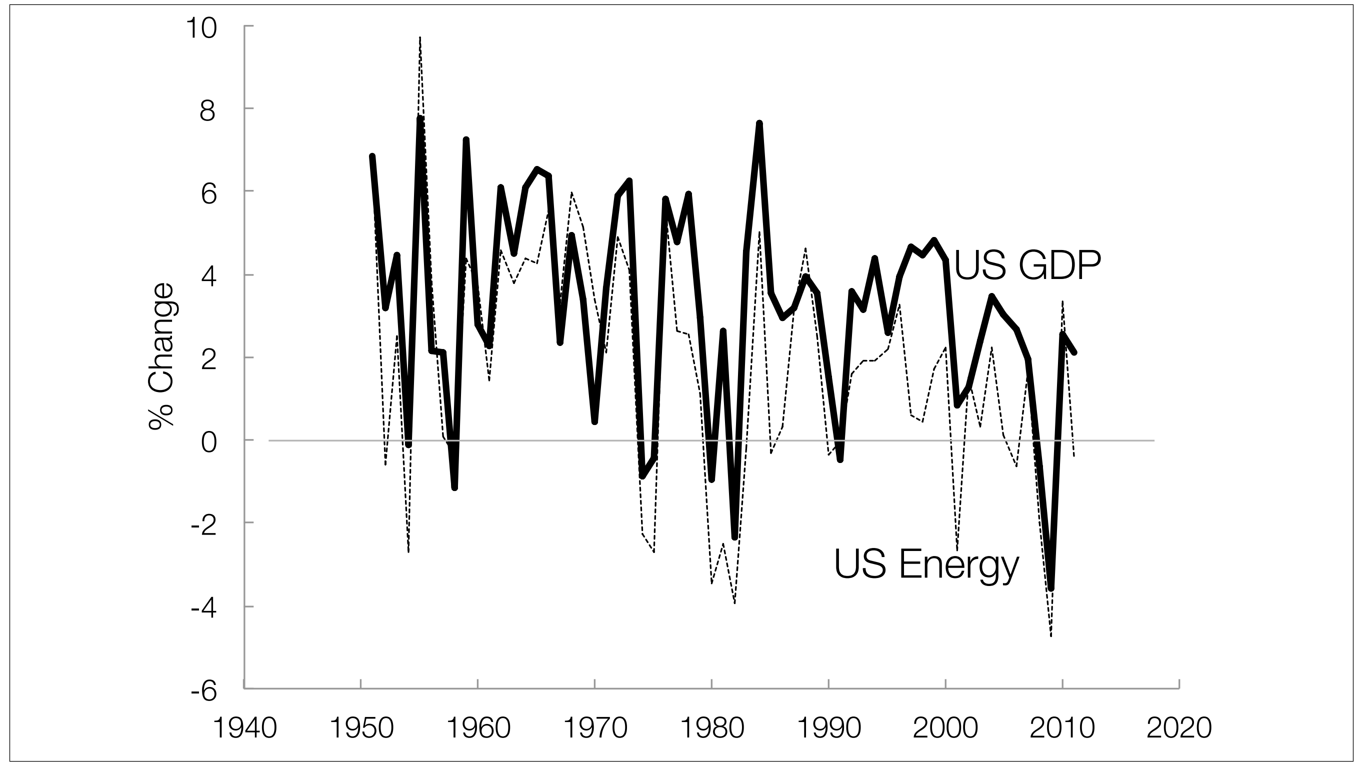
In 1984, an article by Cleveland, Costanza, and Hall entitled *Energy and the US Economy: A Biophysical Perspective* contained this graph. <space> It was one of the first clear indications of the correlation between economic output and energy consumption.



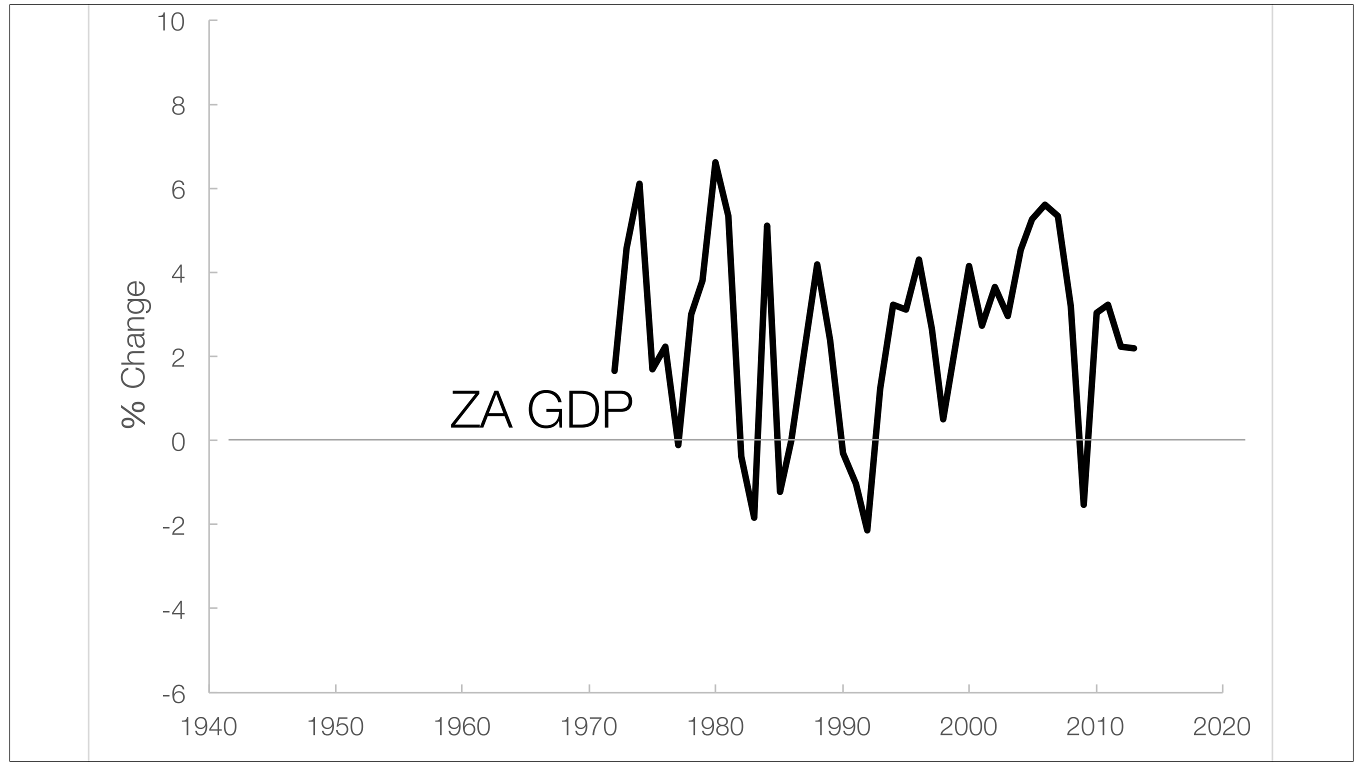
This graph shows post WWII US Energy consumption on the vertical axis and time on the horizontal axis. <space> Significant energy downturns correlate with recessions.



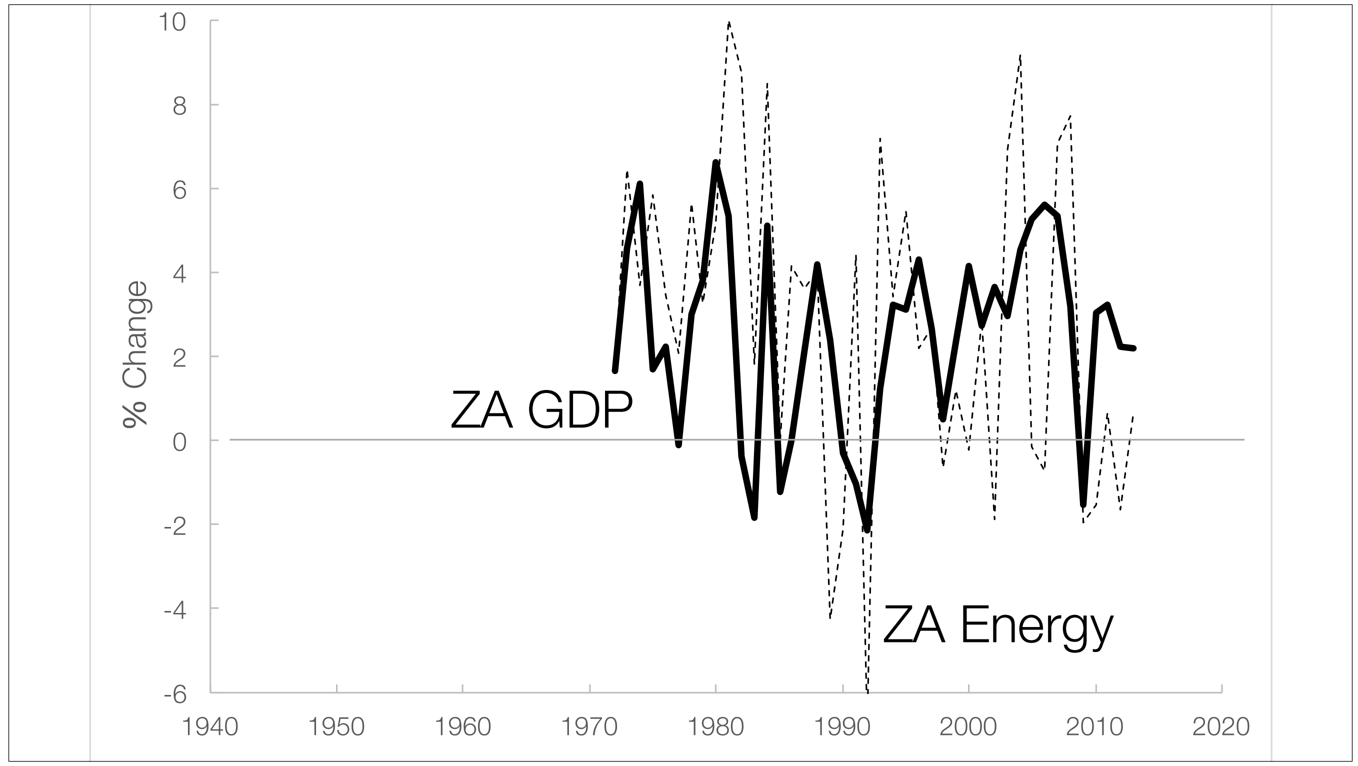
This graph shows the change in US GDP over time.



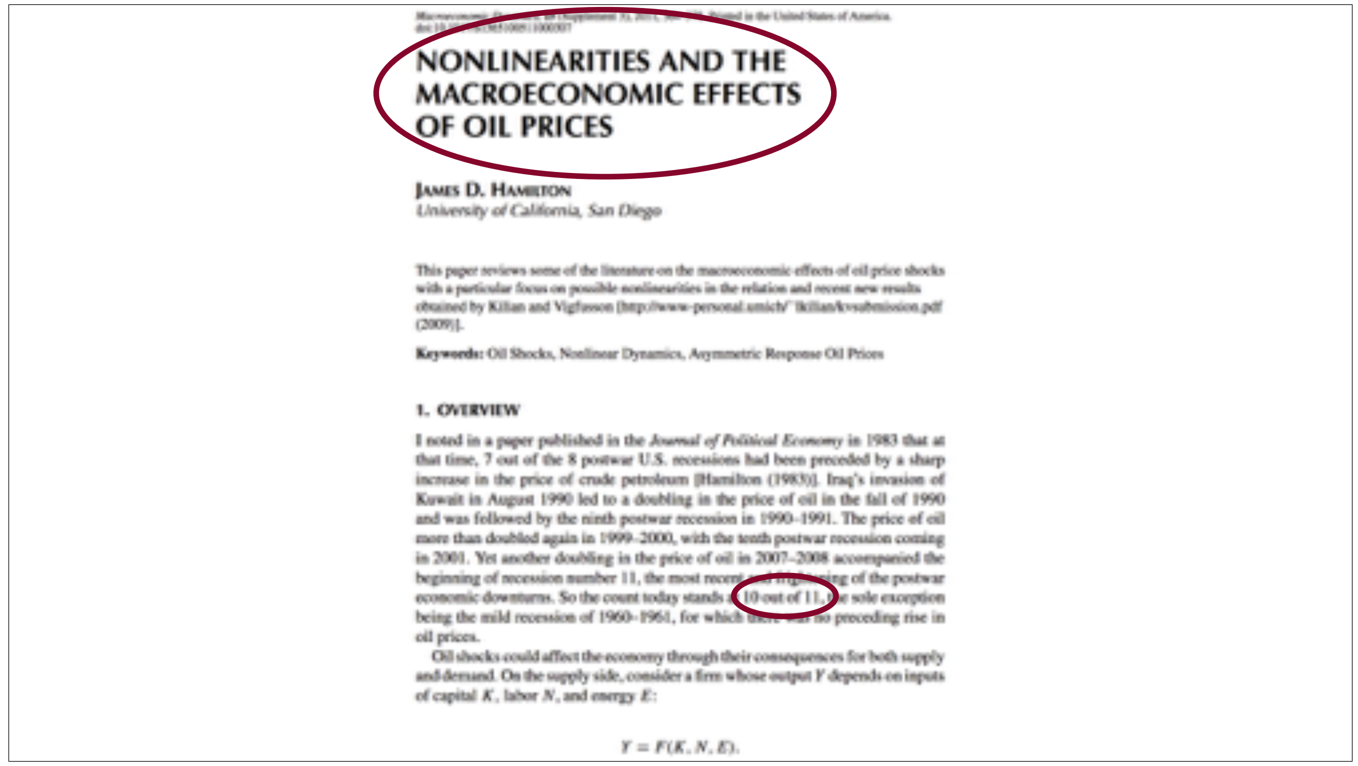
We can overlay change of US energy over time, and the correlation remains true to this day.



We can do the same for South Africa



Data from PWT (GDP) and IEA (TPES).



NONLINEARITIES AND THE MACROECONOMIC EFFECTS OF OIL PRICES

James D. Hamilton
University of California, San Diego

This paper reviews some of the literature on the macroeconomic effects of oil price shocks with a particular focus on possible nonlinearities in the relation and recent new results obtained by Kilian and Vigfusson [http://www-personal.umich/~lkilian/kvsubmission.pdf (2009)].

Keywords: Oil Shocks, Nonlinear Dynamics, Asymmetric Response Oil Prices

1. OVERVIEW

I noted in a paper published in the *Journal of Political Economy* in 1983 that at that time, 7 out of the 8 postwar U.S. recessions had been preceded by a sharp increase in the price of crude petroleum [Hamilton (1983)]. Iraq's invasion of Kuwait in August 1990 led to a doubling in the price of oil in the fall of 1990 and was followed by the ninth postwar recession in 1990–1991. The price of oil more than doubled again in 1999–2000, with the tenth postwar recession coming in 2001. Yet another doubling in the price of oil in 2007–2008 accompanied the beginning of recession number 11, the most recent ... of the postwar economic downturns. So the count today stands at 10 out of 11, the sole exception being the mild recession of 1960–1961, for which ... no preceding rise in oil prices.

Oil shocks could affect the economy through their consequences for both supply and demand. On the supply side, consider a firm whose output Y depends on inputs of capital K, labor N, and energy E:

$$Y = F(K, N, E).$$

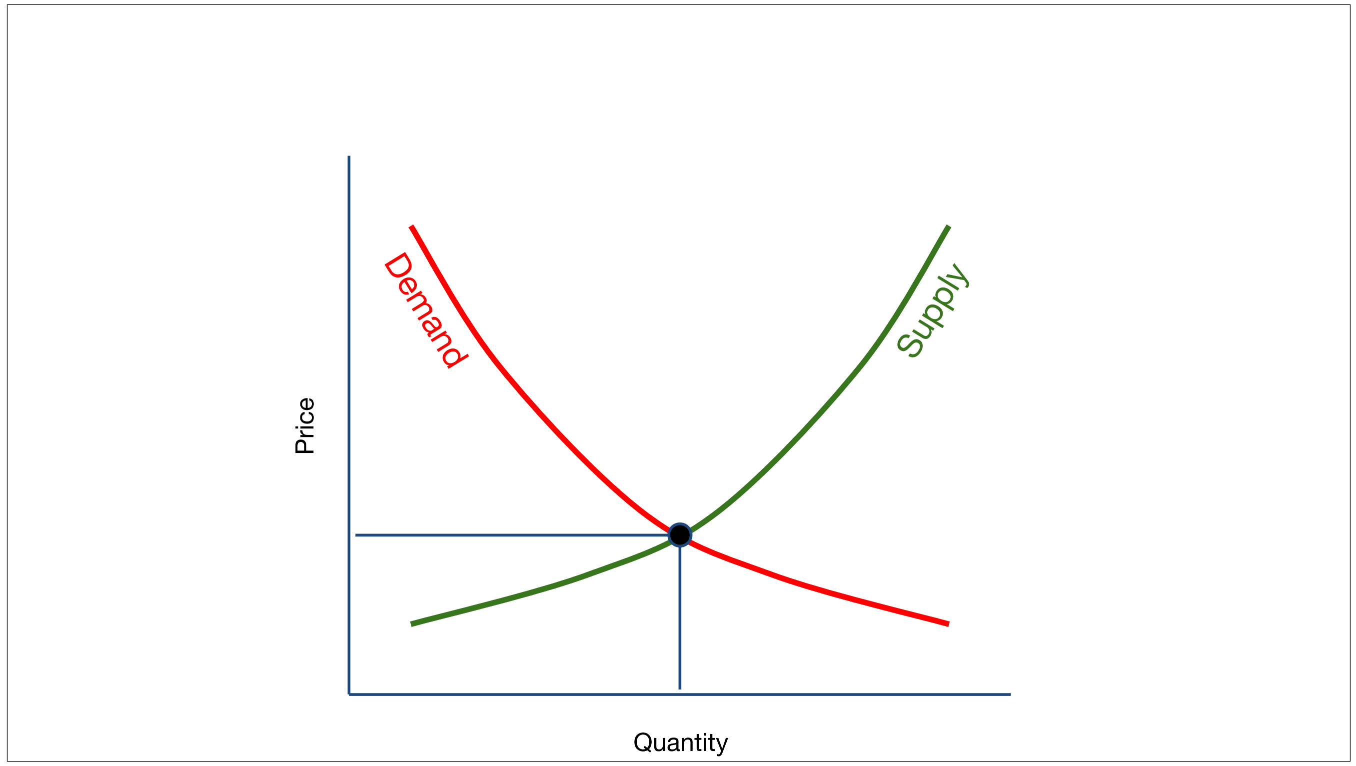
Economist James Hamilton keeps a running total of the number of U.S. recessions preceded by oil market events. He points out in his 2011 paper titled <space> "Nonlinearities and the Macroeconomic Effects of Oil Prices" that <space> 10 of 11 postwar recessions were preceded by a spike in oil prices.

Proposition 1: Energy and the economy are linked.

Proposition 2

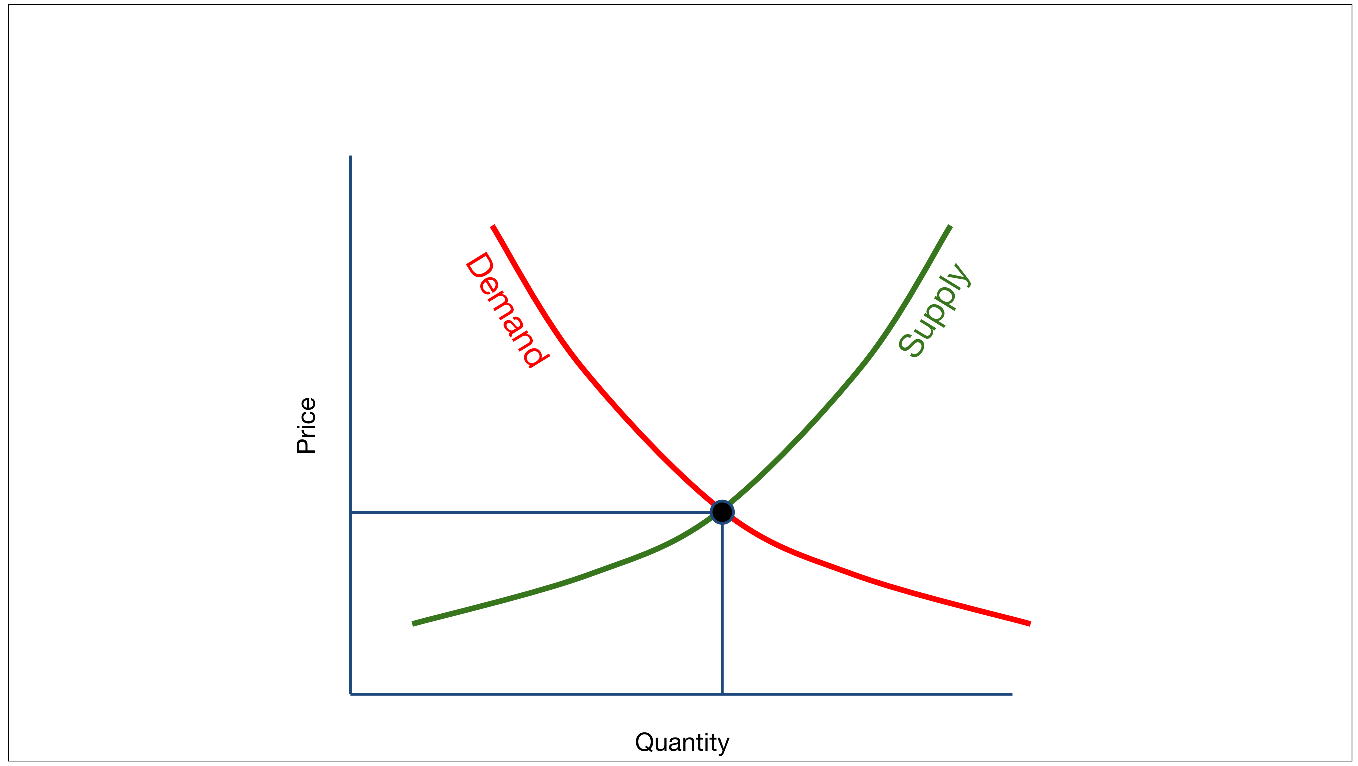
Fundamentals of Energy Supply, Demand, and Prices Are Different Now

My second proposition is that the Fundamentals of Energy Supply, Demand, and Prices Are Different Now. Or at least different from what you remember of your introductory economics course.

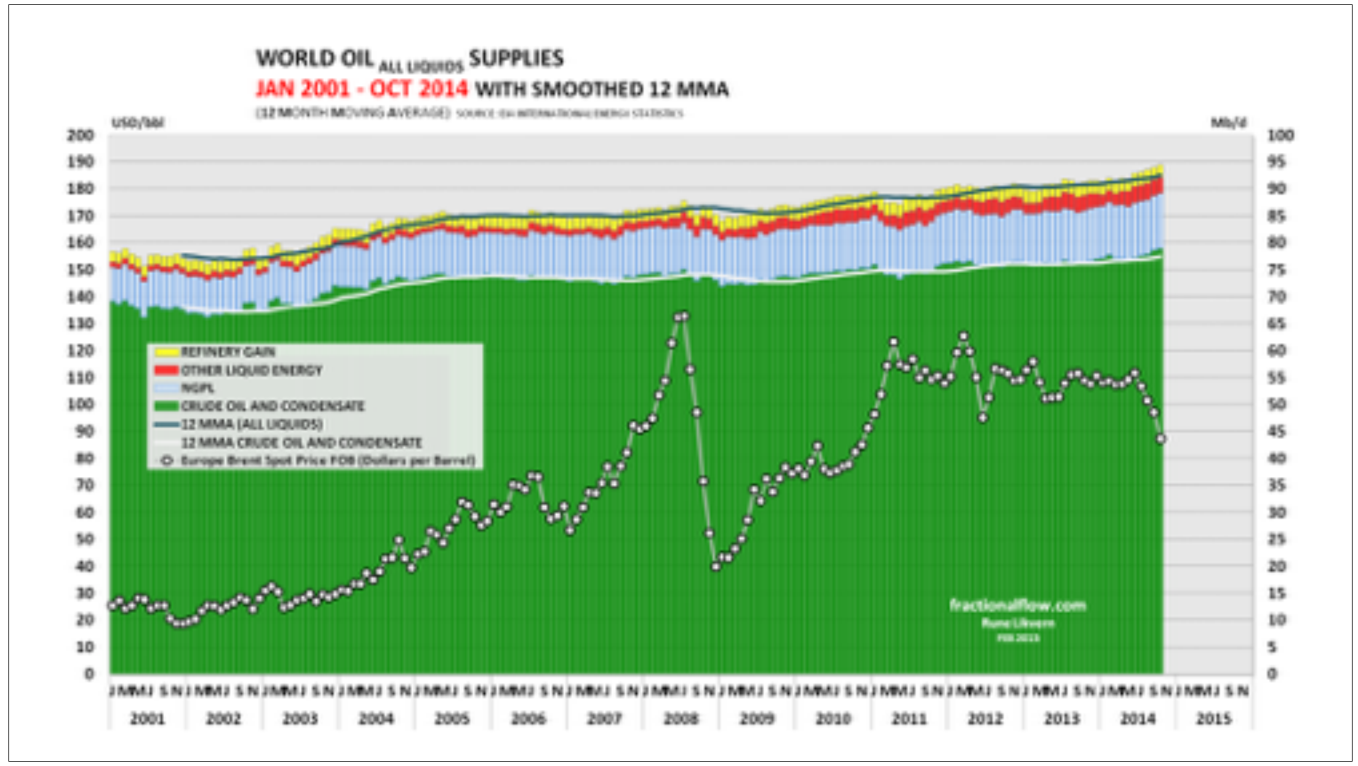


In ECON 101, you would have seen graphs that look like this. Price and quantity of supply and demand are the axes here. <space> Demand DEcreases as price rises. <space> Supply INcreases as price rises. <space> An equilibrium point in terms of price and quantity is obtained where the supply and demand lines cross.

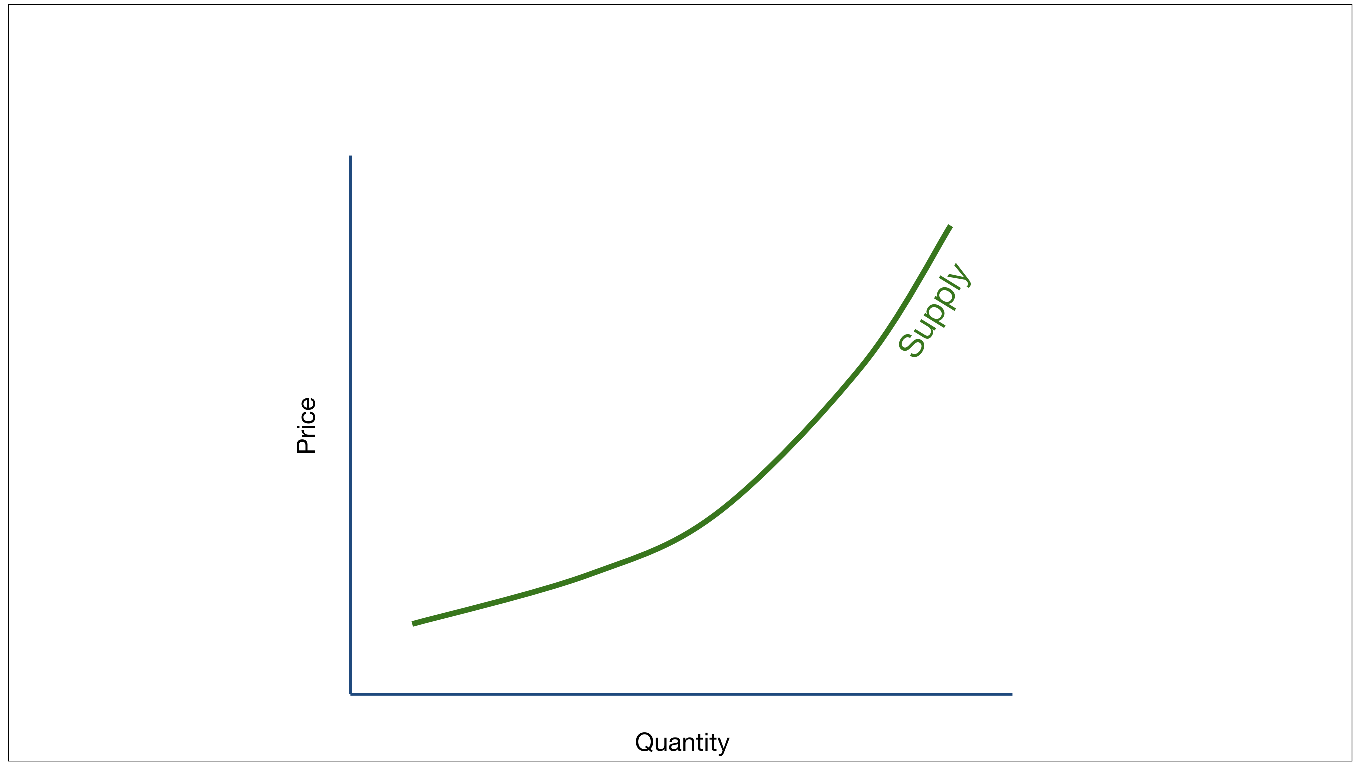
If, for example, demand increases slightly, <space>



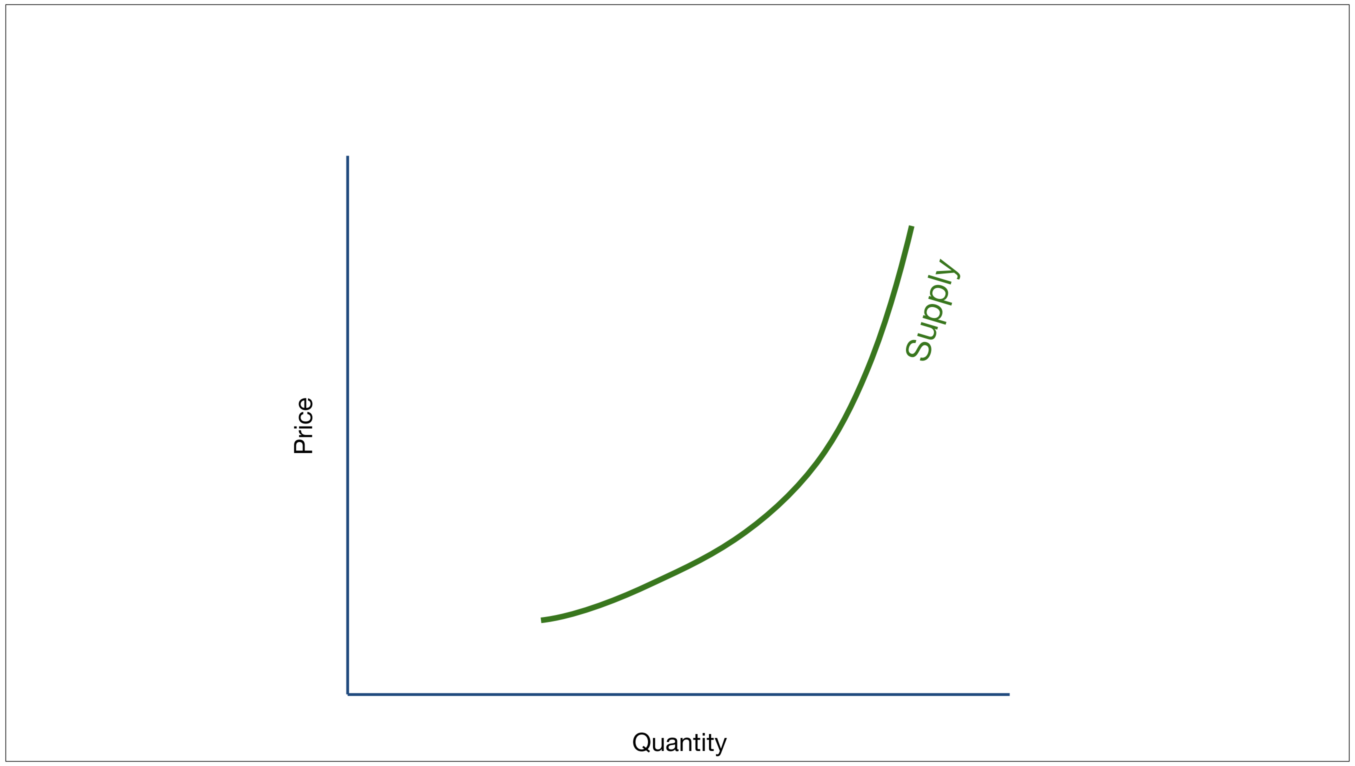
a new equilibrium point of higher price and increased supply rate is established. You'll note that the ECON 101 lines are gradually sloping and that changes in supply and demand lead to moderate changes in price and quantity.

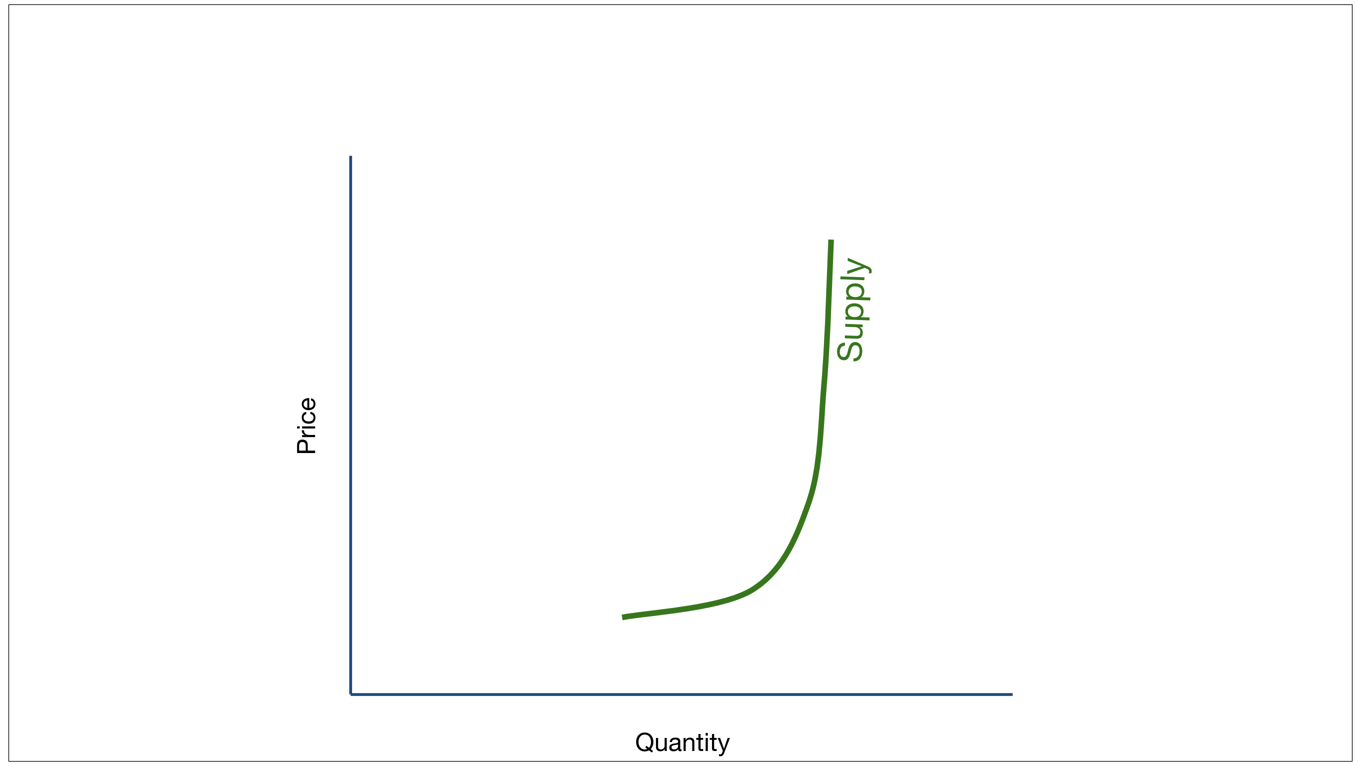


Things look somewhat different in the energy markets. I'll discuss oil, because it is thought by many to be the ultimate resource. This graph from Rune Likvern shows years on the horizontal axis, world oil supply as bars on the right axis, and oil price as the white line with circles on the left axis. Note that, in contrast to the ECON 101 model, very small changes in supply and demand (the bars) correlate with large swings in price (the white line). Why?



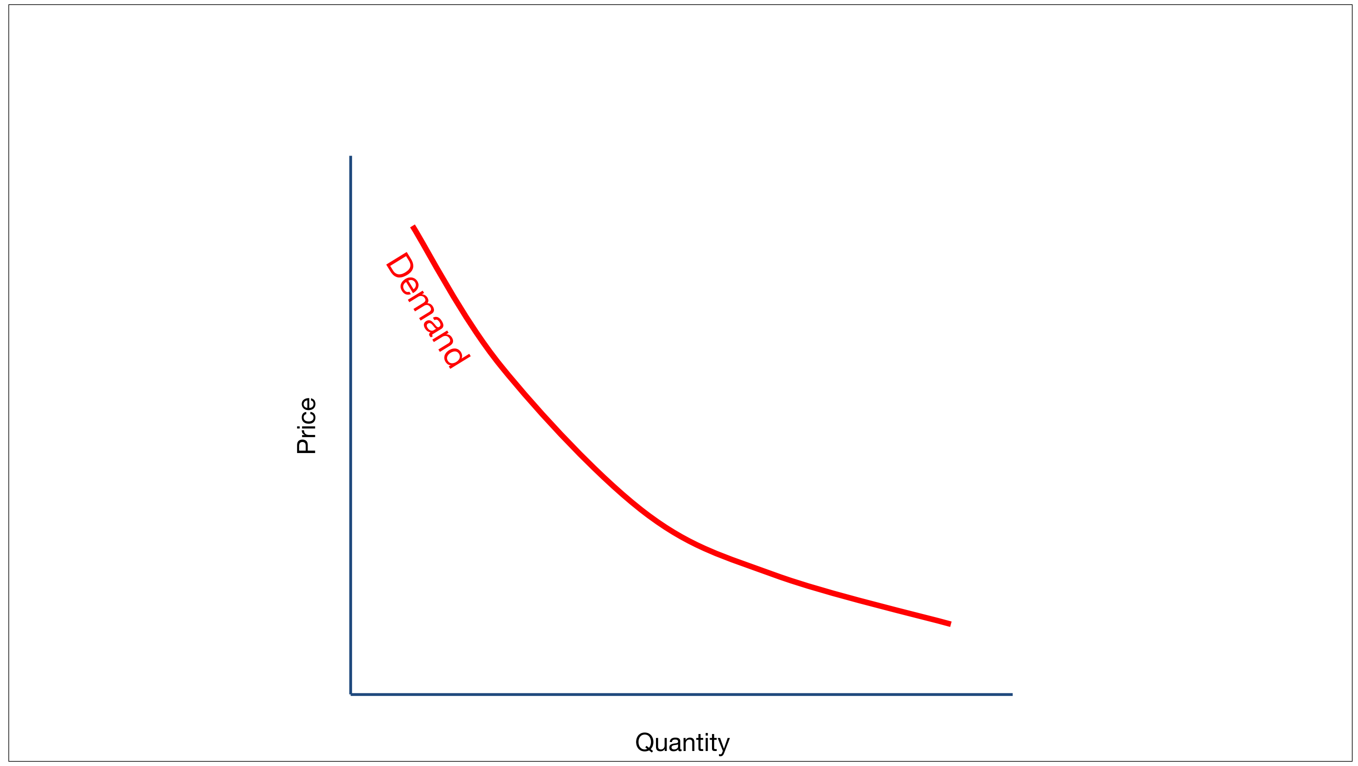
For oil, I don't think the supply line looks like this. Rather, … <space>


Supply
Price
Quantity

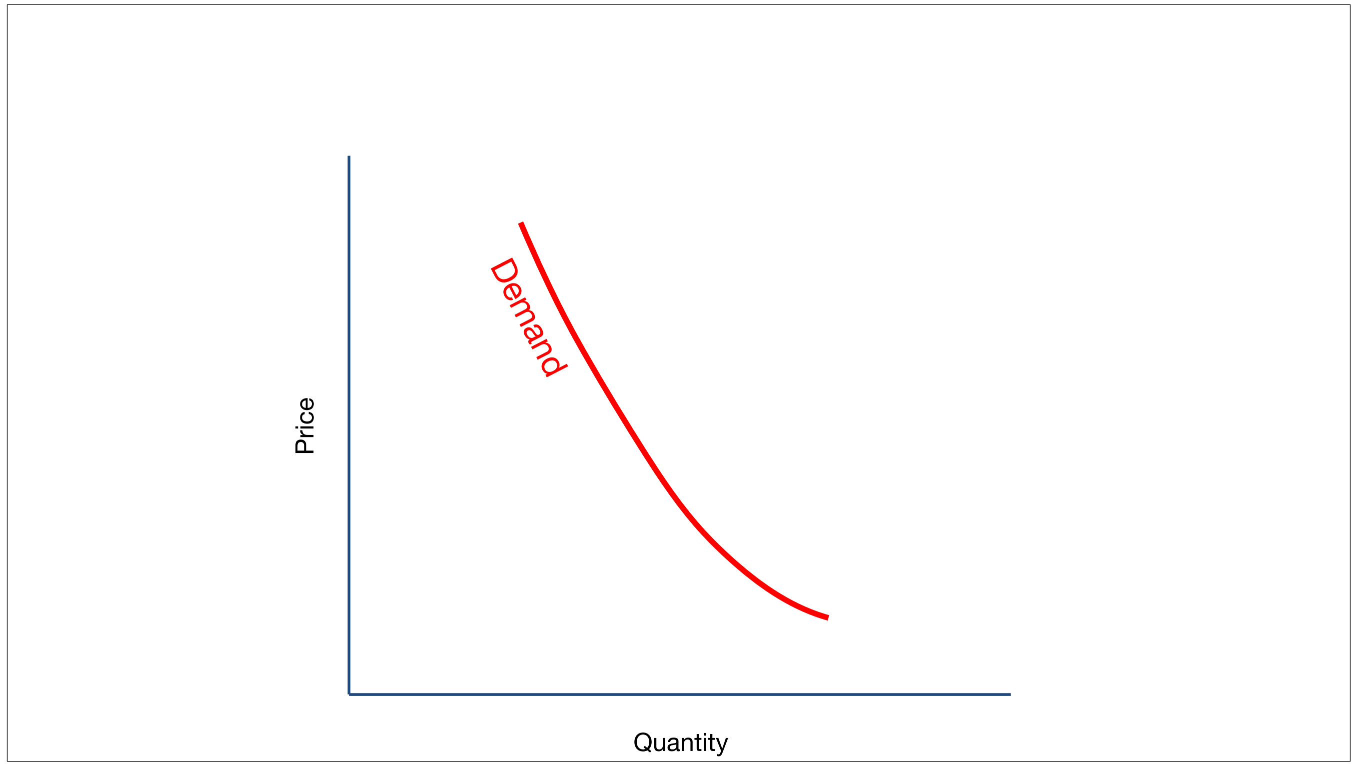


… it looks like this. Above a certain threshold (caused by biophysical limits), very large changes in price are needed to induce very small changes in supply. Under these circumstances, economists say that oil supply is very price inelastic.

This supply curve is characteristic of a depleting resource.

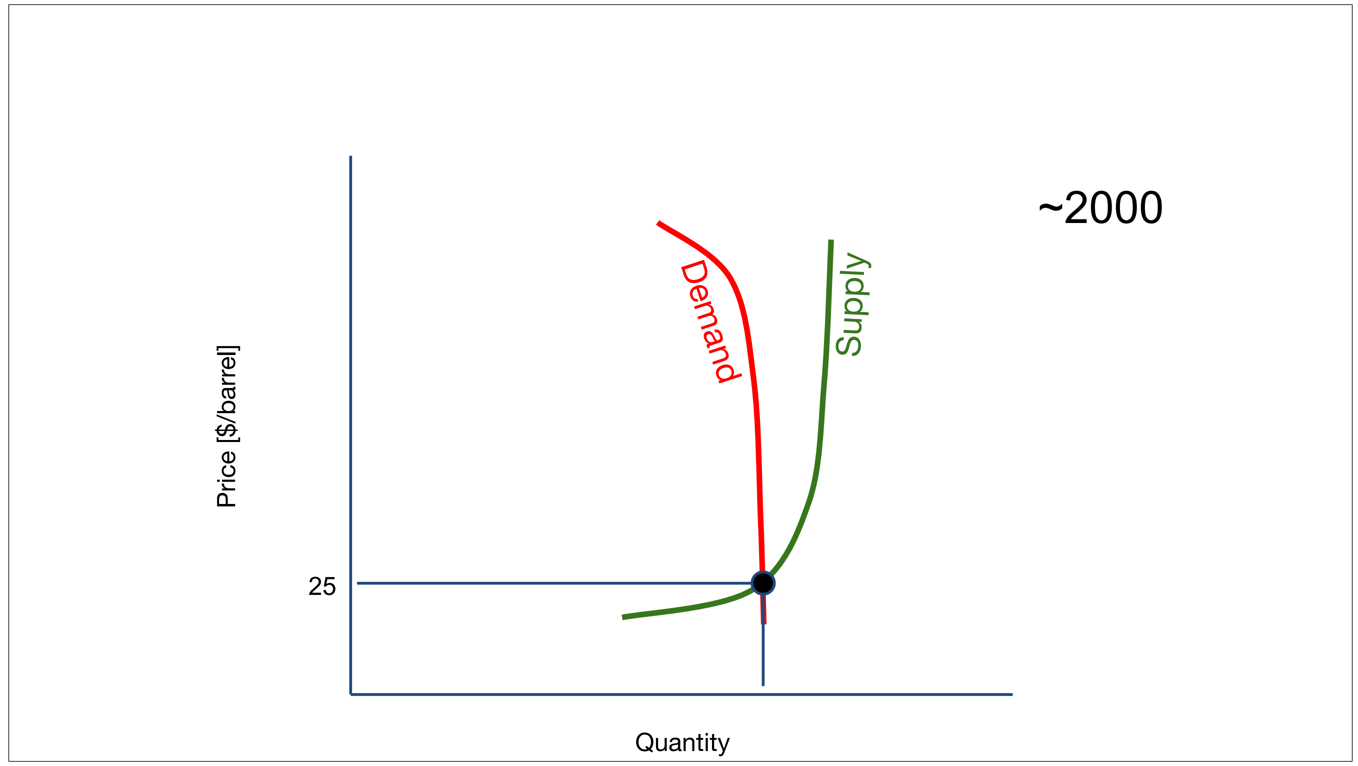


And, oil demand doesn't look like this … <space>

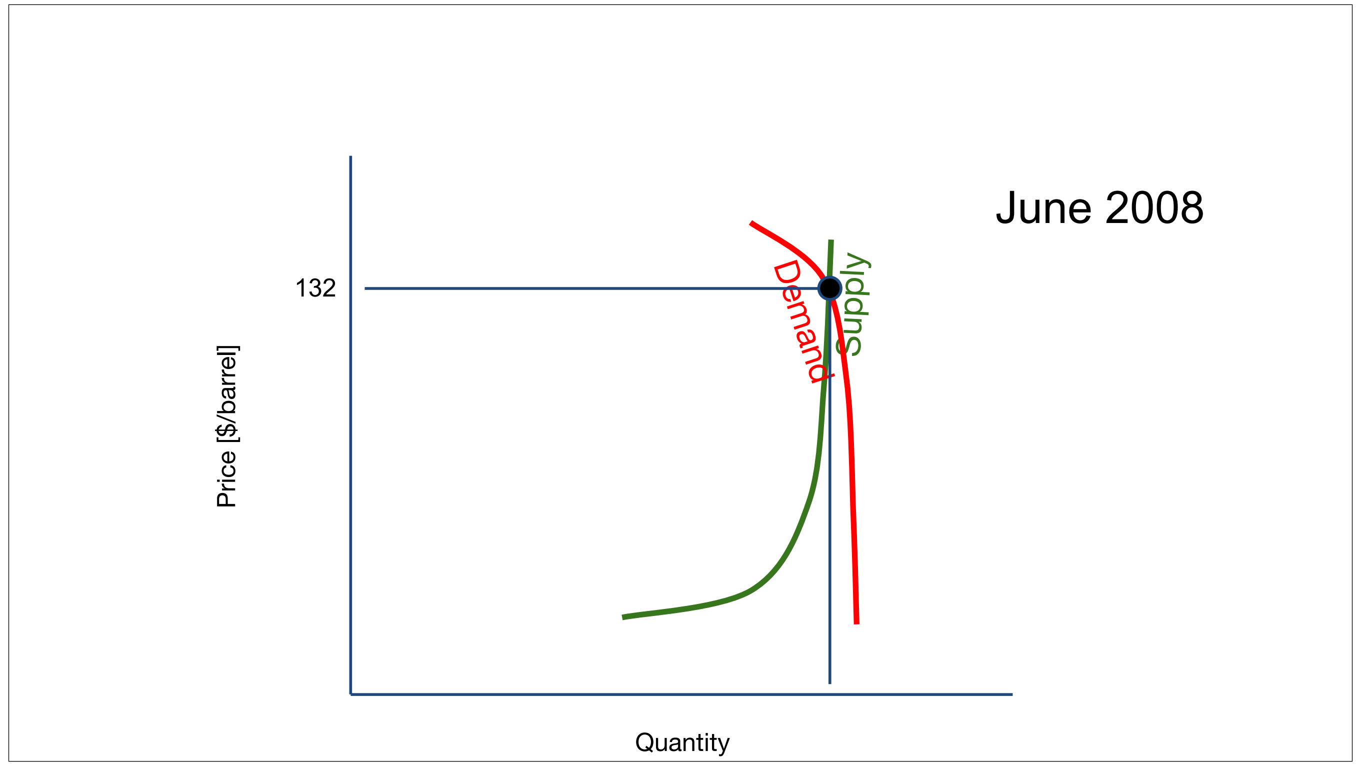

Demand
Price
Quantity

… It looks like this. It takes a very large change in price to reduce consumption. As the oil price rose from 2002–2008, how many of you drove significantly fewer kilometers?

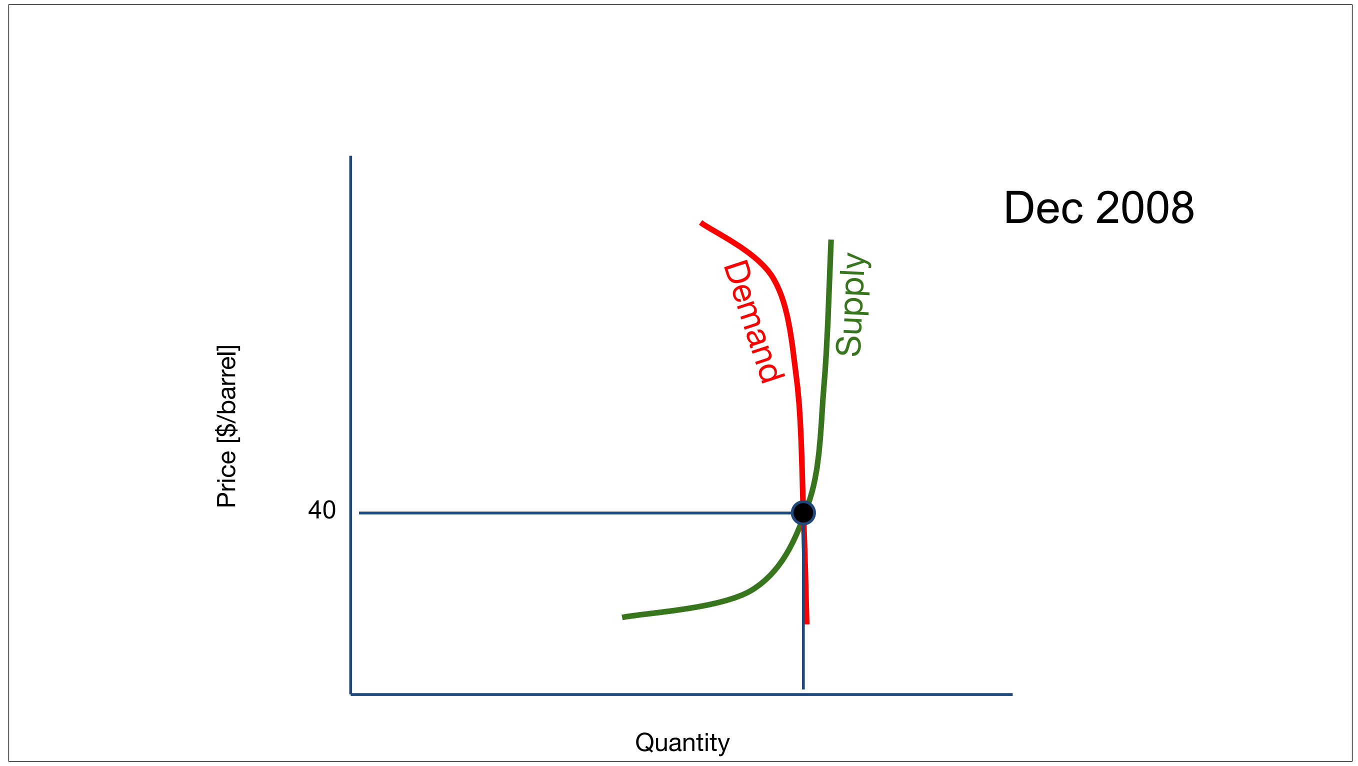
This demand curve is characteristic of an essential resource.



Now let's look at the interaction of essential resource demand with depleting resource supply. In about 2000, this is where things stood in the oil markets. <space> We had about $25/ barrel oil.

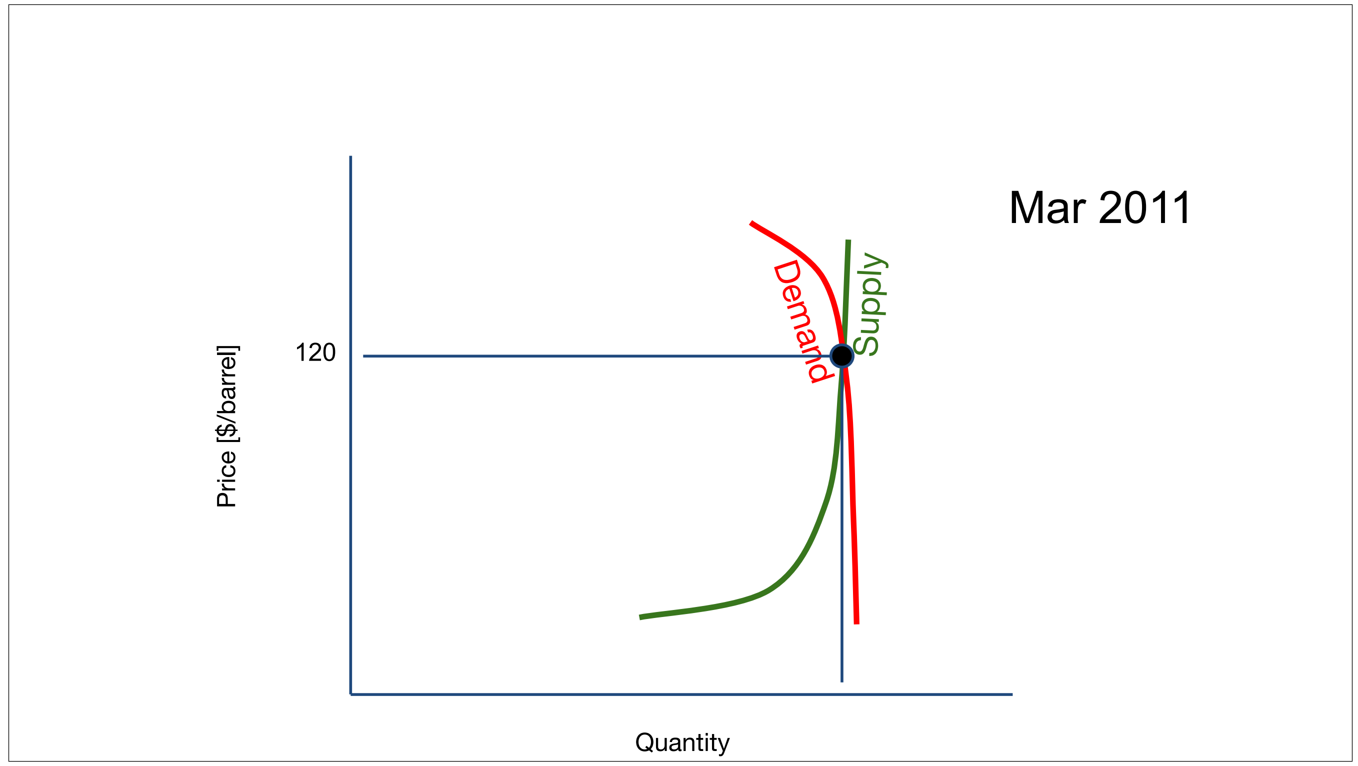


But economic growth, especially in so-called “developing” economies, led to relatively small increases in demand. By June 2008, we had reached over $132/barrel. The large change of price was caused by the interaction of the supply and demand curves.

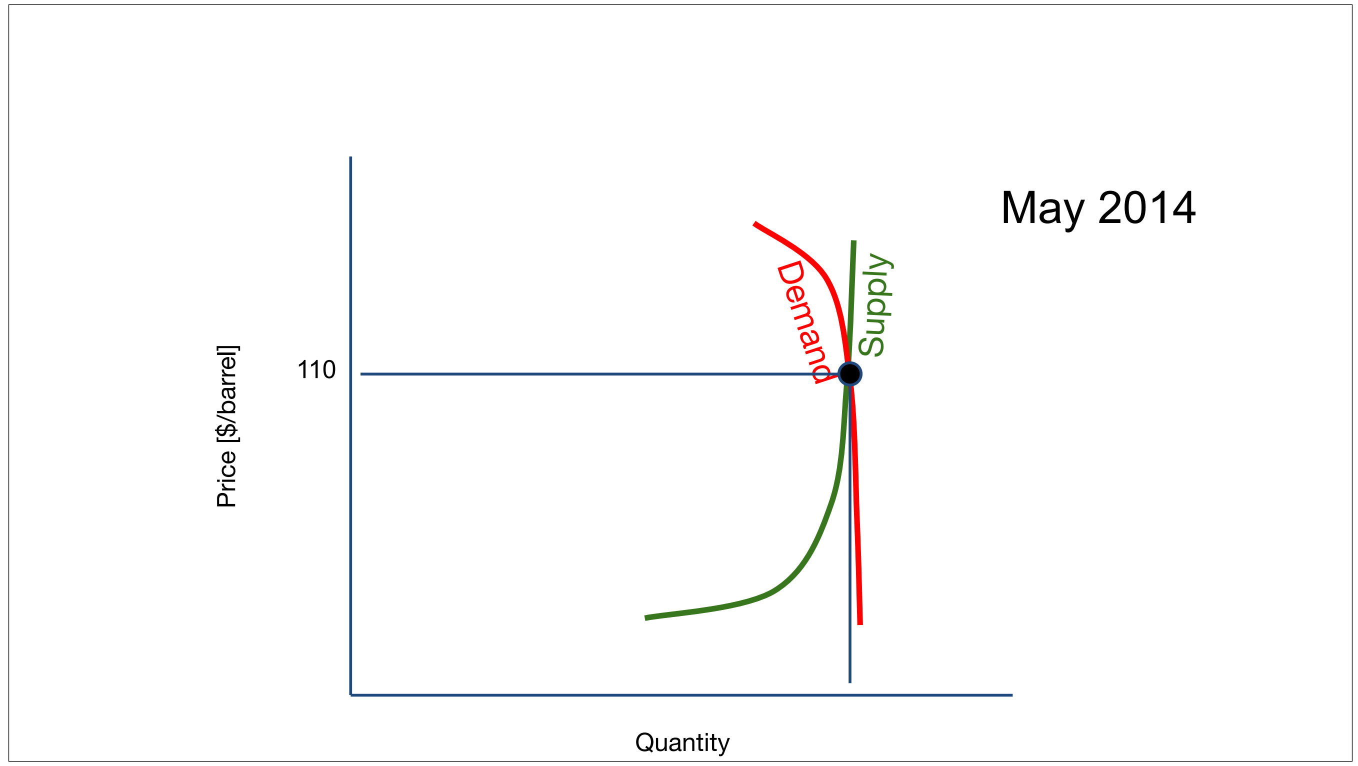


As the Great Recession destroyed demand, price fell, rapidly. By December 2008, we were down to $40/barrel oil.

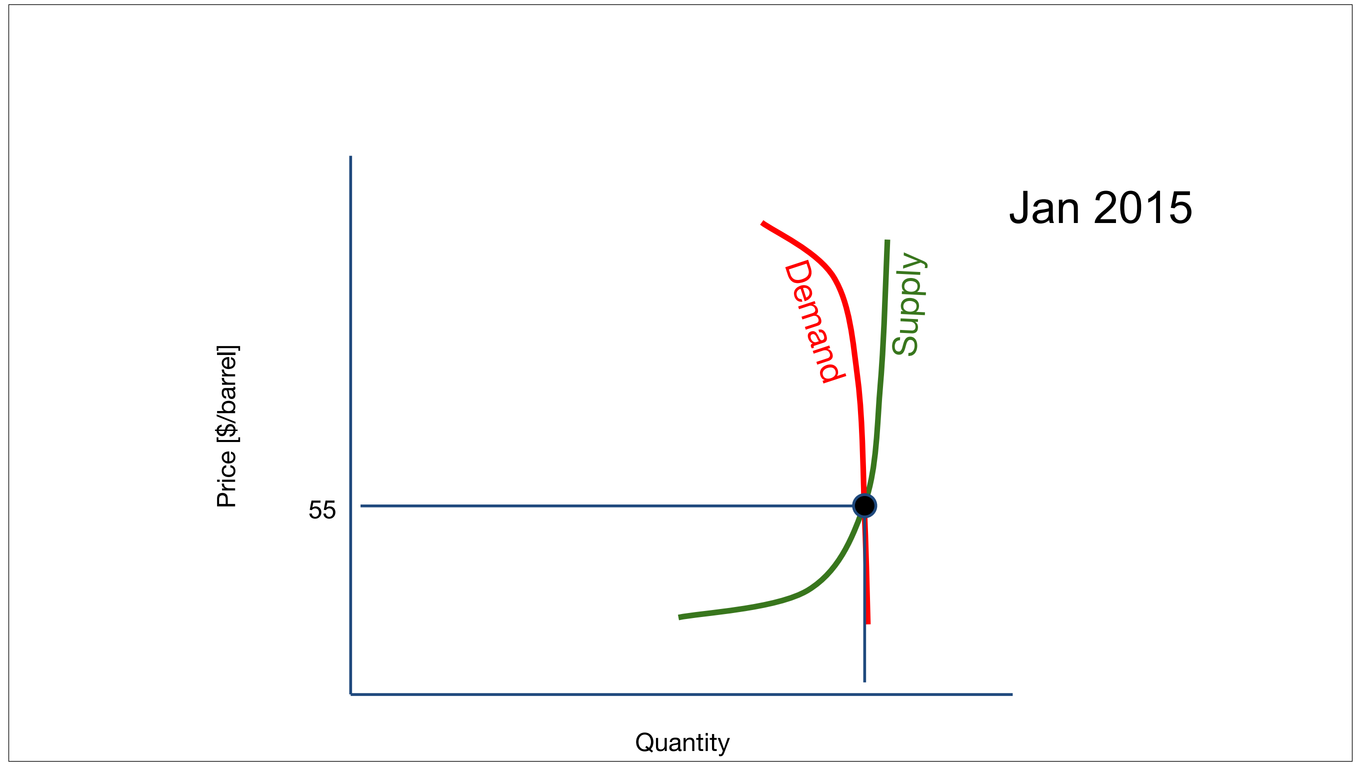
This is a good place to pause and point out that extreme price changes occur only because of the shapes of these supply and demand curves which indicate price inelasticity for an essential and depleting resource.



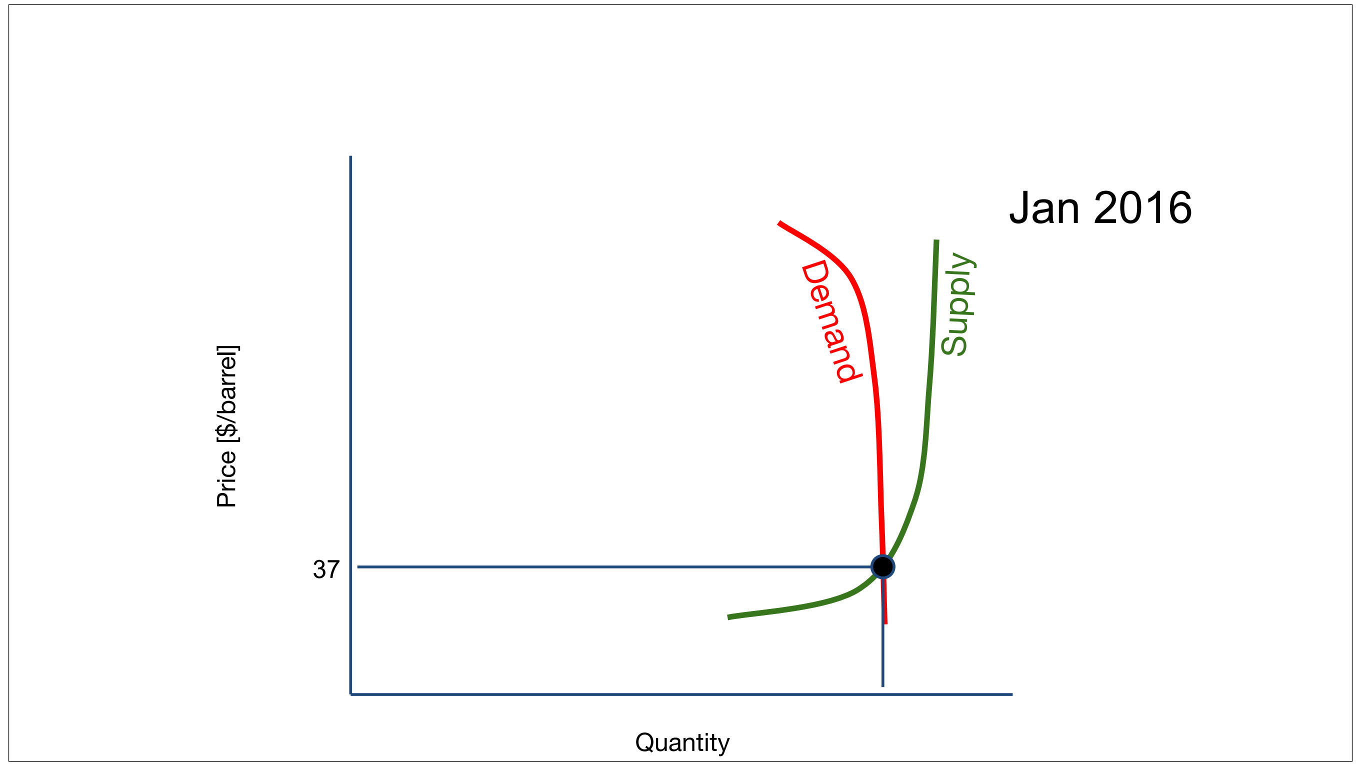
Economic recovery increased demand and supply slightly such that by March 2011, price was back up to $120/barrel.



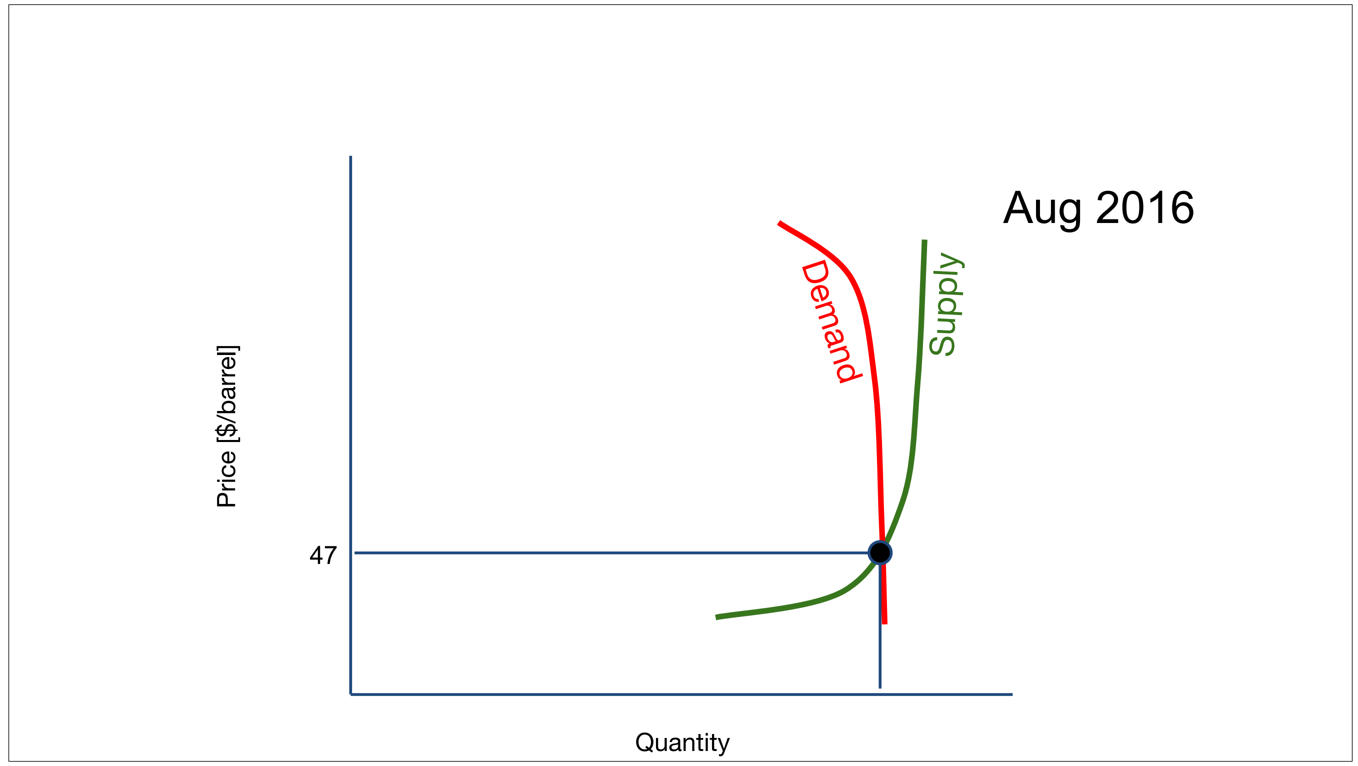
From there, supply rose slightly faster than demand to May 2014 and $110/barrel.



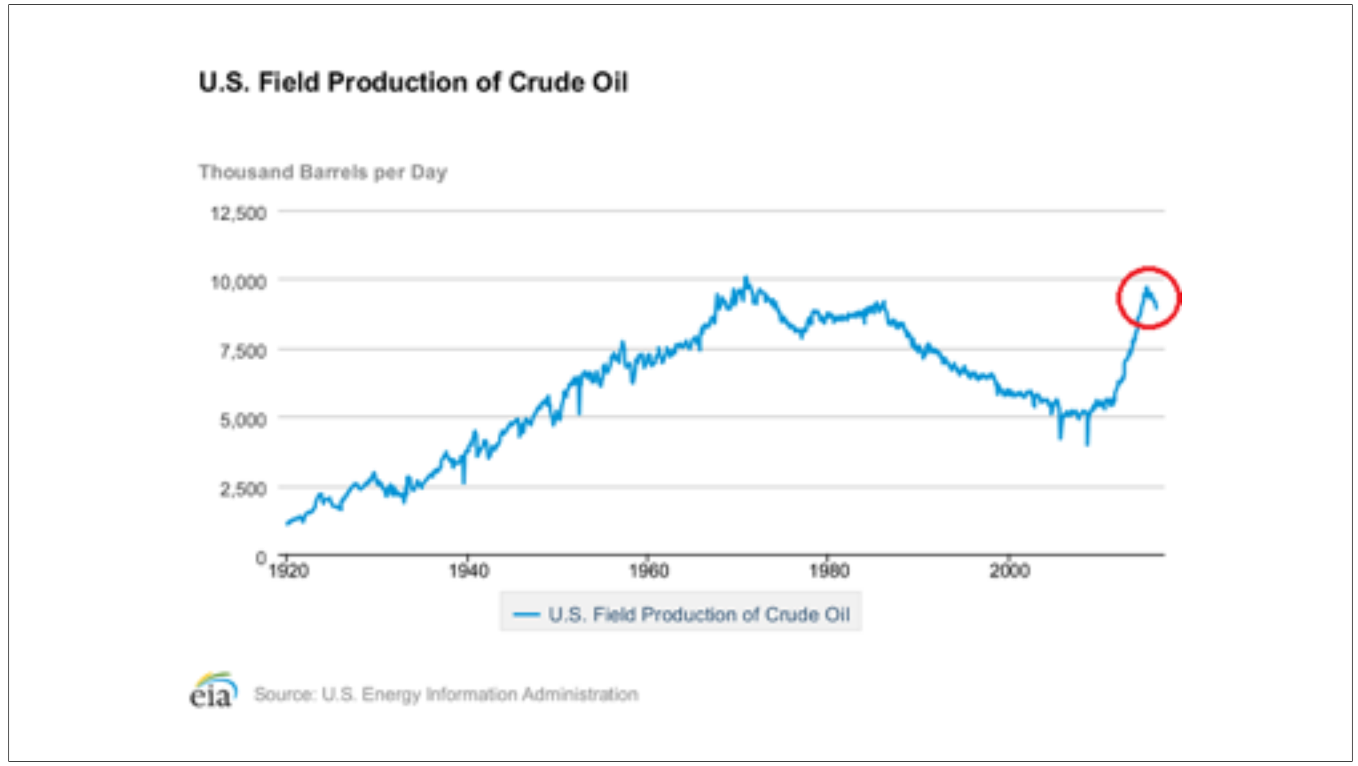
With the recent shale “boom,” supply has increased slightly (a few million barrels per day out of 90-something) to cause the precipitous price drop to $55/barrel in January 2015.



and $37/barrel January 2016.



Recent financial distress and bankruptcies of small shale producers has constrained supply such we're now at about $47/barrel.



And, here is the data on US oil production showing the recent decrease.

Proposition 2: The Fundamentals of Energy Supply, Demand, and Prices Are Different Now, especially when you have an essential and depleting resource such as oil.

Proposition 3

Heretofore
Under-appreciated Metrics
are Fundamentally Important
for Understanding the
Macroeconomy

Which brings us to Proposition 3: Heretofore Under-appreciated Metrics are Fundamentally Important for Understanding the Macroeconomy.

Energy Cost Share

I want to discuss three such metrics. The first is energy cost share.

I. Bashmakov / Energy Policy 35 (2007) 3583–3594

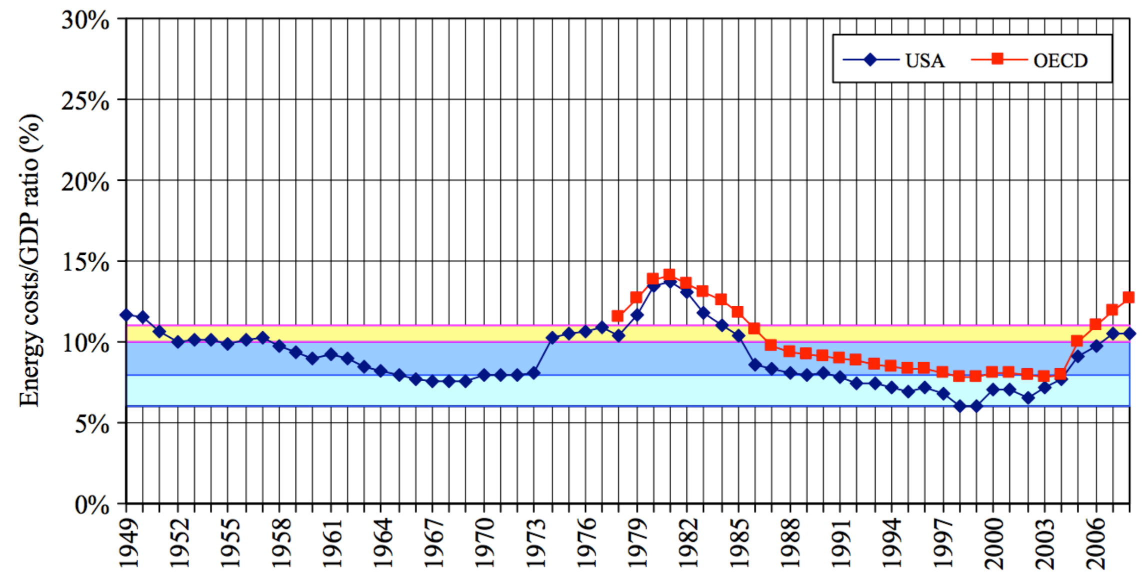


Fig. 2. Energy costs to GDP ratio evolution in OECD and the USA.

I. Bashmakov. Three Laws of Energy Transitions. Energy Policy, 35(7):3583–3594, July 2007.

To my knowledge, Bashmakov (in 2007) was the first to identify a correlation between energy cost share (as opposed to energy prices) and economic performance. This graph shows the evolution over time of energy costs as a percentage of GDP.

The striking feature of this graph is that high cost share (greater than, say, 10%) correlates with recessionary pressures. Low cost share (less than, say, 7%) correlates with economic expansion.

I. Bashmakov. Three Laws of Energy Transitions. Energy Policy, 35(7):3583–3594, July 2007.

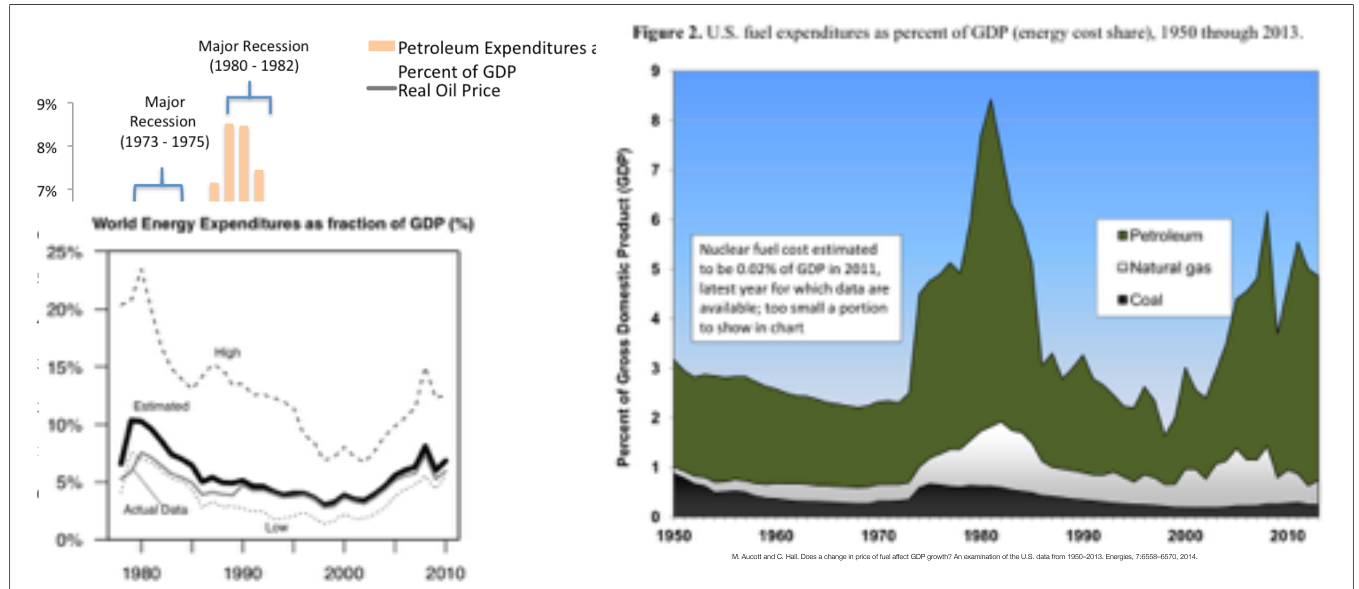


Figure 2. The fraction of GDP (for the 44 countries in the data set) spent on approximated total primary energy ($f_{e,GDP}$) from 1978 to 2010. Actual Data = using data provided in IEA data set. Estimated = assumes reasonable prices for countries with no price data for certain commodities. Low/High = assumes the lowest/highest price in the data set for each commodity is applied to all countries.

Later work by Murphy and Hall (2011), <space> Aucott and Hall (2014), and <space> King et. al. (2015) also find similar results: economic growth is associated with low energy cost share. We have never had a situation where energy cost share was above 10% for a sustained period of time. Economic recessions are associated with high energy cost share.

D. J. Murphy and C. A. S. Hall. Energy return on investment, peak oil, and the end of economic growth. Annals of the New York Academy of Sciences, 1219(1):52–72, Feb. 2011.
M. Aucott and C. Hall. Does a change in price of fuel affect GDP growth? An examination of the U.S. data from 1950–2013. Energies, 7:6558–6570, 2014.
C. W. King, J. P. Maxwell, and A. Donovan. World economy-wide energy expenditures and net energy metrics. Energies, page **** In Review ****, 2015.

Energy Return on Investment (EROI)

The second metric is energy return on investment.

This metric is a measure of the Best First Principle: We, as a society, extract easiest-to-obtain resources first. As easy resources are depleted, more energy is required to extract remaining resources. It takes energy to make energy!

Lucas gusher at Spindletop
West Texas, 1901

Oil platform P-51
Brazil

The Best First Principle is illustrated by the images on this slide. <space> This is the Lucas gusher at Spindletop, West Texas, 1901. You could, almost literally, poke a hole in the ground and “up comes a bubbling crude.” <space> On the right, we have a modern oil platform off the coast of Brazil. The offshore platform is considerably more expensive to emplace, the oil is considerably more expensive to extract, and the oil is considerably more expensive to move to refineries. But, we’re willing to do it, because we need the energy to run our economies.

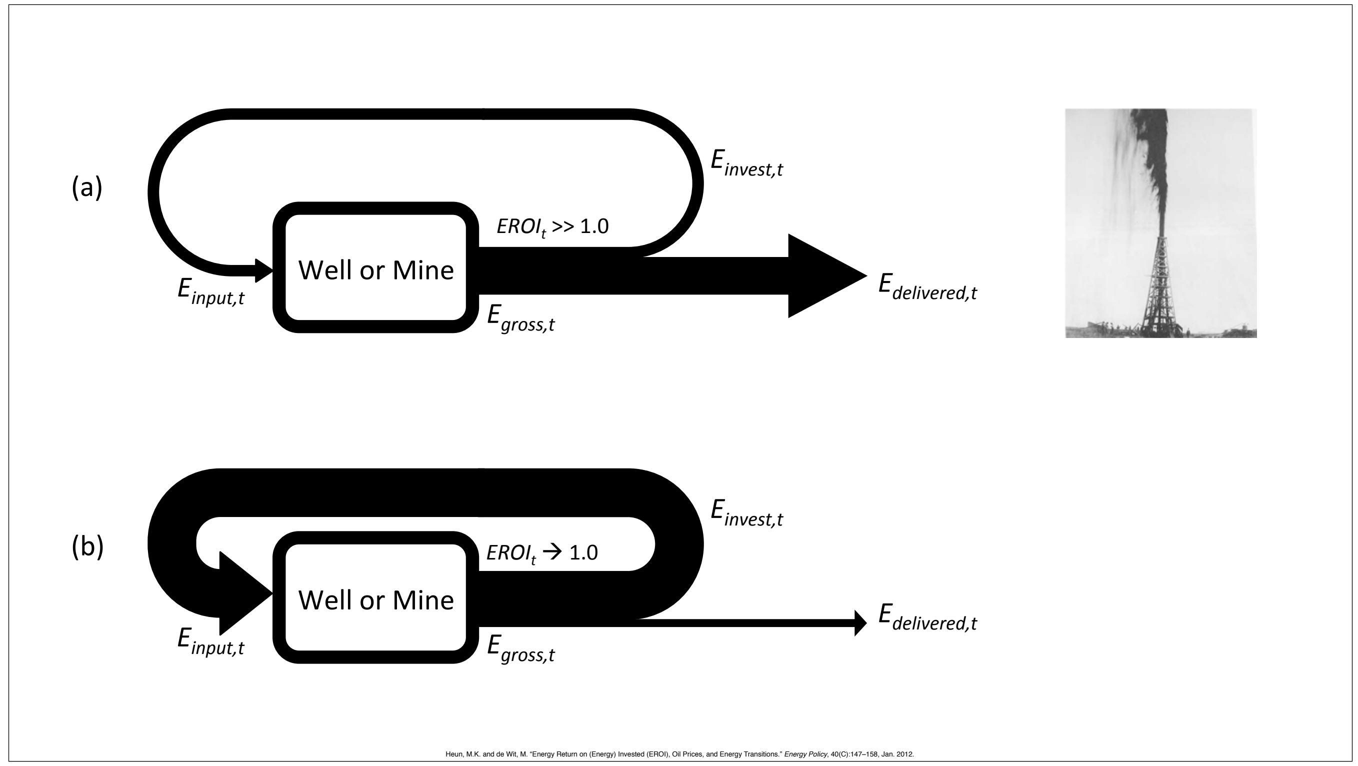
$$EROI = \frac{\text{Energy Delivered}}{\text{Energy Input}}$$

The metric that measures the Best First Principle for energy production is net energy. One metric for net energy is Energy Return on Investment (EROI), the ratio of energy delivered to energy input for an energy production process. As energy resources deplete, they become “harder” to extract, and EROI goes down. Over time, it takes more energy to make the same rate of energy available to society.

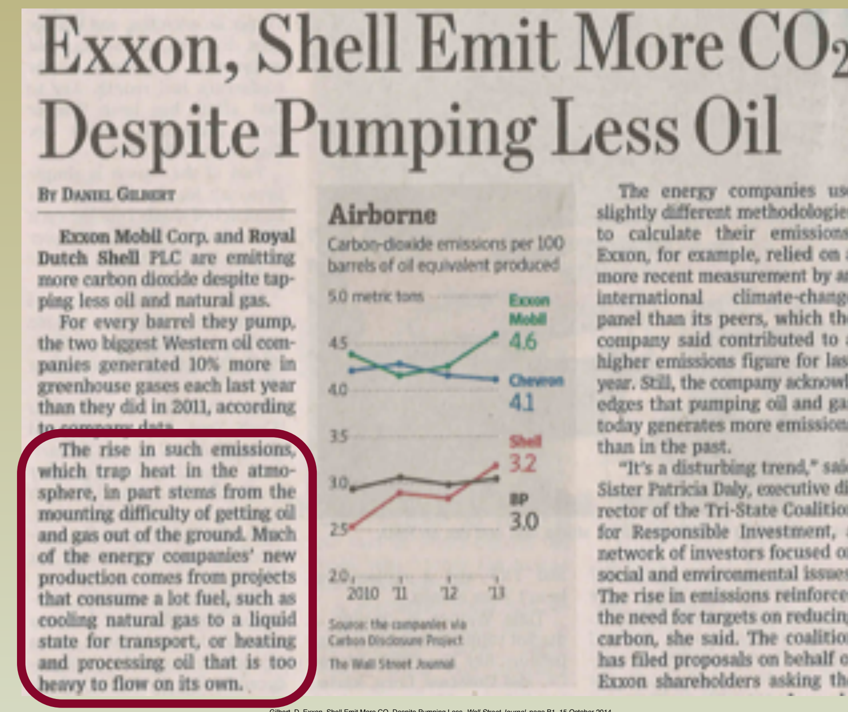
Lucas gusher at Spindletop
West Texas, 1901

Oil platform P-51
Brazil

The difference between high EROI oil (left) and low EROI oil (right) is illustrated by the photos I showed earlier. The offshore platform is considerably more energy intensive to emplace, it takes more energy to operate, its crude oil is considerably more energy intensive to move to ONshore refineries, and it has significantly lower EROI.



In the early 1900s, this was the story, <space> as represented by Spindletop. <Discuss Sankey diagram.> Some estimates put oil EROI at 100:1 in the early 1900s.
As the the Best First Principle affects energy production through time, it takes significantly more energy to make energy available to society, and in the long run, the picture could change to this <space>. Today worldwide oil *EROI* is estimated to be about 18:1.



Exxon, Shell Emit More CO_2 Despite Pumping Less Oil

By Daniel Gilbert

Exxon Mobil Corp. and **Royal Dutch Shell** PLC are emitting more carbon dioxide despite tapping less oil and natural gas.

For every barrel they pump, the two biggest Western oil companies generated 10% more in greenhouse gases each last year than they did in 2011, according to company data.

The rise in such emissions, which trap heat in the atmosphere, in part stems from the mounting difficulty of getting oil and gas out of the ground. Much of the energy companies' new production comes from projects that consume a lot fuel, such as cooling natural gas to a liquid state for transport, or heating and processing oil that is too heavy to flow on its own.

The energy companies use slightly different methodologies to calculate their emissions. Exxon, for example, relied on a more recent measurement by an international climate-change panel than its peers, which the company said contributed to a higher emissions figure for last year. Still, the company acknowledges that pumping oil and gas today generates more emissions than in the past.

"It's a disturbing trend," said Sister Patricia Daly, executive director of the Tri-State Coalition for Responsible Investment, a network of investors focused on social and environmental issues. The rise in emissions reinforces the need for targets on reducing carbon, she said. The coalition has filed proposals on behalf of Exxon shareholders asking the

Gilbert, D. Exxon, Shell Emit More CO_2 Despite Pumping Less. *Wall Street Journal*, page B1, 15 October 2014.

The transition to a lower-*EROI* energy regime is occurring before our eyes. In the October 15, 2014 *Wall Street Journal*, we have this <read headline> <space> <read quote>.

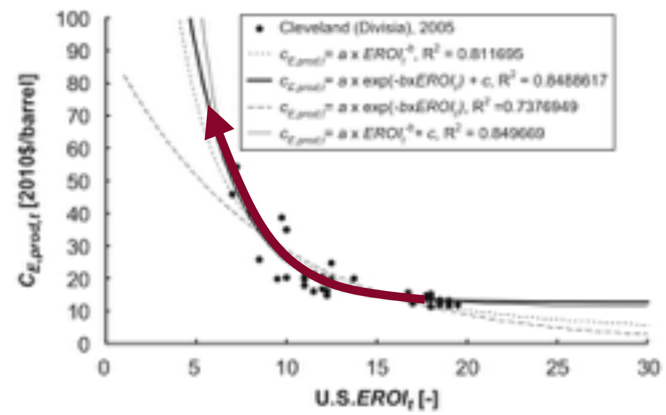
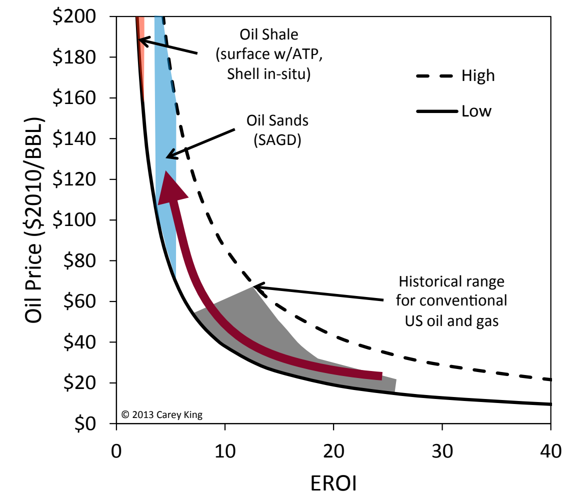


Fig. 12. Correlation between producer prices ($c_{E,prod,t}$) and Divisia-corrected EROI (Cleveland, 2005) for U.S. domestic oil production for the years 1954–1996.

M. K. Heun and M. de Wit. Energy Return on (Energy) Invested (EROI), Oil Prices, and Energy Transitions. Energy Policy, 40(C):147–158, 2012.



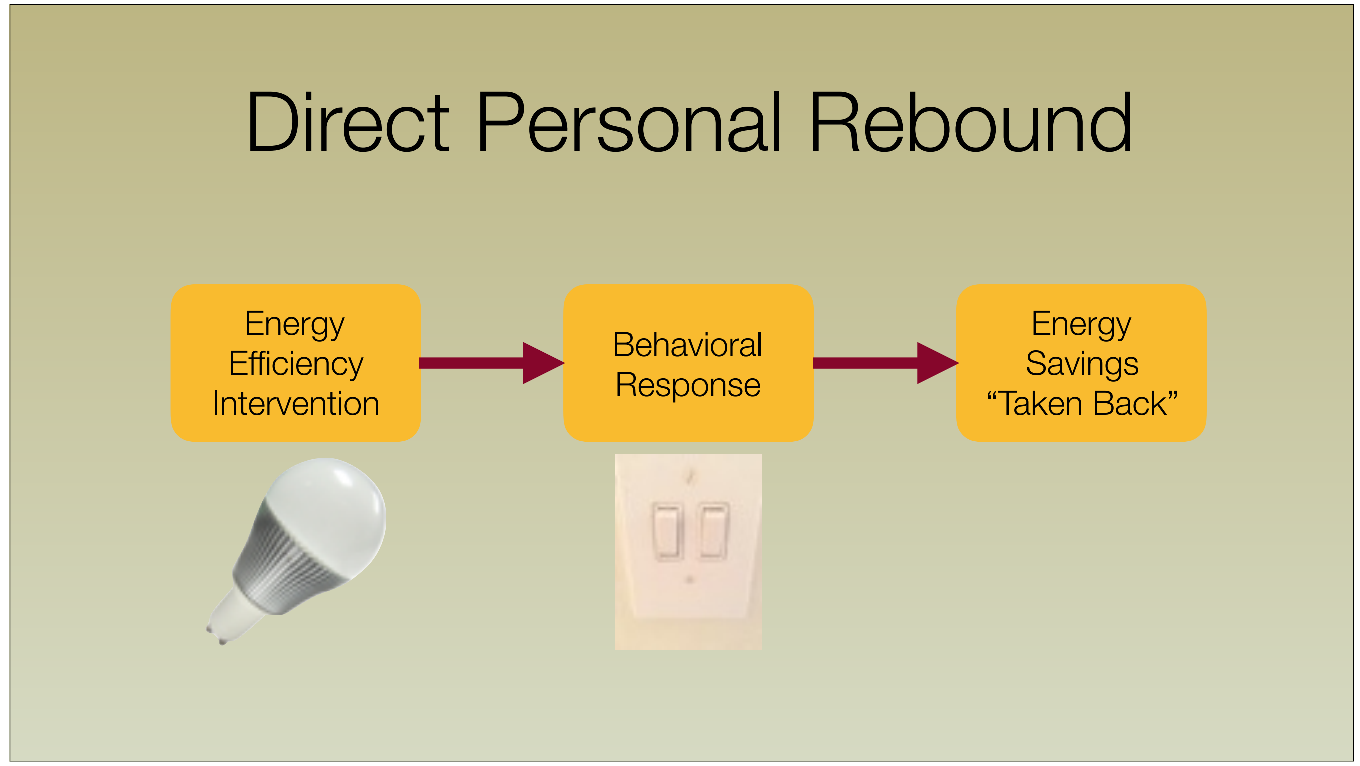
See: C. W. King and C. A. S. Hall. Relating Financial and Energy Return on Investment. Sustainability, 3(10):1810–1832, Oct. 2011.

In two nearly-coincident papers, myself and co-author Martin de Wit (left) and Carey King and Charlie Hall (right) derived similar expressions for the relationship between oil price (on the vertical axes) and EROI (on the horizontal axes). <space> Both found that energy costs are pushed upward non-linearly as EROI declines.

M. K. Heun and M. de Wit. Energy Return on (Energy) Invested (EROI), Oil Prices, and Energy Transitions. Energy Policy, 40(C):147–158, 2012.
C. W. King and C. A. S. Hall. Relating Financial and Energy Return on Investment. Sustainability, 3(10):1810–1832, Oct. 2011.

Rebound Effect

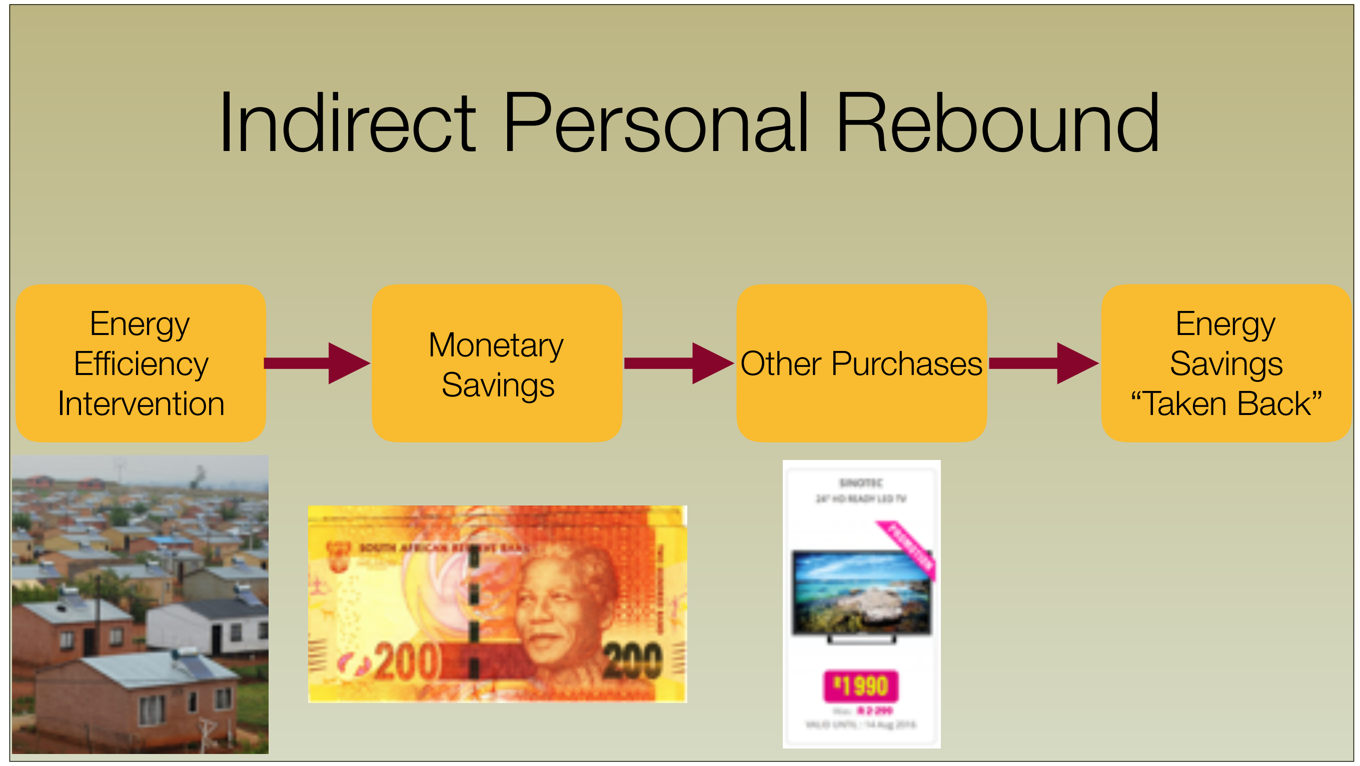
The third metric is energy efficiency rebound of which there are at least three variants: Direct Personal Rebound, Indirect Personal Rebound, and Economy-wide Rebound.



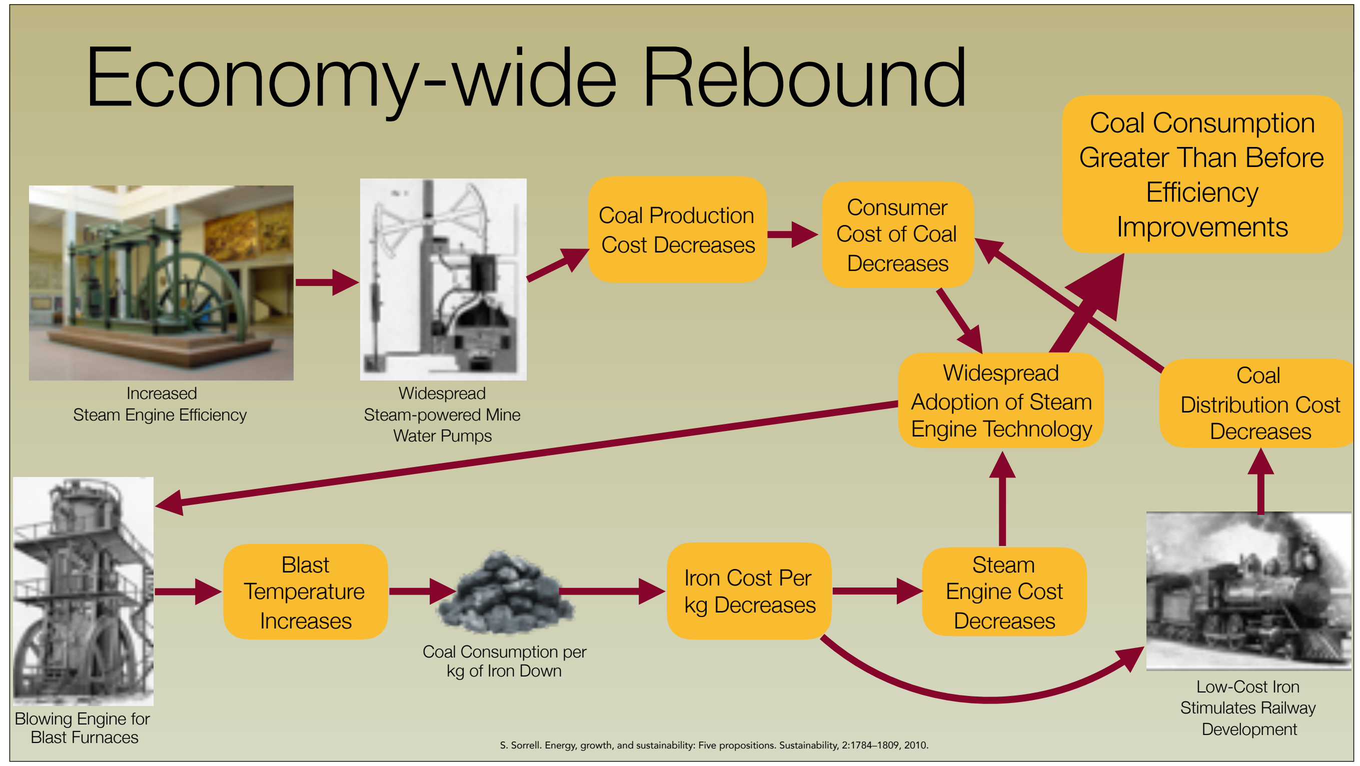
First is direct rebound for the same energy service.

Go through slide.
Rebound is the percentage of technical energy savings not realized or "taken back."
Rebound is an example of unintended consequences.

http://agico-karensun.blogspot.co.za/2012/05/wholesale-of-led-light-bulbs.html



The second type of energy efficiency rebound is an indirect personal rebound involving a different energy service. <space>
Go through slide.
The point is that any additional purchase will take back energy savings due to the production, transport, use, and disposal of any consumer good. There are energy implications to all that we do!
In this case, energy savings are "taken back" at the personal level for a different energy service.
http://greaterpaperminds.blogspot.co.za/2013/08/solar-water-heating-households-in-south.html



The third type of rebound occurs through the entire economy and is represented by this example from Sorrel (2009).
In early 1800s England, machines for pumping floodwater out of mines consumed no coal, because the rate of consumption was too high. Efficiency improvements <space> to the steam engine by Watt and others lowered operating costs for steam engines <space>, thereby catalyzing their use in mining. This reduced the cost of coal production <space>, and savings were passed on to consumers <space> leading to widespread adoption of steam engine technology for many applications <space>.
One such application was so-called "blowing engines" <space> for blast furnaces. Their improved effectiveness allowed blast temperatures to increase <space>, thereby reducing the coal consumed per kg of iron produced <space>. Those savings were passed to iron consumers <space>, some of whom were producers of steam engines, thereby reducing the price of steam engines further <space> and, again, leading to even wider adoption of steam engine technology.
Another consumer of iron was the railways, and decreased iron costs stimulated the development of rail networks <space>, which decreased the distribution cost of coal <space>. As savings were passed on to coal consumers <space>, steam engine technology spread further yet <space>.
In a sense this is all good news, because it kicked off the industrial revolution in England and raised the standard of living for millions of people. But, <space> the net effect of steam engine efficiency improvements was that coal consumption was greater after the efficiency improvements than before. This is called Backfire. It is the rebound effect on steroids routing through the entire economy.

S. Sorrell. Energy, growth and sustainability: Five propositions. Sustainability, 2:1784–1809, 2010.

https://en.wikipedia.org/wiki/Watt_steam_engine
http://alternativeenergy.procon.org/view.timeline.php?timelineID=000015
https://en.wikipedia.org/wiki/Blowing_engine
https://brandonbyrge.com/2013/01/28/from-coal-to-diamonds/

Rebound Effect

- Direct
- Indirect

- Economy-wide (Backfire)

At this point, it is good to pause to note that climate policies predicated on energy efficiency may actually have less effect than planned (due to rebound) or perversely the opposite of their intended effect (due to backfire).
On the other hand, backfire can be good. It essentially kicked off the industrial revolution! To the extent that economic growth improves human well-being, backfire associated with economic expansion can have positive effects.

Ghana Institution of Engineers story.

The bottom line, for now, is that Heretofore Under-appreciated Metrics (namely Energy Cost Share, Net Energy, and the Rebound Effect) are Fundamentally Important for understanding interactions between energy and the economy (Proposition 3).
Propositions 1, 2, and 3 indicate that energy-economy dynamics are complicated, even complex in the sense of Complexity Theory. And, these dynamics are considerably more, shall-we-say, “interesting” than mainstream macroeconomic growth models suggest.

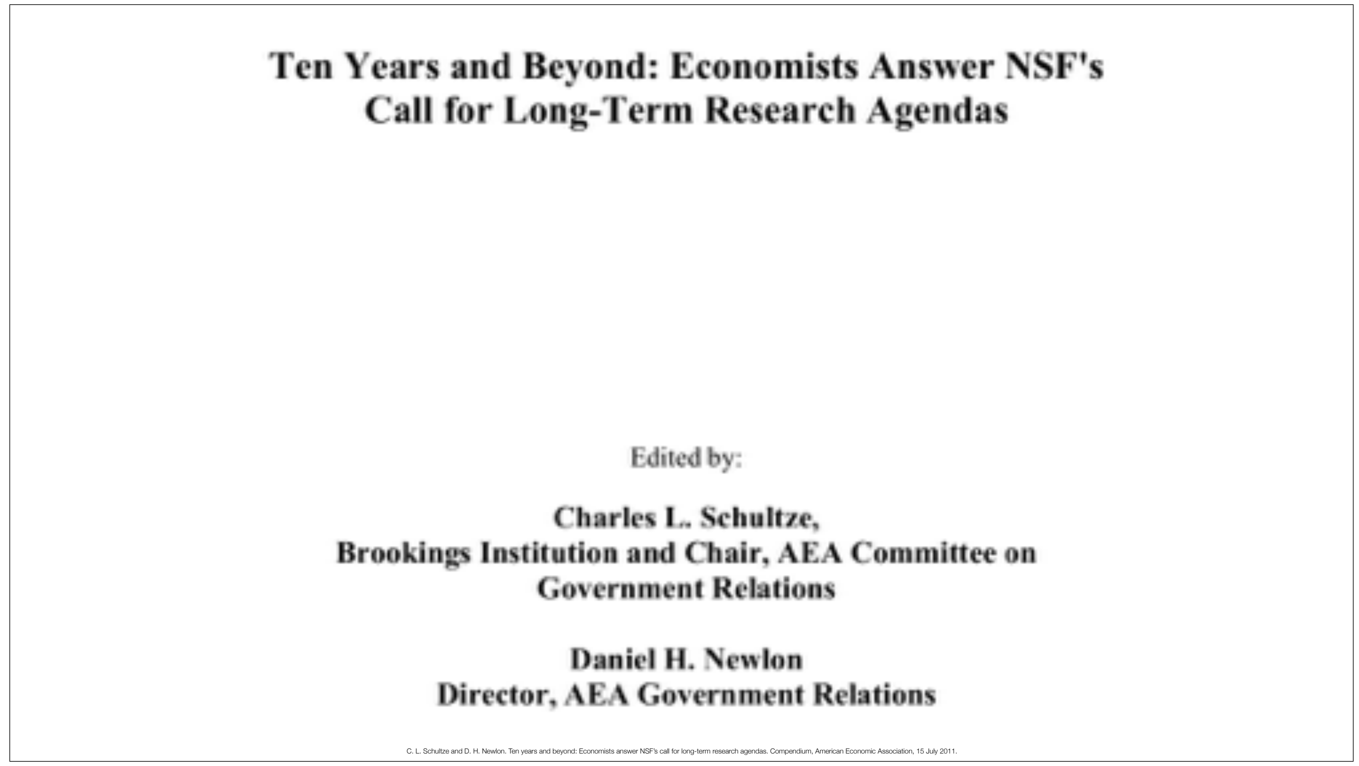
Proposition 4

The Dynamics of the Energy-Economy Nexus are an Interdisciplinary Grand Challenge

My 4th proposition is that because of this complexity, The Dynamics of the Energy-Economy Nexus are an Interdisciplinary Grand Challenge.
A Grand Challenge is a topic that presents fundamental questions and challenges fundamental assumptions. Grand Challenges are sometimes called “wicked problems,” a term I don’t prefer. Grand Challenges are often ill-defined, seemingly intractable, require big solutions (that are difficult to prototype on a small scale), and are interwoven through many areas of society and the academy.
Let’s see what the engineers, economists, and development folks count as grand challenges

Here is the U.S. National Academy of Engineering's list of Grand Challenges that was published in Feb 2008. By my count, energy is integral to at least 5 <space> and arguably 7 of the 14 Engineering Grand Challenges. But, ECONOMICS (actually, merely "costs") are mentioned only in the context of the energy and food markets.

There is simply no understanding or even acknowledgement of the types of energy-economy interactions I am discussing here today.



Ten Years and Beyond: Economists Answer NSF's Call for Long-Term Research Agendas

Edited by:

Charles L. Schultze,
Brookings Institution and Chair, AEA Committee on Government Relations

Daniel H. Newlon
Director, AEA Government Relations

C. L. Schultze and D. H. Newlon. Ten years and beyond: Economists answer NSF's call for long-term research agendas. Compendium, American Economic Association, 15 July 2011.

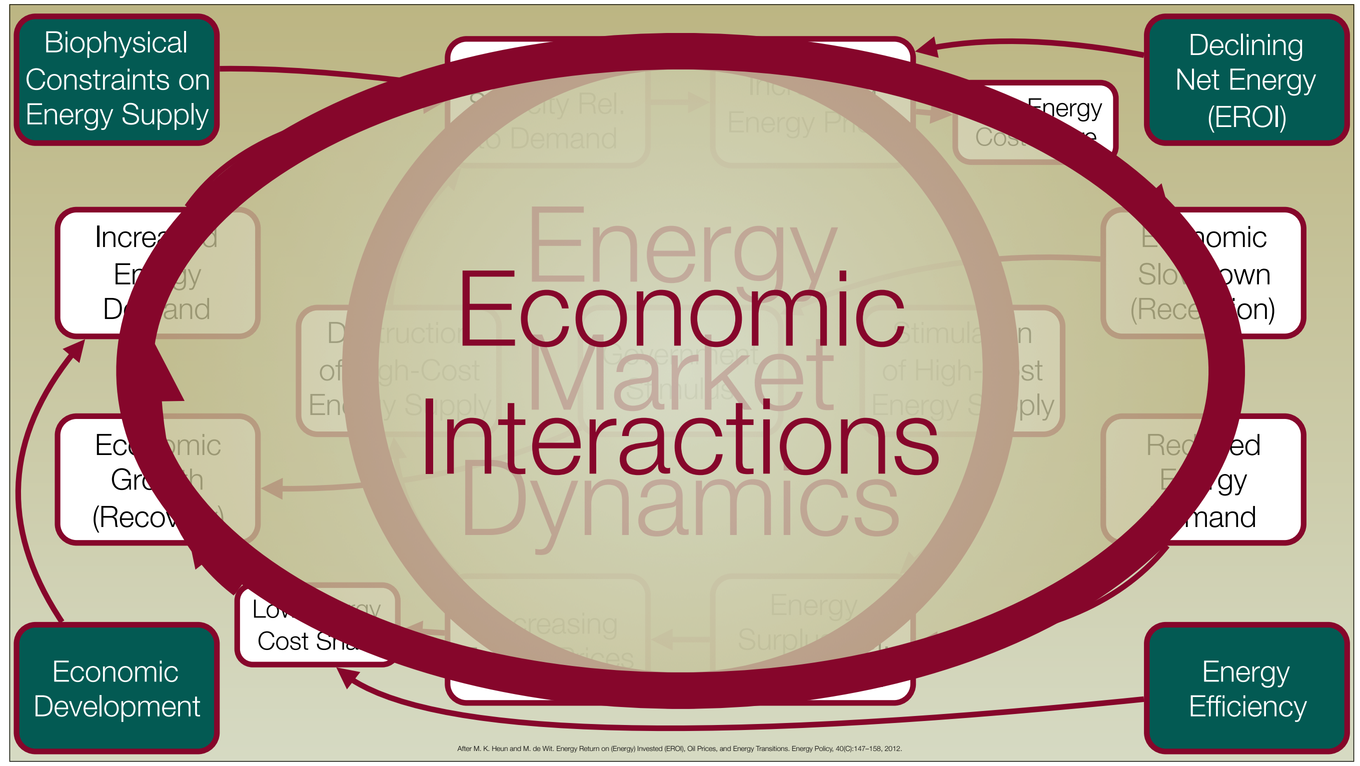
In Aug 2010, the U.S. National Science Foundation’s Directorate for the Social, Behavioral, and Economic Sciences solicited white papers that describe Grand Challenge questions “to drive next generation research.”
Energy is mentioned on 17 of 309 pages of white papers relevant to economics, and 5 of those pages consider “energy” to be intellectual effort. To my eye there is only one white paper that comes anywhere close to the energy-economy nexus, and it doesn’t address the issue I’m discussing today. The only tangentially-relevant white paper raised the topic of energy in relation to barriers to policy action on environmental issues and interdependencies among financial markets.

(The paper is byJames Poterba, MIT and NBER.)

C. L. Schultze and D. H. Newlon. Ten years and beyond: Economists answer NSF’s call for long-term research agendas. Compendium, American Economic Association, 15 July 2011.

USAID complied a list of Grand Challenges, too. Two of eight are energy-related <space>, but none addresses the energy-economy nexus.

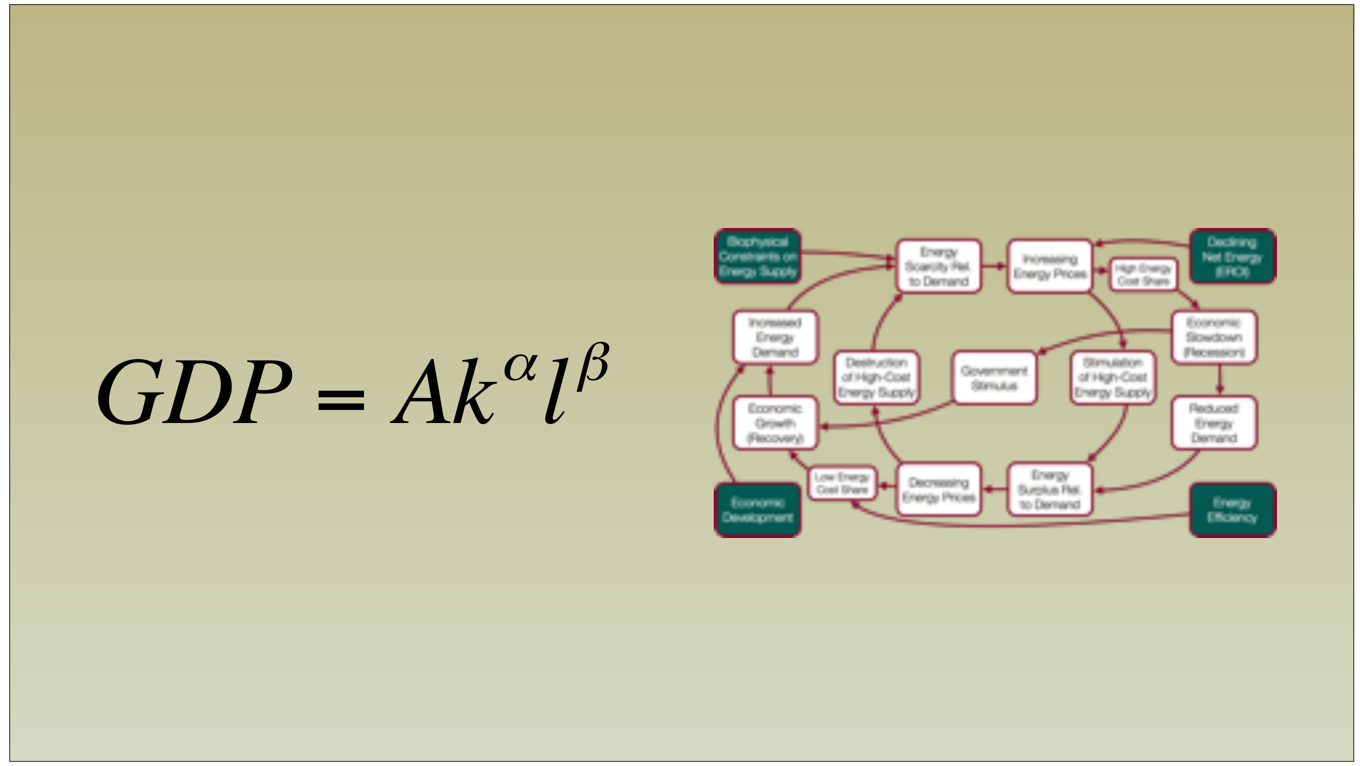
So there is a clear need to think clearly about the energy-economy nexus and to identify factors that contribute to its dynamics.



Based on the previous propositions, an example (and admittedly-incomplete) conceptual model of the dynamics at the energy-economy nexus might look like this.

<go through diagram>

The inner loop appears to be underdamped. Energy prices are swinging "rail to rail" as these dynamics play out. And, the inner loop appears to be amplifying the dynamics of the outer loop! Since the oil crisis of 1973, we've known that energy effects on the global economy are real and significant.



Indeed, the dynamics at the energy-economy nexus bear little resemblance to and are not explained well by mainstream aggregate equilibrium macroeconomic growth models.

So, we have a situation wherein

* Engineers, naturally, recognize that energy is important, but the economy is not on their radar.
* Economists, naturally, recognize that the economy is important, but energy is not on their radar.
* Development agencies, naturally, are focused on PROVIDING energy for farming and ACCESS to energy in remote areas, not on the complex interactions between energy and the economy

None of the disciplines sees the importance of the energy-economy nexus. The disciplines, almost by definition, are not thinking INTERdisciplinarily. Consequently, and with few exceptions, the dynamics of the energy-economy nexus are not understood, they are not modeled, they are not predictable, and our energy and economic policies do not account for them.

If these dynamics cause problems (and I think they do), today's energy-economy policymakers cannot develop solutions. They simply lack the information and tools to do so.

In my opinion, if we, as a society, want to understand these dynamics, we need to be intentional about it. We cannot hope that the disciplines will come to their senses and work on the problem. They can't. They're disciplines! This challenge falls between the cracks.

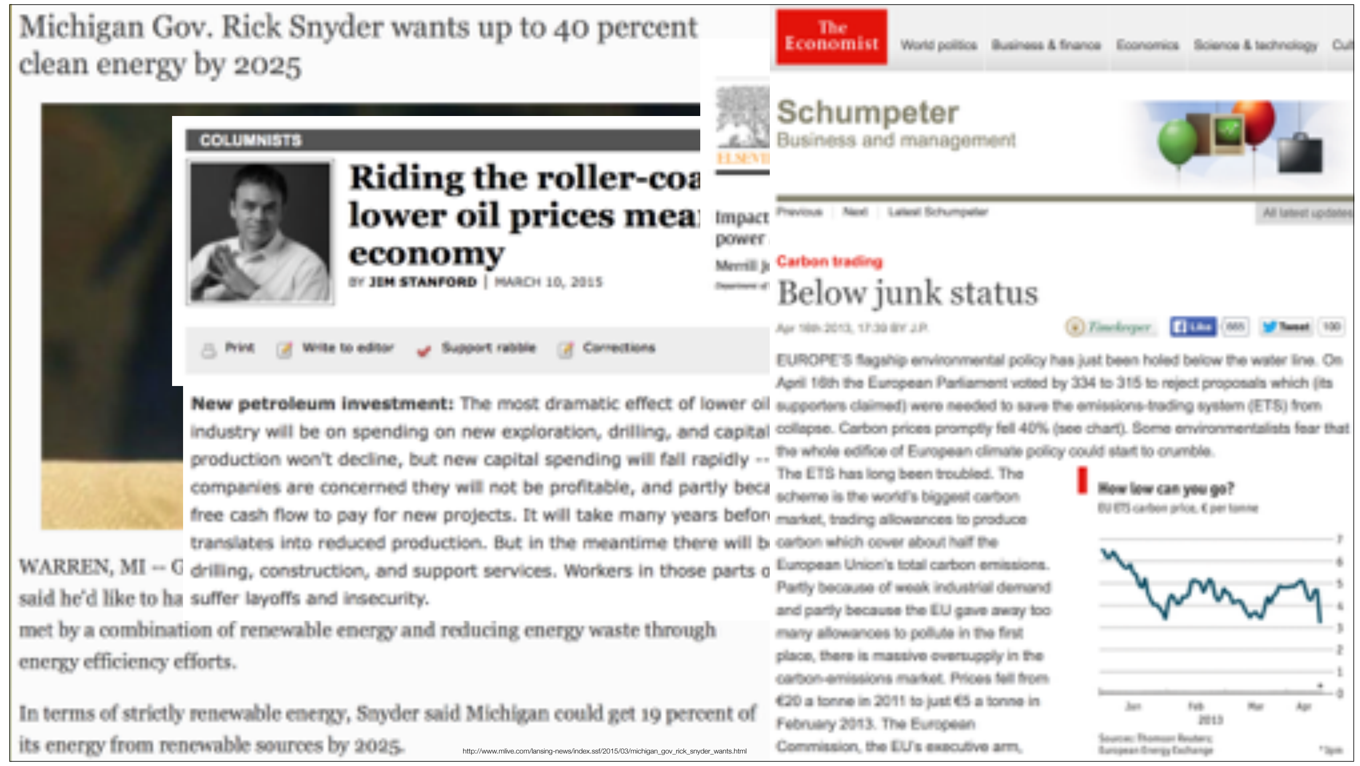
Proposition 4: The Dynamics of the Energy-economy Nexus are an INTERDISCIPLINARY Grand Challenge.

And, all of this is rather unfortunate, because <space>

Proposition 5

Transition to a
Stable Clean Energy Regime is
Incompatible with
an Unstable
Energy-Economy System

My 5th proposition is that Transition to a Stable Clean Energy Regime is Incompatible with an Unstable Energy-Economy System. As we all know, regulatory and policy winds swirl with the energy situation of the moment. If we're "OK" now because oil prices are low, we don't need policies intended to spur the transition to a clean energy future. When combined with the short-term thinking that permeates the policy and regulatory worlds, the instability of the energy-economy nexus is toxic for a transition to a sustainable energy future.



Michigan Gov. Rick Snyder wants up to 40 percent clean energy by 2025

COLUMNISTS

Riding the roller-coa lower oil prices mea economy

BY JIM STANFORD | MARCH 10, 2015

Print Write to editor Support rabble Corrections

New petroleum investment: The most dramatic effect of lower oil industry will be on spending on new exploration, drilling, and capital production won't decline, but new capital spending will fall rapidly -- companies are concerned they will not be profitable, and partly beca free cash flow to pay for new projects. It will take many years befor translates into reduced production. But in the meantime there will b drilling, construction, and support services. Workers in those parts o suffer layoffs and insecurity.

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In terms of strictly renewable energy, Snyder said Michigan could get 19 percent of its energy from renewable sources by 2025.

The Economist World politics Business & finance Economics Science & technology

Schumpeter

Business and management

Carbon trading

Below junk status

EUROPE'S flagship environmental policy has just been holed below the water line. On April 16th the European Parliament voted by 334 to 315 to reject proposals which (its supporters claimed) were needed to save the emissions-trading system (ETS) from collapse. Carbon prices promptly fell 40% (see chart). Some environmentalists fear that the whole edifice of European climate policy could start to crumble.

The ETS has long been troubled. The scheme is the world's biggest carbon market, trading allowances to produce carbon which cover about half the European Union's total carbon emissions. Partly because of weak industrial demand and partly because the EU gave away too many allowances to pollute in the first place, there is massive oversupply in the carbon-emissions market. Prices fell from €20 a tonne in 2011 to just €5 a tonne in February 2013. The European Commission, the EU's executive arm,

Here are some examples: In my home state of Michigan, we’re debating whether to increase or eliminate a 10% renewable portfolio standard. The governor wants more renewables (up to 40%!) but wants to eliminate the RPS. <space> Decisions to invest in oil infrastructure rise and fall with the underdamped movements of oil prices. <space> Wind industry players are deterred from investing when the Production Tax Credit (PTC) is uncertain. <space> The carbon markets, which many hoped would provide financing for clean energy projects, have collapsed, in part, due to reduced energy demand in the wake of the Great Recession.

It appears that a prerequisite for the investment needed for a transition to a sustainable, clean energy future is a stable economy.

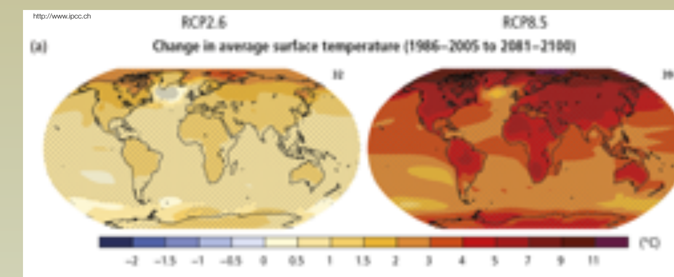
Proposition 5: Transition to a Stable Clean Energy Regime is Incompatible with an Unstable Energy-Economy System.

This talk is focused on the energy transition, but the stability of the economic system could be a pre-requisite for many types of transitions: materials, water, soils, etc.

I want to end by discussing some implications of the five propositions.

Motivations for Energy Transition

Resource Depletion



Climate Change

As I said at the outset, I think there is plenty of motivation to care about energy and the economy, and to care about the transition to a clean-energy future. The two biggest reasons on my list are <space> resource depletion of fossil fuels and <space> climate change caused by global warming and the impact that both will have on human well-being.
But how do we make such a transition?

Routes to an Energy Transition

- Market mechanisms
- Policy and regulation
- Collapse
- Experimentation

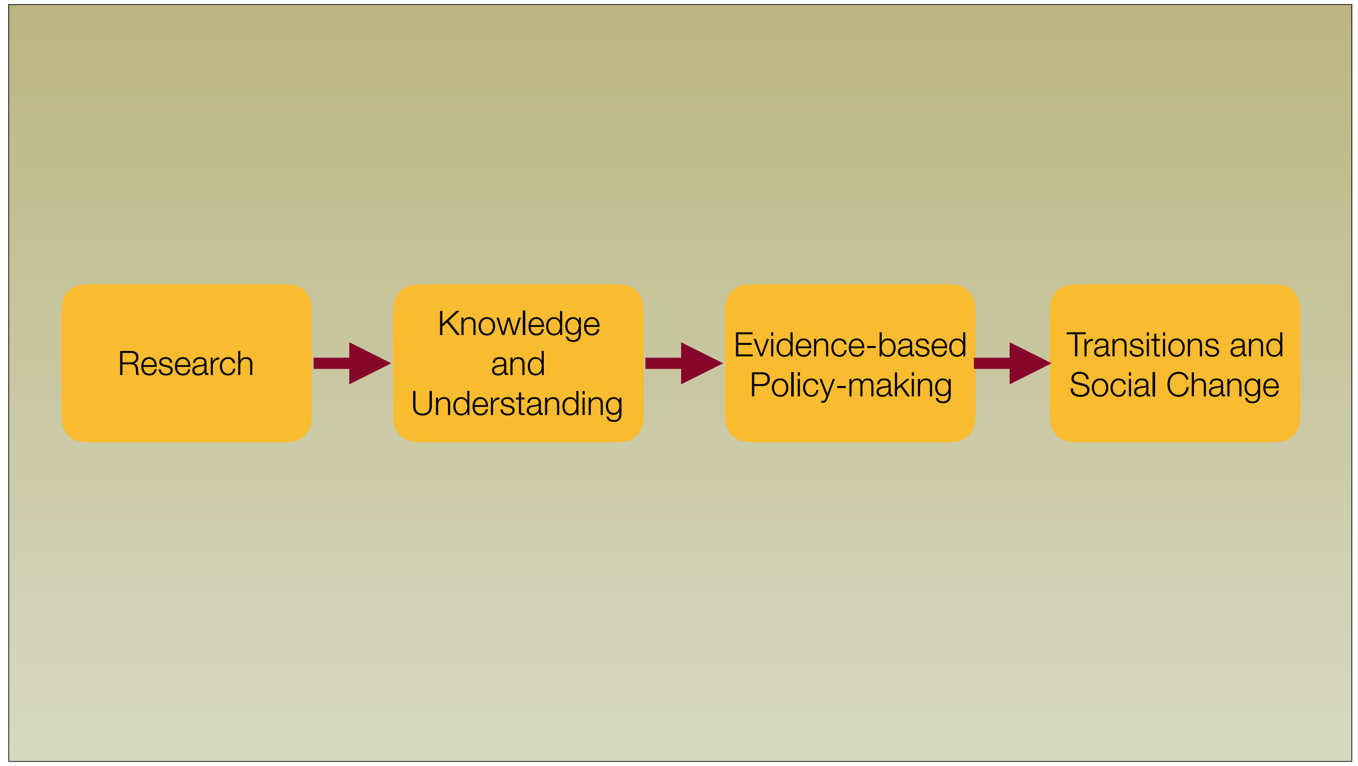
Here is an incomplete list of commonly-cited routes to an energy transition.

Market mechanisms: A common thought is that AS fossil fuels become scarce relative to demand, the high price of fossil fuels will catalyze the transition to renewables in a market-driven transition. You've probably heard people say, the only problem is that FF prices aren't high enough! If prices were higher, we would be moving faster on renewables. However, with the dynamics of the energy-economy nexus in mind, it may be that FF prices NEVER climb high enough to induce a substantial transition to renewables. If they go too high, recession destroys energy demand and brings prices back down. (It happened after 2009 and after the oil price spike of the 1970s.) Could it be that the system as we know it has a built-in preference for maintaining itself, for not transitioning to renewable sources of energy?

Policy and regulation: Ideas like REFIT and REIPPPP are good starts, and we, as a society, are learning from them. There is HOPE here, but history shows that the policy environment is difficult for renewables, and Proposition 5 says that economic instability is incompatible with a policy-driven transition.

Collapse: On the collapse route, the energy transition happens TO us. I don't prefer this option.

Experimentation: The realities of market mechanisms, the current policy world, and a desire to avoid collapse are drivers, I believe, for the explosion in experimentation that Mark Swilling discussed on Monday evening. People who desire a sustainability transition (in energy or elsewhere) must find ways of working outside of or beneath the existing societal structures which view a wholesale sustainability transition as pathogenic. They explore transition spaces and learn; find out what works and what doesn't. Side note: one of the reasons that Stellenbosch is such a rich place for me is that there are at least three entities where such experimentation is happening: CRSES, the SI, and the Center for CST. It is also a rich place for students; consider yourself lucky to have found your way here.



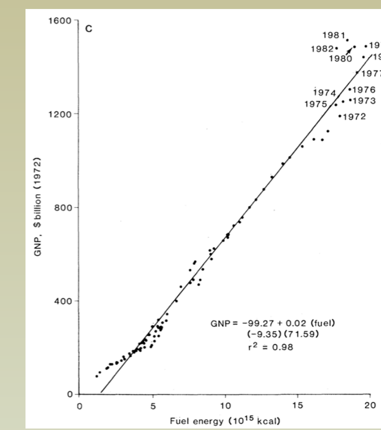
In my view, our best shot at a smooth energy transition and accompanying social change <space> is evidence-based policy-making <space>. We can't wait for the markets to sort this out. At the moment, we lack the knowledge and understanding <space> especially at the energy-economy nexus to inform policy, although experimentation is helping. Thus, an important aspect of stimulating a transition, from an academic point of view, is interdisciplinary research into the energy-economy nexus <space>. We have to understand the nature of this grand challenge to produce actionable information for the policy arena.

Research Questions

So, to conclude today, I'd like to propose an incomplete set of research questions regarding the interdisciplinary grand challenge to understand the dynamics of the energy-economy nexus, organized around the propositions I set forth earlier. These questions are based on my admittedly imperfect and incomplete understanding of the literature, of engineering, and of economics. There may already be partial answers to some of these questions. If you know of them, please let me know. Don't keep me in the dark! Of course, you are free to include additional questions, thereby extending my list. I'm fully aware that I'm leaving my self open to the critique that I'm bringing more questions than answers. But I don't so much care.

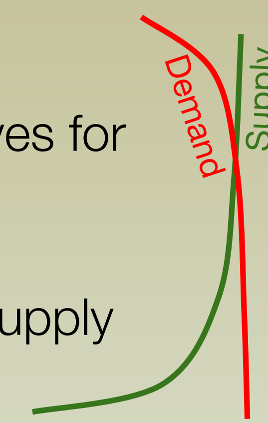
(1) Energy and the Economy are Linked

- Are energy and the economy linked …
  - for all countries?
  - at all levels (municipal, provincial, national, world)?
- Does linkage hold for primary energy? Useful energy? Energy services?
- What is the best point in the energy conversion chain to model energy-economy interactions?
- Under what conditions does energy unlink from the economy (if it does)?



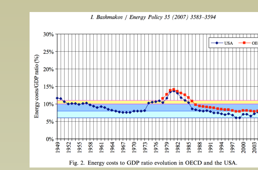
(2) Fundamentals of Energy Supply, Demand, and Prices Are Different Now

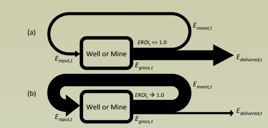
- What is the shape of supply and demand curves for each type of energy and for each country?
- What factors cause shape changes?
- What effect will an energy transition have on supply and demand curves for each type of energy?

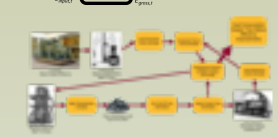


(3) Heretofore Under-appreciated Metrics are Fundamentally Important for Understanding the Macroeconomy

- Is energy cost share correlated to economic performance in all countries? If not, why not?
- What is the time trend of EROI for every energy type, including renewables?
- What is the magnitude of the rebound effect at all levels of society?
- How can we model the rebound effect?

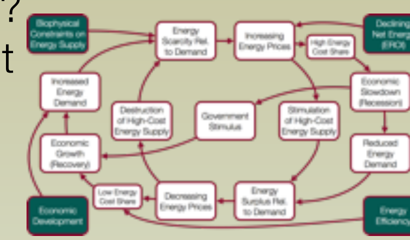






(4) The Dynamics of the Energy-Economy Nexus are an Interdisciplinary Grand Challenge

- Can we develop models that reproduce the dynamics of the energy-economy nexus?
- What is the time scale of a trip around the cycle?
- Can we endogenize policy and evaluate different options?
- What effect does debt have on the energy-economy system?
- Can energy prices rise high enough to induce a market-based energy transition?



(5) Transition to a Stable Clean Energy Regime is Incompatible with an Unstable Energy-Economy System

- Are there energy-economy policies that can damp the dynamics of the energy-economy system?
- What are the societal and economic pre-conditions for energy transition?


Michigan Gov. Rick Snyder wants up to 40 percent clean energy by 2025

WARREN, MI -- Gov. Rick Snyder in the energy message he released on Friday said he'd like to have between 30 and 40 percent of Michigan's energy needs be met by a combination of renewable energy and reducing energy waste through energy efficiency efforts.

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COLUMNISTS

Riding the roller-coaster: What lower oil prices mean for Canada's economy

BY JIM STANFORD | MARCH 10, 2015

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New petroleum investment: The most dramatic effect of lower oil prices on the oil industry will be on spending on new exploration, drilling, and capital spending. Current production won't decline, but new capital spending will fall rapidly -- partly because companies are concerned they will not be profitable, and partly because companies have no free cash flow to pay for new projects. It will take many years before slower investment translates into reduced production. But in the meantime there will be much less activity in drilling, construction, and support services. Workers in those parts of the oil industry will suffer layoffs and insecurity.

So where does this all leave us? I think the four factors of

(a) the continued push for growth in all economies,
(b) biophysical constraints on energy supply,
(c) declining net energy, and
(d) rebound and the possibility of backfire

mean that we need to get working on this NOW. I think that we need to understand the dynamics that bedevil us at the energy-economy nexus so we can move into a clean energy future. There are many unanswered questions, and I hope that I've inspired you to ask your own questions and seek answers in this space.

Thank you.