

Peer Review for the Report,
“How Consumers Value Fuel Economy:
A Literature Review”

Peer Review for the Report, “How Consumers Value Fuel Economy: A Literature Review”

Assessment and Standards Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency



March 30, 2010

MEMORANDUM

SUBJECT: Peer Review for David Greene paper, "How Consumers Value Fuel Economy: A Literature Review"

FROM: Gloria Helfand, Assessment and Standards Division
Office of Transportation and Air Quality, U.S. Environmental Protection Agency

In December 2009, EPA contracted with RTI International (RTI) to conduct a peer review of a literature survey conducted by David Greene of Oak Ridge National laboratory. The draft study, titled "How Consumers Value Fuel Economy: A Literature Review," looked at 22 papers that, in some fashion, provided quantitative estimates of the role of fuel economy in consumer vehicle purchase decisions.

The three peer reviewers selected by RTI were Drs. Carolyn Fischer of Resources for the Future, Christopher Knittel of the University of California at Davis, and Walter McManus of the University of Michigan. EPA would like to extend its appreciation to all three reviewers for their efforts in evaluating this survey. The three reviewers brought useful and distinctive views in response to the charge questions.

The first section of this document contains the final RTI report summarizing the peer review of David Greene's literature survey, including the detailed comments of each peer reviewer and an overview of the most significant comments compiled by RTI. The RTI report also contains the peer reviewers' resumes, the charge letter, and cover letters from each reviewer explaining any real or perceived conflicts of interest. The second major section contains our responses to the peer reviewers' comments. In this section, we repeat the summarized comments provided by RTI and, after each section of comments, provide our response. We have retained the organization reflected in RTI's summary of the comments to aid the reader in moving from the RTI report to our responses.

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II.. EPA's Response to Peer Review Comments

TO: Kent Helmer, Gloria Helfand, U.S. Environmental Protection Agency, Office of Transportation and Air Quality (OTAQ)

FROM: Paramita Sinha, RTI

DATE: February 26, 2010

SUBJECT: Peer Review of EPA's Study of Vehicle Choice Models for Estimating Impacts of Fuel Economy

1. Background

The U.S. Environmental Protection Agency's (EPA's) Office of Transportation and Air Quality (OTAQ) is involved in exploring the regulation of CO₂ and other greenhouse gas (GHG) emission control measures in motor vehicles and equipment. An important component of the costs of such regulations is the cost of improved technology, while the benefits include, among others, the value of reduced fuel consumption. Understanding the role of fuel economy in consumer vehicle purchases will contribute to EPA's assessment of the impacts of its rules on vehicle sales.

EPA is assessing the use of consumer vehicle choice models to analyze the impacts of regulatory programs that affect fuel economy. Coefficients from discrete choice models of consumer vehicle choice are typically used to estimate the value of improving fuel economy. Other studies use hedonic price methods. These vehicle choice models could help EPA anticipate market responses to vehicle regulations and thus judge the effectiveness of regulations.

EPA is analyzing a set of existing consumer vehicle choice models to see whether there is a robust estimate of the value of additional fuel economy to consumers. EPA is seeking a peer review of its comparative study of consumer vehicle choice models and what each model may predict for the value of improving vehicle fuel economy at the time of vehicle purchase. This report contains documentation of the peer review process for the vehicle choice study.

Section 2 of this memorandum provides a description of the process for choosing reviewers, administering the review process, and closing the peer review. Section 3 contains an overview of the comments made by the panel of reviewers. The appendices to this memorandum provide the resumes of the reviewers; charge letter to the peer reviewers, which describes their task and what was

requested from them in terms of deliverables; and the cover letters and review comments from the panel.

2. Description of Review Process

In December 2009, EPA's OTAQ contacted RTI International to facilitate the peer review of EPA's study of vehicle choice models for estimating impacts of fuel economy regulations. This study, authored by David L. Greene, is entitled "How Consumers Value Fuel Economy: A Literature Review."

EPA provided a short list of subject matter experts from academia and industry (Appendix A of the performance work statement) to RTI, and this served as a "starting point" from which we assembled the list of peer reviewers. RTI selected three independent (as defined in Sections 1.2.6 and 1.2.7 of EPA's *Peer Review Handbook*) subject matter experts to conduct the requested reviews. Subject matter experts familiar with economic valuation, discrete choice models and the use of these models for valuation, and the use of these models for predicting automobile purchases were selected.

To ensure that the review process was conducted in a timely manner, RTI contacted potential reviewers within a week of submitting the work plan and determined that each reviewer would be able to perform work during the period of performance. To make the review process as credible as possible, RTI did not consult the Agency in the final determination of reviewers. RTI obtained the resumes of the selected reviewers, and these are included in Appendix A.

RTI provided the panel reviewers with the final edited version of the analysis that each subject matter expert was expected to review along with a set of charge questions (both provided by EPA) in the first week of January.¹ The memo from RTI to the reviewers with the charge questions is included in Appendix B of this report.

A teleconference between EPA, the reviewers, and RTI was organized to provide an opportunity to the panel to discuss any questions or concerns they may have regarding the material provided and expected deliverables. Completed reviews from the panel were sent to EPA by the requested date. These reviews included the response to the charge questions and any additional comments the reviewer may have had (e.g., margin notes on review materials). From each reviewer, RTI

¹ Upon request from one of the reviewers, EPA provided RTI with two examples of previous peer reviews, and these were subsequently forwarded to them. These are entitled "Peer Review for the RTI Report, Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers (Assessment and Standards Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, June 2009, EPA-420-R-09-004) and "Review: Vehicle Greenhouse Gas Emission (VGHG) Emissions Cost and Compliance Model (Jonathan Rubin, January 2010).

obtained a cover letter stating the reviewer's name; the name and address of their organization if applicable; a list of review documents/media received by the reviewer and which were actually reviewed; and a statement of any real or perceived conflict(s) of interest. The cover letters and reviews are included in Appendices C and D, respectively.

3. Summary of Review Comments

Carolyn Fischer (Resources for the Future), Christopher Knittel (Department of Economics, University of California at Davis), and Walter McManus (University of Michigan, Transportation Research Institute) reviewed "How Consumers Value Fuel Economy: A Literature Review." This section provides a summary of the comments received from them.

3.1 OVERALL APPROACH AND METHODOLOGY OF THE STUDY

The reviewers are supportive of the overall approach and methodology.

Walter: "The overall approach and methodology are within the mainstream of critical review practice in economics, and the execution is unexceptionable." He does comment on the fact that "Greene (2009) adopts a conventional 'literature review' approach" and "both the conventional approach to reviewing economic research and the conventional approach to economic research itself do not give much help to decision makers who are understandably made uncomfortable by the widely differing expert opinions about parameters that are crucial in predicting the impacts of regulations and in choosing between alternatives. An overall critique of conventional practice is beyond the scope of this review. However, I do have some suggestions for improvements in the methodology for comparing studies and for dealing with the lack of consensus in expert opinions. (The References section below lists some papers by Edward E. Leamer, a professor at UCLA, in which a critique of conventional practice is developed along with alternative practices that would enhance the usefulness of economic research to policy makers.)"

Chris comments that the study does not discuss "*why* consumers undervalue gasoline, relative society (if they do indeed undervalue fuel economy). This has important implications for which policies are most effective at aligning discount rates." However, he recognizes that papers dealing with such issues are lacking.

3.2 APPROPRIATENESS OF THE DATASETS AND ANY OTHER INPUTS

One reviewer commented that the choice of the papers was comprehensive. Another reviewer recommended including some explanation of how the studies were selected for inclusion in Greene (2009).

3.3 DATA ANALYSIS CONDUCTED FOR THE STUDY

Two reviewers comment on the fact that the type of analysis done for the different papers varies greatly.

Chris: “It strikes me that there are two ways to conduct a review such as this. One is to report the results of papers with little, or no, discussion of the quality each paper. The other is to both review and critique each paper. I found a lack of uniformity in this regard. For many of the papers, the latter strategy is taken. The report discusses key weakness of these papers. Still many papers are simply summarized, with little or no discussion of their strengths or weaknesses. This gives the impression that the results in these papers are more accurate. This may actually be the case, but if it is, this should be stated more explicitly.

For example, the first paper (Alcott and Wozny) is simply summarized with no editorializing. One possibility is that there are no weaknesses in this paper. But, many of the issues raised later for other papers also relate to this paper. For example, the report correctly states, when discussing the Sawhill paper, that in order to get a consistent estimate of how consumers value fuel economy, the author is required to correctly specify how consumers form expectations about gas prices and drive their vehicles. If any of these are incorrectly specified, the estimate will be biased. The same is true for the Alcott and Wozny paper. While I find Alcott and Wozny’s specification for how expectations are formed to likely be more accurate, ironically, they assume consumers are hyper-rational in the sense that they form their gas price expectations based on NYMEX futures prices. In some ways the myopia result is inconsistent with this key assumption.”

Walter: “It is difficult for the reader to verify that the same standards are being used to assess each paper, especially since the amount of discussion by paper varies greatly. This leads the reader to have less confidence in the reviewer’s opinions of the individual studies (that this or that one had plausible or implausible assumption, methodologies, or results).”

3.4 APPROPRIATENESS OF THE CONCLUSIONS DRAWN

There was general consensus among the reviewers on the major conclusion of the document: that the literature remains mixed as to whether consumers undervalue, overvalue, or approximately value fuel economy.

One reviewer raised doubts that differences in assumptions, opinions, and methods have been sufficiently examined to support even the weak proposition that “there do not appear to be clear associations among methods or data sources and the resulting inferences.”

One reviewer expressed doubts about what Greene means by “incorrect models” of consumer decision making about fuel economy but suggested efficient markets hypothesis and economic rationality to be a possible interpretation of this phrase.

3.5 RECOMMENDATIONS FOR ALTERNATE DATA AND/OR ANALYSES

3.5.1 Additional Data

Two of the reviewers suggested several other studies that are relevant for this work. A list of these studies is provided below.

Dreyfus, Mark K. and W. Kip Viscusi (1995). “Rates of Time Preference and Consumer Valuations of Automobile Safety and Fuel Efficiency.” *Journal of Law and Economics* 38: 79-98.

Hughes, Jonathan E., Christopher R. Knittel and Daniel Sperling (2008). “Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand.” *Energy Journal*.

Kilian, Lutz and Eric Sims (2006). The Effects of Real Gasoline Prices on Automobile Demand: A Structural Analysis Using Micro Data, Working Paper, University of Michigan (April).

Klier and Linn (2010 working paper) “The Price of Gasoline and New Vehicle Fuel Economy: Evidence from Monthly Sales Data”

Klier, Thomas, and Joshua Linn (2008). “The Price of Gasoline and the Demand for Fuel Efficiency: Evidence from Monthly New Vehicles Sales Data.” Working Paper, University of Illinois at Chicago (September).

Sallee and West (2009 working paper)

Sallee, James, and Sarah West (2008). "Testing for Consumer Myopia: The Effect of Gasoline Price Changes on the Demand for Fuel Economy in Used Vehicles." Working Paper, Macalester College (December).

West, S. (2008). "The Effect of Gasoline Prices on the Demand for Sport Utility Vehicles." Working Paper. Macalester College.

3.5.2 Additional Analysis

The reviewers suggested several additional analyses to strengthen the study.

3.5.ii a. The author should take advantage of the summary section to indicate whether some approaches reviewed in the study are likely to be better than others.

3.5.ii b. The analysis to explain the difference in results could be improved.

Carolyn: "First, the discussion interweaves reasons that could explain why we can plausibly believe any of a range of results (e.g., heterogeneous decision rules, uncertainty) with reasons for why different studies get different results. It would be helpful to separate these discussions, reminding readers of the former, and then focusing on the latter, which is the most important contribution. This kind of analysis should help indicate best practices and directions for future research. Can we suggest some experiments (e.g., new techniques on old data sets, or old techniques on new data sets) that can help tease out what differences arise from alternative econometric approaches? If most studies have focused on other aspects of vehicle demand, are there better specifications for looking directly at the valuation of fuel economy?"

A summary of key differences in approaches and data and an analysis of their consequences would be useful. These would include

- levels of aggregation;
- time horizons (how useful is information from the 1970s in estimating current demand?);
- incorporation of the supply side;
- details of other attributes and variable definitions;
- allowing for separate responses to MPG and fuel costs (this was raised as lacking in the discussion of Gramlich, but it was not apparent which other studies had done this);
- assumptions of vehicle lifetime, VMT, discount rates, etc.; and
- econometric approach.

Although Table 10 provides some of these summary indicators (model type, data, and time), additional analysis such as the following would be useful: “Do we observe any trends across classes or time? Within a class of models, what drives the differences?”

Walter: “It would be useful to expand Table 10 (or to create a set of tables) to show other differences that could be important sources of differences in estimates. The items that could be included would show differences in:

1. Maintained assumptions reported (assumptions that are maintained across any alternative specifications or sensitivities),
2. Reported sensitivity analyses (is one done? which assumptions are varied? how widely?),
3. Econometric challenges and approaches used to address them (Greene (2009) appears to discuss these comprehensively in the text.), and
4. Out-of-sample predictive performance (are predictions made? about what? are the predictions compared to actual outcomes? how accurate are the predictions?).

Adding these additional side-by-side comparisons would increase the reader’s confidence that the same standards are being used to form the reviewer’s opinions about the relative usefulness of each paper to inform decision making by EPA.

My opinion: The additional elements are responsible for more of the variation in the estimates of consumer value for fuel economy than are the elements already included in Table 10.”

He also suggested a measure of researcher/specification uncertainty and disagreement to quantitatively assess whether we have made progress toward a consensus. He also provides illustrative suggestions on ways to use and interpret this measure. “The idea is to compare the range of parameter estimates to the parameter value predicted by mainstream theory.”

The metric is called Multiple Extreme Estimates Test (MEET) and is defined as the ratio of the value predicted by theory to the difference between the two extreme estimates.

$$MEET = \frac{|\text{Value Predicted by Theory}|}{|\text{Largest Estimate} - \text{Smallest Estimate}|} = \frac{V}{R}$$
$$\lim_{R \rightarrow \infty} MEET = 0 \quad \text{and} \quad \lim_{R \rightarrow 0} MEET = \infty$$

“Numerically, MEET measures the predicted value as a share of the range of expert opinion. The range of expert opinion, R, is a crude and partial measure of the uncertainty or fragility of the estimates due to differences in assumptions, specification, and opinions between researchers. The metric MEET views this fragility compared to the theoretical value of the parameter, V.”

- 3.5.ii.c. Though the issue of consumer heterogeneity has been mentioned in several places, this may be important area for additional analysis, both to explain differences and to suggest future research directions.

3.6 OVERALL CLARITY OF THE PRESENTATION

The reviewers agreed that the overall clarity of the document was high.

Reviewers had several suggestions about organizing the paper.

- i. One reviewer suggested that since the articles are organized logically by class of data and methods, it would be helpful to review those methods at the beginning of each section “including the advantages and drawbacks, as well as key factors or assumptions that can affect the results.”
- ii. It has also been suggested that it would be helpful to begin with the seminal papers in each category, “so as to understand the evolution and improvements made subsequently.”
- iii. Two reviewers agreed that the publication status of papers should be recognized and one reviewer suggested that the review should “focus first on published papers and then second on unpublished papers.”
- iv. Chris Knittel: “Many of the papers reviewed did not focus on measuring the implicit discount rate, or even on the issue of how gas prices affect vehicle demand. If a paper did not focus on either of these two questions, it is difficult to gauge the robustness of their results with respect to these questions, the quality of the variation in gas prices in the data, etc. Perhaps a better method would be to first focus on those papers where gas prices and vehicle choice are the central research question, and those papers where this is more a tangential part of the analysis.”

On a related note, another reviewer commented on studies that do not explicitly estimate the value of fuel economy: “Since few econometric studies have explicitly estimated the value of fuel economy, a significant contribution of the paper is to translate a wide variety of results into more consistent indicators. Yet, they could still be more consistent. In Table 10, can all of the results be converted into the same WTP metric, preferably using the same assumptions about vehicle lifespan, VMT, discounting, etc.?”

Another comment on the presentation of the paper was that “the author’s baseline assumptions need to be stated clearly early in the paper, so careful attention can be given throughout to assumptions that deviate from that baseline. Indeed, the statement made in the Allcott and Wozny analysis (‘Calculating the discounted present value of fuel costs requires a number of assumptions...’) should be made earlier in a general context, so that the variety and range of assumptions can be understood and explored.”

3.7 OTHER CLARIFICATION COMMENTS

One reviewer provided the following comments to clarify or rephrase certain statements.

1. The authors should “use the phrase ‘at *society’s* discounted expected value...’ (top of page 5) instead of ‘does the market value fuel economy improvements at the discounted expected value of future fuel savings over the lifetime of the vehicle, or less, or more?’”
2. The statement (on page 5) that “On the other hand, if consumers are myopic and consider only the first three years of fuel savings, for example, fuel economy standards can increase welfare even based solely on private costs and benefits” should be made clearer.
3. One of the reviewers comment on the statement on page 5 that “it is surprising that there is no basic research on how consumers consider fuel economy.” “This is a strange use of the term basic research, which I take to mean research on pure science. Does the author equate basic science with interviews? I have never heard basic science used in this manner.”

Two of the reviewers also provided several detailed comments on specific paper reviews, Section 2 of the document, and editorial comments and corrections to typographical errors.

4. References

Rubin, J. January 2010. “Review: Vehicle Greenhouse Gas Emission (VGHG) Emissions Cost and Compliance Model.”

U.S. Environmental Protection Agency, Office of Transportation and Air Quality, Assessment and Standards Division. June 2009. “Peer Review for the RTI Report, Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers. EPA-420-R-09-004.

Appendix A:
Resumes of Selected Reviewers

CAROLYN FISCHER

Resources for the Future
1616 P St., NW
Washington, D.C. 20036

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EDUCATION

University of Michigan, Ann Arbor, MI. 1991-97.

Ph.D. in Economics with fields in public finance and natural resource economics.
M.A. in Economics, 1993.

University of Pennsylvania, Philadelphia, PA. 1986-90.

B.A. in International Relations with honors (major Valedictorian) and Economics,
minor in French, magna cum laude.

PROFESSIONAL EXPERIENCE AND AFFILIATIONS

Resources For the Future, Washington, DC. 1997-present.

Senior Fellow. Indefinite appointment (tenure), 2004.

Fellow, CESifo Research Network, Energy and Climate Economics Area, 2009-present.

Board of Directors, Association of Environmental and Resource Economists, 2008-2010.

Editorial Board, *Resource and Energy Economics*, 2006-2009.

Leadership Committee for the Energy Collaborative Analysis Initiative, NREL, 2007-present.

Fellow, Center for Advanced Study at the Norwegian Academy of Science and Letters, with the group "Environmental Economics: Policy Instruments, Technology Development, and International Cooperation," 2005.

Johns Hopkins University, 1999. Instructor, Natural Resource and Environmental Economics.

Council of Economic Advisors, Washington, DC. 1994-95. Staff economist.

The WEFA Group, Philadelphia, PA. 1990-91. Economic analyst in World Service division.

SELECTED PUBLICATIONS

Current Work

Fischer, C. and T.P. Lyon (2009) "Competing Environmental Labels." RFF Working Paper.

Fischer, C. and C. Coleman (2009) "Imperfect Competition, Consumer Behavior, and the Provision of Fuel Efficiency in Light-Duty Vehicles"

Fischer, C. and A. K. Fox (2009) "Comparing Policies to Combat Emissions Leakage: Border Tax Adjustments versus Rebates" RFF DP 09-02. (under review at *JEEM*)

Fischer, C. and A. K. Fox (2009) "Combining Rebates with Carbon Taxes: Optimal Strategies for Coping with Emissions Leakage and Tax Interactions" (under review at *JPubE*)

Fischer, C. and R. Morgenstern (2008) "Metrics for Evaluating Policy Commitments in a Fragmented World: The Challenges of Equity and Integrity" Discussion Paper 08-17, Harvard Project on International Climate Agreements.

Fischer, C. and T. Sterner (2008) "Climate Policy, Prudence, and the Role of Technological Innovation." (under review at *JEEM*)

Journal Articles

- Fischer, C. (forthcoming) “Does trade help or hinder the conservation of natural resources?” *Review of Environmental Economics and Policy*.
- Fischer, C. (forthcoming) “When Do Renewable Portfolio Standards Lower Electricity Prices?” *The Energy Journal* 30 (4).
- Fischer, C., R. Morgenstern, and E. Herrnstadt (forthcoming) “Understanding Bias in EIA Forecasts of Energy Demand.” *The Energy Journal*.
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- Fischer, C. (2005) “On the Importance of the Supply Side in Demand-Side Management,” *Energy Economics*, 27 (1): 165-180.
- Margolis, M., J.F. Shogren and Carolyn Fischer (2005) “How trade politics affect invasive species control,” *Ecological Economics*, 52 (3): 305-313.
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- Fischer, C. (2004) “The Complex Interactions of Markets for Endangered Species Products,” *Journal of Environmental Economics and Management*, 48 (2): 926-953.
- Fischer, C., I.W.H. Parry and W.A. Pizer (2003) “Instrument Choice for Environmental Protection when Technological Innovation is Endogenous,” *Journal of Environmental Economics and Management* 45(3): 523-545.
- Fischer, C. (2001) “Read This Paper Later: Procrastination with Time-Consistent Preferences.” *Journal of Economic Behavior and Organization*, (46)3 pp. 249-269.

Recent Policy Briefs:

- Fischer, C. (2009) “Are Consumers or Fuel Economy Policies Efficient?” in Sperling, Daniel and James S. Cannon, Eds., *Reducing Climate Impacts in the Transportation Sector*. Springer.
- Fischer, C. and R.G. Newell (2008) “What’s the Best Way to Promote Green Power? Don’t Forget the Emissions Price.” *Resources*, Summer (169): 10-13.
- Fischer, C. and C. Egenhofer. (2008). “The Critical Role of Technology for International Climate Change Policy,” in *Beyond Bali: Strategic Issues for the international climate change negotiations*, Brussels, Belgium: CEPS; and Washington, DC: Brookings Institution.

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CURRENT APPOINTMENTS:

2006-present, Associate Professor of Economics, University of California, Davis

2008-present, Chancellor's Fellow, University of California, Davis

2007-present, Research Associate, National Bureau of Economic Research. Groups:
Environmental Economics and Energy, Industrial Organization, and Productivity

2003-present, Visiting Research Fellow, University of California Energy Institute

2005-present, Faculty Affiliate, Institute of Transportation Studies, UC Davis

2006-present, Strategy and Policy Thread Leader for STEPS

2006-present, Associate Editor, *The Journal of Industrial Economics*

2007-present, Associate Editor, *American Economic Journal – Economic Policy*

2007-present, Associate Editor, *The Journal of Energy Markets*

2008-present, Member, Economic and Allocation Advisory Committee for AB32's cap-and-trade program, State of California

PREVIOUS APPOINTMENTS:

2002-2006, Assistant Professor of Economics, University of California, Davis

2004-2007, Faculty Research Fellow, National Bureau of Economic Research. Groups:
Environmental Economics and Energy, Industrial Organization, and Productivity

1999-2002, Assistant Professor of Finance and Economics, School of Management, Boston University

1996-1999, Research Assistant, University of California Energy Institute

1994-1996, Teaching Assistant, University of California, Davis

EDUCATION:

Ph.D., University of California, Berkeley, 1999 (Economics)

M.A., University of California, Davis, 1996 (Economics)

B.A., California State University, Stanislaus, *summa cum laude*, 1994 (Economics and Political Science)

PUBLICATIONS:

- Knittel, Christopher R. and Jason J. Lepore. "Tacit Collusion in the Presence of Cyclical Demand and Endogenous Capacity Levels." Forthcoming in *The International Journal of Industrial Organization*.

- Stewart, Scott, John J. Neumann, Christopher R. Knittel, and Jeffrey Heisler. "Absence of Value: An Analysis of Investment Allocation Decisions by Institutional Plan Sponsors," *Financial Analyst Journal*, 65(6), November/December 2009.
- Knittel, Christopher R. and Victor Stango. "How Does Incompatibility Affect Prices?: Evidence from ATMs," *The Journal of Industrial Economics*, LVII(3), September 2009, pp. 557-582.
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- Kim, Dae-Wook and Christopher R. Knittel "Biases in Static Oligopoly Models? Evidence from the California Electricity Market," *The Journal of Industrial Economics*, LIV(4), December 2006, pp. 451-470.
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- Knittel, Christopher R. "Market Structure and the Pricing of Electricity and Natural Gas," *The Journal of Industrial Economics*, LI(2), June 2003, pp. 167-191.
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- Knittel, Christopher R. and Victor Stango. “Strategic Incompatibility in ATMs.” Revisions requested from *The Journal of Banking and Finance*.
- “The Implied Cost of Carbon Dioxide under the Cash for Clunkers Program” Revisions requested from *The BE Journal of Economic Analysis & Policy*.
- Busse, Meghan, Christopher R. Knittel and Florian Zettelmeyer. “Pain at the Pump: How Gasoline Prices Affect Automobile Purchasing.” *In submission*.
- Knittel, Christopher R. and Konstantinos Metaxoglou. “Estimation of Random Coefficient Demand Models: Challenges, Difficulties and Warnings.” *In submission*.
- Fowlie, Meredith, Christopher R. Knittel and Catherine Wolfram. “Sacred Cars: Optimal Regulation of Stationary and Non-stationary Pollution Sources.” *In submission*.
- Knittel, Christopher R. and Victor Stango. “The Productivity Benefits of IT Outsourcing.”
- Knittel, Christopher R., Douglas Miller, and Nick Sanders. “Caution, Drivers! Children Present. Traffic, Pollution and Infant Health”
- Huckfeldt, Peter, and Christopher R. Knittel. “Patents, Pharmaceutical Use and Pharmaceutical Prices”

AWARDS, HONORS, AND GRANTS:

- Chancellor’s Fellowship, UC Davis (one of five faculty members), 2008
- Barry D. McNutt Award for Excellence in Automotive Policy Analysis (with Jonathan Hughes and Dan Sperling), 2008
- National Science Foundation Grant (with Victor Stango), 2008-2010, \$240,000
- Chevron Bio-Fuel Research Grant, 2007-2008, \$127,000
- Chevron Bio-Fuel Research Grant, 2007-2008, \$77,000
- Chevron Bio-Fuel Research Grant (Co-PI), 2007-2009, \$370,000
- Woods Institute for the Environment Leadership Scholar Training, 2007
- Distinguished Paper, 2006 Academy of Finance
- University of California Energy Institute Research Grant, 2005-2006, \$50,000
- Best Paper Award for the 31st NBEA Conference
- ASUCD Excellence in Teaching Award, 2004
- University of California Energy Institute Research Grant, 2003
- Faculty Research Grant, UC Davis, 2002, 2003, 2004, 2005, 2006
- Institute of Governmental Affairs Junior Faculty Grant, 2002, 2003, 2004, 2005
- Junior Faculty Research Grant, Boston University, 2001
- Graduate Fellowship, University of California, Berkeley, 1997–1999
- Graduate Fellowship, University of California, Davis, 1994–1996
- Institute of Transportation Fellow, University of California, Davis, 1995–1996
- Student Commencement Speaker, California State University, Stanislaus, 1994

REFEREE SERVICES:

Agricultural Economics, American Economic Review, Bulletin of Economic Research, Census Bureau, Econometrica, Economic Inquiry, The Economic Journal, Economics Letters, Energy Economics, The Energy Journal, Energy Studies Review, European Economic Review, International Journal of Industrial Organization, International Journal of Power and Energy Systems, Journal of Banking and Finance, The Journal of Business, Journal of Business and Economic Statistics, Journal of Economic Behavior and Organization, Journal of Economic Education, Journal of Economics and Management Strategy, Journal of Futures Markets, Journal of Industrial Economics, Journal Institutional and Theoretical Economics, Journal of Law and Economics, Politics and Economics, Quarterly Journal of Economics, Rand Journal of Economics, Resource and Energy Economics, Review of Economic Studies, Review of Economics and Statistics, Review of Industrial Organization, Review of Network Economics, Southern Economic Journal, Socio-Economic Planning Sciences, Utilities Policy, University of California Energy Institute Grant Program, NSF Grant Program

RECENT INVITED PRESENTATIONS:

- Energy Institute @ Haas, Policy Conference, Sacramento, October 2009
- Institute of Transportation Studies, UC Davis, October 2009
- TREE Seminar, Raleigh/Durham/Chapel Hill, North Carolina, October 2009
- UC Berkeley, ARE, February 2009
- NBER Winter IO Meeting, February 2009
- Iowa State, Economics, January 2009
- NBER Summer EEE Meeting, July 2009
- UC Berkeley IO/Innovation Seminar, November 2008
- UC Berkeley IO/Innovation Seminar, October 2008
- Department of Justice, March 2008
- University Retirement Community, February 2008
- New American Foundation, February 2008
- Tainjin Chinese Delegation at UC Davis
- UCEI Policy Conference, December 2007
- University of California Energy Institute, July 2007
- Institute of Transportation Studies, UC Davis, October 2007
- NBER EEE, Summer Meeting, July 2007
- NBER Winter IO Meetings, January 2008
- UC Berkeley, Department of Economics, November 2007
- University of Alberta and Calgary University Industrial Organization Conference, October 2007
- Washington University, Olin School of Business, November 2007

REGULATORY FILINGS:

- Arons, S.M., A.R. Brandt, M.A. Delucchi, A. Eggert, A.E. Farrell, B.K. Haya, J. Hughes, B.M. Jenkins, A.D. Jones, D.M. Kammen, S.R. Kaffka, C.R. Knittel, D.M. Lemoine, E.W. Martin, M.W. Melaina, J.M. Ogden, R.J. Plevin, D. Sperling, B.T. Turner, R.B. Williams, C. Yang, 2007. "A Low-Carbon Fuel Standard for California, Part 1: Technical Analysis." Available Online: <http://www.lcfs.ucdavis.edu>.
- Brandt, A.R., A.E. Farrell, B.K. Haya, J. Hughes, B.M. Jenkins, A.D. Jones, D.M. Kammen, C.R. Knittel, M.W. Melaina, M. O'Hare, R.J. Plevin, D. Sperling, 2007. "A Low-Carbon Fuel

Standard for California, Part 2: Policy Analysis.” Available Online:
<http://www.lefs.ucdavis.edu>.

- Peer Review Comments on AB 1493, California Environmental Protection Agency Air Resource Board, September 2004.
- “Comments on the Use of Computer Models for Merger Analysis in the Electricity Industry,” (Joint with Severin Borenstein and James Bushnell), Federal Energy Regulatory Commission. Docket No. PL98-6-000, June 1998.
- “A Cournot-Nash Equilibrium Analysis of the New Jersey Electricity Market,” December 1997. (Joint with Severin Borenstein and James Bushnell). Filed with the New Jersey Public Utility Commission as testimony on the potential for market power in a deregulated Pennsylvania-Jersey-Maryland Power Pool.

CONSULTING:

Customers First! Coalition, Energy Information Agency, Korean Electric Power Company, California Air Resource Board, City of West Sacramento

PH.D. COMMITTEES (FIRST JOB):

UC Davis:

Anson Soderbery (on-going)

Nick Sanders (chair, on-going)

Chai-Wen Chen (chair, on-going)

Jonathan Hughes (chair, University of Colorado, Boulder)

Adib Bagh (University of Kentucky, Math and Economics)

Seungjoon Lee (Korean Insurance Research Institute)

Jason Lepore (chair, Cal Poly)

Wei-Min Hu (Peking University)

Byeongil Ahn (Gyeongsang University)

Konstantinos Metaxoglou (chair, Bates and White LLC)

Lan Li (University of Melbourne)

Neil Norman (Cornerstone Research)

Dae-Wook Kim (chair, Korean Institute for Industrial Economics and Trade)

Boston University:

Gustavo Genoni (2002, Finance, IAE, School of Business, Universidad Austral)

John Neumann (2003, Finance, St. John’s University)

TEACHING:

- UC Davis
 - Graduate Empirical Industrial Organization (6 times)
 - Ratings: Mean 4.9 (out of 5)
 - Transportation Economics (4 times)
 - Ratings: Mean 4.7
 - Intermediate Microeconomics (1 time),
 - Ratings: Mean 4.8
 - Undergraduate Industrial Organization (9 times)
 - Ratings: Mean 4.8
- Boston University
 - Modeling Business Decision Making,
 - Spring 2000, Spring 2001 and Spring 2002

- Ratings: 4.53 (out of 5), 4.77, 4.70
- Modeling Business Decision Making (honors),
 - Spring 2001 and Spring 2002
 - Ratings: 4.88, 4.70

UNIVERSITY SERVICE:

UC Davis:

2007-2008, Co-writer (with Jean Vandergehst) of a proposal for a Graduate Program in "Energy Science and Technology" and "Energy Policy and Management"

2006-Present, Member, Energy Institute Steering Committee

2008, Founding Faculty Member, UC Davis Energy Institute

2005-2006, Hiring Committee and Interviewing Committee

2004-2005, Hiring Committee and Interviewing Committee

2002-2003, Hiring Committee and Interviewing Committee

2002-2007, Graduate Advisor

Oral committees: Dae-Wook Kim, Konstantinos Metaxoglou, Neil Norman (chair), Seungjoon Lee, Wei-Min Hu, Lan Li (ARE), Sunhwa Lee, Byeongil Ahn (ARE), Michele Amaral, David Ong, Adib Bagh, Jason Lepore, Bei Li, Chenguang Li (ARE), Tina Saitone (ARE), Carlo Russo (ARE), Sandhya Patlolla (ARE), Jon Hughes (TTP), Peter Huckfeldt, Kyungwon Rho, Nick Sanders, Chia-Wen Chen, Joeri de Witt (ARE), In-Sung Lee (TTP), Anson Soderbery, Nils Johnson (TTP), David McCollum (TTP)

Boston University:

2000-2001, Finance Hiring Committee and Interviewing Committee

1999-2000, Finance Hiring Committee

RECENT MEDIA CITATIONS:

Print: Alameda Times-Star, Arizona Daily Star, Argus, ATMmarketplace.com, Austin-American Statesman, Boston Globe, Buffalo News, California Aggie, Contra Costa Times, PE.com, bankrate.com, marketwatch.com, Crain's Business Report (New York), Credit Card Magazine, Kiosk Marketplace News, LA Observed, LA Times, International Herald Tribune, Northwestern Herald, Oakland Tribune, Oregonian, Philadelphia Inquirer, Providence Journal, New York Times, Sacramento Bee, St. Petersburg Times, Salon.com, San Diego Union Tribune, Salt Lake Tribune, San Diego Union Tribune, SF Chronicle, San Mateo County Times, Santa Rosa Press Democrat, Sarasota Herald-Tribune, Scripps News (DC), Tuscaloosa News Sun Herald, Quad City News (Iowa), Winston-Salem Journal, Worcester Telegram

Radio: KQED's "Forum", KXJZ, KFBK, KUOP, KCBS, KNX, WHYI with Marty Moss-Coane, WPR with Kathleen Dunn, Bloomberg Radio, Lambasted by Rush Limbaugh

Television: KCRA-3, CBS-13 Sacramento, NBC Nightly News, ABC World News, CBS Evening News, ABC Good Morning America

REFERENCES:

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Michael Greenstone
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Frank Wolak
Professor of Economics
Stanford University
wolak@zia.stanford.edu

Catherine Wolfram
Associate Professor
Haas School of Business
University of California at Berkeley
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Résumé

Dr. Walter McManus
Research Scientist and Director
Economics, Energy, and Environment Research Group
University of Michigan Transportation Research Institute
2901 Baxter Rd.
Ann Arbor, MI
(248) 821-0493
watsmcm@umich.edu

Biography

Dr. Walter McManus is a Research Scientist at the University of Michigan Transportation Research Institute (UMTRI) and Director of the Economics, Energy, and Environment Research Group. Dr. McManus has been a member of the UMTRI faculty since March 2005. Immediately prior to that, he was Executive Director of Forecasting and Analytics at the global marketing information company, J.D. Power and Associates. His business experience also includes nine years with General Motors in forecasting, marketing analysis and strategy, and new-product development. (He also spent a year as a production supervisor in a GM manufacturing plant.)

Dr. McManus graduated from Louisiana State University (BA 1977) and earned a doctorate in economics from the University of California, Los Angeles (PhD 1983). Dr. McManus pursues a research program that is focused on issues arising from the interaction of transportation, society, and the environment. The research program generates knowledge through excellent, creative research on the social, economic, and environmental dynamics that are producing change in the automotive transportation energy sphere; with the goal of developing and delivering useful applications of findings to assist policy makers, industry, and stakeholders in anticipating future societal needs.

Research Interests

Transportation economics, energy, and environment; the automotive industry; adoption and diffusion of clean transportation technologies

Tools

Economic analysis (market demand and supply models, strategic behavior of firms, economic history), econometrics, forecasting and simulation, finance, public speaking

Education

PhD, Economics, University of California, Los Angeles, 1983
BA, Economics, Louisiana State University, 1977

Awards

2008 UMTRI Research Excellence Award for the article in *Business Economics* 2007
NABE Abramson Award for the best article published in *Business Economics* 2007
GM Chairman's Honors for innovations enhancing performance in new-product development 1991 & 98
Sidney Stern Fellow; University of California, Los Angeles; 1979 – 82

Affiliations

Automotive Industry Expert Panel, U.S. Government Accountability Office, 2009 – present
Ceres Stakeholder Committee on Sustainability, Ford Motor Company, 2009 – present
Fellow, Michigan Memorial Phoenix Energy Research Institute, 2007 – present
Executive Committee, Michigan Center for Advancing Safe Transportation throughout the Lifespan, 2007 – present
Transportation Energy Committee, Transportation Research Board
Transportation Working Group, Energy Futures Coalition, 2003 – 04
American Economic Association
National Association for Business Economics
Society of Automotive Engineers

Professional History

Research Scientist and Director, Economics, Energy, and Environment Research Group, University of Michigan Transportation Research Institute, Mar 2005 - Present

Visiting Scholar and Research Engineer, Transportation Sustainability Research Center, Institute of Transportation Studies, University of California, Berkeley, Mar 2009 – Oct 2009

Executive Director of Forecasting and Analytics, J.D. Power and Associates, Oct 1999 – Jan 2005

Director of Marketing, Textron Automotive Company, Dec 1998 – Sept 1999

Leader, Industry Analysis Group, General Motors Corporation, July 1996 – Nov 1998

Manager, North American Market Analysis, General Motors Corporation, Jan 1994 – June 1996

Economist, Delco Remy Division, General Motors Corporation, Anderson, IN, Aug 1991 – Dec 1993 (Memo: included development assignment as Manufacturing Supervisor, Jan 1993 – Dec 1993)

Economist, General Motors Corporation, Detroit, MI, June 1989 – Aug 1991

Associate Professor of Economics and Fellow, Center for the Study of Business and Government, Baruch College, New York, NY, July 1988– May 1989

Assistant Professor of Economics, University of Florida, Gainesville, FL, July 1983 – June 1988

Testimony and Briefings

U.S. EPA and NHTSA Public Hearing, Proposed Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, October 21, 2009

Investor Briefing, Citigroup Investment Research, CAFE Panel Conference Call & Briefing, April 2009.

Testimony, Committee on Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy, National Research Council, March 16, 2009

Testimony, US EPA, Hearing on California Greenhouse Gas Waiver, March 3, 2009

Testimony, Environmental Regulation Commission Hearing, Greenhouse Gas Emissions Reduction-Florida Clean Car Emission Rule, Florida Department of Environmental Protection, October 29, 2008

US Congressional Briefing, Environmental and Energy Study Institute & Investor Network on Climate Risk, December 4, 2007

Investor Briefing, Citigroup Investment Research, CAFE and the U.S. Auto Industry: A Growing Auto Investor Issue, 2012-2020, October 31, 2007

Public Briefing, National Commission on Energy Policy and the International Council on Clean Transportation, Fuel Economy: Technology Trends and Policy Options, Washington, DC. October 1, 2007.

Congressional Testimony, U.S. Senate Finance Subcommittee on Energy, “Advanced Technology Vehicles: The Road Ahead”, May 1, 2007

Congressional Testimony, U.S. Senate Energy and Natural Resources Committee, “the Consumer Market for Fuel Economy”, January 30, 2007

Publications

Rogozhin, A., Gallaher, M., Helfand, G., and McManus, W. (2010 forthcoming), Using indirect cost multipliers to estimate the total cost of adding new technology in the automobile industry, *International Journal of Production Economics*.

McManus, W., Senter, R., Curtin, R., and Garver, S. (2009), The demographic threat to Detroit's automakers, *Targeting, Measurement and Analysis for Marketing* 17:81-92

Senter, R. and McManus, W. (2009), General Motors in an age of corporate restructuring, in the second automobile revolution: the automobile firms' trajectories at the beginning of the 21st century (Chapter 9), Edited by M. Freyssenet, New York: Palgrave Macmillan

McManus, W. (2007), The link between gasoline prices and vehicle sales: economic theory trumps conventional Detroit wisdom. *Business Economics* 1.42:54-60

McManus, W. and Griffor, E. (2006), Toward a science of driving: Safety in rules-based versus adaptive self-regulating traffic systems, *SAE Convergence*, 2006-21-0064

McManus, W. (1985), Estimates of the deterrent effect of capital punishment: the importance of the researcher's prior beliefs, *Journal of Political Economy* 93:417-25

McManus, W. (1985), Labor market assimilation of immigrants: the importance of language skills, *Contemporary Economic Policy* 3:77-89

McManus, W. (1985), Labor market costs of language disparity: an interpretation of Hispanic earnings differences, *American Economic Review* 75:818-27

Theil, H., Rosalsky, M., and McManus, W. (1985), Lp-norm estimation of non-linear systems *Economics Letters* 17(1-2):123-125

McManus, W. and Rosalsky, M. (1985), Are all asymptotic standard errors awful? *Economics Letters* 17(3):243-245

McManus, W., Gould, W., and Welch, F. (1983), Earnings of Hispanic men: the role of English language proficiency, *Journal of Labor Economics* 1:101-30

Technical Reports and Working Papers

McManus, W. and Senter, R., Market Models for Predicting PHEV Adoption and Diffusion, UMTRI-2009-37, August 2009.

McManus, W. and Kleinbaum, R., Fixing Detroit, How Far, How Fast, How Fuel-Efficient, UMTRI-2009-26, June 2009

Senter, R. and McManus, W., Reshaping the Big Three, GERPISA, June 2009

Rogozhin, A., Gallaher, M., Helfand, G., and McManus, W., Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers, EPA-420-R-09-003, Feb 2009

McManus, W., The Impact of Attribute-Based Corporate Average Fuel Economy (CAFE) Standards: Preliminary Findings, Automotive Analysis Division, University of Michigan Transportation Research Institute (UMTRI), July 2007

McManus, W., Economic Analysis of Feebates to Reduce Greenhouse Gas Emissions from Light Vehicles for California, Automotive Analysis Division, University of Michigan Transportation Research Institute (UMTRI), May 2007

McManus, W., Can Proactive Fuel Economy Strategies Help Automakers Mitigate Fuel-Price Risks? Automotive Analysis Division, University of Michigan Transportation Research Institute (UMTRI), September 2006

McManus, W., Baum, A., Hwang, R., Luria, D., and Baura, G., In The Tank – How Oil Prices Threaten Automakers' Profits and Jobs, Office for the Study of Automotive Transportation, July 2005

McManus, W. and Berman, B., The 2005 OSAT – HybridCars.com Survey of Owners and Shoppers, Office for the Study of Automotive Transportation (OSAT), University of Michigan Transportation Research Institute (UMTRI), 2005.

McManus, W., The Effects of Higher Gasoline Prices on U.S. Light Vehicle Sales, Prices, and Variable Profit by Segment and Manufacturer Group, 2001 and 2004. Office for the Study of Automotive Transportation (OSAT), University of Michigan Transportation Research Institute (UMTRI), June 2005.

Greene, D., Duleep, K., and McManus, W., Future Potential of Hybrid and Diesel Powertrains in the US Light-Duty Vehicle Market, Report to Department of Energy, July 2004.

McManus, W., Consumer Acceptance of Alternative Powertrains, OE Industry Review. Troy, MI: Original Equipment Suppliers Association, 2004.

McManus, W., "Diesel vs. Hybrid-Electric Powertrains: Assessing Dependability," Power Report (July 2004)

McManus, W., "Interest in Diesel Grows—Quietly," Power Report (June 2004)

McManus, W., Consumer Acceptance of Alternative Powertrains Study. Westlake Village, CA: J.D. Power and Associates, 2004.

Malesh, T. and McManus, W., Clean Diesel Market Acceptance Study. Westlake Village, CA: J.D. Power and Associates, 2003.

McManus, W., Analysis of Tax Credits to Stimulate Consumer Demand for Advanced-Technology Fuel-Efficient Vehicles: Final Report to Energy Future Coalition Transportation Working Group. Westlake Village, CA: J.D. Power and Associates, 2003.

McManus, W., Generation Y Automotive Market Assessment. Westlake Village, CA: J.D. Power and Associates, 2002.

McManus, W., Interaction Between New and Used Vehicle Sales in the U.S. Market. Westlake Village, CA: J.D. Power and Associates, 2002.

McManus, W., Telematics Forecast. Westlake Village, CA: J.D. Power and Associates, 2002.

McManus, W., Satellite Radio Forecast. Westlake Village, CA: J.D. Power and Associates, 2002.

McManus, W. and Bussmann, W., Isuzu in the U.S., Westlake Village, CA: J.D. Power and Associates, 2001

McManus, W., Adaptive Cruise Control Forecast, Westlake Village, CA: J.D. Power and Associates, 2001

Appendix B:
Charge Questions



TO: Carolyn Fischer
Walter McManus
Christopher Knittel

FROM: Paramita Sinha

CC: Michael Gallaher

DATE: December 31, 2009

SUBJECT: Charge Questions for Peer Review of EPA's Study of Vehicle Choice Models

The US EPA's Office of Transportation and Air Quality is currently analyzing a set of existing consumer vehicle choice models to see whether there is a robust estimate of the value of additional fuel economy to consumers. EPA is seeking a peer review of its comparative study of consumer vehicle choice models and what each model may predict for the value of improving vehicle fuel economy at the time of vehicle purchase.

EPA has provided direction and charge questions for this review and these are included below. A teleconference call will also be arranged so that EPA can provide technical and/or background information on the analysis. Any future questions you may have can be directed back through RTI for resolution with EPA.

The review will involve a written report that includes the response to the charge questions and any additional comments you may have, e.g., margin notes on review materials. Comments should be provided in an enclosure to a cover letter that clearly states the reviewer's name, the name and address of their organization if applicable, which model review documents/media were received by the reviewer and which were actually reviewed and a statement of any real or perceived conflict(s) of interest.

ELEMENTS TO BE ADDRESSED IN THE CHARGE TO THE REVIEWERS OF EPA'S ANALYSIS OF THE VALUE OF ADDITIONAL FUEL ECONOMY TO CONSUMERS

EPA's report on using vehicle choice models to estimate the impacts of fuel economy regulations will inform its analyses of the effects of regulatory programs that affect vehicle fuel economy. This report details an analysis of the value of additional fuel economy to consumers, estimated

Carolyn Fischer
Walter McManus
Christopher Knittel
Page 2
December 31, 2009

from consumer vehicle choice models. No independent data analysis will be required for this review.

Specifically, EPA is seeking the reviewers' expert opinions on the data, concepts, and methodologies upon which the analysis relies, whether or not the analysis was conducted correctly, and whether the analysis draws appropriate conclusions. Toward this end, we ask that each subject matter expert review and comment on the following items:

1. overall approach and methodology of the study;
2. appropriateness of the datasets and any other inputs;
3. data analysis conducted for the study;
4. appropriateness of the conclusions drawn;
5. recommendations for alternate data and/or analyses; and
6. overall clarity of the presentation.

In making their comments, the reviewers should distinguish between recommendations for clearly defined improvements that can be readily made based on data or literature reasonably available to EPA, and improvements that are more exploratory or dependent on information not readily available to EPA. Any comment should be sufficiently clear and detailed to allow a thorough understanding by EPA or other parties familiar with the model. EPA requests that the reviewers not release the peer review materials or their comments to anyone else until the Agency makes its report and supporting documentation public.

If a reviewer has questions about what is required in order to complete this review or need additional background material, please direct the reviewer to contact (RTI project manager/PI). If a reviewer has any questions about the EPA peer review process itself, please have the reviewer contact Ms. Ruth Schenk in EPA's Quality Office, National Vehicle and Fuel Emissions Laboratory by phone (734-214-4017) or through e-mail (schenk.ruth@epa.gov).

Appendix C:
Cover Letters

To:
Gloria Helfand
US EPA, Assessment and Standards Division (OTAQ)
2000 Traverwood Drive
Ann Arbor, Michigan 48105

From:
Dr. Carolyn Fischer
3215 Pauline Dr.
Chevy Chase, MD 20815

January 27, 2010

Cover Letter to Accompany “Review of Greene ‘How Consumers Value Fuel Economy’”

Greetings:

The documents that I received from EPA (or RTI International) were a memo containing the charge questions and the draft report by Greene (2009). I also furnished versions of some unpublished papers relevant to the report, including Alcott and Wozny (2009); Busse, Knittel, and Zettelmeyer (2009); and Sallee, West, and Fan (2009).

I reviewed all of the documents that I received in developing my expert opinion as contained in the “Review of Greene ‘How Consumers Value Fuel Economy’,” submitted on January 25.

I declare that there are no real or perceived conflicts of interest concerning my involvement in this review for the EPA.

Best regards,

Carolyn Fischer

To:
Gloria Helfand
US EPA, Assessment and Standards Division (OTAQ)
2000 Traverwood Drive
Ann Arbor, Michigan 48105

From:
Christopher R. Knittel
Department of Economics
University of California, Davis
Davis, CA 95616

January 27, 2010

Cover Letter to Accompany Review How Consumers Value Fuel Economy: A Literature Review, by David Greene.

Greetings:

The documents that I received from EPA (or RTI International) were a memo containing the charge questions, the draft report by Greene (2009), and two unpublished papers that are covered in the draft report. The unpublished papers are Alcott and Wozny (2009) and Sallee, West, and Fan (2009).

I reviewed all of the documents that I received in developing my expert opinion as contained in the enclosed Review of How Consumers Value Fuel Economy: A Literature Review, by David Greene.

I declare that there are no real or perceived conflicts of interest concerning my involvement in this review for the EPA.

Sincerely,

Christopher R. Knittel

To:
Gloria Helfand
US EPA, Assessment and Standards Division (OTAQ)
2000 Traverwood Drive
Ann Arbor, Michigan 48105

From:
Walter McManus
University of Michigan Transportation Research Institute
2901 Baxter Rd.
Ann Arbor, MI 48109-2150

January 25, 2010

Cover Letter to Accompany Review of Greene, D.L. (2009) How Consumers Value Fuel Economy: A Literature Review

Greetings:

The documents that I received from EPA (or RTI International) were a memo containing the charge questions, the draft report by Greene (2009), and three unpublished papers that are covered in the draft report. The unpublished papers are Alcott and Wozny (2009); Busse, Knittel, and Zettelmeyer (2009); and Sallee, West, and Fan (2009).

I reviewed all of the documents that I received in developing my expert opinion as contained in the enclosed Review of Greene, D.L. (2009) How Consumers Value Fuel Economy: A Literature Review.

I declare that there are no real or perceived conflicts of interest concerning my involvement in this review for the EPA.

Best regards,

Walter McManus

Appendix D:
Reviews

Review of Greene “How Consumers Value Fuel Economy” by Carolyn Fischer

David Greene is contributing an in-depth review of the recent literature on the demand for vehicle fuel economy that will be extremely valuable to researchers and policymakers alike. Although ultimately he is unable answer the key question—how do consumers value fuel economy?—he does provide considerable insight into how researchers have attempted to answer this question and why we see so much variation in the results.

This review is structured to provide feedback and suggestions aimed at improving this work and ultimately enhancing its impact.

Presentation

Overall, the writing is excellent. Some modest changes could help the reader.

The reviewed articles are organized logically by class of data and methods. At the beginning of each section, it would be helpful to review those methods in general fashion, including the advantages and drawbacks, as well as key factors or assumptions that can affect the results. Also, it might be easier to begin with the seminal papers in each category, so as to understand the evolution and improvements made subsequently.

The status of the papers should also be recognized, since many of the important new studies are still unpublished working papers and subject to change.

Since few econometric studies have explicitly estimated the value of fuel economy, a significant contribution of the paper is to translate a wide variety of results into more consistent indicators. Yet, they could still be more consistent. In Table 10, can all of the results be converted into the same WTP metric, preferably using the same assumptions about vehicle lifespan, VMT, discounting, etc.?

Also, the author’s baseline assumptions need to be stated clearly early in the paper, so careful attention can be given throughout to assumptions that deviate from that baseline. Indeed, the statement made in the Allcott and Wozny analysis (“Calculating the discounted present value of fuel costs requires a number of assumptions...”) should be made earlier in a general context, so that the variety and range of assumptions can be understood and explored.

Additional Analysis

The paper reviews many approaches, and the author should take advantage of the summary section to indicate whether some approaches are likely to be better than others.

That section does point out some factors that may explain such different results, but this analysis could be improved. First, the discussion interweaves reasons that could explain why we can plausibly believe any of a range of results (e.g., heterogeneous decision rules, uncertainty) with

reasons for why different studies get different results. It would be helpful to separate these discussions, reminding readers of the former, and then focusing on the latter, which is the most important contribution. This kind of analysis should help indicate best practices and directions for future research. Can we suggest some experiments (e.g., new techniques on old data sets, or old techniques on new data sets) that can help tease out what differences arise from alternative econometric approaches? If most studies have focused on other aspects of vehicle demand, are there better specifications for looking directly at the valuation of fuel economy?

It would be useful to summarize key differences in approaches and data and analyze their consequences. Some that were gleaned along the way:

- levels of aggregation,
- time horizons (how useful is info from the 1970s in estimating current demand?),
- incorporation of the supply side,
- details of other attributes and variable definitions,
- allowing for separate responses to MPG and fuel costs (this was raised as lacking in the discussion of Gramlich, but it wasn't apparent what other studies had done this),
- assumptions of vehicle lifetime, VMT, discount rates, etc.
- econometric approach

Some of these summary indicators (model type, data, and time) are given in Table 10, but some additional analysis would be useful. Do we observe any trends across classes or time? Within a class of models, what drives the differences?

The paper raises the issue of consumer heterogeneity in several places, but the importance of this fact should be pushed further. Fischer (2009) points out that, facing consumers with heterogeneous preferences over fuel economy, manufacturers with market power have distorted incentives for providing fuel economy. More generally, failure to capture such consumer heterogeneity can lead to significant errors in predicting the distribution of effort in complying with regulation, as well as the calculation and distribution of the benefits.² Portions of this review highlight certain studies that captured differences in tastes for fuel economy (BLP, Goldberg, Brownstone et al.), while most studies ignored such heterogeneity. This seems like an important area for additional analysis, both to explain differences and to suggest future research directions.

Additional Empirical Literature

I am aware of a few other studies that likely deserve attention as well.

Sallee and West (2009 working paper) "The Effect of Gasoline Prices on the Demand for Fuel Economy in Used Vehicles: Empirical Evidence and Policy Implications"

Abstract: Fossil fuel consumption and greenhouse gas emissions from the personal transportation sector pose serious challenges to today's policy-makers. If consumers acknowledge the full value of fuel economy, a tax on gasoline could be as efficient as a tax on greenhouse gas emissions, since the amount of carbon released by a gallon of gasoline is independent of the manner in which it is combusted. If, however, consumers do not sufficiently value fuel economy when

² Fischer, Carolyn (2009) "Imperfect Competition, Consumer Behavior, and the Provision of. Fuel Efficiency in Vehicles." Working Paper, Washington, DC: Resources for the Future.

making the decision about what car to buy, an additional complementary policy, such as a fuel economy standard or a feebate, can be welfare improving. We use microdata on used vehicle prices and a unique identification strategy based on micro-level variation in vehicle odometers to test whether used car prices change by the amount predicted by a fully rational asset pricing model. Our baseline results indicate that used car prices adjust by about 80% of the amount predicted by theory, and sensitivity analysis suggests that for a reasonable discount rate, they adjust by the full amount. These results contrast with recent literature, which finds adjustment closer to 25%, and suggest a limited role for complementary policy tools.

Klier and Linn (2010 working paper) “The Price of Gasoline and New Vehicle Fuel Economy: Evidence from Monthly Sales Data”

This paper uses a unique data set of monthly new vehicle sales by detailed model from 1978-2007, and implements a new identification strategy to estimate the effect of the price of gasoline on individual vehicle model sales. We control for unobserved vehicle and consumer characteristics by using within model-year changes in the price of gasoline and sales. We find a significant sales response, suggesting that the gasoline price increase from 2002-2007 explains nearly half of the decline in market share of U.S. manufacturers. On the other hand, an increase in the gasoline tax would only modestly raise average fuel economy.

(Their estimate implies that a one dollar increase in the price of gasoline raises average fuel economy by 0.5-1 MPG.)

Dreyfus, Mark K. and W. Kip Viscusi (1995). “Rates of Time Preference and Consumer Valuations of Automobile Safety and Fuel Efficiency.” *Journal of Law and Economics* 38: 79-98.

This seems like an earlier, influential study, of the same era as BLP, so worth some comparison, although fuel economy demand was a secondary target of interest.

Description from Howarth (2004): “Dreyfus and Viscusi (1995) undertook a hedonic price analysis of the U.S. automobile market to assess consumers’ willingness to pay for improved safety and energy efficiency. On the assumption that consumers use a common discount rate in evaluating both safety and fuel economy, the study calculates an implicit discount rate that ranges from 11 to 17 percent in alternative specifications. More tellingly, Dreyfus and Viscusi conclude that only 35 percent of the present-value cost savings provided by improved energy efficiency is capitalized in the purchase price of vehicles.” (derived from coefficients from operating cost and that interacted with weight)

Hughes, Jonathan E., Christopher R. Knittel and Daniel Sperling (2008). “Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand.” *Energy Journal*.

West, S. (2008). “The Effect of Gasoline Prices on the Demand for Sport Utility Vehicles.” Working Paper. Macalester College.

(mentioned in Helfand and Wolverton)

Other Points

- 2.0 in the discussion of Turrentine and Kurani, recent research on “The MPG Illusion” may be relevant to mention, supporting the difficulty of consumers in calculating fuel cost savings.
Larrick, R. P., & Soll, J. B. (2008). The MPG illusion. *Science*, 320, 1593-1594.
<http://faculty.fuqua.duke.edu/~larrick/bio/Reshighlights.htm>
- 2.1 The author talks about the global vehicle market; it seems relevant to give the statistics for the U.S. market.
- 2.2 The review of the literature on the demand for energy efficiency should include Gillinham et al., who “review economic concepts underlying consumer decision making in energy efficiency and conservation and examine related empirical literature. In particular, we provide an economic perspective on the range of market barriers, market failures, and behavioral failures that have been cited in the energy efficiency context.” Gillingham, K.T., R.G. Newell and K.L. Palmer (2009). “Energy Efficiency Economics and Policy.” RFF Discussion Paper 09-13, April 2009.

The statement “With the exception of externalities, there is little quantitative evidence of the impact of these failures on consumers’ choices of energy using durable goods” seems hard to reconcile with the preceding discussion. Is there any better (peer-reviewed) support than ACEEE (2007)?

This section also offers the opportunity to introduce other studies outside the economics literature—are there any documented industry studies on their approach to consumer payback expectations?

Section 3

BLP (1995) is a seminal paper, and should probably be presented first. Is the same critical eye being given to them with respect to omitted variables. They used HP/weight to represent power, but what if weight is valued separately, such as for safety concerns in that era?

Dasgupta et al. (2007): this description seems too curt. I had a hard time following the structure of the model and the conversion of the results. (Also later in the discussion of McManus, where the coefficient units are interpreted as discounted lifetime miles).

Bento et al. (2005): I believe the parameter estimates are provided in the Appendix. Are they in a form that can be useful for comparison?

Feng et al. (2005): given the important question raised of the units, it seems worth asking the authors directly.

Brownstone et al. (1996): did any of the identification for WTP for fuel economy come from the demand for alternative fuel options? It wasn’t clear in the discussion what was done with the

information about alternatives, and whether that is reliable, given the lack of availability of these technologies.

Cambridge Econometrics: if they included both fuel costs and fuel consumption rates, was there some other heterogeneity to distinguish between the two?

Espey and Nair (2005) is referred to before it is discussed; perhaps the order should be reversed. Also, since the gas guzzler tax is mentioned, one should perhaps point out that they mischaracterized the policy in such a way as to affect their consumer price calculations (it is actually paid by producers, not consumers), although this is unlikely to affect their results. The lack of controlling for manufacturer may, however. In discussing the differences with the Rosen method, the implications for how their results might be biased were unclear.

Bhat and Sen (2006): Table 6 is difficult to interpret.

Busse et al.: p. 32 “These results do not necessarily imply that new car buyers undervalue fuel economy, since the change in price also depends on the elasticities of supply and demand.” It seems they also depend on the formulation of price expectations.

Minutiae

p. 8 “Two recent analysis have quantified the [potential] impacts of uncertainty...”

p. 10 2nd para: market imperfect[ion]
sales[-]mix (might be preferred)

p. 12 end of the Gramlich discussion is a bit confusing; it was not clear what his model predicted for fuel economy in comparison to the EPA numbers. May just need to be clarified which numbers are being discussed.

p. 12 [reverse order so that citation always begins the paragraph] BLP (1995), in a seminal paper,...
“consumer I” should be “consumer *i*”

p. 16 last full sentence (“Different influences... in econometric analyses of VMT, for example”) could use some citations.

p. 23 top para: “But this is not stated in the report[;] indeed,...

p. 25 figure says “Qin and Rubin” instead of “Fan and Rubin”

References please check working papers to update citations

p. 36 2nd para: remove the “,” after “Allcott and Wozny”
e.g., Fischer et al. (2007) is *Energy Journal* 28: 1-29.

Review of:
“How Consumers Value Fuel Economy: A Literature Review”
by David L. Greene
Reviewed by Christopher R. Knittel

January 22, 2010

Dear Sir/Madam:

This report summarizes the literature regarding the value that consumers place on fuel economy at the time of purchasing a vehicle. Understanding this is important for a variety of public policy issues. How consumers trade-off paying more for fuel economy with future fuel savings defines their discount rate. Therefore, statements such as “consumers undervalue fuel economy” necessarily imply that the consumers’ discount rate is below society’s discount rate. If consumers do not value fuel economy as much as society-at-large, then gasoline will be over-consumed and policies may improve social welfare.

Equally important, though not analyzed in this report (it is discussed however), is *why* consumers undervalue gasoline, relative society (if they do indeed undervalue fuel economy). This has important implications for which policies are most effective at aligning discount rates. For example, do consumers undervalue fuel economy because capital markets are imperfect? Subsidized loans would likely be the most effective policy. Do they undervalue fuel economy because of a lack of cognitive ability? Education policies and/or information campaigns are likely to be most effective. Papers dealing with these issues are largely lacking, unfortunately.

Bottom line: This is an excellent review. This review will be an asset to policy makers. I agree with the conclusion that the literature remains mixed as to whether consumers fully value fuel economy at reasonable discount rates. I provide some comments that may improve the review.

Is the goal to summarize, or analyze papers?:

It strikes me that there are two ways to conduct a review such as this. One is to report the results of papers with little, or no, discussion of the quality each paper. The other is to both review and critique each paper. I found a lack of uniformity in this regard. For many of the papers, the latter

strategy is taken. The report discusses key weakness of these papers. Still many papers are simply summarized, with little or no discussion of their strengths or weaknesses. This gives the impression that the results in these papers are more accurate. This may actually be the case, but if it is, this should be stated more explicitly.

For example, the first paper (Alcott and Wozny) is simply summarized with no editorializing. One possibility is that there are no weaknesses in this paper. But, many of the issues raised later for other papers also relate to this paper. For example, the report correctly states, when discussing the Sawhill paper, that in order to get a consistent estimate of how consumers value fuel economy, the author is required to correctly specify how consumers form expectations about gas prices and drive their vehicles. If any of these are incorrectly specified, the estimate will be biased. The same is true for the Alcott and Wozny paper. While I find Alcott and Wozny's specification for how expectations are formed to likely be more accurate, ironically, they assume consumers are hyper-rational in the sense that they form their gas price expectations based on NYMEX futures prices. In some ways the myopia result is inconsistent with this key assumption.

Differentiating papers by their focus:

The author should be commended for reviewing such a diverse set of papers. The report categorizes papers by the data used in the analysis and empirical model (e.g., aggregate data v. micro-level data and discrete choice v. hedonic pricing model). I propose two alternatives. Many of the papers reviewed did not focus on measuring the implicit discount rate, or even on the issue of how gas prices affect vehicle demand. If a paper did not focus on either of these two questions, it is difficult to gauge the robustness of their results with respect to these questions, the quality of the variation in gas prices in the data, etc. Perhaps a better method would be to first focus on those papers where gas prices and vehicle choice are the central research question, and those papers where this is more a tangential part of the analysis.

Differentiating papers by their publication status:

Many of the papers reviewed have not undergone the peer-review process. While I do not claim that mistakes do not make it through the peer-review process, related to comment above, in some ways a review of an unpublished paper requires a more thorough review of the paper itself. A

second way to organize the review would be to focus first on published papers and then second on unpublished papers. At the very least the fact that a number of the papers are unpublished should be explicitly noted in the text. Many readers may never make it to the bibliography.

Comments related to discussion of issues:

The review has an excellent discussion of the issues related to how consumers value fuel economy and the market for fuel economy more generally. I enjoyed reading this section. I have a few comments related to it, however.

At the top of page 5, the author poses: “does the market value fuel economy improvements at the discounted expected value of future fuel savings over the lifetime of the vehicle, or less, or more?”

The author should use the phrase “at *society’s* discounted expected value...”

In many ways questioning whether the market values fuel economy improvements at the discounted expected value of future fuel savings is simply a tautology. There is always a discount rate that equates how much consumers are willing to pay for fuel economy improvements given the expected value of the future fuel savings. Therefore, any statement about whether they are willing to pay too little, or too much, is actually a statement about how the consumers’ discount rates compare with society’s discount rate.

On page 5, the author states, “On the other hand, if consumers are myopic and consider only the first three years of fuel savings, for example, fuel economy standards can increase welfare even based solely on private costs and benefits.”

If the author is making a statement about the consumers’ welfare, and not society’s, then more should be added here. If consumers are myopic because their utility function is myopic, then I do not see how fuel economy standards make them better off. If my discount rate is actually 20%, because these are my preferences, then I am better off by investing less in fuel economy compared to someone whose discount rate is 10%. Forcing standards does not improve my

welfare. Someone with a 10% discount rate may disagree with my choice, but there is nothing here that makes my choice non-optimal for me. In contrast, if I behave myopically for reasons outside of my utility function, such as a lack of access to credit or a lack of cognitive ability, then fuel economy standards, as well as subsidized loans and/or information campaigns, can improve my welfare. Alternatively, the author can also point to more behavioral economics reasons why this market might fail, for example, because consumers have self-control issues. I find many of these reasons to be quite compelling. My point is that the author should be more clear here. As it currently reads, it implies that high discount rates, alone, imply fuel economy standards are welfare improving. This is simply not the case.³

On page 5 the author states that it is surprising that there is no basic research on how consumers consider fuel economy. This is a strange use of the term basic research, which I take to mean research on pure science. Does the author equate basic science with interviews? I have never heard basic science used in this manner.

Comments on specific paper reviews:

The reviews of the papers are very well done and the choice of papers very comprehensive. I have a few comments that may improve this discussion, as well as a few papers to be added.

Busse, Knittel and Zettelmeyer

Unfortunately the discussion of Busse et al. on page 32 is incorrect. The report states that the paper does not control for vehicle attributes. In fact, it controls for an extremely wide set of vehicle attributes through the use of “fixed effects.” In the price equations there are fixed effects for vehicle type, defined as the *interaction* of make, model, model year, trim level, doors, body type, displacement, cylinders, and transmission. Put in more layman’s terms, the paper is controlling for all vehicle attributes within this vehicle type. That is, the only way something like horsepower would not be entirely controlled for is if there were two vehicles of the same make, model, model year, trim level, doors, body type, displacement, cylinders, and transmission that had different horsepower levels. So, for example, any attribute that does not vary within 2009

³ I freely admit that the use of “can improve” helps.

Honda Accord four-door EX-L, with a 3.5 liter, 6-cylinder and an automatic transmission vehicles is completely controlled for. The only attributes that would not be entirely controlled for are attributes that vary within this definition, such as color or dealer installed options. Variables such as horsepower likely do not vary within the same make/model/engine size/number of cylinders. Viewed in this way, perhaps this paper is best included in the Hedonic Models section.

In addition, the latest version (NBER Working Paper 15590) also controls for when in the lifecycle of vehicles (both new and used) the transaction took place. This has cleared up a lot of the issues that the author raises at the top of page 32.

The newest version of Busse et al. also is clearer on what is required, theoretically, to account for the differences across new and used car markets. Market power in the new car market is not required. As the author of this report notes, the results simply imply that the supply elasticity in the new car market is more elastic than in the used car market (where a perfectly inelastic supply is likely a good first-order approximation). Therefore, I would recommend that the author edit or drop the sentence that states “The used car market was believed to function more efficiently.”

Finally, Table 10 of the report should include the used car results for Busse et al. Without taking into account the results regarding market shares in the new car specifications, the used car results are a more accurate reflection of the shift in demand from increases in gas prices. So, if only one of the sets of results is to be reported, the used car results should be reported. Reporting only the new car results, without a discussion of the quantity effects, or the used car results, is misleading.

Papers that solve for price from a discrete choice model

A number of papers in the literature, and among those reviewed here, argue that if consumers value fuel economy “correctly,” the price of a vehicle should rise and fall *one-for-one* with the vehicle’s lifetime fuel costs. If prices move less than one-for-one, this is taken as evidence that consumers are myopic. These papers typically specify utility to be some variant of the logit model (e.g., simple logit, nested logit, etc.) and then solve for the equilibrium price for a vehicle, conditional on the assumed functional form for utility. The intuition behind this empirical

strategy is best summarized by Alcott and Wozny's motivating example, where price is expressed as:

$$p = \frac{1}{\eta}(-\gamma G + \alpha - q)$$

where G is the discounted fuel cost and q the quantity of vehicles available. They note that: "To keep this consumers indifferent between the vehicles and the most attractive outside option, the overall product price $p+G$ must stay the same as G changes." This statement requires that the utility from the outside option does not also change with G . For those consumers where the "no car ownership" option is not the most attractive outside option this restriction is unlikely to hold.

For example, imagine using this framework to test whether consumers correctly value fuel economy using an ideal experiment and tracking Prius prices. In one universe gas prices are \$2, in another alternate universe gas prices are \$3. Given the condition above, in order to keep consumers from shifting demand from the Prius to the next best option, *whose operating cost is assumed not to have increased*, the price of the Prius must be lower in the \$3-universe by the increase in fuel costs over the life of the vehicle. If the price of the Prius falls by less than this amount, estimating the above equation would force you to conclude that consumers undervalue fuel economy.

Now instead imagine that the fuel cost of the next best option for many Prius owners has increased by *more* than the Prius, because the next best option is likely to be something like a Camry. In this case, the demand for the Prius actually *increases*, and prices increase. Thus, we have explained why we concluded that consumers are myopic in the above regression. Indeed, this is precisely the reason why Busse et al. argues, and shows empirical support for, that the demand, and therefore price, of more fuel efficient cars will increase when gas prices increase. And, is the reason why these authors focus on the difference in price changes between high and low fuel economy vehicles.

Of course across all vehicles, the price of some vehicles will decrease and the price of others will increase. Therefore, we should not expect the coefficient associated with discounted fuel costs to be negative one, since it will represent the average of these prices changes.

In principle, if one were to specify the correct utility function and demand system, then the above empirical strategy would be a valid test of myopia. The most general demand system would imply that the price of a given vehicle is a function of its fuel costs, *as well as the fuel costs of all competitors*. This is often intractable. Instead, the profession has migrated to specific demand models that are more parsimonious, such as logit demand models, since the implication of these demand models is that the ratio of the demand for a particular vehicle to the demand for the outside good is independent of the fuel costs of other vehicles. However, this is simply a by-product of the functional form assumptions, and as the Prius example illustrates, is not a general theoretical result, or one that is very intuitive. Insofar as these models are mis-specified, we will be biased towards finding myopic consumers.

A conundrum that may be impossible to solve:

As noted by the author in his review of the Sawhill paper, the correct statistical test of consumer myopia requires specifying the present discounted value of future fuel expenditures for each vehicle. This requires assumptions regarding how consumers form expectations regarding future gas prices. The available choices for this are limitless, ranging from assuming that consumers view gas prices as a random walk (so today's price is sufficient to describe the expected value of future gas prices) to models that assume consumers use some number of recent prices within an autoregressive model, to a hyper-rational model where consumers use NYMEX futures on crude oil and a regression model of how gas prices move with crude oil.

For ordinary least squares to be unbiased, the econometrician must have the correct model of how consumers form expectations. Otherwise, the key right hand side variable is measured with error and the estimated coefficient will be biased towards zero.⁴ This typically biases the statistical test towards concluding consumers are myopic. Unfortunately, in the end there may

not be a solution to this. Indeed, the irony is that some papers assume complex ways in which consumers form expectations, but then conclude they are myopic. In some way this strikes me as being inconsistent. If consumers are myopic, then they are also not likely to use NYMEX futures to form their expectations. Therefore, using NYMEX futures to generate the variable of interest is likely to bias a researcher towards concluding myopia.

Other papers to consider in the review:

The paper should consider reviewing the following papers:

Kilian, Lutz and Eric Sims (2006). The Effects of Real Gasoline Prices on Automobile Demand: A Structural Analysis Using Micro Data, Working Paper, University of Michigan (April).

Klier, Thomas, and Joshua Linn (2008). “The Price of Gasoline and the Demand for Fuel Efficiency: Evidence from Monthly New Vehicles Sales Data.” Working Paper, University of Illinois at Chicago (September).

Sallee, James, and Sarah West (2008). “Testing for Consumer Myopia: The Effect of Gasoline Price Changes on the Demand for Fuel Economy in Used Vehicles.” Working Paper, Macalester College (December).

⁴ This holds when the measurement error is uncorrelated with the regressor. When the measurement error is correlated with the regressor, the bias can go in either direction.

Review of Greene, D.L. (2009) How Consumers Value Fuel Economy: A Literature Review

Walter McManus, University of Michigan Transportation Research Institute

EPA intends to use vehicle choice models to inform the Agency's analyses of the impacts of regulatory programs that affect vehicle fuel economy. To adequately predict the ultimate impacts and judge the effectiveness of particular regulatory actions, EPA needs to understand how consumers (and producers) are likely to change their market behavior in response to the regulatory actions.

Market choices by producers and consumers of vehicles and fuels have direct negative impacts on the nation's air quality and the stratospheric ozone layer. EPA, which is responsible for protecting and improving air quality and the ozone layer, can influence but cannot control the behavior of consumers and producers. Market models, including models of consumer vehicle choice and models of producer technology and product decisions, could help EPA anticipate market responses to regulatory actions.

This report is a peer review of EPA's comparison of recent mainstream economic estimates of the value of additional fuel economy to consumers. The documents that I received from EPA (or RTI International) a memo containing the charge questions, the draft report by Greene (2009), and three unpublished papers that are covered in the draft report. The unpublished papers are Alcott and Wozny (2009); Busse, Knittel, and Zettelmeyer (2009); and Sallee, West, and Fan (2009). I reviewed all of these documents in developing my expert opinion as reported here.

Overall approach and methodology of the study

Greene (2009) adopts a conventional "literature review" approach. The question of how consumers value fuel economy in vehicle choice has been the subject of a lively conversation on and off for decades. One appealing feature of the paper is that the same author conducted a similar review in Greene (1983). Consumers of research face many temptations to undervalue the retrospective approach, and it is encouraging that EPA's choice of authors reveals the Agency's rationality as a consumer of research.

The motivation, objectives, and structure of the paper are described in two paragraphs.

"Recent historically high fuel prices, combined with renewed interest in fuel economy and greenhouse gas emissions standards for automobiles have engendered a number of new assessments, many specifically aimed at understanding the effects of fuel prices and fuel economy on consumers' vehicle choices. This paper reviews those studies, published and unpublished, with the objectives of determining whether a consensus now exists on the value consumers place on fuel economy, and of gleaning insights into how consumers use fuel economy information in their car buying decisions.

"This paper is organized as follows. Section 2 summarizes views of how the market for fuel economy functions, including both supply and demand. The body of the report is Section 3 which reviews recent empirical estimates of the value of fuel economy based on aggregate and disaggregate data, discrete choice models and hedonic demand analyses. Section 4 discusses the implication of those estimates and Section 5 contains concluding observations." (page 4)

The overall approach and methodology are within the mainstream of critical review practice in economics, and the execution is unexceptionable. However, both the conventional approach to reviewing economic research and the conventional approach to economic research itself do not give much help to decision makers who are understandably made uncomfortable by the widely differing expert opinions about parameters that are crucial in predicting the impacts of regulations and in choosing between alternatives. An overall critique of conventional practice is beyond the scope of this review. However, I do have some suggestions for improvements in the methodology for comparing studies and for dealing with the lack of consensus in expert opinions. (The References section below lists some papers by Edward E. Leamer, a professor at UCLA, in which a critique of conventional practice is developed along with alternative practices that would enhance the usefulness of economic research to policy makers.)

Data analysis conducted for the study

The experts' papers differ in several dimensions that could be responsible for some of the differences in opinions between experts. Greene (2009) helpfully provides a side-by-side comparison for econometric model type, data structure, and estimation period. In the text he covers other issues such as the econometric challenges each author faced and the strategies chosen to address the challenges. It is difficult for the reader to verify that the same standards are being used to assess each paper, especially since the amount of discussion by paper varies greatly. This leads the reader to have less confidence in the reviewer's opinions of the individual studies (that this or that one had plausible or implausible assumption, methodologies, or results).

Recommendations for alternate data and/or analyses

It would be useful to expand Table 10 (or to create a set of tables) to show other differences that could be important sources of differences in estimates. The items that could be included would show differences in:

1. Maintained assumptions reported (assumptions that are maintained across any alternative specifications or sensitivities),
2. Reported sensitivity analyses (is one done? which assumptions are varied? how widely?),
3. Econometric challenges and approaches used to address them (Greene (2009) appears to discuss these comprehensively in the text.), and
4. Out-of-sample predictive performance (are predictions made? about what? are the predictions compared to actual outcomes? how accurate are the predictions?).

Adding these additional side-by-side comparisons would increase the reader's confidence that the same standards are being used to form the reviewer's opinions about the relative usefulness of each paper to inform decision making by EPA.

My opinion: The additional elements are responsible for more of the variation in the estimates of consumer value for fuel economy than are the elements already included in Table 10.

To quantitatively assess whether we have made progress toward a consensus, we need a measure of researcher/specification uncertainty and disagreement. The 1983 and 2009 results are not compared quantitatively. Greene (1983) compared estimates of the consumer discount rate, while Greene (2009) compared estimates of consumer willingness to pay for improvements in fuel

economy. The idea is to compare the range of parameter estimates to the parameter value predicted by mainstream theory. For the consumer discount rate the theoretical value is the real discount rate, which is assumed to be 7% the following. For the willingness to pay version, the theoretical value is 100% (or willing to pay \$1 for future fuel cost savings with a discounted present value of \$1).

The metric, which I call the Multiple Extreme Estimates Test (MEET), is defined as the ratio of the value predicted by theory to the difference between the two extreme estimates.

$$MEET = \frac{|\text{Value Predicted by Theory}|}{|\text{Largest Estimate} - \text{Smallest Estimate}|} = \frac{V}{R}$$

$$\lim_{R \rightarrow \infty} MEET = 0 \quad \text{and} \quad \lim_{R \rightarrow 0} MEET = \infty$$

Numerically, MEET measures the predicted value as a share of the range of expert opinion. The range of expert opinion, R, is a crude and partial measure of the uncertainty or fragility of the estimates due to differences in assumptions, specification, and opinions between researchers. The metric MEET views this fragility compared to the theoretical value of the parameter, V.

If the span of disagreement between experts is large, then MEET is small. The limiting case, infinite disagreement, produces a MEET of 0; there is not a meeting of the minds. If the span of disagreement is very small (compared to the theoretical value of the parameter), then MEET is large. Complete agreement implies an infinite MEET.

Multiple Extreme Estimates Test (MEET)

(The ratio of the parameter value predicted by theory to the range of extreme parameter estimates.)

Estimates used to compute MEET	Greene (1983)	Greene (2009)
All studies*	0.002	0.055
All but one "outlier" **	0.096	0.080
Greene (1983) "plausible" ***	0.194	

* 22/22 in 2009 & 8/8 in 1983

** The 1983 range 0% to 73% is used, based on Table 1. In the text Greene (2009) reports the range for 1983 as 2% to 73%. The MEET for the narrower range is 0.099.

*** In my opinion, this represents Greene's opinion that the plausible range is 4% to 40%.

Do the 1983-2009 changes in MEET provide any evidence that a meeting of the minds is closer today than it was in 1983? The table shows several alternative calculations of MEET for Greene (1983) and Greene (2009). The alternatives vary by which of the studies in each year are actually used in computing the metric for that year (based on my interpretation of comparisons made by Greene to which are added alternatives that include all studies in each year).

The first thing to observe is that all of the MEET values are very low, indicating that the disagreement between experts is very large. Using all studies each year in the computation of MEET shows an increase from 0.002 to 0.055. This result is driven by the extreme outliers—the 1983 outlier (-164% to 2840% range for consumer discount rate compared to 7% predicted by

theory) is more of an outlier than is the 2009 outlier (-360% to 1410% range for willingness to pay compared to the 100% predicted by theory).

Dropping the outliers (not something I would be comfortable doing if the authors of the 30 studies had reported more informative and thorough sensitivity analyses) would result in a drop in MEET from 0.096 in 1983 to 0.080 in 2009. We are getting farther away from a consensus, but the backtrack is small in absolute terms. If the meeting of the minds is in Ann Arbor, and there was only one holdout and he was located in Davis (CA) in 1983, instead of beginning the 2,300-mile hike to Ann Arbor (according to Google), he wandered 35 miles in the opposite direction.

Appropriateness of the datasets and any other inputs

It is not clear how the studies were selected for inclusion in Greene (2009). There needs to be some explanation.

Appropriateness of the conclusions drawn

There are two fundamental conclusions made by Greene (2009). Firstly, expert opinion remains widely divided about the value of fuel economy to consumers. Despite the improvements in the quality of data about consumer behavior and in econometric tools, opinion is as widely divided today as it was three decades ago. I agree that this is the appropriate, discouraging conclusion to draw.

The second fundamental conclusion drawn by Greene (2009) concerns the causes of the wide divisions in expert opinion and what should be done about it.

“Although the methodologies or model formulations of a few of the studies are questionable, there do not appear to be clear associations among methods or data sources and the resulting inferences. It is suggested that such conflicting results may be attributable to incorrect models of consumer decision making about fuel economy, the statistical problems caused by omitted variables, errors in variables and correlated variables, and the complexity of consumers’ vehicle choice decisions. Additional, empirical behavioral research appears to be needed to resolve the issue.” (abstract)

I am not convinced that the differences in assumptions, opinions, and methods have been sufficiently examined to support even the weak proposition that “there do not appear to be clear associations among methods or data sources and the resulting inferences.” See my recommendations on pp. 2-4 above. I am not sure exactly what Greene means by “incorrect models” of consumer decision making about fuel economy, but if he means the efficient markets hypothesis and economic rationality, then I agree. Assuming that it is this deficiency in our models of consumer behavior that would be the subject of “behavioral research,” I agree.

Overall clarity of the presentation

The overall clarity of the presentation was very high.

References

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March 30, 2010

MEMORANDUM

SUBJECT: EPA Response to Comments on David Greene paper, “How Consumers Value Fuel Economy: A Literature Review,” by peer reviewers Drs. Carolyn Fischer, Christopher Knittel, and Walter McManus

FROM: Dr. Gloria Helfand, Assessment and Standards Division

Dr. Carolyn Fischer of Resources for the Future, Dr. Christopher Knittel of the Department of Economics of the University of California at Davis, and Dr. Walter McManus of the University of Michigan Transportation Research Institute reviewed David Greene’s paper, “How Consumers Value Fuel Economy: A Literature Review,” dated December 29, 2009.

This memo includes a summary of comments prepared by RTI International, and responses and actions in response to those comments from Dr. David Greene of Oak Ridge National Laboratory and EPA.

3.1 OVERALL APPROACH AND METHODOLOGY OF THE STUDY

The reviewers are supportive of the overall approach and methodology.

Walter: “The overall approach and methodology are within the mainstream of critical review practice in economics, and the execution is unexceptionable.” He does comment on the fact that “Greene (2009) adopts a conventional ‘literature review’ approach” and “both the conventional approach to reviewing economic research and the conventional approach to economic research itself do not give much help to decision makers who are understandably made uncomfortable by the widely differing expert opinions about parameters that are crucial in predicting the impacts of regulations and in choosing between alternatives. An overall critique of conventional practice is beyond the scope of this review. However, I do have some suggestions for improvements in the methodology for comparing studies and for dealing with the lack of consensus in expert opinions. (The References section below lists some papers by Edward E. Leamer, a professor at UCLA, in which a critique of conventional practice is developed along with alternative practices that would enhance the usefulness of economic research to policy makers.)”

Chris comments that the study does not discuss “*why* consumers undervalue gasoline, relative society (if they do indeed undervalue fuel economy). This has important implications for which policies are most effective at aligning discount rates.” However, he recognizes that papers dealing with such issues are lacking.

Response:

EPA is satisfied with the “conventional” literature review approach that Dr. Greene has used. If there is a lack of consensus about model parameters, this is important information for EPA as it pursues its modeling activities.

EPA did not request that Dr. Greene discuss why consumers may undervalue – or, more generally, misestimate the value of -- gasoline. EPA’s initial interest is learning how consumers consider fuel economy when they are purchasing vehicles. Greene includes some discussion of this topic on p. 8 as well as in the Executive Summary and the Conclusion. We agree that understanding why consumers may misestimate this value is an important topic.

3.2 APPROPRIATENESS OF THE DATASETS AND ANY OTHER INPUTS

One reviewer commented that the choice of the papers was comprehensive. Another reviewer recommended including some explanation of how the studies were selected for inclusion in Greene (2009).

Response:

The paper includes a discussion of its selection of papers on p. 2. In particular, it states Dr. Greene’s intent to be comprehensive. The literature review includes some of the most well known papers in the field (such as papers by Berry, Levinsohn, and Pakes and Goldberg) as well as other less well known works and papers in progress. Dr. Greene added additional papers to the review between the initial draft and the final report, in response to reviewers’ suggestions. Dr. Greene notes that he felt it important to include studies not (yet) published in peer reviewed literature because he considered them of publishable quality. EPA’s assessment is that, even if the review may have missed some papers, there does not appear to be any systematic bias in inclusion or exclusion. In addition, we support the inclusion of gray literature, because it is the most current research being conducted.

3.3 DATA ANALYSIS CONDUCTED FOR THE STUDY

Two reviewers comment on the fact that the type of analysis done for the different papers varies greatly.

Chris: “It strikes me that there are two ways to conduct a review such as this. One is to report the results of papers with little, or no, discussion of the quality each paper. The other is to both review and critique each paper. I found a lack of uniformity in this regard. For many of the papers, the latter strategy is taken. The report discusses key weakness of these papers. Still many papers are simply summarized, with little or no discussion of their strengths or weaknesses. This gives the impression that the results in these papers are more accurate. This may actually be the case, but if it is, this should be stated more explicitly.

For example, the first paper (Alcott and Wozny) is simply summarized with no editorializing. One possibility is that there are no weaknesses in this paper. But, many of the issues raised later for other papers also relate to this paper. For example, the report correctly states, when discussing the Sawhill paper, that in order to get a consistent estimate of how consumers value fuel economy, the author is required to correctly specify how consumers form expectations about gas prices and drive their vehicles. If any of these are incorrectly specified, the estimate will be biased. The same is true for the Alcott and Wozny paper. While I find Alcott and Wozny’s specification for how expectations are formed to likely be more accurate, ironically, they assume

consumers are hyper-rational in the sense that they form their gas price expectations based on NYMEX futures prices. In some ways the myopia result is inconsistent with this key assumption.”

Walter: “It is difficult for the reader to verify that the same standards are being used to assess each paper, especially since the amount of discussion by paper varies greatly. This leads the reader to have less confidence in the reviewer’s opinions of the individual studies (that this or that one had plausible or implausible assumption, methodologies, or results).”

Response:

As Dr. Greene discusses on p. 2 of the paper, “This review attempts to compare the inferences of different studies on a consistent basis: a typical consumer’s willingness to pay for a reduction in the present value of fuel costs through improved fuel economy.” The comments on individual studies are valuable in identifying issues and difficulties that arise in conducting these studies. These critiques are, to EPA, nevertheless less important than a comparison of the estimates of the willingness to pay for fuel economy across studies. Table 12 of the paper (pp. 50-51) provides that comparison.

3.4 APPROPRIATENESS OF THE CONCLUSIONS DRAWN

There was general consensus among the reviewers on the major conclusion of the document: that the literature remains mixed as to whether consumers undervalue, overvalue, or approximately value fuel economy.

One reviewer raised doubts that differences in assumptions, opinions, and methods have been sufficiently examined to support even the weak proposition that “there do not appear to be clear associations among methods or data sources and the resulting inferences.”

One reviewer expressed doubts about what Greene means by “incorrect models” of consumer decision making about fuel economy but suggested efficient markets hypothesis and economic rationality to be a possible interpretation of this phrase.

Response:

EPA accepts the general conclusion that the literature remains mixed and unsettled on how consumers consider fuel economy when buying vehicles.

The Executive Summary, the Conclusion, and Table 13 of the report provide new, further identification and assessment of the effects of different factors on modeling results. As Greene notes on p. 55, “There does not appear to be an obvious explanation for the widely divergent results. Neither model type, formulation of the variable representing fuel economy, data type, time period, nor any other readily identifiable factor shows a strong association with inferences about the values consumers place on fuel economy (Table 13).”

About the comment that there has been insufficient examination to support the proposition that “there do not appear to be clear associations among methods or data sources and the resulting inferences:” it is possible that further examination may reveal associations between results and

underlying characteristics of the studies, and Greene's statement leaves open that possibility. In the meantime, Greene was not able to find such patterns.

Greene has modified the "incorrect models" language to refer to "the likelihood that the rational economic consumer model does not adequately describe the decision-making of consumers in the real world" (p. xix, the Abstract; see p. 9 for similarly revised language). This new language appears to correspond to the reviewer's interpretation.

3.5 RECOMMENDATIONS FOR ALTERNATE DATA AND/OR ANALYSES

3.5.1 Additional Data

Two of the reviewers suggested several other studies that are relevant for this work. A list of these studies is provided below.

Dreyfus, Mark K. and W. Kip Viscusi (1995). "Rates of Time Preference and Consumer Valuations of Automobile Safety and Fuel Efficiency." *Journal of Law and Economics* 38: 79-98.

Hughes, Jonathan E., Christopher R. Knittel and Daniel Sperling (2008). "Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand." *Energy Journal*.

Kilian, Lutz and Eric Sims (2006). The Effects of Real Gasoline Prices on Automobile Demand: A Structural Analysis Using Micro Data, Working Paper, University of Michigan (April).

Klier and Linn (2010 working paper) "The Price of Gasoline and New Vehicle Fuel Economy: Evidence from Monthly Sales Data"

Klier, Thomas, and Joshua Linn (2008). "The Price of Gasoline and the Demand for Fuel Efficiency: Evidence from Monthly New Vehicles Sales Data." Working Paper, University of Illinois at Chicago (September).

Sallee and West (2009 working paper)

Sallee, James, and Sarah West (2008). "Testing for Consumer Myopia: The Effect of Gasoline Price Changes on the Demand for Fuel Economy in Used Vehicles." Working Paper, Macalester College (December).

West, S. (2008). "The Effect of Gasoline Prices on the Demand for Sport Utility Vehicles." Working Paper. Macalester College.

Response:

Greene has added 5 papers to the review since the draft that the reviewers saw: Kilian and Sims (2006), Klier and Linn (2008), Sallee, West, and Fan (2010), Vance and Mehlin (2009), and Fifer and Bunn (2009). Time limitations affected his ability to incorporate additional papers.

3.5.2 Additional Analysis

The reviewers suggested several additional analyses to strengthen the study.

- 3.5.ii a. The author should take advantage of the summary section to indicate whether some approaches reviewed in the study are likely to be better than others.

Response:

In the Executive Summary, Greene suggests convening researchers to investigate jointly why results differ so greatly. He also suggests investigation of alternatives to the rational economic model as a starting point for the analyses.

The conclusion has some discussion of study characteristics that might be superior to others. As he notes, it is not clear whether studies that had superior characteristics produced more consistent results than studies with less ideal characteristics. He suggests several factors (pp. 54-55) that might improve results: recognition that consumers do not appear to follow “the strict model of rational economic behavior;” consideration of consumer heterogeneity; and use of fixed effects.

3.5.ii b. The analysis to explain the difference in results could be improved.

Carolyn: “First, the discussion interweaves reasons that could explain why we can plausibly believe any of a range of results (e.g., heterogeneous decision rules, uncertainty) with reasons for why different studies get different results. It would be helpful to separate these discussions, reminding readers of the former, and then focusing on the latter, which is the most important contribution. This kind of analysis should help indicate best practices and directions for future research. Can we suggest some experiments (e.g., new techniques on old data sets, or old techniques on new data sets) that can help tease out what differences arise from alternative econometric approaches? If most studies have focused on other aspects of vehicle demand, are there better specifications for looking directly at the valuation of fuel economy?”

A summary of key differences in approaches and data and an analysis of their consequences would be useful. These would include

- levels of aggregation;
- time horizons (how useful is information from the 1970s in estimating current demand?);
- incorporation of the supply side;
- details of other attributes and variable definitions;
- allowing for separate responses to MPG and fuel costs (this was raised as lacking in the discussion of Gramlich, but it was not apparent which other studies had done this);
- assumptions of vehicle lifetime, VMT, discount rates, etc.; and
- econometric approach.

Although Table 10 provides some of these summary indicators (model type, data, and time), additional analysis such as the following would be useful: “Do we observe any trends across classes or time? Within a class of models, what drives the differences?”

Walter: “It would be useful to expand Table 10 (or to create a set of tables) to show other differences that could be important sources of differences in estimates. The items that could be included would show differences in:

1. Maintained assumptions reported (assumptions that are maintained across any alternative specifications or sensitivities),
2. Reported sensitivity analyses (is one done? which assumptions are varied? how widely?),
3. Econometric challenges and approaches used to address them (Greene (2009) appears to discuss these comprehensively in the text.), and
4. Out-of-sample predictive performance (are predictions made? about what? are the predictions compared to actual outcomes? how accurate are the predictions?).

Adding these additional side-by-side comparisons would increase the reader's confidence that the same standards are being used to form the reviewer's opinions about the relative usefulness of each paper to inform decision making by EPA.

My opinion: The additional elements are responsible for more of the variation in the estimates of consumer value for fuel economy than are the elements already included in Table 10."

He also suggested a measure of researcher/specification uncertainty and disagreement to quantitatively assess whether we have made progress toward a consensus. He also provides illustrative suggestions on ways to use and interpret this measure. "The idea is to compare the range of parameter estimates to the parameter value predicted by mainstream theory."

The metric is called Multiple Extreme Estimates Test (MEET) and is defined as the ratio of the value predicted by theory to the difference between the two extreme estimates.

$$MEET = \frac{|\text{Value Predicted by Theory}|}{|\text{Largest Estimate} - \text{Smallest Estimate}|} \frac{V}{R}$$

$$\lim_{R \rightarrow 0} MEET = 0 \text{ and } \lim_{R \rightarrow 0} MEET$$

"Numerically, MEET measures the predicted value as a share of the range of expert opinion. The range of expert opinion, R, is a crude and partial measure of the uncertainty or fragility of the estimates due to differences in assumptions, specification, and opinions between researchers. The metric MEET views this fragility compared to the theoretical value of the parameter, V."

Response:

The Executive Summary, Conclusion, and Table 13 include further identification and assessment of the characteristics that might, in principle, be useful in a meta-analysis: the publication status of the study; the kind of model used; the dependent variable; the type of data; the time period covered; the fuel economy measure; the form of price expectations; whether actual transactions prices were used; whether the model allowed for heterogeneous tastes; whether the model included both the demand and the supply side; and whether fuel economy standards were included. This list does not include all the variables that the reviewers cite, but it includes many of them. The discussions of individual papers include some of the other factors, such as some of the assumptions of the models. As the Executive Summary and Conclusion indicate, there are no obvious connections among these factors and the model results.

With so many variables and not very many studies, a statistical meta-analysis of these results is unlikely to produce statistically valid results.

The MEET criterion is an interesting way to think about the variation in study results. EPA at this time is satisfied with a qualitative discussion of the variation of these results.

- 3.5.ii.c. Though the issue of consumer heterogeneity has been mentioned in several places, this may be important area for additional analysis, both to explain differences and to suggest future research directions.

Response:

The issue of modeling consumer heterogeneity is likely to be important in these models. At this time it is a source of distinction among models: some approaches, especially mixed logit, incorporate this feature. The review at this time does not extend to include a discussion of the “dream” analysis – what would be the ideal data sets, methods, etc. Assessing the state of the literature is a first step to get to that discussion, and this review has focused on that step.

3.6 OVERALL CLARITY OF THE PRESENTATION

The reviewers agreed that the overall clarity of the document was high.

Reviewers had several suggestions about organizing the paper.

- i. One reviewer suggested that since the articles are organized logically by class of data and methods, it would be helpful to review those methods at the beginning of each section “including the advantages and drawbacks, as well as key factors or assumptions that can affect the results.”

Response:

Greene has not included this review of methods. EPA agrees that it would be useful information, but such review information is available elsewhere.

- ii. It has also been suggested that it would be helpful to begin with the seminal papers in each category, “so as to understand the evolution and improvements made subsequently.”

Response:

Greene has reorganized the presentation of the papers. For instance, the section on discrete choice models with aggregate data now begins with the paper by Berry, Levinsohn, and Pakes (1995), a widely cited paper.

- iii. Two reviewers agreed that the publication status of papers should be recognized and one reviewer suggested that the review should “focus first on published papers and then second on unpublished papers.”

Response:

Greene discusses, on p. 2, his reasons for including unpublished papers – in particular, his opinion that “they are of publishable quality.” The new Table 13 has a column identifying the publication status of all the studies included.

- iv. Chris Knittel: “Many of the papers reviewed did not focus on measuring the implicit discount rate, or even on the issue of how gas prices affect vehicle demand. If a paper did not focus on either of these two questions, it is difficult to gauge the robustness of their results with respect to these questions, the quality of the variation in gas prices in the data, etc. Perhaps a better method would be to first focus on those papers where gas prices and vehicle choice are the central research question, and those papers where this is more a tangential part of the analysis.”

Response:

Perhaps the major concern with studies that do not focus on fuel economy decisions is that there may not have been adequate attention to specification of the variable, or problems with omitted or collinear variables. For those reasons, the studies may not produce robust estimates of the implicit value of fuel economy.

On the other hand, studies that focus on these variables may suffer from the attention as well: if the results come out against expectations, there can be a temptation to revise the analysis until the results meet expectations. Only if results to all specifications are reported is it possible to see whether the reported results are robust.

As Greene discusses in the conclusion (p. 55), omitted variables, errors in variables, and correlated variables are likely to be problems that may be difficult to overcome in the vehicle choice context. Fixed effects may help, but may not solve the problem.

On a related note, another reviewer commented on studies that do not explicitly estimate the value of fuel economy: “Since few econometric studies have explicitly estimated the value of fuel economy, a significant contribution of the paper is to translate a wide variety of results into more consistent indicators. Yet, they could still be more consistent. In Table 10, can all of the results be converted into the same WTP metric, preferably using the same assumptions about vehicle lifespan, VMT, discounting, etc.?”

Response:

Table 12 seeks to translate estimates from all the papers into both a willingness to pay for fuel economy as a percent of the discounted present value of fuel savings, and an implied annual discount rate. As Greene discusses in the paper, it is not possible with some of the studies to find the common metric; with others, he has questions about some of the values reported that are necessary for the metric. EPA hopes that identifying these difficulties may stimulate future researchers to report these values more consistently.

Another comment on the presentation of the paper was that “the author’s baseline assumptions need to be stated clearly early in the paper, so careful attention can be given throughout to assumptions that deviate from that baseline. Indeed, the statement made in the Allcott and Wozny analysis (“Calculating the discounted present value of fuel costs requires a number of

assumptions...’) should be made earlier in a general context, so that the variety and range of assumptions can be understood and explored.”

Response:

Greene includes his assumptions for a baseline analysis in the Appendix to the paper and discusses these assumptions on p. 2.

3.7 OTHER CLARIFICATION COMMENTS

One reviewer provided the following comments to clarify or rephrase certain statements.

1. The authors should “use the phrase ‘at *society’s* discounted expected value...’ (top of page 5) instead of ‘does the market value fuel economy improvements at the discounted expected value of future fuel savings over the lifetime of the vehicle, or less, or more?’”

Response:

This change has been made.

2. The statement (on page 5) that “On the other hand, if consumers are myopic and consider only the first three years of fuel savings, for example, fuel economy standards can increase welfare even based solely on private costs and benefits” should be made clearer.

Response:

This language continues in its original form.

3. One of the reviewers comment on the statement on page 5 that “it is surprising that there is no basic research on how consumers consider fuel economy.” “This is a strange use of the term basic research, which I take to mean research on pure science. Does the author equate basic science with interviews? I have never heard basic science used in this manner.”

Response:

The word “basic” has been changed to “behavioral.”

Two of the reviewers also provided several detailed comments on specific paper reviews, Section 2 of the document, and editorial comments and corrections to typographical errors.

Response:

Greene has incorporated most of these comments into the revision.