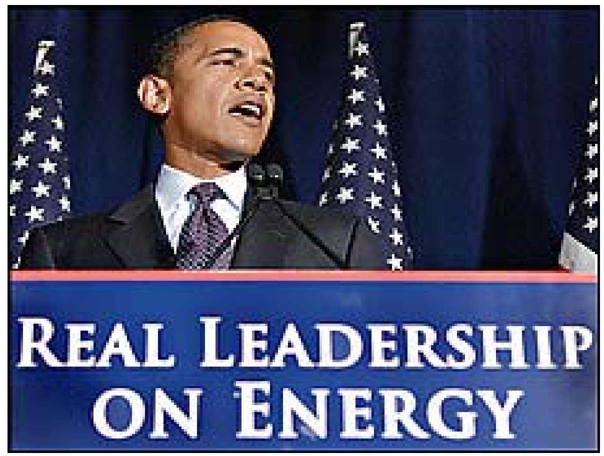
US Energy and Environmental Policies and the World Energy Market

Amy Myers Jaffe

James A. Baker III
Institute for Public Policy,
Rice University



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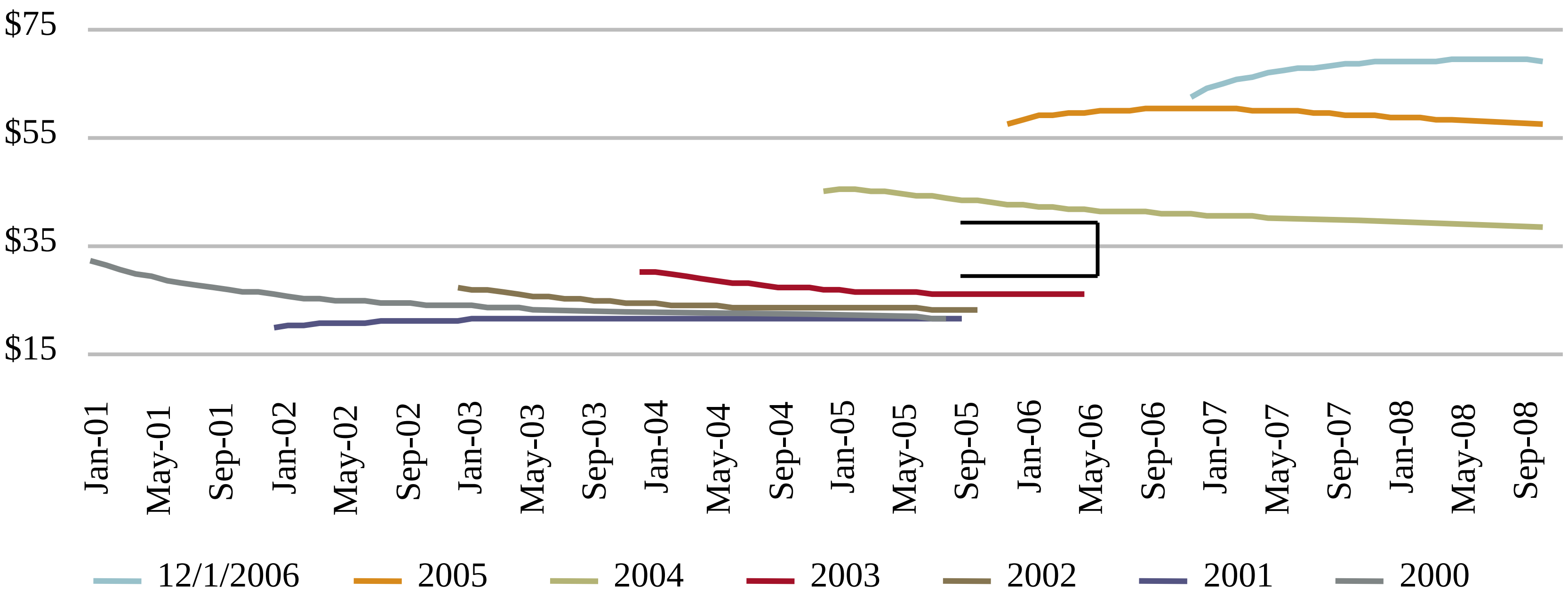
Long oil price increased and perception of the “floor” price changed

Why did the long oil price move upwards?

- Pessimism about level of NOC investment in new capacity
- IOC opportunities seen as constrained
- Terror Premium, Iranian nuclear aspirations created permanent change in attitudes about price floors
- F&D cost inflation
- China, India demand “story”
- Financial players consider oil as an attractive asset class investment vehicle to hedge against the dollar, treasuries and traditional equities

The Long Oil Price Didn’t Move Until 2004



1. *Forward curve on December 1, every year.*

Changes Always Come After A Price Spike Cycle Peak

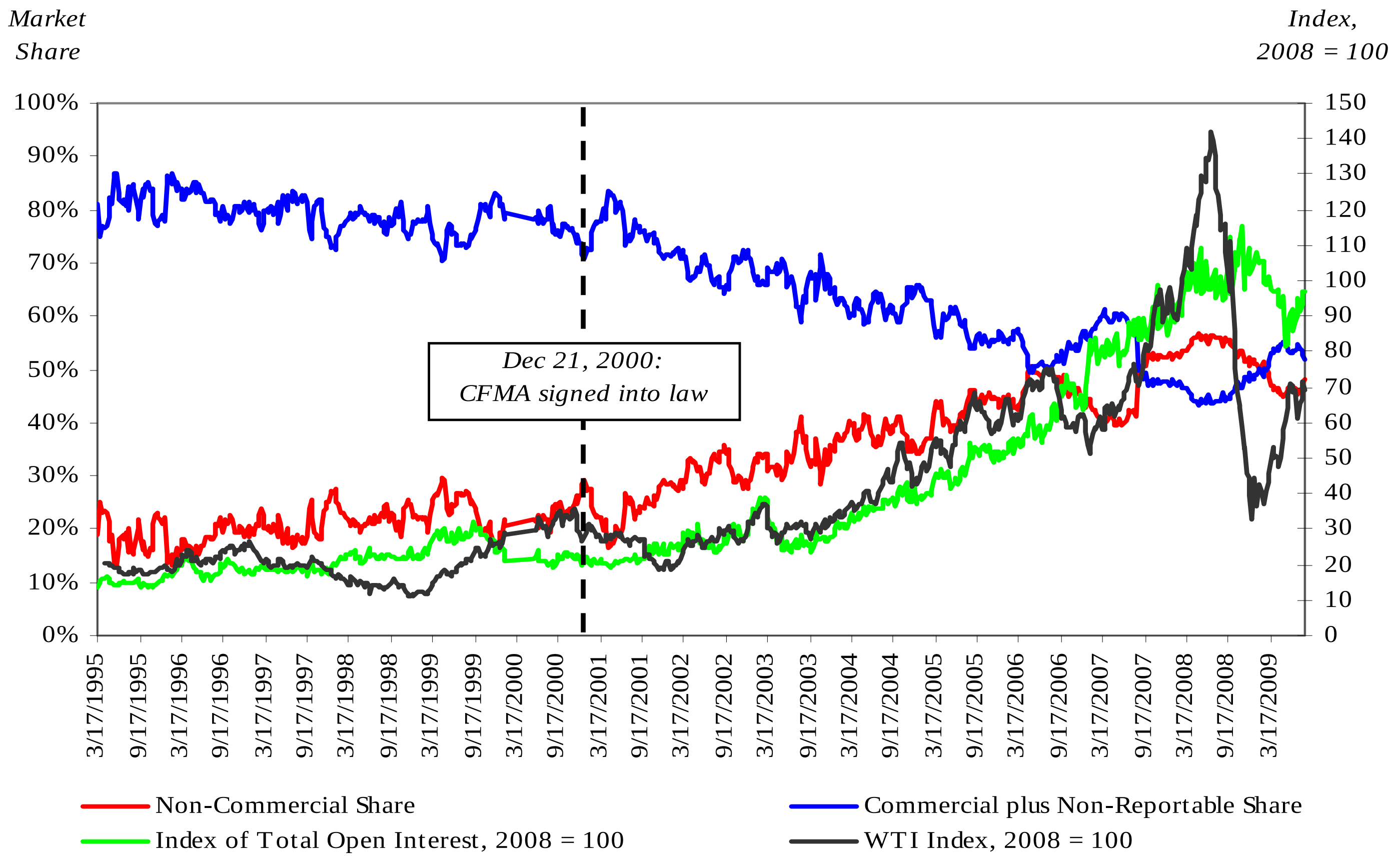
- In past cycles, demand growth has not returned to the same growth pace as soon as the global economy bounces
- Cycle of industry overcapacity restarts: Too many rigs, too many LNG receiving terminals, too much refining capacity, new high volume resource plays
- Demand slump also leads to supplemental OPEC spare capacity which in the past has capped prices
- This cycle was accompanied by expansion into market of financial players who are investing in oil commodity markets based on stimuli other than oil market fundamentals
- High prices tends to stimulate new resource plays in high cost resources, followed by cost reductions in those plays based on technology advances and experience
- High prices usher in new energy efficiency gains and technologies
- Energy efficiency gains may come also in the developing world

Changes Always Come After A Price Spike Cycle Peak but Now Enhanced by U. S. Gulf of Mexico Drilling Disaster

- Price spikes bring political responses around the world, but especially pronounced in the United States
- Appetite for taxing industry goes up. For U.S. Gulf of Mexico and even onshore, the Obama administration will be looking to tax the industry
- In light of BP oil spill, renewed calls for more effective energy and climate regulation
- But U.S. policy options to significantly lower oil use quickly are limited
- Challenge is the 3 to 5 year horizon: President Obama administration so far focused on 30 to 50 year horizon. BP oil spill may change the politics of focusing just on a long term strategy.

Growth of Financial Players in Crude Oil Futures

- Market composition changed after the Commodity Futures Modernization Act (CFMA) was passed with financial players increasing from 20% to over 50% of open interest.

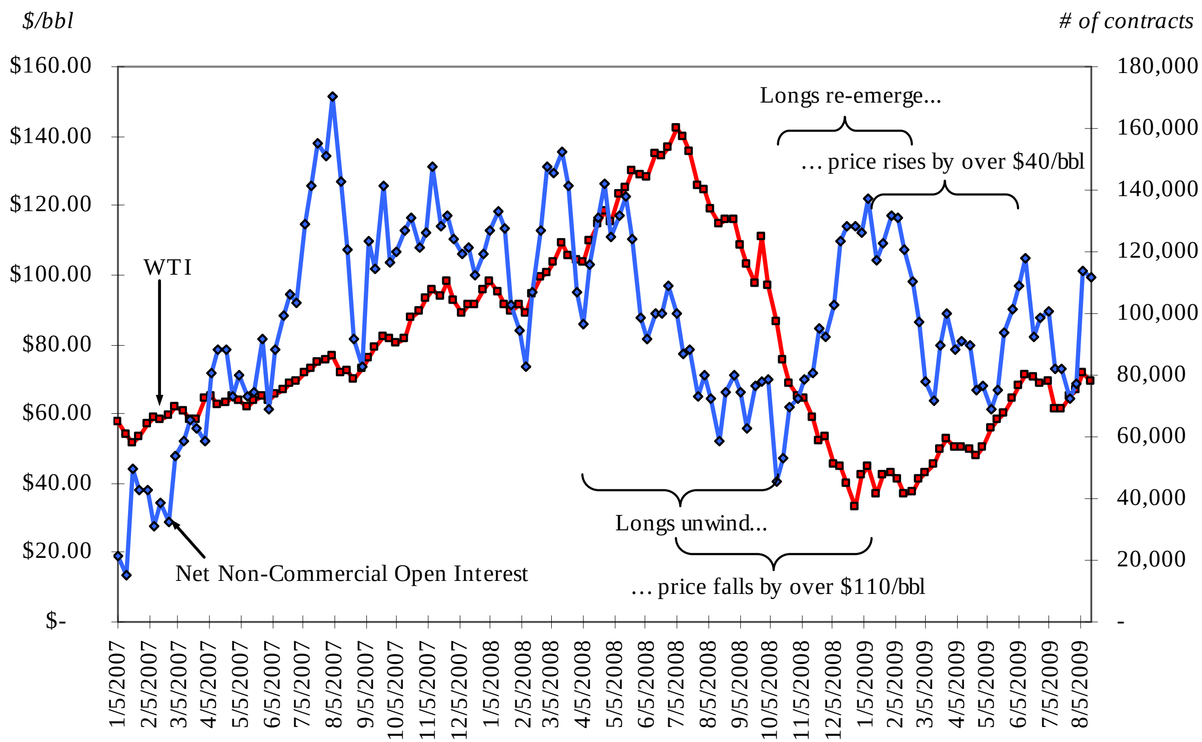


Source: CFTC COT Reports – CRUDE OIL, LIGHT SWEET - NYMEX

- Some financial players enter and exit the market based on relative returns to other commodities, financial instruments and equities. Harder for U.S. and its allies to affect the oil market.

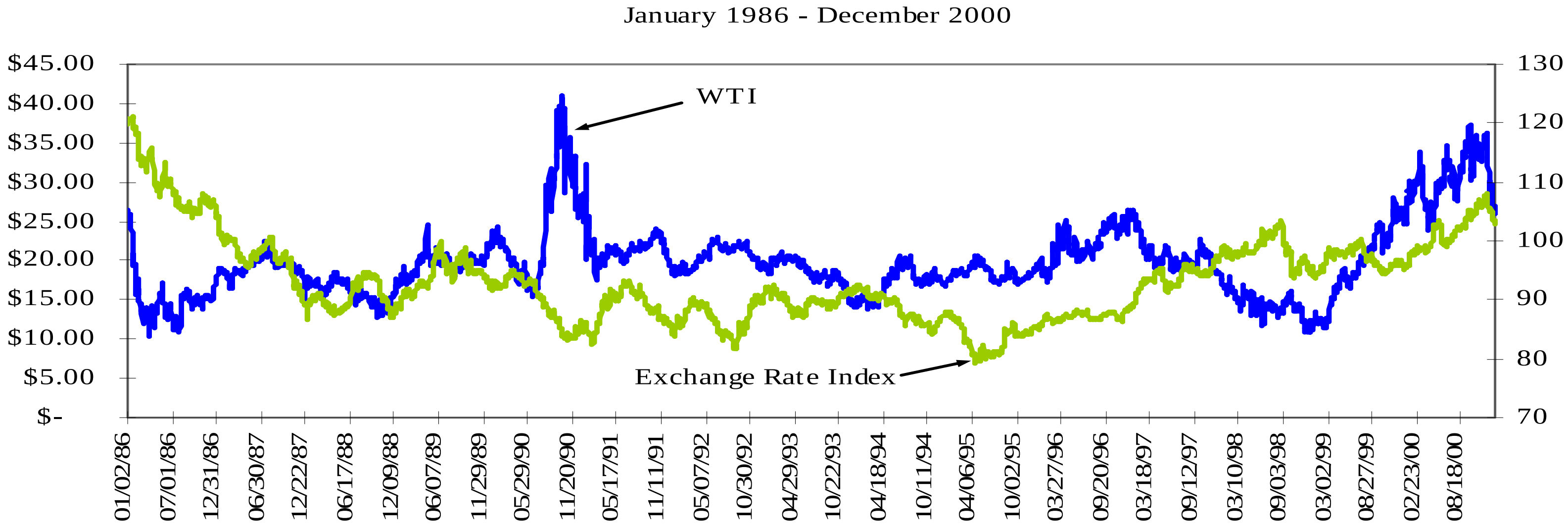
"Speculation and the Price of Oil"

- Non-commercials have been consistently net long, as a group, for the past few years.
- The net long position shows evidence of leading oil price.
  - Tests of bivariate Granger causality reveal this to be the case. Omitted variables bias render this suggestive rather than definitive. For example, changes in physical market indicators could lead market positions and oil price. A more complete multivariate analysis is being conducted.



Source: CFTC COT Report - 'CRUDE OIL, LIGHT SWEET' - NYMEX

Oil Continues to Follow the Dollar



The Emergence of Shale Gas

- Shale Gas resource assessments are large.
  - BIPP research indicates the technically recoverable resource in North America at over 580 tcf
    - Navigant Consulting, Inc. estimated a high of almost 900 tcf (2008).
    - The Potential Gas Committee estimates exceed 680 tcf (2009).
    - Advanced Resources International estimates exceed 1000 tcf (2010).
  - Estimates outside of North America are also large.
    - Recent assessment from ARI (2010)
      - European technically recoverable shale at over 170 tcf.
      - China at over 100 tcf.
      - Southern Africa at 35 tcf.
- Shale is not the only unconventional gas source…
  - Coal Bed Methane estimates in China, India and Australia are also large, and likely to reach market sooner than shales in those countries.

Current BIPP Study:
Energy Market Consequences of Emerging Renewable and Carbon Dioxide Abatement Policies in the United States

Current BIPP Study

- "Energy Market Consequences of Emerging Renewable and Carbon Dioxide Abatement Policies in the United States"
  - Development of the Rice World Energy Model (RWEM) – a derivative of the Rice World Gas Trade Model (RWGTM) – developed using *MarketPoint* software.
  - 2 year study with final reporting in May 2010.
  - Preliminary results are available.
- A scenario approach is being used to examine and compare various outcomes under different sets of assumptions.
  - Degree of CO2 emissions cuts (no clear policy yet, so we are choosing to investigate effects by degrees)
  - Safety valves and offset programs
  - The operating and capital costs of various end-use technologies (there is wide disagreement between government and industry here)
  - Elasticity of supply of various fuels
  - Elasticity of demand in different sectors
  - Rate of technological innovation (ongoing parallel study examining the effect of R&D spending on breakthroughs)
  - Regional policies versus harmonized federal and international policies.
  - "Carbon leakage"

Costs of Generation Technologies

- Substantial disagreement between government and industry!

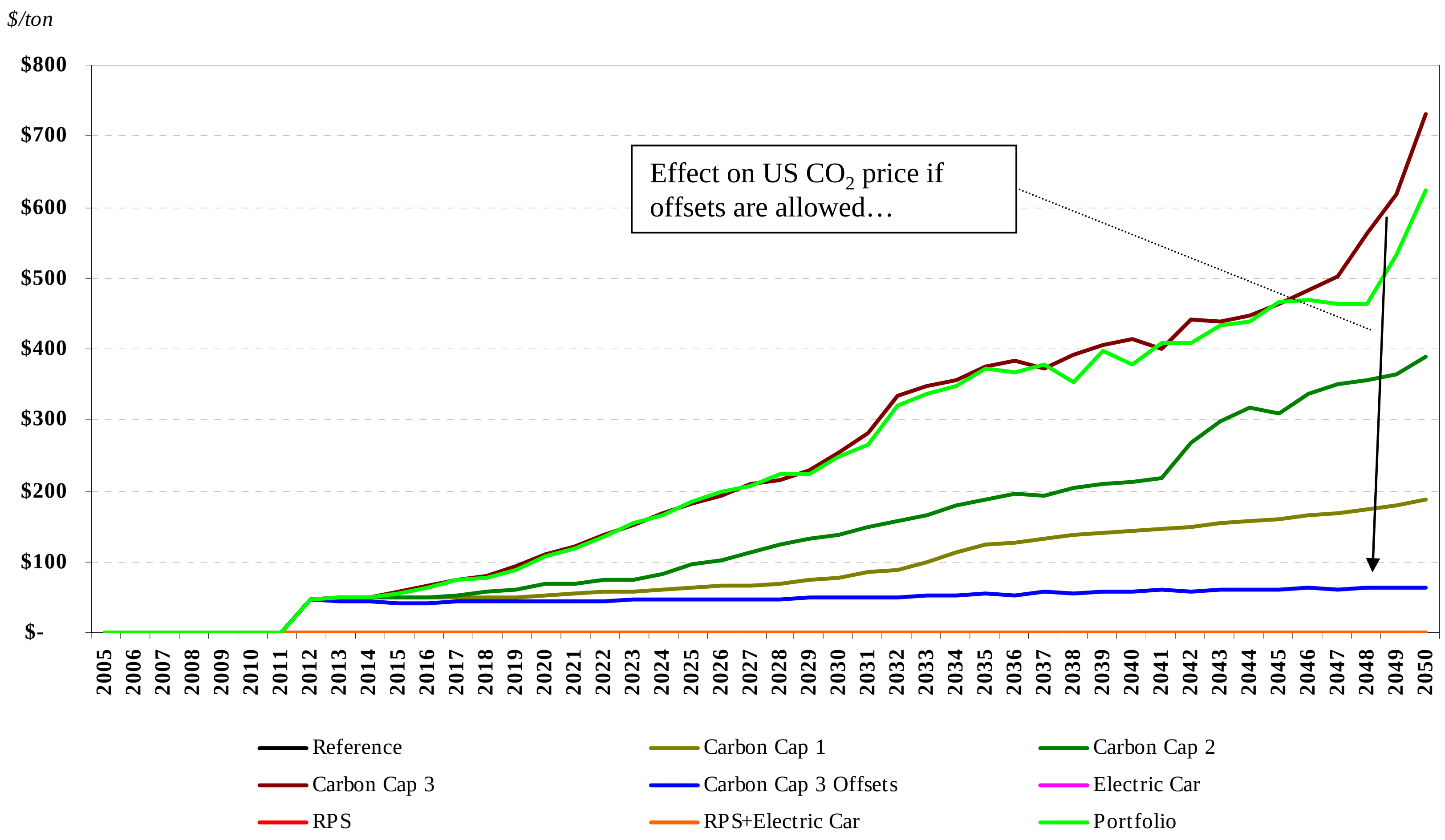
Technology	Total Overnight Cost 2005 $/kW DOE Source	Total Overnight Cost 2005 $/kW Industry Sources	Industry Adjustment	Variable O&M 2005 $/kWh DOE Source	Fixed O&M 2005 $/kW DOE Source	Heat Rate BTU/kWh DOE Source
Scrubbed Coal New	$ 1,939	$ 3,080	*1.588*	$ 0.046	$ 25.94	9,200
w/ CCS	$ 2,993	$ 4,846	*1.619*	$ 0.061	$ 32.96	11,061
Integrated Coal-Gasification Combined Cycle	$ 2,241	$ 3,714	*1.657*	$ 0.029	$ 36.44	8,765
w/ CCS	$ 3,294	$ 5,480	*1.663*	$ 0.044	$ 43.46	10,781
Conventional Gas/Oil Comb Cycle (CC)	$ 907	$ 1,011	*1.115*	$ 0.021	$ 11.76	7,196
Advanced Gas Comb Cycle (CC)	$ 893	$ 996	*1.115*	$ 0.020	$ 11.03	6,752
w/ CCS	$ 1,781	$ 1,850	*1.038*	$ 0.029	$ 18.75	8,613
Conventional Combustion Turbine	$ 631	$ 747	*1.182*	$ 0.036	$ 11.41	10,810
Conventional Combustion Turbine (FO6)	$ 631	$ 747	*1.182*	$ 0.036	$ 11.41	10,810
Advanced Combustion Turbine	$ 597	$ 712	*1.192*	$ 0.032	$ 9.92	9,289
Advanced Combustion Turbine (FO6)	$ 597	$ 712	*1.192*	$ 0.032	$ 9.92	9,289
Fuel Cells	$ 5,051	$ 6,070	*1.202*	$ 0.479	$ 5.32	7,930
Advanced Nuclear	$ 3,127	$ 5,887	*1.883*	$ 0.005	$ 84.83	10,434
Distributed Generation Base	$ 1,291	$ 1,379	*1.068*	$ 0.071	$ 15.11	9,050
Distributed Generation Peak	$ 1,550	$ 1,628	*1.050*	$ 0.071	$ 15.11	10,069
Biomass	$ 3,539	$ 4,617	*1.305*	$ 0.067	$ 60.73	9,646
MSW Landfill Gas	$ 3,339	$ 4,425	*1.325*	$ 0.000	$ 107.66	13,648
Geothermal	$ 1,612	$ 1,612	*1.000*	$ -	$ 155.15	34,633
Conventional Hydropower	$ 2,113	$ 2,031	*0.961*	$ 0.024	$ 12.84	---
Wind	$ 1,812	$ 1,811	*1.000*	$ -	$ 28.55	---
Wind Offshore	$ 3,629	$ 3,351	*0.923*	$ -	$ 84.32	---
Solar Thermal	$ 4,741	$ 4,619	*0.974*	$ -	$ 53.51	---
Photovoltaic	$ 5,690	$ 5,208	*0.915*	$ -	$ 11.01	---

Modeling the Impacts of CO_2 and Other Regulations

- A scenario approach is used (see Hartley and Medlock, "Energy Market Consequences of Emerging Renewable and Carbon Dioxide Abatement Policies in the United States" (2010)). Note that all scenarios use industry costs.
  - **Carbon Cap 1** – CO_2 emissions are forced to fall to their 1990 levels by 2050. The manner of enforcement is through a cap-and-trade scheme in which trading begins in 2012. The CO_2 permits allowed for trade are slowly decreased to the target level from the date at which CO_2 permit trading begins. No assumptions about renewable portfolio standards or electric vehicles are explicitly made, although investments in renewables and electric vehicles are allowed.
  - **Carbon Cap 2** – Same as Carbon Cap 1 except CO_2 emissions fall to 80% of their 1990 levels by 2050.
  - **Carbon Cap 3** – Same as Carbon Cap 1 except CO_2 emissions fall to 50% of their 1990 levels by 2050.
  - **Carbon Cap 3 Offsets** – Same as Carbon Cap 3 except investment in offsets is allowed.
  - **Electric Car** – The electric car is adopted at a rate such that it represents 40 percent of vehicle fuel demand by 2050. Note penetration increases over time, reflecting the time it takes for vehicle stock turnover to occur. No assumptions are made about renewable portfolio standards or the existence of a CO_2 market.
  - **RPS** – Renewable portfolio standards (RPS) are introduced such that renewable energy sources must account for 20 percent of electricity generation by 2030 and 40 percent by 2050. Also, ethanol must account for 20 percent of vehicle fuel by 2030. No assumptions are made regarding electric vehicles or cap-and-trade.
  - **Electric Car plus RPS** – The Electric Car case and the RPS case are combined.
  - **Portfolio** – This case combines assumptions made for the Electric Car case, the RPS case, and the Carbon Cap 3 case.

CO2 *Price* is Sensitive to Policy Design

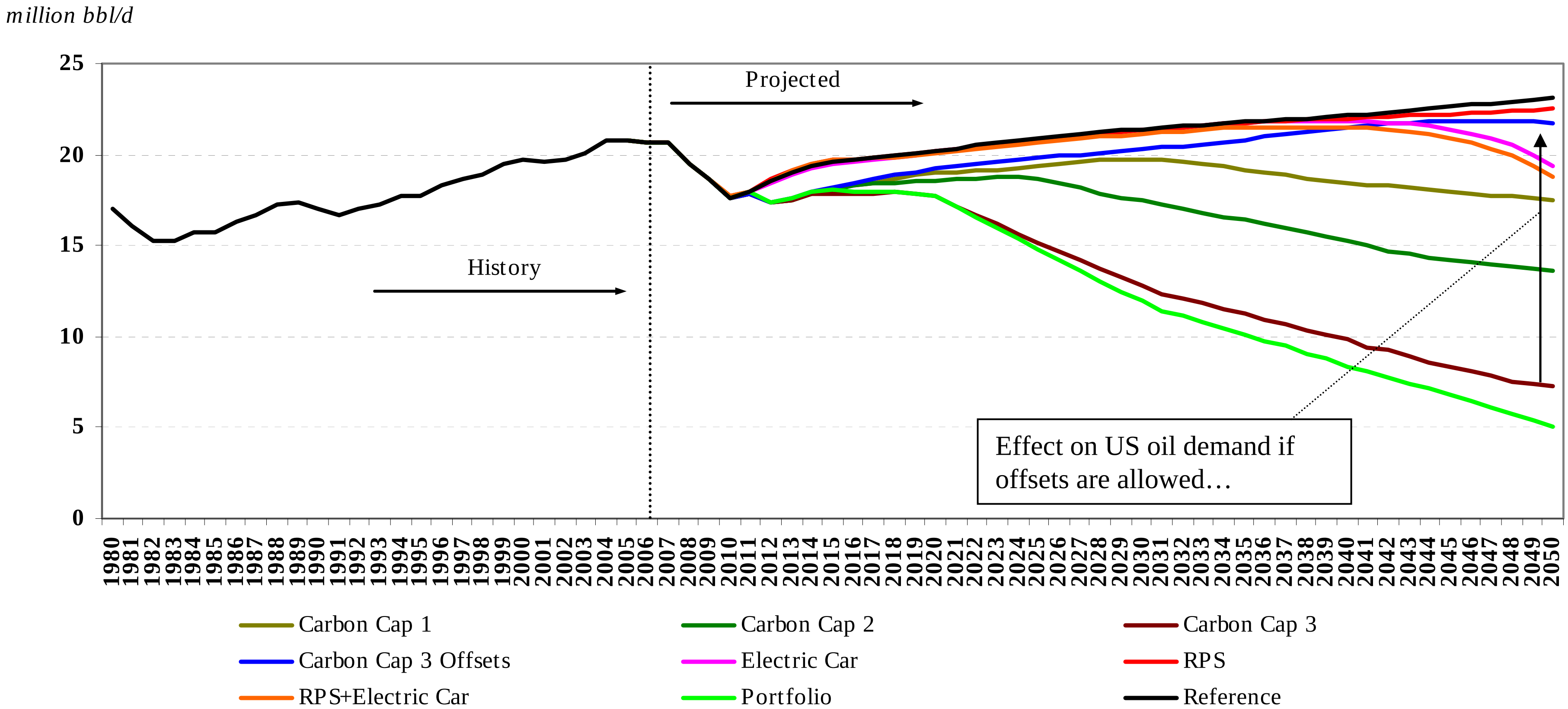
- Increasing restrictions raises price.
- CCS deployment, demand reduction, and offset mechanisms are critical!



Source: Hartley and Medlock, "Energy Market Consequences of Emerging Renewable and Carbon Dioxide Abatement Policies in the United States" (2010)

Trends in Oil Demand Sensitive to Policy Design

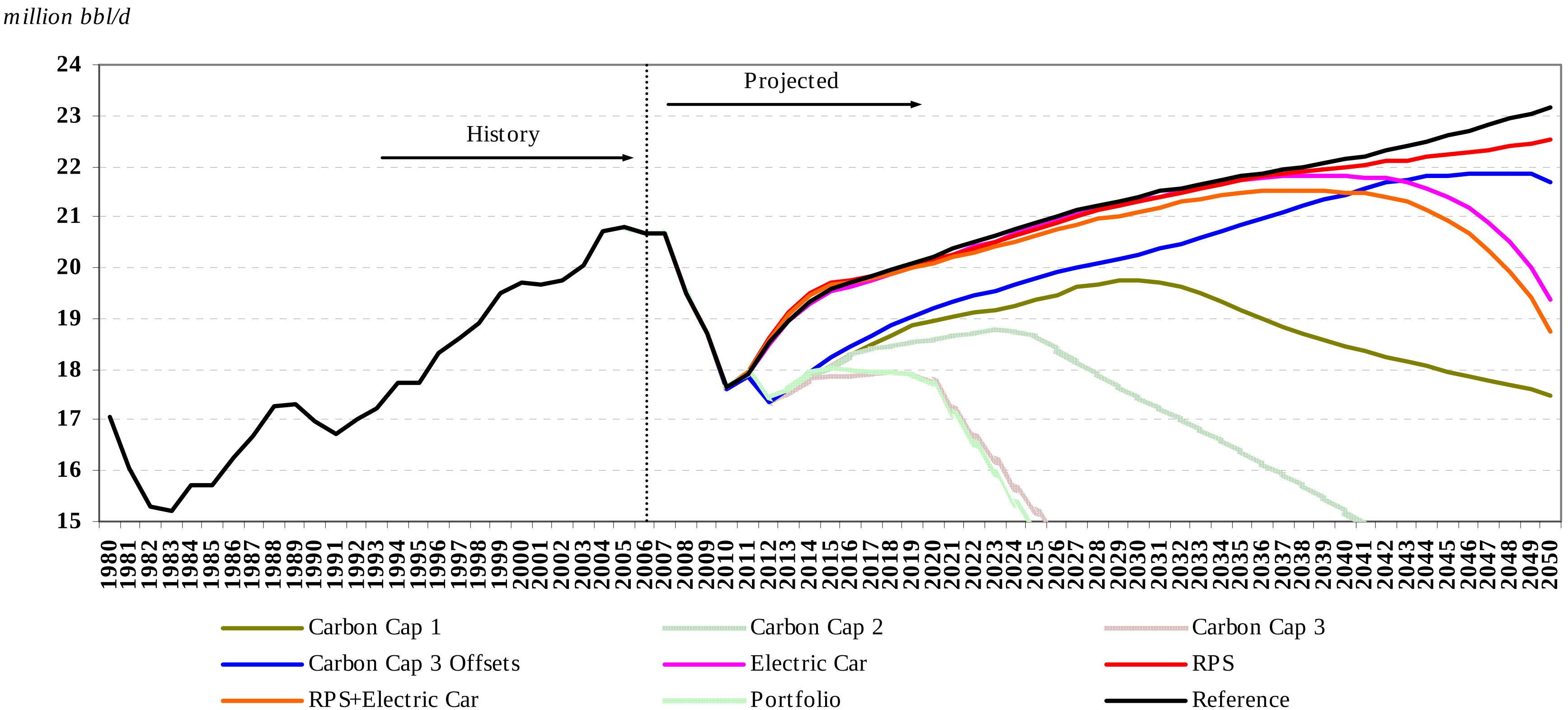
- Oil demand reduction could be significant under aggressive policies such as those originally proposed by the Obama administration
- US politically feasible scenarios (such as a cap and trade market with active offsets (Carbon Cap 3) would shave 1.5 million bbl/d off projected demand growth.
- Note: All scenarios incorporate improvements in CAFE standards.



Source: Hartley and Medlock, "Energy Market Consequences of Emerging Renewable and Carbon Dioxide Abatement Policies in the United States" (2010)

Oil Demand is Sensitive to Policy Design (cont.)

- Focusing on the less aggressive scenarios, we see…
  - RPS has almost no effect on oil demand.
  - An aggressive target for electric vehicles results in a decline in oil demand that accelerates with EV penetration.



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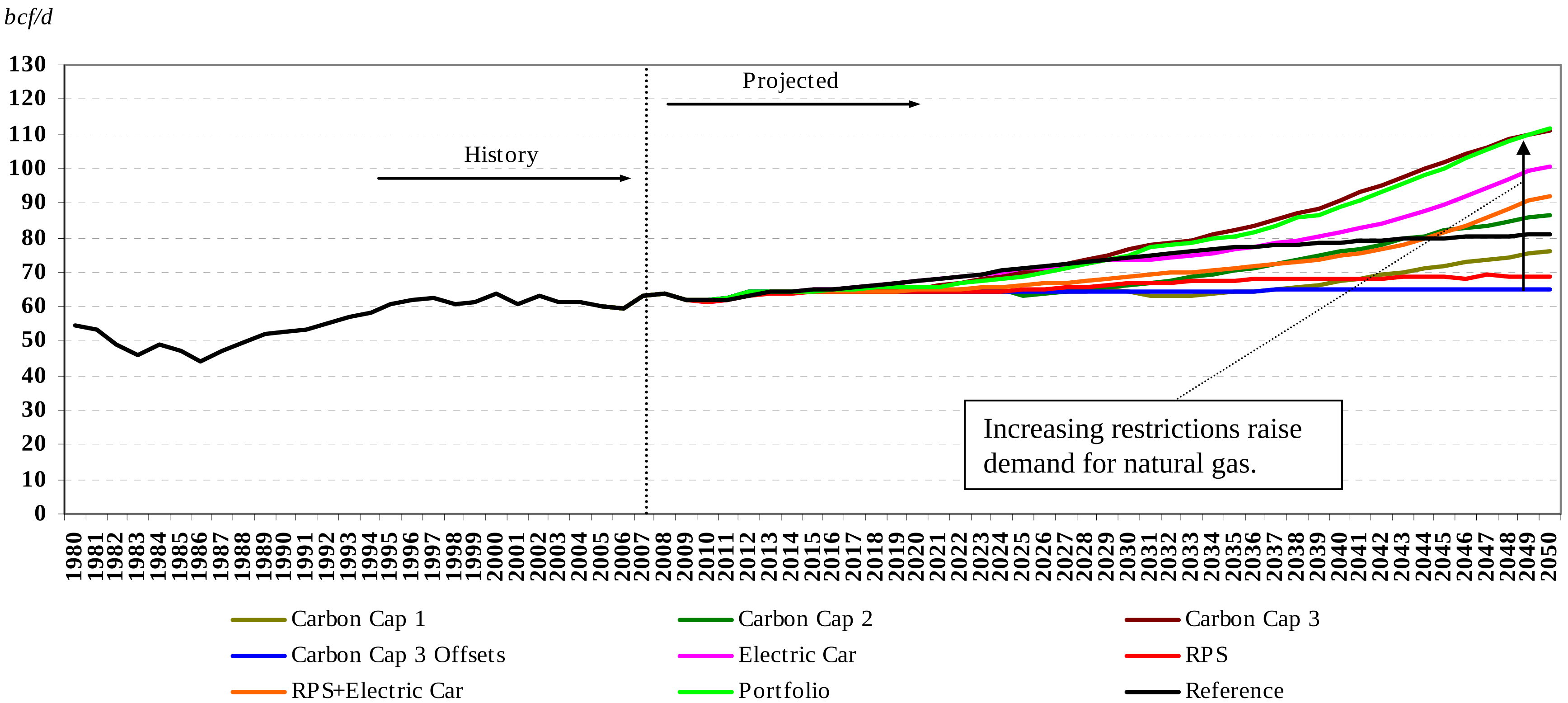
Natural Gas Demand is also Sensitive to Policy Design

- In no case does natural gas demand decline.
- Faster penetration of EVs raises the demand for natural gas.
- Strong RPS standards result in natural gas demand that is below the reference case. Even in the highest demand case, LNG imports do not gain due to prominence of shale gas in North America.



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Key Points

- Handling of offsets is a crucial determinant of CO_2 market implications
- The price of CO_2 is largely determined by the cost of deploying lower carbon alternatives, so capital costs are critical
- The bulk of the impact of higher CO_2 prices falls on the petroleum sector
  - Reflecting the difference between mobile sources of emissions versus fixed-point sources of emissions.
- Elasticity of supply of low carbon fuels is important
  - For example, if the supply curve for natural gas is very flat, then the price of CO_2 need only rise to the point at which natural gas substitutes for coal, assuming natural gas is less expensive to deploy and use.
- Elasticity of demand for energy is important
  - If energy demand is very inelastic, so that consumers do not reduce demand very much when price increases, then the price of CO_2, *ceteris paribus*, will be higher to achieve a given reduction.
- Availability of new technologies is critical
  - If new technologies are made available sooner and more cheaply, then the price of CO_2 is influenced lower.