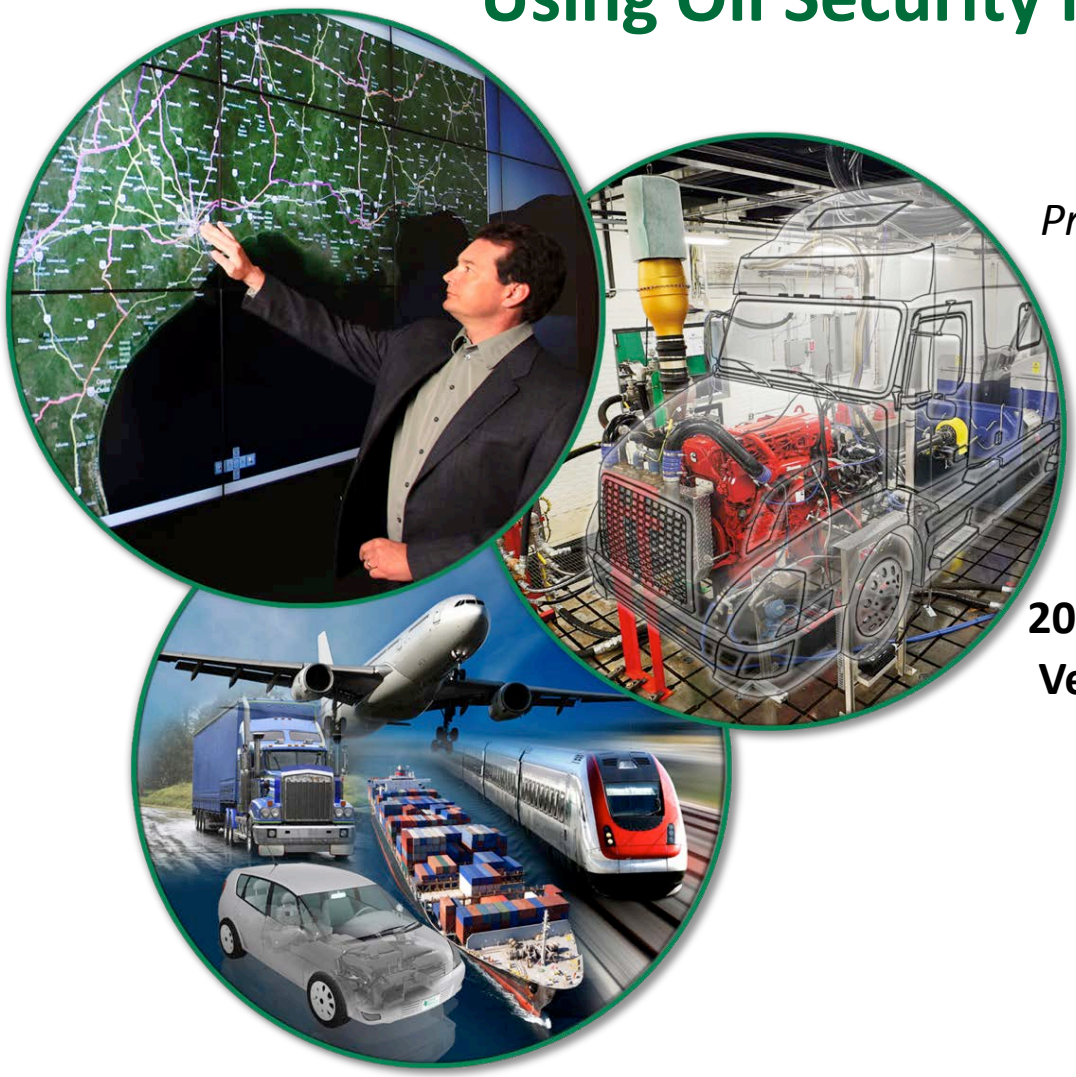
Assessing the Outlook of US Oil Dependence Using Oil Security Metrics Model (OSMM)



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2015 U.S. DOE Hydrogen Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting

June 11, 2015

Project ID: van010

Center for Transportation Analysis

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MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

OVERVIEW

Timeline

- Project start date: Oct. 2005
- Project end date: Continuing

Barriers/Targets*

- Supports program portfolio management by quantifying the value of reducing future U.S. petroleum consumption and improving substitutes (p. 3.0-2).
- Measures and explains past economic costs of oil dependence to enhance public understanding of the importance of reduced petroleum dependence (p. 1.0-5)

**from 2011-2015 VTP MYPP*

Budget (DOE share)

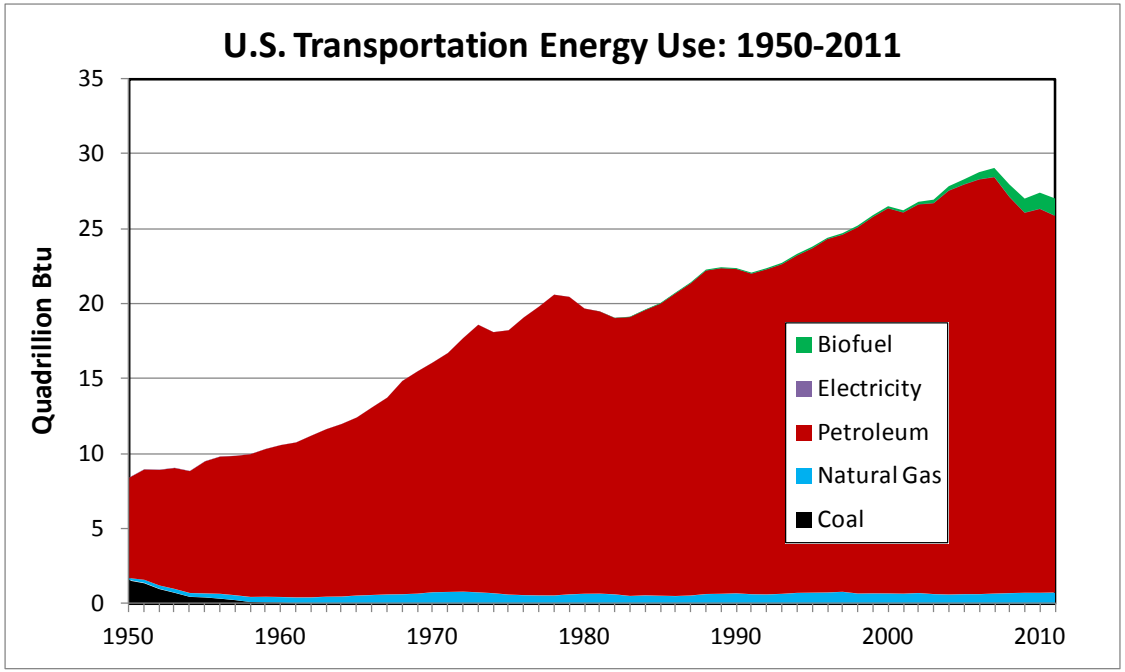
- FY13 funding: $100k
- FY14 funding : $100k

Partners

- University of Tennessee
- Argonne National Laboratory
- Project Lead: ORNL

Relevance: The OSMM estimates the cost of U.S. oil dependence and the direct economic value of reducing it.

- **Enhancing US energy security is a primary objective of the DOE.**
- **The transportation sector's oil dependence is probably the greatest threat to US energy security.**
- **The OSMM project tracks and explains oil dependence costs and measures the energy security benefits of vehicle technologies and alternative fuels in an uncertain future.**



Source: EIA

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Objective: Reassess the outlook of US oil independence under new world oil market dynamics

- **Calibrate OSMM to 2014 Annual Energy Outlook**
- **Update OPEC market share – world oil price graph**
- **Improve OSMM by incorporating recent understanding to the dynamics of oil market**
  - Review recent literature on oil market and revise price elasticities
  - Review literature and revise assumption of competitive price
  - Enhance oil supply shock simulation algorithm by allowing for post-shock recovery period, i.e., OPEC increases supply and retakes market share.
- **Deliverables: Submit a report or journal paper.**

Milestone, Tasks and Status

AOP Milestone	Due Date	Sub-task	Status as of 02/17/2015 (% completed)
Modeling	12/31/ 2014	Calibrate the model to AEO 2014	Completed
Modeling	03/31/ 2015	Release new version of OSMM	Completed
Analysis	06/30/ 2015	Preliminary results on US oil dependence cost estimation	Completed
Reporting	09/30/ 2015	Final report or draft paper submitted for publication	Completed

Publications & Presentations

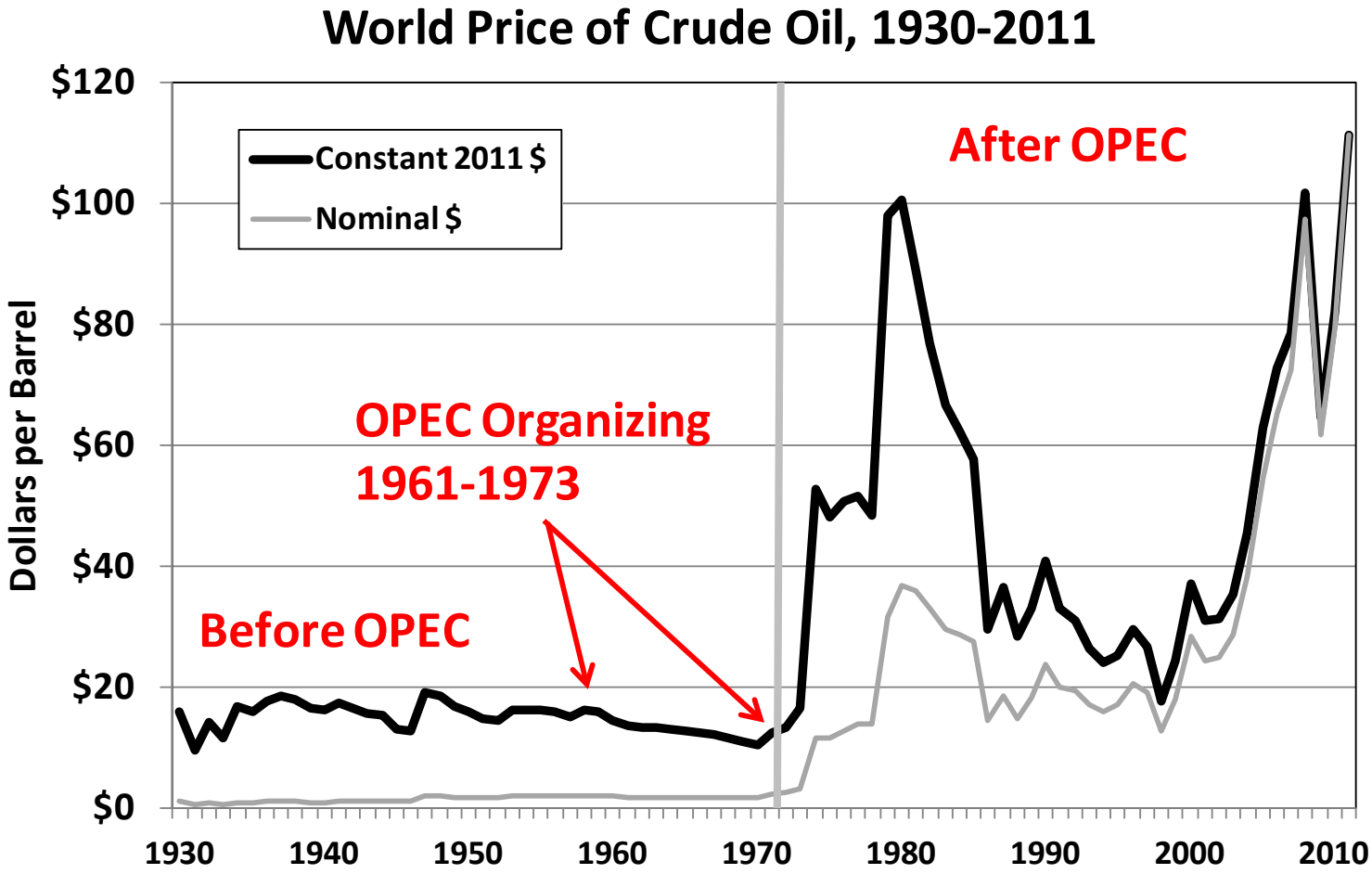
Greene, D. L., and C. Liu (2014). The Outlook for U.S. Oil Dependence 2014: Is Energy Independence in Sight? Presented at the 94th Transportation Research Board (TRB) Annual Meeting, Washington, DC, USA, January 2015 and submitted to Energy Policy

Greene, D.L., C. Liu, P.N. Leiby (2014). The Oil Security Metrics Model: 2014 Update, ORNL/TM-2014/628, Oak Ridge National Laboratory, Oak Ridge, Tennessee, September, 2014.

Approach: The OSMM recognizes the influence of the partial monopoly of oil-producing states on the world oil market.

"The real problem we face over oil dates from after 1970: a strong but clumsy monopoly of mostly Middle Eastern exporters operating as OPEC." Prof. M. Adelman, MIT, 2004.

- Algeria
- Angola
- Ecuador
- Iran
- Iraq
- Kuwait
- Libya
- Nigeria
- Qatar
- Saudi Arabia
- UAE
- Venezuela



Source: BP Statistical Review of World Energy 2012, "Oil: Crude oil prices 1861-2011".

Approach: The OSMM is built upon the oil market module that simulates the evolution of world oil market

INPUTS:

- AEO projections of Oil demand, supply and prices
- Price elasticity
- Changes in oil consumption due to DOE VT progress

MODEL:

- Linear supply and demand equations
- Simulate oil supply shocks
- Uncertainty analysis using @risk software

OUTPUTS:

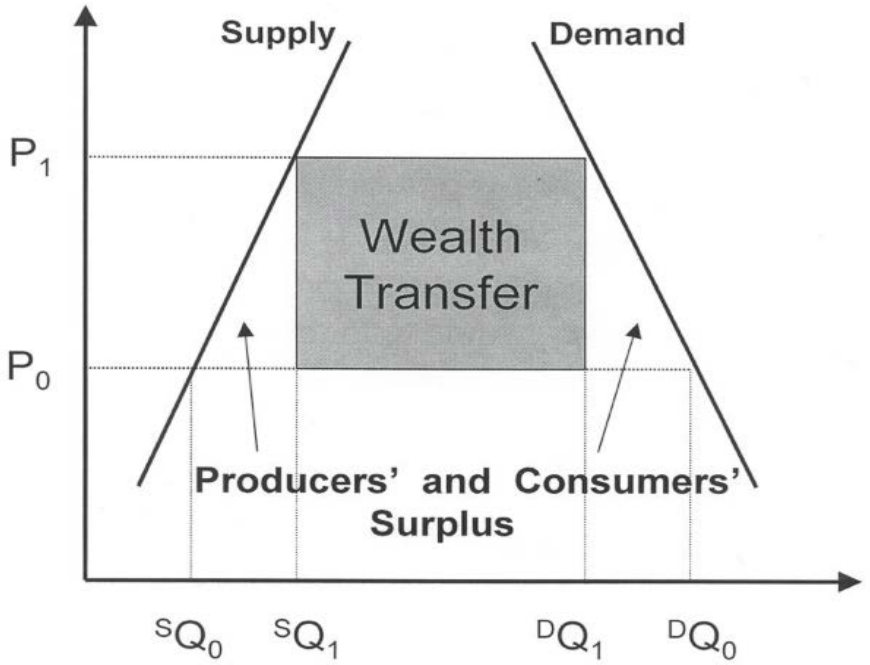
- U.S. oil dependence cost
- Oil security net benefits of DOE R&D programs and other policies

Approach: The OSMM measures 3 losses to the U.S. economy in comparison to a competitive market.

1. **Loss of potential GDP = producers' & consumers' surplus losses in oil markets (dynamic).**

2. **Dislocation losses of GDP due to oil price shocks.**

3. **Transfer of wealth due to monopoly pricing and price shocks (requires counterfactual competitive price).**



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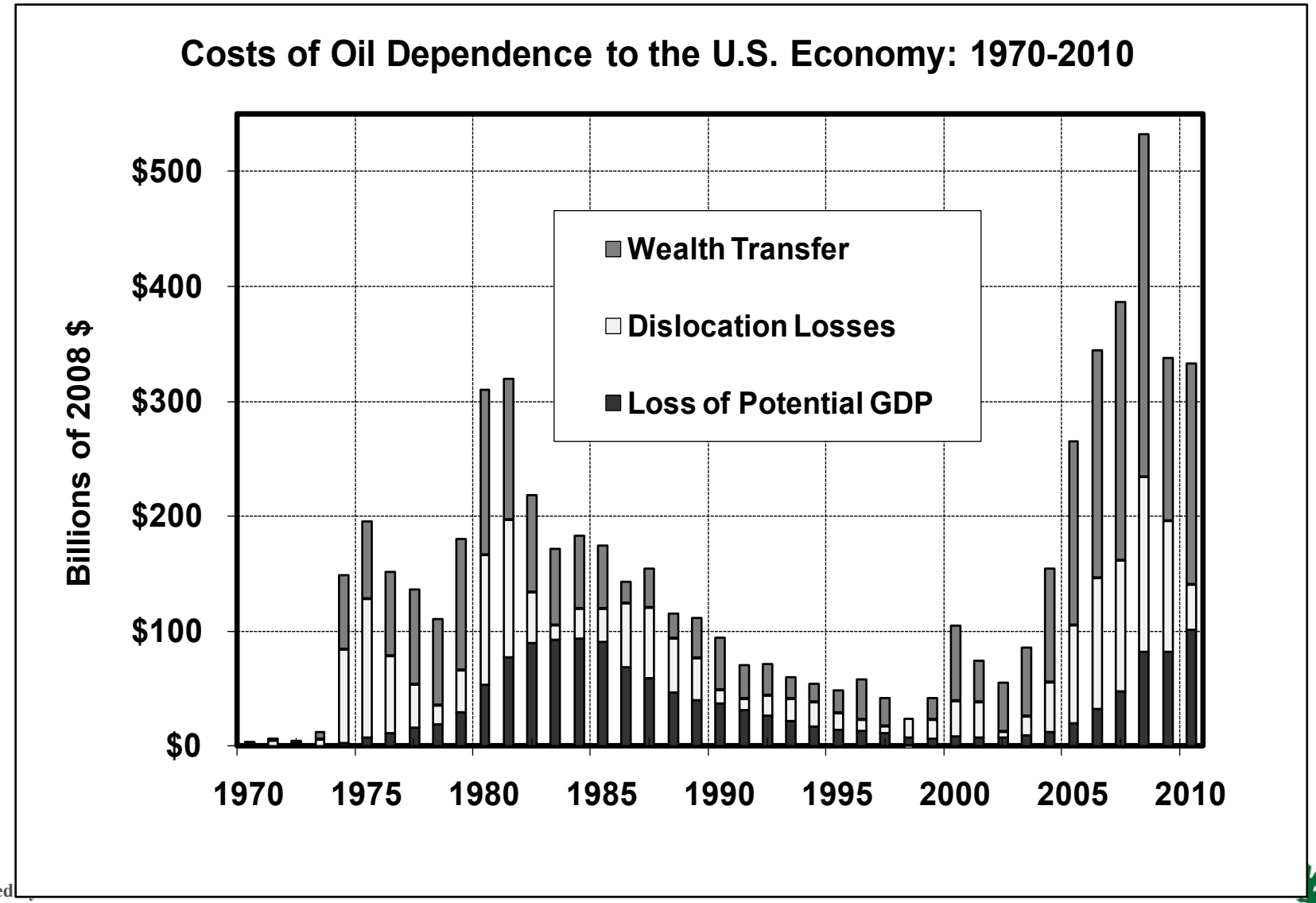
Technical Accomplishments : Oil dependence cost the US about $500 billion in 2008 and about $3 trillion from 2005 to 2010.



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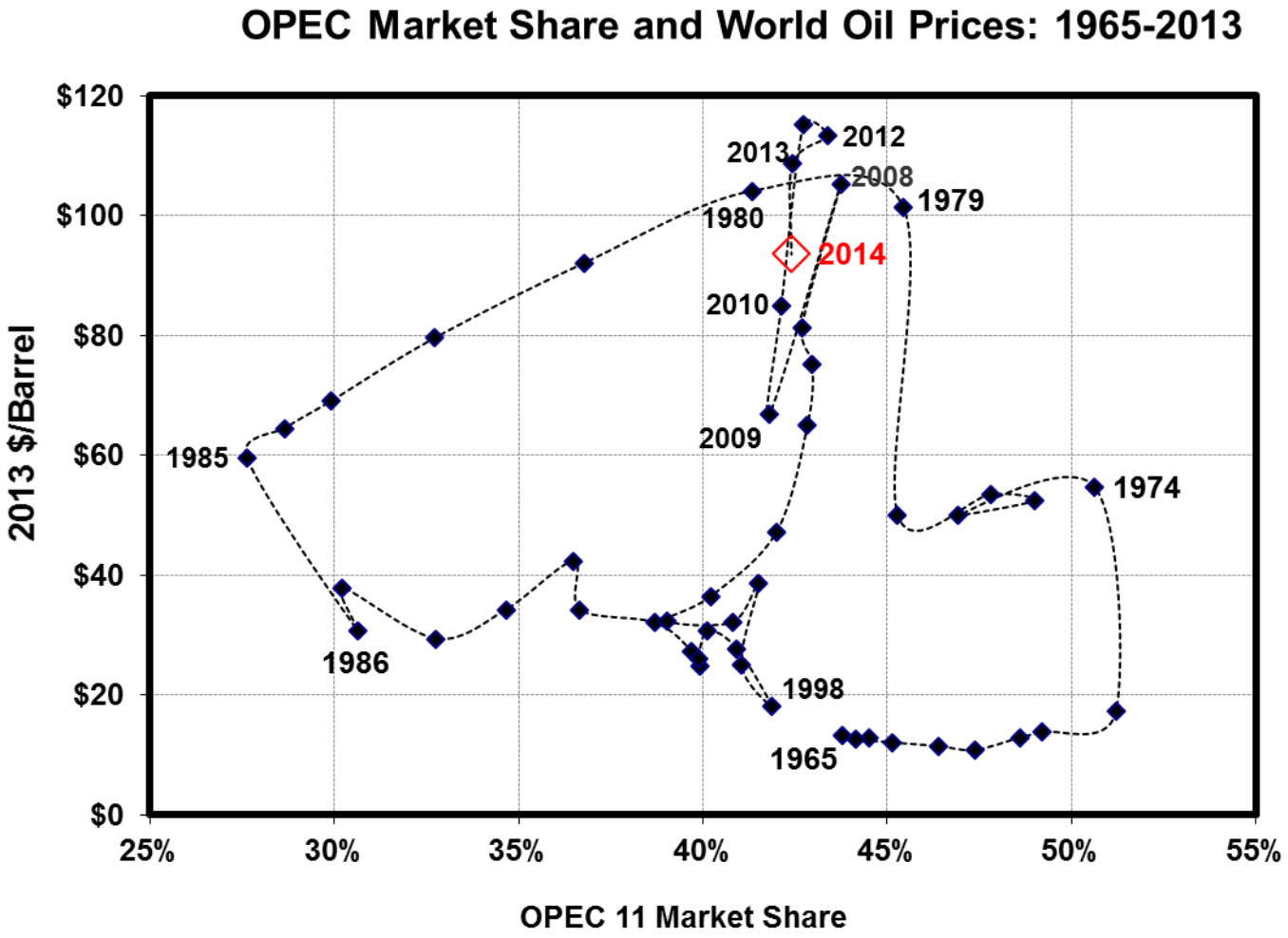
Technical Accomplishments

The relationship between oil prices and OPEC's market share is very different today than it was from 1979 to 1985.



Source: *BP Statistical Review of World Energy 2014*. "Oil Production - barrels" and "Oil - crude oil prices since 1861".

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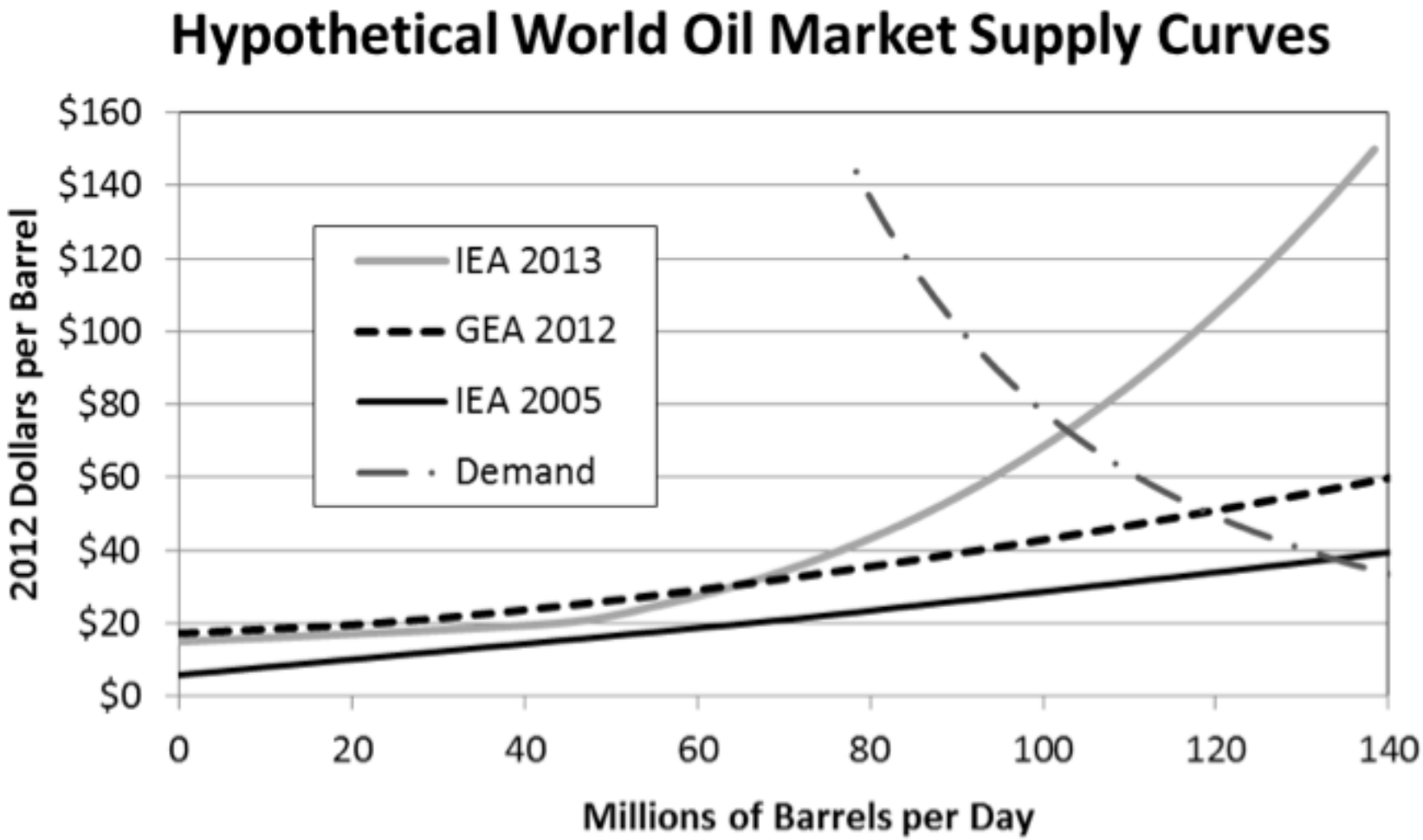
Technical Accomplishments

Recent assessments of counterfactual, competitive world oil prices indicate a substantial increase to $40-$70/bbl.



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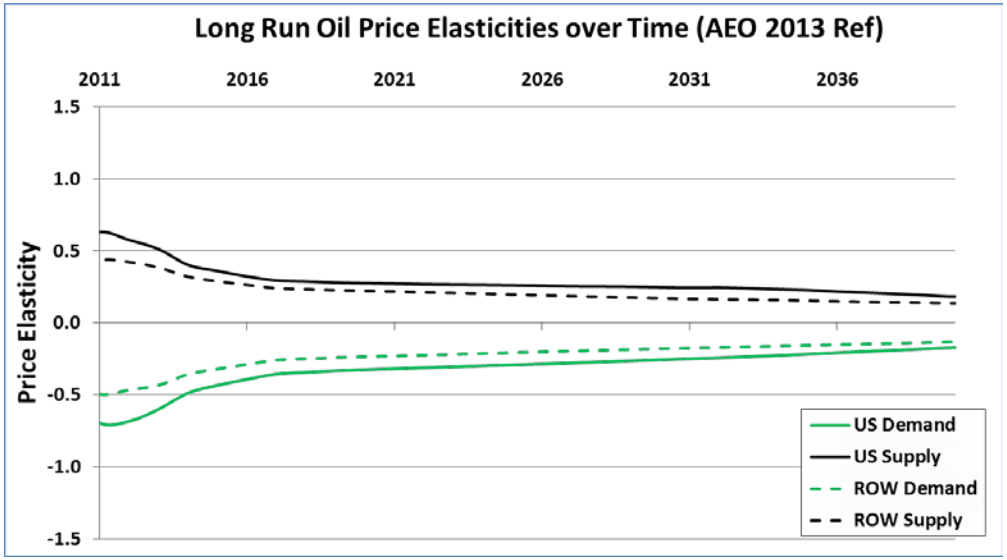
Model improvement considers the new dynamics of oil market: reduced price responsiveness of oil supply and demand.

- Peaking of conventional oil implies it is more difficult and more costly to find and produce oil outside of OPEC.
- Environmental concerns and regulations will make the increase of supply more slow and costly.
- Demand has become concentrated in less price sensitive sectors (i.e., transportation).
- Demand has shifted towards less price sensitive economies (i.e., non-OECD countries).

Long run price elasticities are revised to be consistent with recent literature estimates (Dagay and Gately,2010; Baumeister and Peersman,2013)



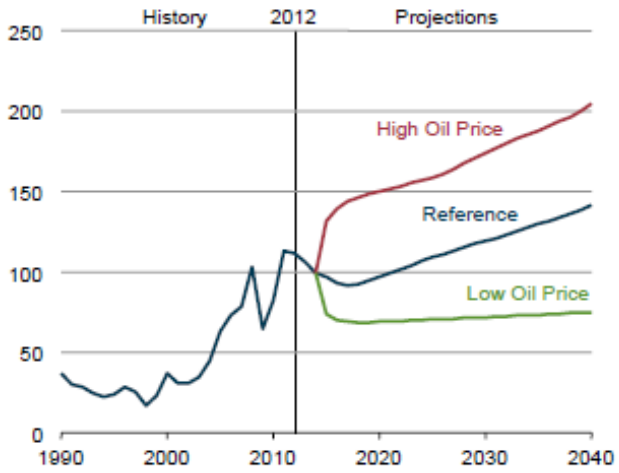
References: J.M. Dargay and D. Gately, 2010, *Energy Policy*, v. 38, pp. 6261-6277; C. Baumeister and G. Peersman, 2013. *J. Applied Econometrics, v. 28, pp. 1087-1109.*

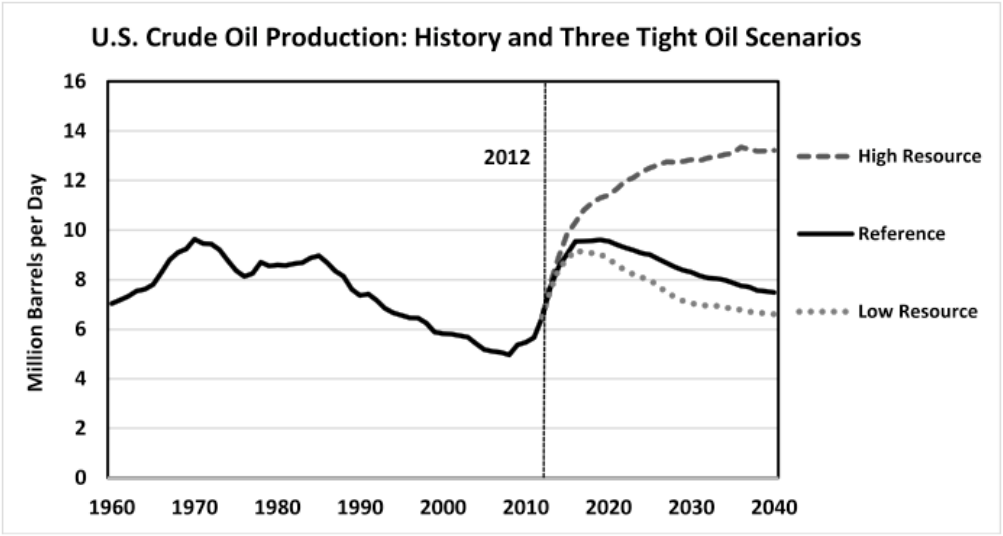
Using OSMM to estimate changes in future oil dependence costs

- 3 supply regions: US, OPEC, Rest-of-World
- 2 demand regions: US, ROW
- Price elasticities are inputs
- Supply & Demand calibrated to AEO 2014

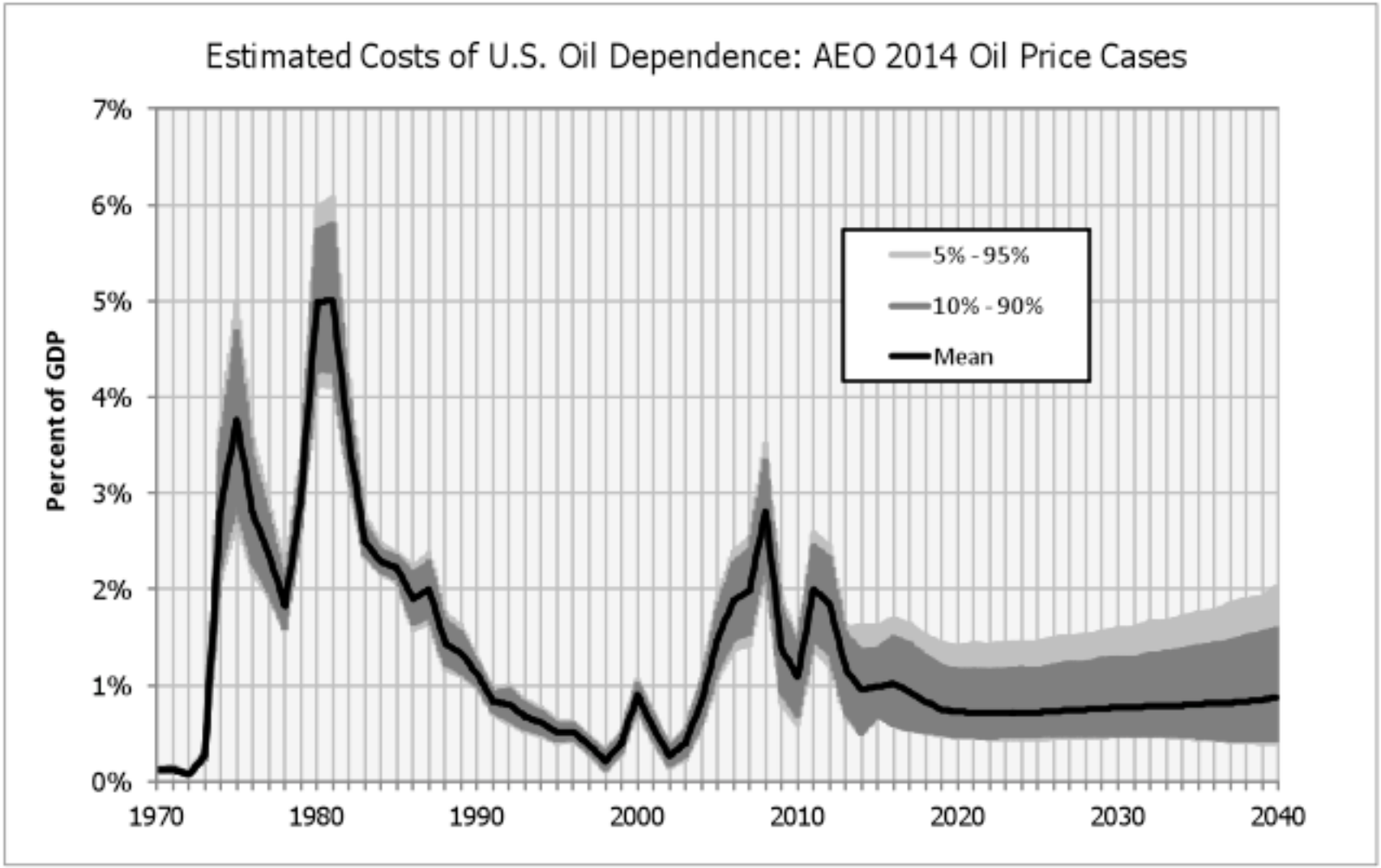
- Oil supply/price shocks simulated
- Uncertainty represented by:
  - Alternative Oil Price Cases: high oil price, reference, low oil price, and high resource
  - Probability distributions of parameters

Figure MT-4. North Sea Brent crude oil spot prices in three cases, 1990-2040 (2012 dollars per barrel)

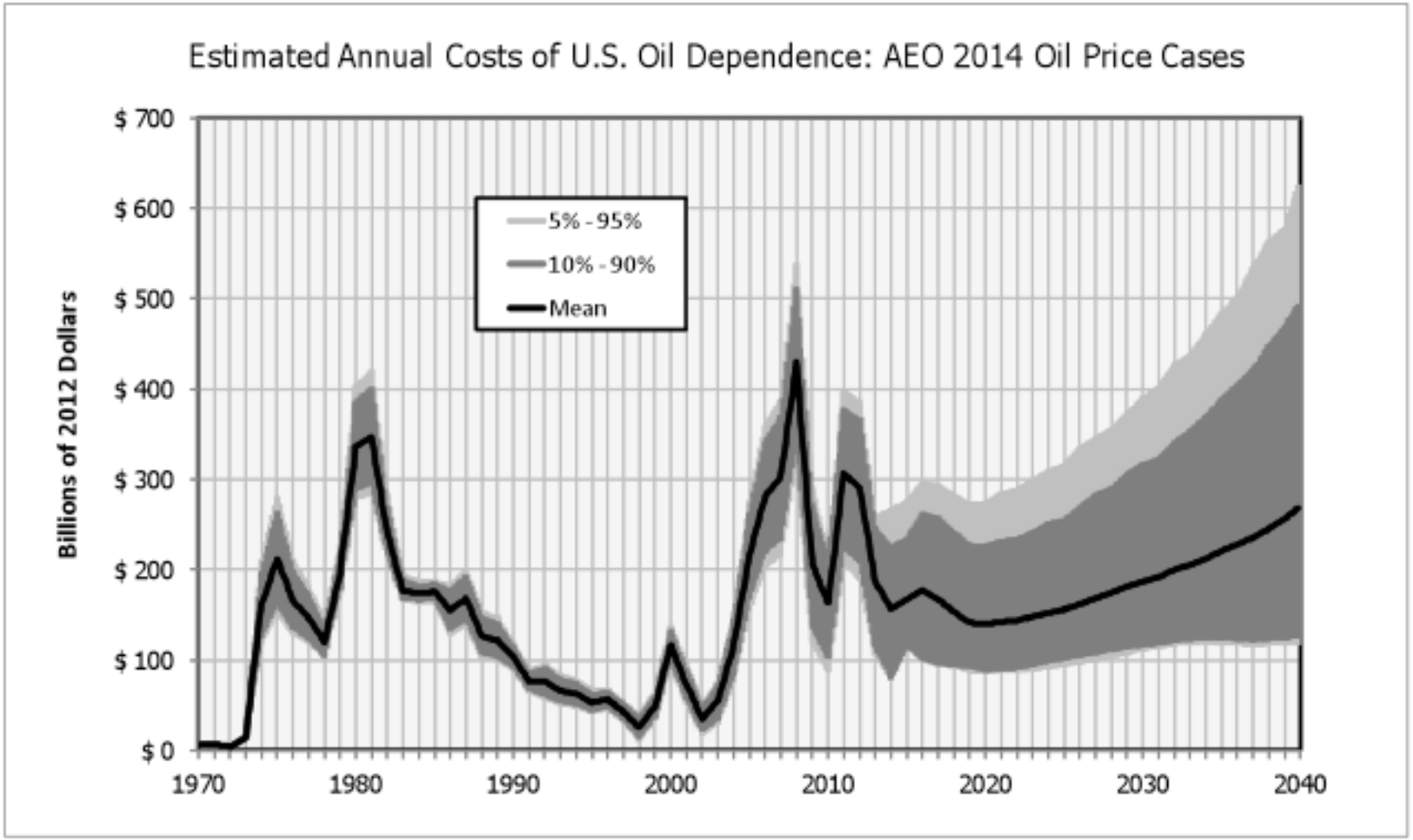




Reduced oil dependence + GDP growth indicate oil dependence costs will be a smaller % of GDP.



In constant dollars, however, oil dependence costs are likely to continue to be hundreds of billions per year.



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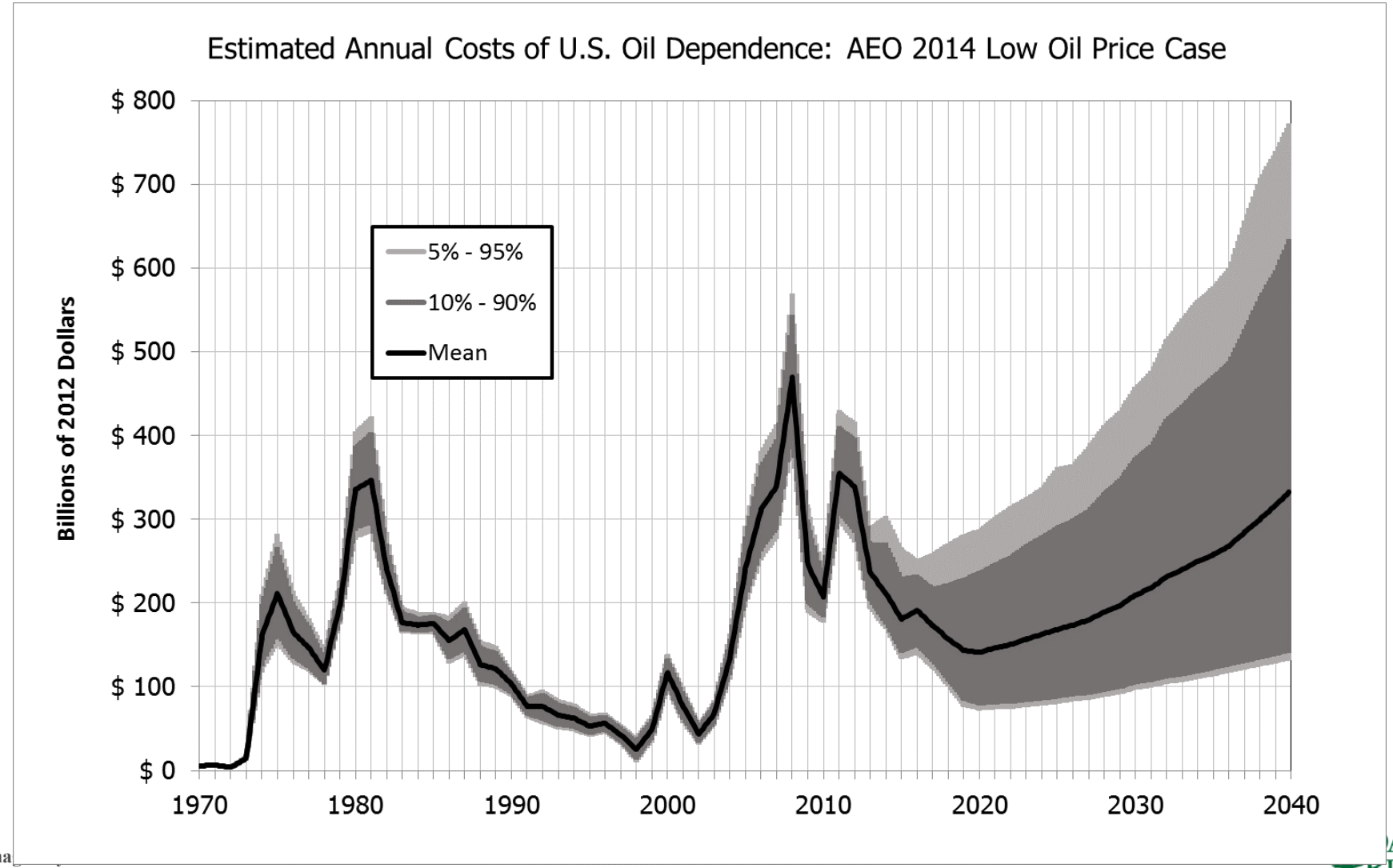
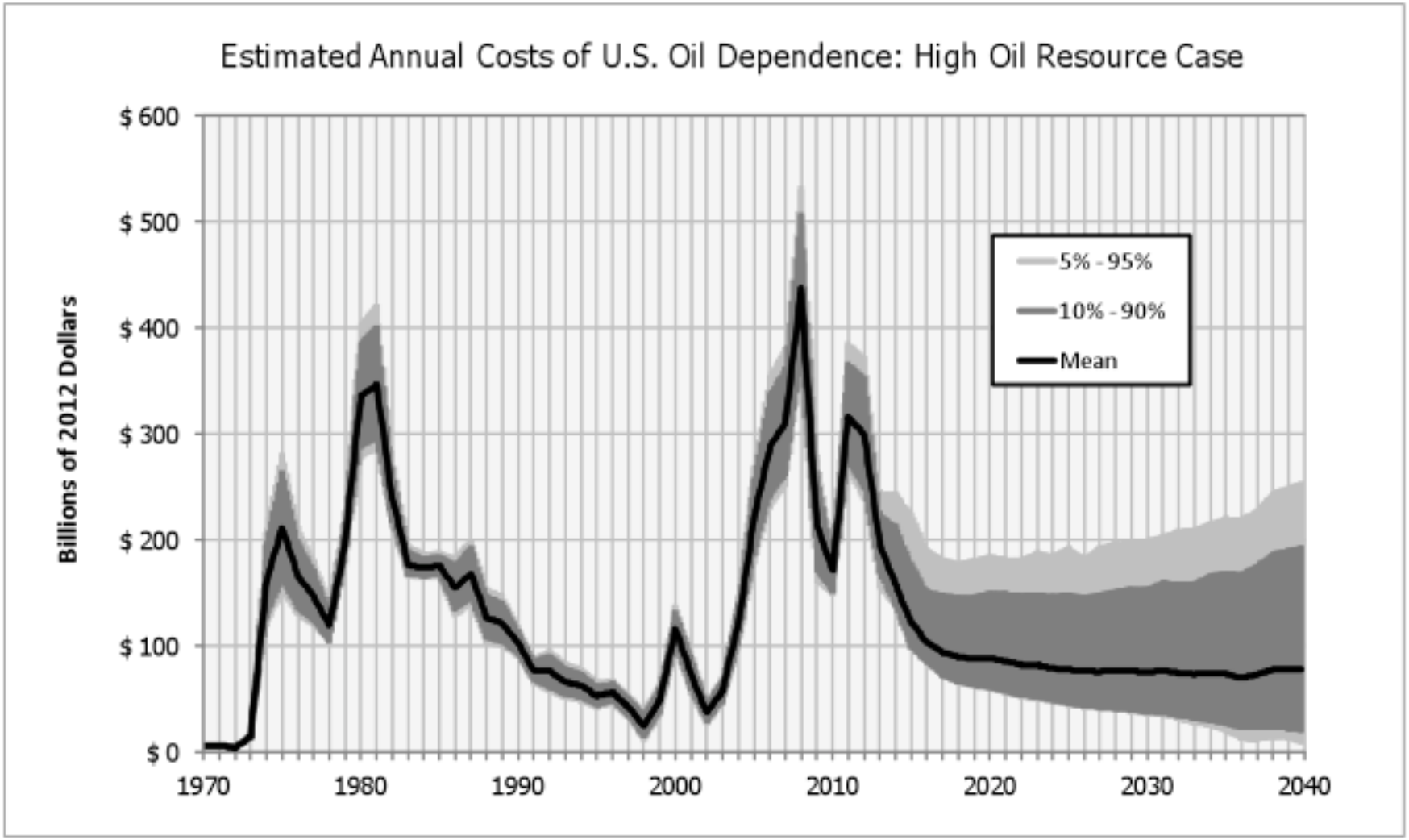
Technical Accomplishments

Counter-intuitively, perhaps, the distribution of costs is not lower in the Low Oil Price Case because of the greater potential for large price shocks and increased imports



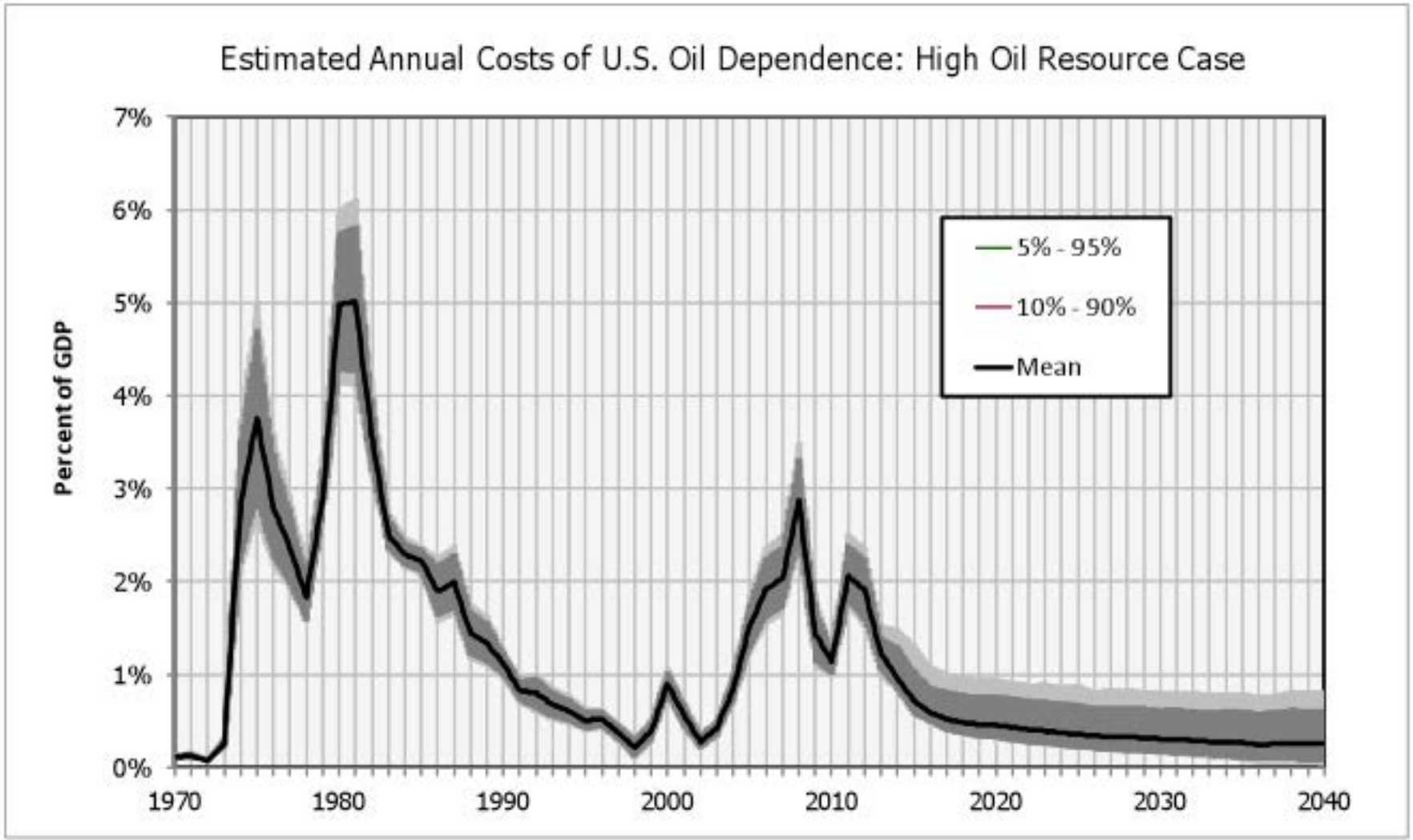
If US oil resources are much greater than the EIA expects, oil dependence costs will be lower even in constant dollars.



Technical Accomplishments

US oil dependence costs in the high oil resource case satisfy one definition of energy independence:

Less than 1% of GDP with 95% probability.



Direct economic costs of U.S. Oil dependence will likely continue to be on the order of hundreds of billions of dollars per year.

- *Unless* US oil resources are much larger than estimated by the EIA.
- But smaller in relation to GDP.
- Not highly sensitive to the AEO Oil Price Case.
- Lower US oil imports reduce US oil dependence costs.
- Reduced price elasticities and increased production costs outside of OPEC increase costs.
- Reducing oil dependence will likely continue to be an important co-benefit of GHG mitigation.

COLLABORATION AND COORDINATION

The progress of the OSMM project benefits greatly from collaboration with many partners.

- **David Greene, University of Tennessee, model development and policy analysis**
- **Paul Leiby, Oak Ridge National Laboratory, model development**
- **Janet Hopson, University of Tennessee, update of the model and data**
- **Tom Stephens, Argonne National Laboratory, analyzing the impact of VTO program on oil security**

PROPOSED FUTURE WORK

- **Remainder of FY2015**
  - **Revise the paper submitted to Energy Policy by responding to review comments**
  - **Design the plan to develop a graphic user interface for the model**
- **FY2015**
  - **Continue model update and enhancement**
  - **Develop a graphic user interface for the model**
  - **Assess the impacts of VTO technology penetration scenarios**
  - **Publish analysis of the outlook for US oil dependence and potential impacts of transition to electric and fuel cell vehicles.**

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Summary

- **Relevance:** The OSMM project tracks and explains oil dependence costs and measures the energy security benefits of vehicle technologies and alternative fuels.
- **Objective in FY15**: Reassess the outlook of US oil dependence given resurgent US oil supply and new world oil market dynamics
- **Technical Accomplishments in FY 15:**
  - Calibration to AEO 2014
  - OPEC market share – world oil price graph update
  - Price elasticities revision
  - competitive oil prices update
  - Oil price shock simulator improvement
  - Estimated US oil dependence cost
  - Published a ORNL report that documents the model
  - Submitted a paper to Energy Policy
- **Future work** will estimate the benefits of advanced vehicle technologies , transitions to alternative fuels and develop a graphic user interface.

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Thank you!

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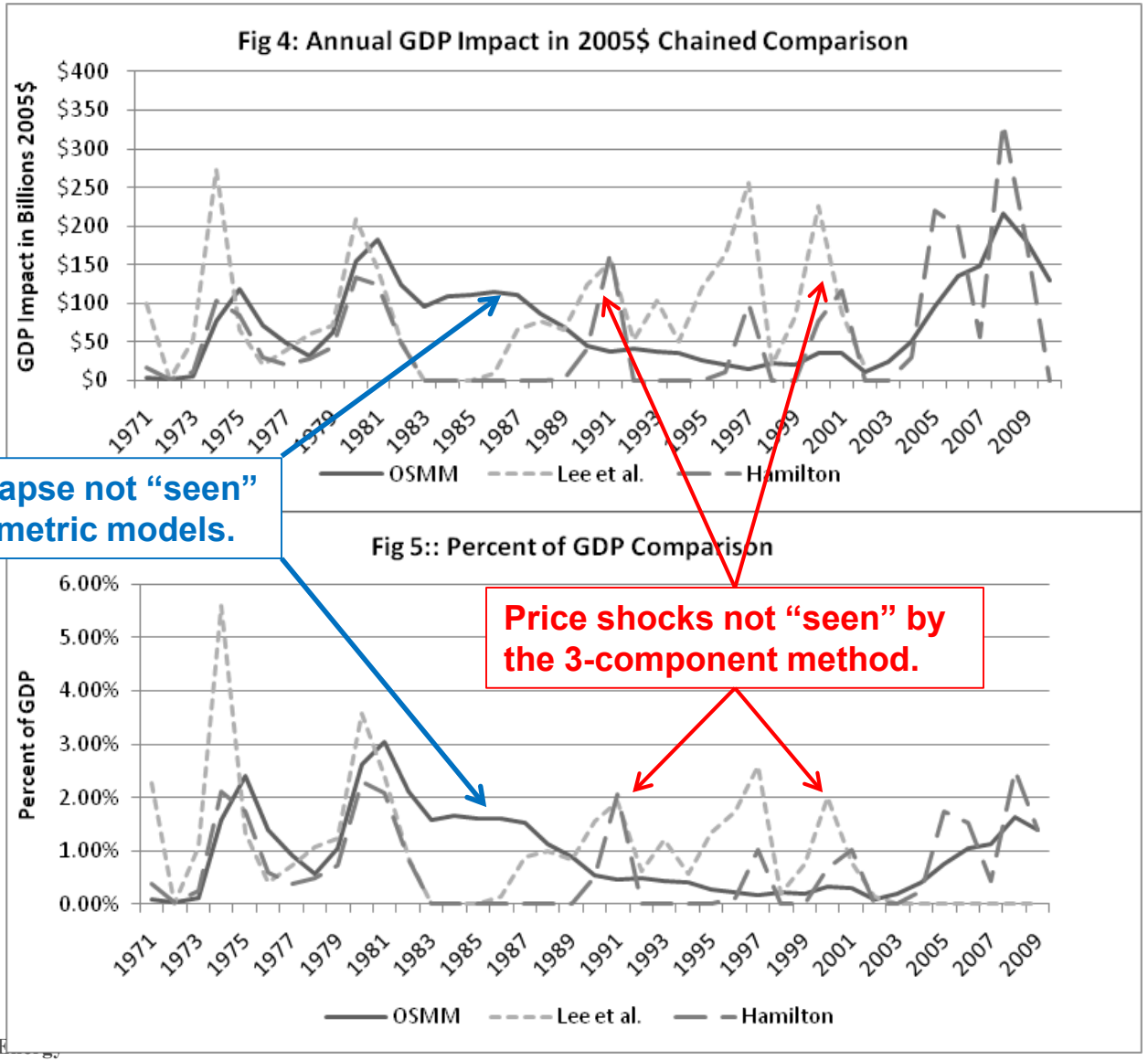
Recent Publications and Presentations

- Greene, D. L., and C. Liu (2015). The Outlook for U.S. Oil Dependence 2014: Is Energy Independence in Sight? Submitted to Energy Policy
- Greene, D.L., C. Liu, P.N. Leiby (2014). The Oil Security Metrics Model: 2014 Update, ORNL/TM-2014/628, Oak Ridge National Laboratory, Oak Ridge, Tennessee, September, 2015.
- D.L. Greene, R.S. Lee and J.L. Hopson, 2013. "OPEC and the Costs to the U.S. Economy of Oil Dependence: 1970-2010, White Paper 1-13, Howard H. Baker, Jr. Center for Public Policy, University of Tennessee.
- D.L. Greene, 2013. "The Future of Energy for Transportation: Why a Transition?", presentation to the Executive Committee of the Transportation Research Board, National Academy of Sciences, Washington, DC, June 20, 2013.
- D.L. Greene, 2013. "The Future of Energy and the Automobile: How Will It Go?", presentation to the SAE 2013 Hybrid and Electric Vehicle Technologies Symposium, Anaheim, California, February 19, 2013.
- D.L. Greene, 2013. "The Future of the World Oil Market", presentation to the International Subcommittee of the Energy Committee of the Transportation Research Board, at the Annual Meeting, Washington, D.C., January 15, 2013.
- D.L. Greene, 2012. "The economics of US oil dependence and implications for public policy", lecture at The Kennedy School, Harvard University, October 22, 2012.

Approach: The OSMM 3-component method estimates compare reasonably well with some well-known econometric models.



Price collapse not "seen" by econometric models.

Price shocks not "seen" by the 3-component method.

Critical Assumptions and Issues

- **The OSMM relies on critical assumptions of price elasticities of oil supply and demand, as well as the counterfactual competitive oil prices. The approach we take is to survey the literature and take consensus estimates.**
- **Recognizing that estimates of key parameters vary among literature work, the OSMM is designed to have the capability of running Monte Carlo simulation for sensitivity analysis.**

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