The political economy of biofuels

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Energy policy

- United States always pursued policies to secure affordable fuel.
  - First from domestic sources
  - And then from foreign reserves
- September 1st, 1969, Libyan King overthrown
- Coup leader Qaddafi tries to hike posted price of oil
  - Most companies resist (other oil sources);
  - Occidental can't ultimately concedes
- Other countries sought higher prices

James Placke's warning

"***The extent of dependence by western industrial countries upon oil as a source of energy has been exposed, and the practicality of controlling supply as a means of exerting pressure for raising the price of oil has been dramatically demonstrated.***"

- James Placke's warning

Local environmental policy and the balance of trade

- Although local environmental policy reduces domestic consumption of an energy resource, it may increase exports of the resource and thus improve the country's balance of trade.
  - The effect on a country's balance of trade depends on the elasticities of demand and supply.
  - Because the United States is not a big player in the international oil markets (till 2012 it was a net importer of petroleum products), demand for US petroleum products is likely to be elastic and thus the effect on the US balance of trade large.

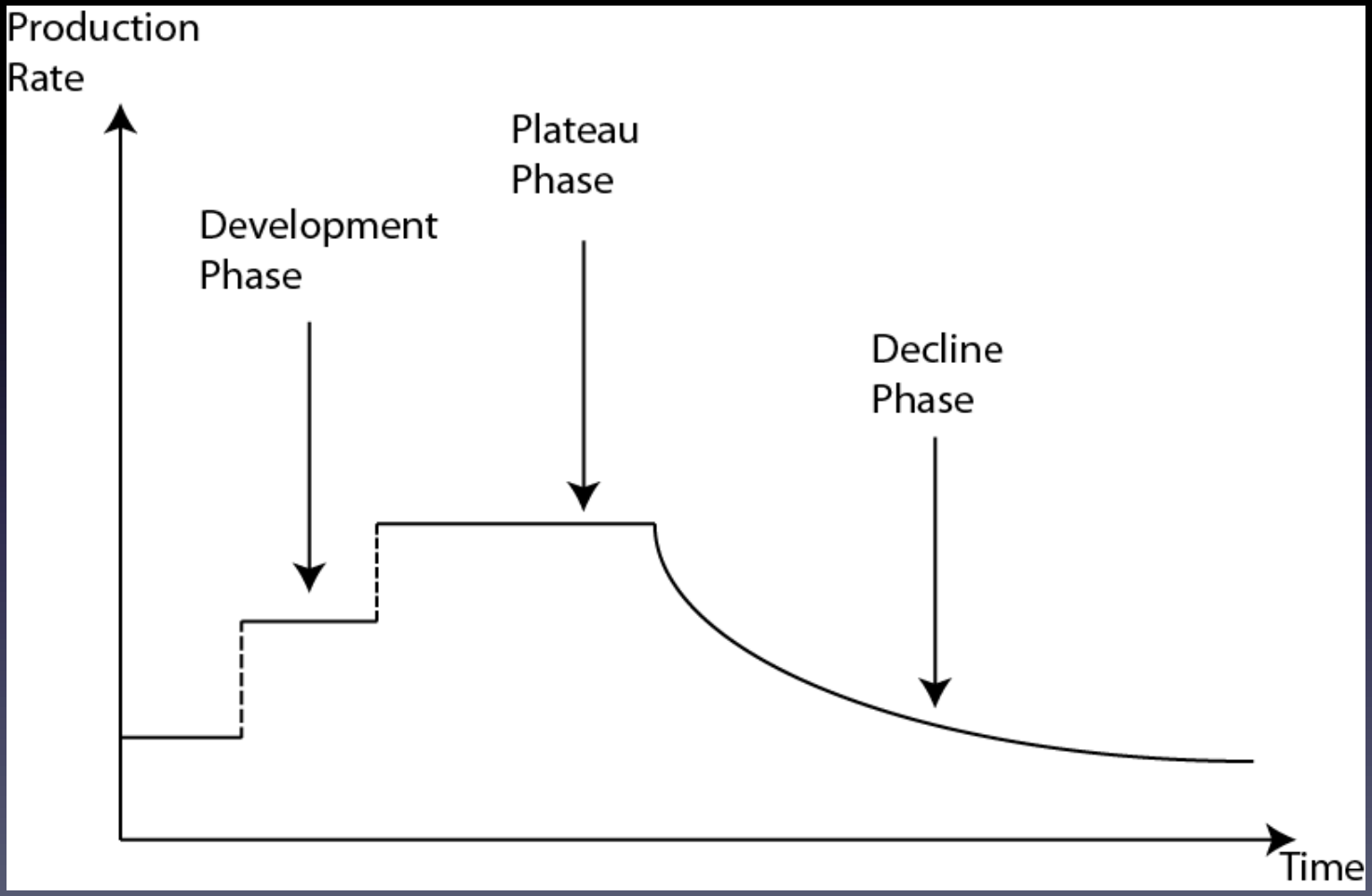
- These elasticities also affect policy leakages:
  - when environmental policies in one country increase the cost of fuel, local demand for these products falls and their price decline. Other countries that do not increase domestic cost of fuel may then take up the demand and use the excess supply, thus negating any environmental benefit.
- This tension has important implications for the green paradox.

THE KEY BUILDING BLOCKS OF THE CONCEPTUAL MODEL

Oil production and extraction: single well

- The amount recovered from a particular location depends on distance of reserve to well.
- Increasing number of wells increases amount of reserves that can be reached.
- Where,
  - If the areas allocated to various wells do not intersect, then production capacity 'scales up'
  - But if areas intersect then capacity increases but at decreasing rate
- Initially, unit cost of extraction and production stable:
  - In early periods of development, capacity constraint likely bind
    - "development" and "plateau" phase
  - In later periods capacity constraint doesn't bind and production declines
    - "decline" phase

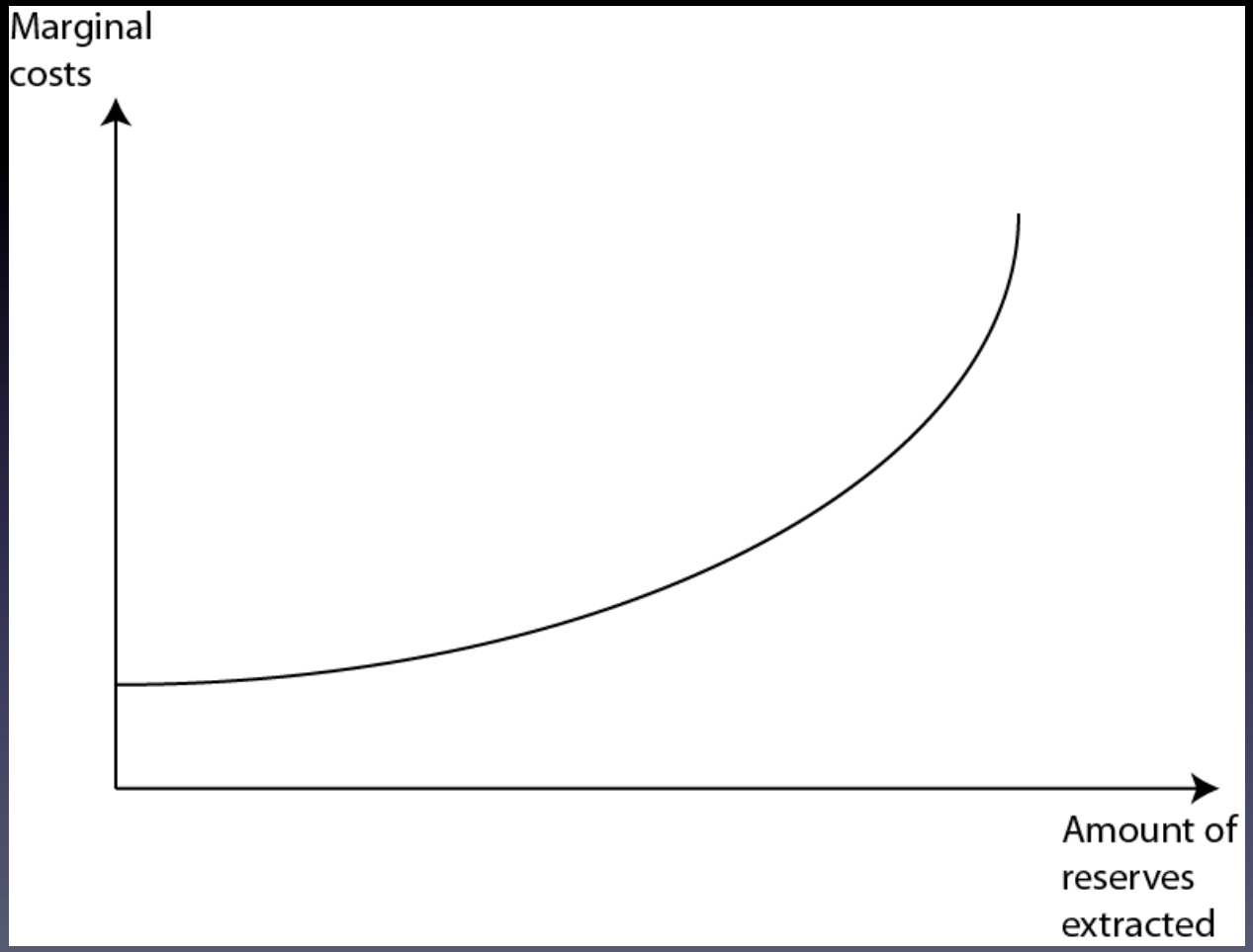
Three phases of production: Development, Plateau, and Decline phases



Oil extraction and production: Multiple wells

- Production from multiple wells
  - Initially, increase in number of wells increases extraction rates
  - But total amount produced increases at declining rate
    - Conflict between areas
    - There is potential to dissipate pressure when number of wells increase
- We assume increase in amount extracted is accompanied with an increase in the number wells, and this raises production at a declining rate
- what happens with oil prices over time?

Moving from single well to the industry's supply curve



Assume multiple resources

- Assume multiple types of fossil resources that differ from each others in the cost of extraction.
- For now, we do not assume differences in the carbon footprint among the different fossil resources.
- Assume stable demand

The government

$$U\left(\underbrace{p_{y,t}\cdot\tilde{y}_t + p^*_{y,t}\cdot y^*_t - \sum_i^N \left(c_i\left(R_{i,t}\right)+\tau_t\right)\cdot\tilde{x}_{i,t} - c_r\left(\tilde{x}_{r,t}\right)}_{\text{Economic Benefit}}, \underbrace{\tilde{x}_{r,t}}_{\text{Cost of Local Emissions}}\right) - \underbrace{\Psi\left(Z_t\right)}_{\text{Cost of GHG}}$$

- The government wants to look good (cost of local emissions), and
- It cares about economic surplus and GHG emissions (cost of GHG).

Introducing interest groups

$$U\left(\underbrace{(1+a)\left(p_{y,t}\cdot\tilde{y}_{o,t}+p^{*}_{y,t}\cdot y^{*}_{o,t}-\sum_{i}^{N}\left(c_i\left(R_{i,t}\right)+\tau_t\right)\cdot\tilde{x}_{i,t}\right)+\left(p_{y,t}\cdot\tilde{y}_{r,t}+p^{*}_{y,t}\cdot y^{*}_{r,t}-c_r\left(\tilde{x}_{r,t}\right)\right)}_{\text{interest groups and the economic surplus}},\ \underbrace{\tilde{x}_{r,t}}_{\text{Cost of Local Emissions}}\right)-\underbrace{\Psi\left(Z_t\right)}_{\text{Cost of GHG}}$$

- The government places extra weight on the incumbent oil industry: (1+a) where a>0.

The optimal control problem

- Assume fuel is a competitive industry, and that firms maximize profit and are forward-looking.
- Firms take government policy as given.
- The government is forward-looking, and sets a dynamic carbon tax.

The balance of trade effect

- While focusing on US energy policy, we demonstrate our findings using the petroleum refining and coal industries as an example.
- Although biofuel and other "green" policies achieve only modest environmental improvements, they do result in substantial improvements to the US balance-of-trade and its energy balance.

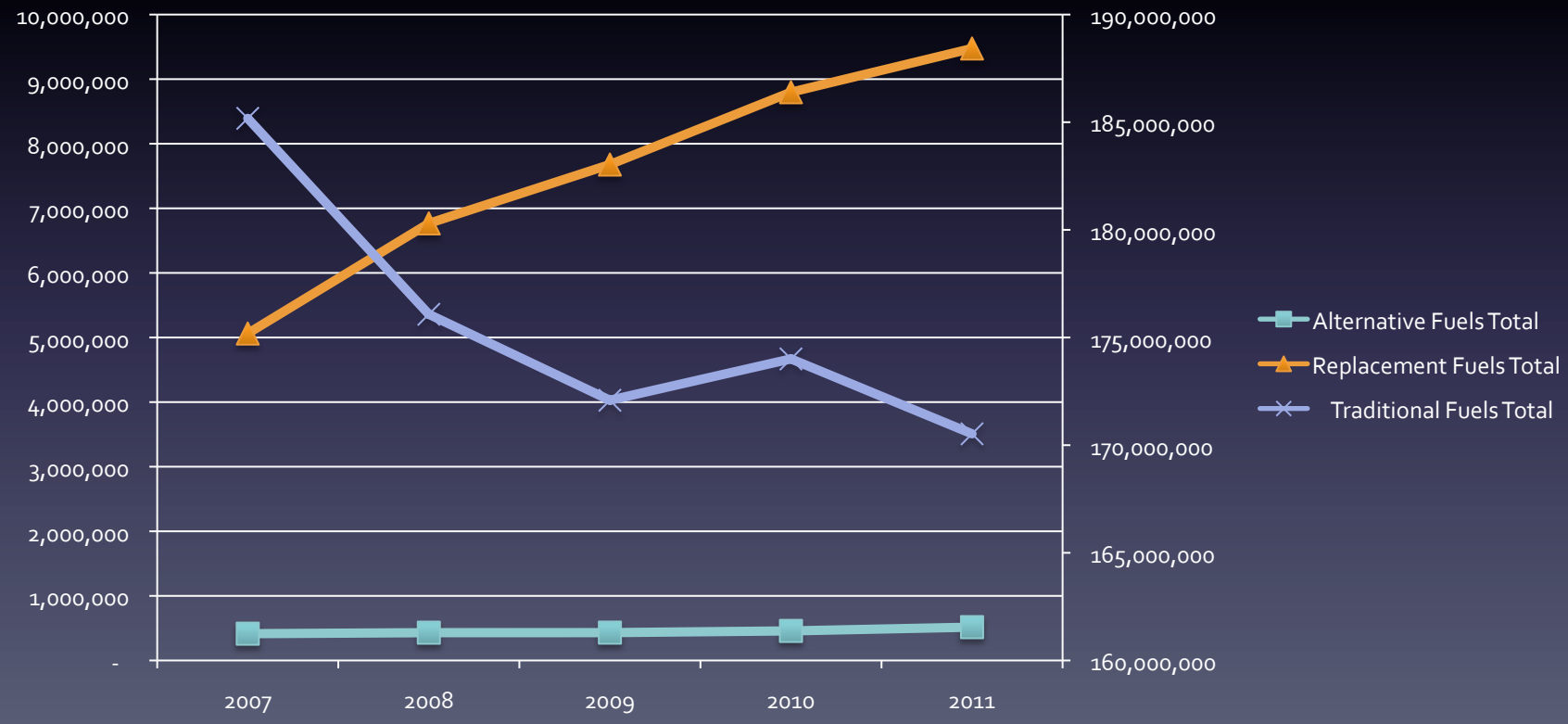
Biofuel and the balance of trade

- Although in 2005, the US consumed 3,343,131 thousand barrels of finished motor gasoline annually, in 2011 US consumption of finished motor gasoline declined to 3,194,754 thousand of barrels annually.
- The amount of ethanol consumed in the US in 2011 equaled 67.25% of the decline of finished motor gasoline consumption from 2005 to 2011.
- On the other hand, production of US gasoline in 2005 was 3,035,889 thousand of barrels annually but it increased to 3,306,028 in 2011 – an increase of 9%.

Growth in alternatives to fossil fuel

- Since 2007 total vehicle fuel consumption in the US declined from 185.5 billion to 171 billion gasoline equivalent gallons – a 7.8% decline
- However, during the same period, replacement fuels such as ethanol increased by 87.2% while alternative fuels such as compressed and liquefied natural gas increased by 24.4%.
- In sum, since 2007 the decline of traditional fuels (i.e., petroleum fuels) by 14.7 billion gasoline equivalent gallons was met with 4.5 billion of gasoline equivalent gallons of replacement and alternative fuels. The remaining difference is the outcome of fuel efficiency regulation and spiking crude oil prices.

Estimated Consumption of Vehicle Fuels in Thousand Gasoline Equivalent Gallons, by Fuel Type, 2007 – 2011



Changes in energy consumption

- The average miles per gallon of light-vehicle fleet increased from 24.5 miles per gallon in 1999 to 29.6 miles per gallon in 2011.
- The average US retail price of all formation gasoline prices on 1/3/2000 was 1.272 but reached 3.265 on 11/4/2013.
- These changes resulted in a 20.8% increase in average fuel-efficiency, and reduced the amount of gasoline consumed.
  - While in 2000 gallons per light-duty vehicles were 547, fuel consumption dropped to 460 in 2011 – a 16% decline in fuel consumption per vehicle

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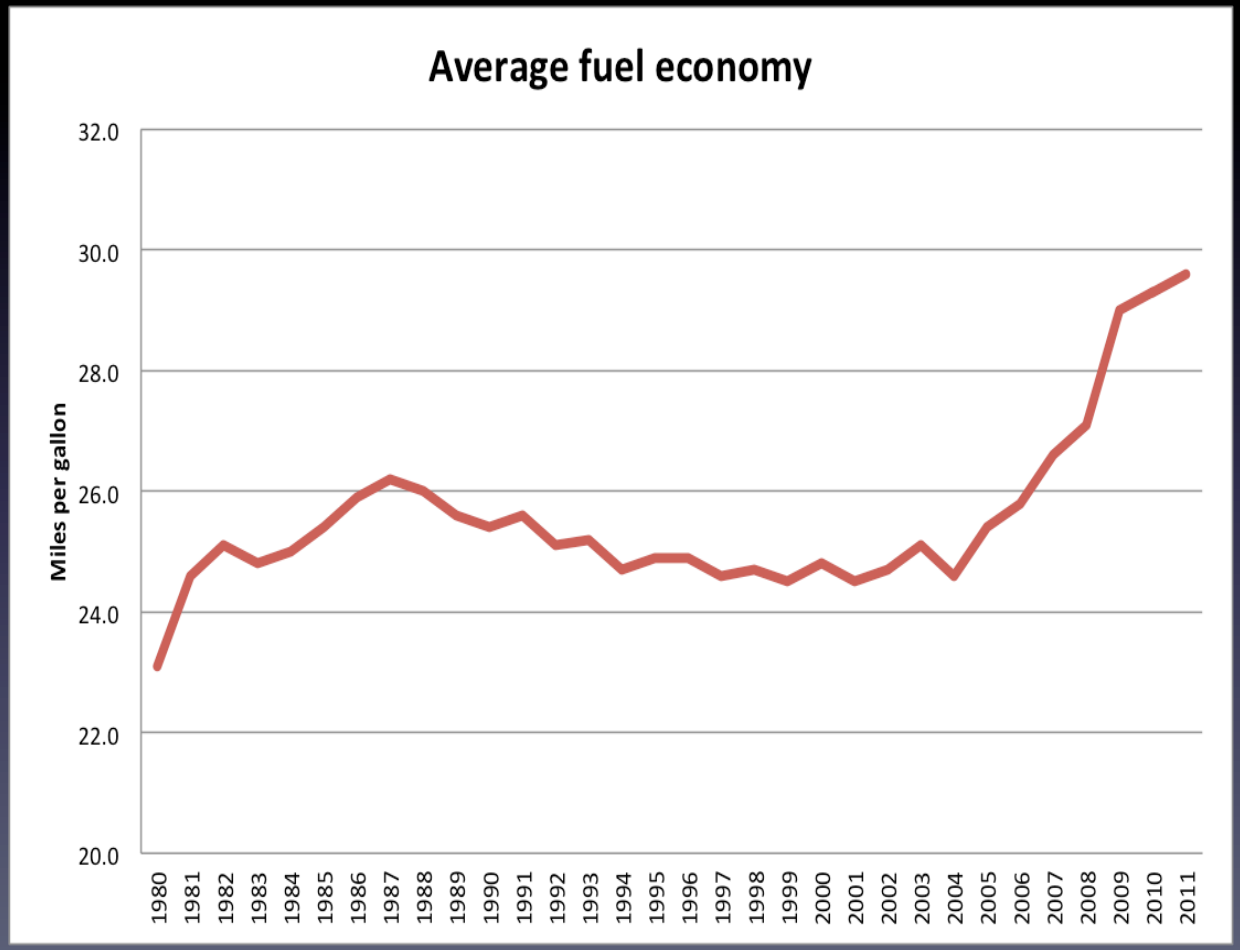
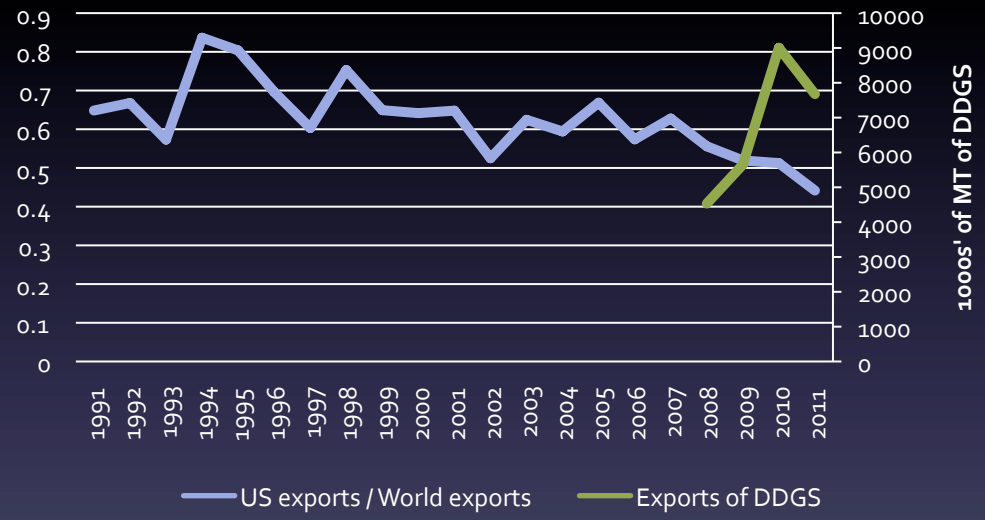


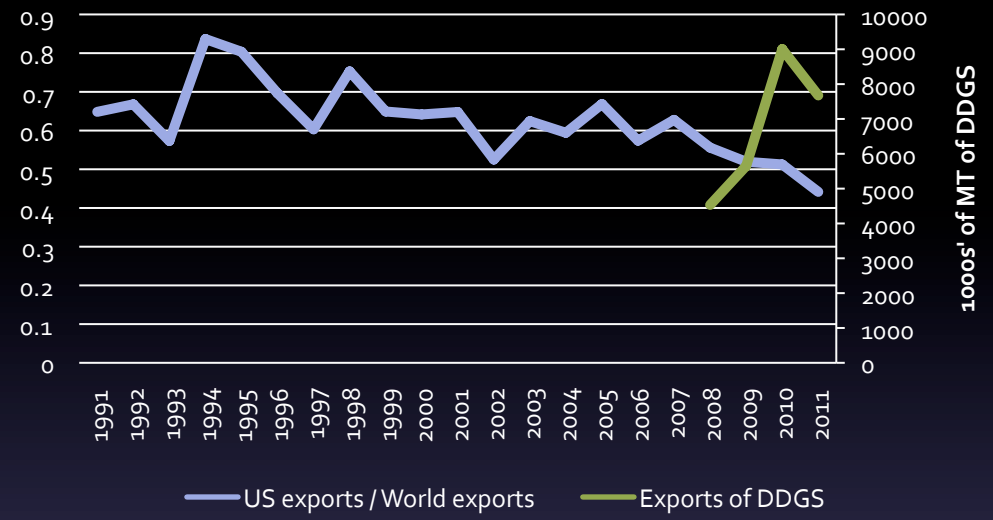
Corn exports and DDGS

Biofuel led to an increase in the price of corn-ethanol, but to decline in amount of corn-exports (49 MMT in 2000 to 42 MMT in 2011).

Using FAOSTAT trade data, as well as the IMF corn price index, the value of net-corn exports increased from 2000 to 2011 by 180%.



Dried Distillers Grains with Solubles (DDGS)



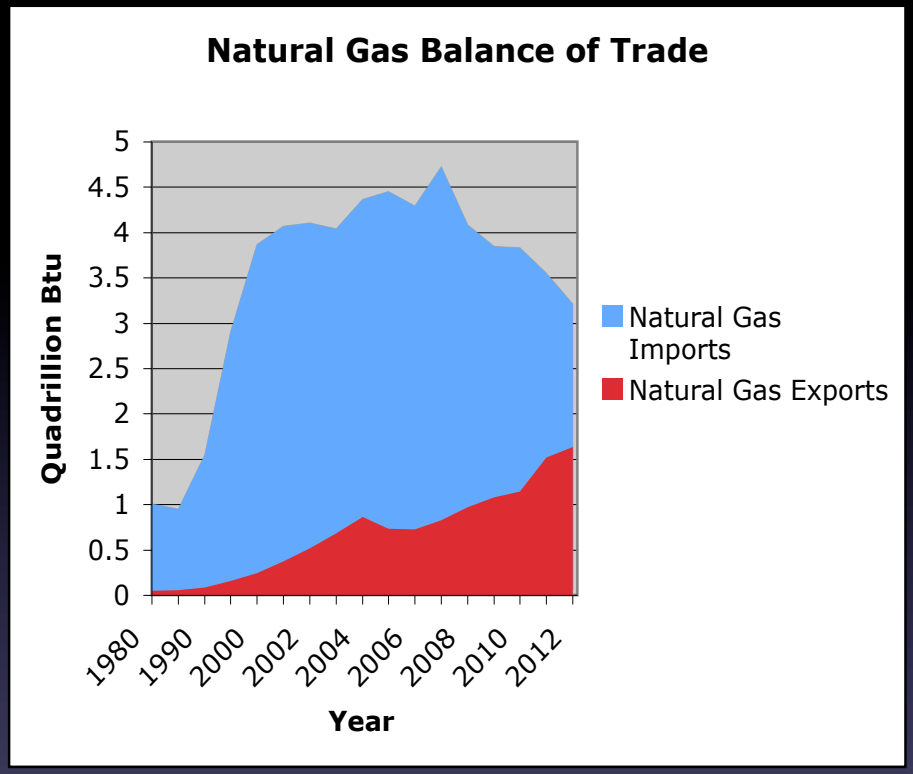
However, as corn-exports plummeted, production of DDGS increased from 4.5 MMT in 2005 to 7.7 MMT in 2011.

THESE EFFECTS ARE NOT UNIQUE TO THE BIOFUEL-GASOLINE NEXUS

Coal: a victim of hydraulic fracturing and horizontal drilling but also of regulation

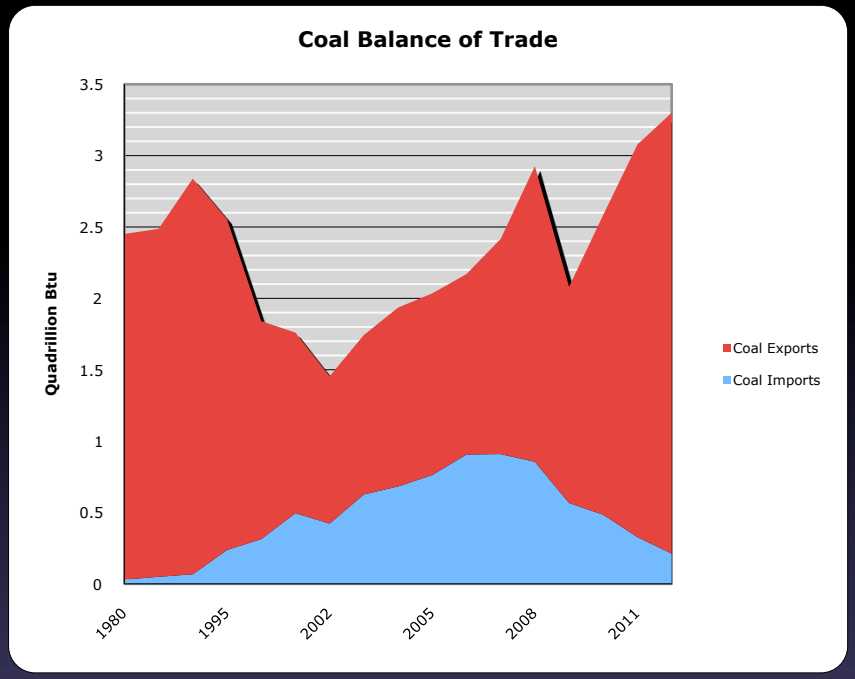
- In recent years, natural gas in the U.S. became an exception. While prices of other energy sources used by manufacturers were rising, those of natural gas declined.
  - Since 2007, production of natural gas in the United States increased rapidly because of newly discovered shale formations. These discoveries led to a decline of 36% in the average natural gas price paid by manufacturers between 2006 and 2010; price of natural gas dropped from $7.59 to $4.83 per million Btu.

The shale gas effect



Due to domestic natural gas production, natural gas imports fell by 23% in 2012 and net imports of natural gas as percentage of total natural gas consumed decreased to 6%.

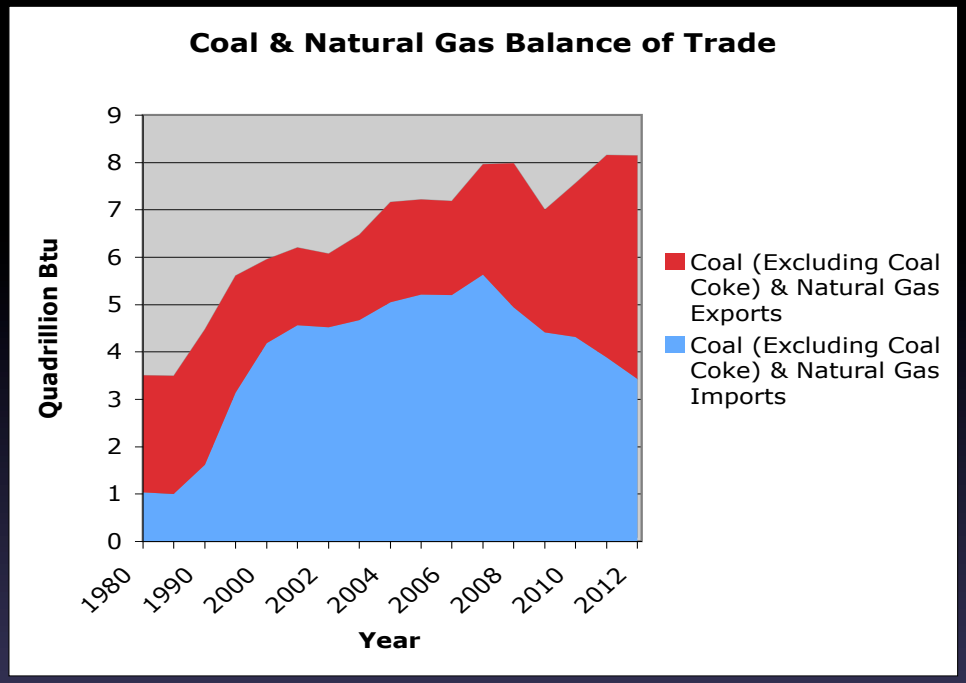
Coal imports and exports



The United States is a net exporter of coal since at least 1955.

The most coal exported by the United States was in 2012, with 3.088 Quadrillion Btu being exported, and only 0.212 Quadrillion Btu imported.

Net exports of coal and natural gas in B Btu



When combining amount imported and exported of both coal and natural gas, the US became a net exporter in recent years, with the change in trends beginning in 2007 – when extracting natural gas from shale formations began to boom

To conclude

- Macro-level aggregate considerations, in addition to special interests, guide policy and have a profound effect.
- While focusing on the macro-level effects from the introduction of biofuels, we conclude that macro-level aggregate considerations that are emphasized by the executive branch, yield substantial economic benefits to the economy. But this comes at the expense of the environment.