# Consumer Willingness to Pay for Vehicle Attributes: What is the Current State of Knowledge?

United States
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# Consumer Willingness to Pay for Vehicle Attributes: What is the Current State of Knowledge?


Assessment and Standards Division
Office of Transportation and Air Quality
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## ABSTRACT

As standards for vehicle greenhouse gas emissions and fuel economy have become more stringent, concerns have arisen that the incorporation of fuel-saving technologies may entail tradeoffs with other vehicle attributes valued by consumers including safety, comfort, and performance. To the extent that such interactions are present, they may influence the rate of consumer acceptance of fuel-saving technologies. Understanding and quantifying such interactions, both positive and negative, is important for transportation policy analyses. Not only will these estimates provide a better understanding of the role of fuel-saving technologies in consumers' evaluation of new vehicles, and in consumer purchase decisions, but they will also enable a better estimate of policy impacts on overall household welfare. Given the potential importance of accounting for consumer willingness to pay (WTP) for changes in vehicle attributes when conducting policy analyses, we conduct a detailed review and analysis of literature that presents or can be used to calculate WTP for vehicle attributes in order to assess the current state of knowledge in this area. We identified 52 relevant U.S.-focused papers published since 1995 (with one exception) with sufficient data to calculate WTP values. We identify 142 individual characteristics considered in the literature, which we consolidate into the 15 general categories of comfort, fuel availability, fuel costs, fuel type, incentives, model availability, non-fuel operating costs, performance, pollution, prestige, range, reliability, safety, size, and vehicle class. We then calculate WTP values for those characteristics based on the coefficients and data reported in the papers. In addition to central tendency WTP estimates, we present indicators of variability around each WTP value, based either on standard errors of the estimated coefficients or the standard deviations in random coefficient models. We also examine the implications of heterogeneous consumer characteristics (e.g., different levels of income, household size, and other factors). Our findings suggest large variation in WTP values for vehicle characteristics, both within and across studies. This variation may result in part because of methodological difficulties in estimating how attributes affect consumer vehicle choices, such as omitted variables, errors in variables, collinearity, and the use of proxies. We discuss the implications of this variation in WTP estimates for estimating changes in consumer demand due to a change in fuel efficiency technology.



**Keywords:** Consumer preference, fuel efficiency, vehicle demand, willingness to pay

***JEL Codes:*** D12, O33, Q52, R40

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# SECTION 1.
# INTRODUCTION

As standards for vehicle greenhouse gas emissions and fuel economy become more stringent, vehicle design modifications made to achieve environmental goals could potentially impact other vehicle attributes valued by consumers including noise, safety, comfort, and performance. To the extent that such interactions are present, they may influence the rate of consumer acceptance of fuel-saving technologies. For instance, some analysts have argued that consumers undervalue fuel savings and therefore underinvest in technologies that improve fuel economy, but one possible explanation for consumer adoption patterns deviating from market projections is that there are interactions with other vehicle attributes that consumers are considering. Understanding and quantifying such interactions, both positive and negative, is important for transportation policy analyses.

The research presented in this report has three main objectives.

- Survey the econometric literature to identify the vehicle attributes for which estimates of marginal willingness to pay (WTP) can be computed.
- Derive central tendency estimates of WTP for as many attributes as possible.
- Produce summary statistics describing the distribution of WTP estimates for all attributes, with special attention to fuel cost and performance.

Developing consensus estimates of WTP for vehicle attributes is not a goal of the research presented in this paper. A meta-analysis of WTP for fuel cost and performance using the estimates developed in this study has also been completed (Greene et al., 2018).

This exploratory analysis of estimates of WTP for vehicle attributes is intended to provide a better understanding of the role of vehicle attributes in consumers' evaluation of new vehicles and in consumer purchase decisions, to eventually enable a better estimate of policy impacts on overall household welfare when vehicle attributes change in response to a policy. Given the potential importance of accounting for consumer WTP for changes in vehicle attributes when conducting policy analyses, we conduct a detailed review and analysis of literature that presents or can be used to calculate WTP for vehicle attributes in order to assess the current state of knowledge in this area. We identified 52 relevant U.S.-focused papers published since 1995 (with one exception[1]) with sufficient data to calculate WTP values. We

[1] We retain Lave and Train (1979), the first application of a multinomial discrete choice model to automobile choice, as a useful comparison point despite its publication year falling outside our primary restriction criteria.

identify 142 individual characteristics considered in the literature, which we consolidate into the 15 general categories of comfort, fuel availability, fuel costs, fuel type, incentives, model availability, non-fuel operating costs, performance, pollution, prestige, range, reliability, safety, size, and vehicle class. We then calculate marginal WTP values for those characteristics based on the coefficients and data reported in the papers.

Our method follows the first four steps of the procedure for meta-analysis of WTP data recommended by Van Houtven (2008):

- Problem formulation: specifying research objectives and defining the scope of the analysis,
- Data collection: via a formal literature search,
- Data evaluation and abstraction: insuring that the WTP are valid and acquiring them along with descriptors (e.g., units) and study attributes,
- Data preparation: standardization of WTP and potential explanatory variables in constant dollars and units to the extent possible.

The final two steps, data analysis and presentation of results, will be accomplished in a separate paper focusing on fuel economy and performance (Greene, et al., 2018).

We limit the scope of our analysis to U.S. studies published between 1995 and 2015, with the sole exception of Lave and Train (1979), the first use of a random utility model to vehicle choice. We consider only U.S. studies because there are a sufficient number of them and because our goal is to inform U.S. policy making. Introducing results from other countries with different vehicle choices, consumer preferences, and government policies would require an analysis of the impacts of those differences on the WTP estimates. In addition, consumers' preferences can change over time. Focusing on more recent studies is intended to make our analysis more relevant to current policy making. We focus on peer-reviewed studies but also include a smaller number of studies from the grey literature, a procedure recommended for meta-analyses to reduce publication bias (Van Houtven, 2008, p. 904). By means of a structured literature search (described in Section 2), we identified 52 U.S.-focused papers with sufficient data to calculate WTP values for various vehicle attributes. Within papers, we include all estimation results presented unless they are identified by the authors as incorrect or erroneous. We do not include only the authors' preferred model if alternatives are considered plausible. We do this to reduce confirmation bias. For all plausible models we include all attribute estimates, statistically significant or not, because the values of all parameter estimates are interdependent and because a finding of statistical insignificance can also be meaningful.

This report describes the central tendencies of the WTP estimates derived from the literature. In addition to central WTP estimates, we present estimates of variability around each WTP value. These ranges are based either on standard errors of the estimated coefficients or the standard deviations in random coefficient models for models in which WTP depends on income. The WTP estimates exhibit large variation in the implied values for vehicle characteristics, both within and across studies. This variation may result in part because of methodological difficulties in estimating how attributes affect consumer vehicle choices, such as omitted variables, errors in variables, collinearity, and the use of proxies where the exact variables that the authors would ideally like to include are not available. We discuss the implications of this variation in WTP estimates for estimating changes in consumer demand due to a change in fuel efficiency technology. A meta-analysis of the variability of WTP estimates is in Greene et al. (2018).

This report revises the Final Report prepared under previous contract EP-C-11-045, work assignment 4-11. Since that report was written, we contacted the authors of the studies comprising our main sample used in this report to ask for their feedback on our use of their study results. As detailed in Appendix F, we received feedback from authors on 36 of the 52 papers in our main sample. Responses for 20 of those papers either indicated agreement with our calculations or suggested we verify certain calculations, which we did but that verification resulted in no changes. For the other 16 papers where we received author feedback, we made revisions to our calculations in response. The authors of two additional papers made suggestions for additional clarification within the report that we incorporated. This report thus supersedes the Final Report from Work Assignment 4-11.

The following section provides a brief overview of the econometric literature on consumers' choices of vehicles and preferences for their attributes. This is followed by a description of the studies analyzed and the attributes for which WTP estimates could be derived in Section 3. Our methods for estimating WTP using coefficients and other information available from the studies in our sample are described in Section 4. Descriptive statistics and analysis of the results for the most prevalent attributes are presented in Section 5. Our discussion in Section 6 focuses on additional analyses of five specific studies within our data set that provide special insights into the great variability of WTP estimates found in the literature. The studies present varying results from the same database using different model formulations or estimation methods. Finally, in Section 7 we conclude by reflecting on possible explanations for the divergence of WTP estimates found in the literature and offering some recommendations for future research.

## SECTION 2.
## LITERATURE REVIEW

The econometric literature dealing with consumers' vehicle choices is extensive and rich in terms of data sources, models and estimation methods. Vehicle choice models based on the attributes of vehicles and consumers have their origins in economic theories and models developed in the latter half of the 20th century. The theory that consumers desire the attributes of goods and not the goods themselves and that a single good generally possesses multiple attributes was proposed fifty years ago by Lancaster (1966). Among the earliest applications of the new theory of consumer demand was an effort to predict choice of mode of transportation based on the attributes, speed, frequency of service, comfort and cost (Quandt and Baumol, 1966). The new theory of consumer demand led to empirical efforts to estimate hedonic demand equations, models for predicting consumers' willingness to pay for goods as a function of their attributes (Rosen, 1974). Hedonic price modeling has also been applied to correcting price indices for changes in the quality of goods over time (Grilliches, 1971). McFadden (1974) applied the theory of demand for attributes to modeling consumers' choices among discrete modes of transportation. Consumers were assumed to base their choices on indirect utility functions comprised of an observable function of the attributes of the choices and of the consumers and an unobservable random utility component. By specifying the distribution of random utility as a type I extreme value distribution, McFadden derived the multinomial logit model, variations of which still dominate the literature today. The first application of the multinomial logit discrete choice model to automobile choice appeared in 1979 (Lave and Train, 1979). Lave and Train's model predicted consumers' choices among ten vehicle classes using data from a survey of new car buyers in seven U.S. cities. The first estimation of an automobile choice model using market shares data was a random coefficient model developed by Cardell et al. (1977). Over the past 35 years, formulations of discrete choice models applied to vehicle choices have increased in number and complexity. Methods have been developed for estimating discrete choice models using market sales data (Berry et al., 1995) and for estimating models from survey data with random coefficients to reflect variations in consumers' valuation of different attributes (McFadden and Train, 2000). These theoretical and methodological developments have engendered an extensive published literature that provides a rich resource for analyzing consumers' willingness to pay for vehicle attributes.

Tardiff (1980) reviewed the earliest efforts to apply discrete choice models to automobile choice in a special issue of *Transportation Research* devoted to automobile choice and its energy implications. The earliest applications were efforts to predict the number of vehicles households would own and their choice of transportation mode. Attributes typically included only the price of an automobile and such modal characteristics as travel times for the journey to work. The first application of a random coefficient model to the choice of type of automobile that we identified was Beggs and Cardell (1980), an analysis of consumers' likelihood of purchasing an electric car. A number of studies published in the early 1980s extended Lave and Train's (1979) initial multinomial logit (MNL) model of choice among vehicle classes to predict choices among individual makes and models of vehicles and to represent consumers' decisions about how many vehicles of which types to own or whether or not to purchase a vehicle. These efforts led to the development of the nested multinomial logit (NMNL) model in which the choice of type of vehicle was "nested" within the choice of how many vehicles to own. All of these models estimated trade-offs between vehicle attributes and vehicle price, enabling the calculation of marginal willingness to pay for various vehicle attributes.

Potoglou and Kanaroglou (2008) provide an overview of the more recent discrete choice modeling literature as applied to households' automobile choices. The review covers models of car ownership, vehicle type choice, as well as models of vehicle holdings and transactions. During the 1980s the NMNL model came to be preferred by researchers over the simple MNL model because of its ability to represent more flexible choice structures involving a larger number of alternatives. Mixed Multinomial Logit (MMNL or MXL) models with random coefficients representing heterogeneous preferences for vehicle attributes can approximate any random utility model but must generally be estimated by numerical approximation or simulation. Methods for estimation of random coefficient models from survey data were further developed by McFadden and Train (2000) and Train (2009) and from vehicle sales data by Berry et al. (1995). Because of differences in estimation methods and type of data used (individual survey responses for MXL versus aggregated market sales data for the Berry, Levinson and Pakes, BLP, method) we make a distinction between BLP and MXL models. Random coefficient models greatly increased the potential to represent heterogeneous consumer preferences and more complex preference structures. Not only could the means and standard deviations of coefficients be estimated but also correlations among preferences.

While the econometric literature on vehicle choice is rich in terms of theory and methodology, evaluations of the coefficient estimates and predictive ability of vehicle choice models is relatively scarce. Haaf et al. (2014) observe that the bulk of the vehicle choice literature is focused on explanation rather than prediction. Model validity is primarily judged by goodness of fit measures and statistical significance and signs of coefficient estimates. However, models that fit existing data best may not be best for prediction. Coefficients may be biased due to misspecification, omitted variables or errors in variables or may be sensitive to overfitting noise in the data instead of the signal. There is some evidence that this may be the case with vehicle choice models. In a study that appears to be unique in the literature, Haaf et al. (2014) fitted 8,993 discrete choice models, including MNL, NMNL and MXL, to aggregate US sales data for 2004–2006 using variables commonly included in models in the peer-reviewed literature and choosing model formulations based on objective measures of goodness of fit to the within sample data. They found that none of the models could outperform a static model which predicted that market shares in 2007 would be equal to those of the most recent year in the estimation data. Berry et al. (1995) similarly concluded that their random coefficient model, also estimated on aggregate sales data but including some aggregate consumer data, had limited ability to predict future market behavior. They report that it predicted market shares and new vehicle average fuel economy well for the first two forecast years but that once new makes and models with different attributes began to be introduced, the model's predictions "…became markedly worse and deteriorated further over time" (Berry et al., 1995, p. 886).

Potoglou and Kanaroglou (2008) note that the early use of revealed preference data to estimate consumers' likelihood of choosing alternative fuel vehicles (AFV) was problematic because actual choices of AFVs were either rare or nonexistent in the marketplace. This led researchers to develop stated preference (SP) surveys in which choices could be presented to respondents using a structured experimental design, and the information given could be carefully controlled. But SP surveys also had limitations. Most respondents had no direct experience with the attributes of AFVs making their assessment of their values potentially unreliable. And, like other surveys, SP surveys are susceptible to a variety of response biases, including "yea-saying" in which respondents tend to give answers they believe are the ones wanted or social desirability bias which can make respondents more likely to exaggerate their desire to purchase a low-polluting vehicle. Indeed, early studies predicted a substantial willingness to purchase AFVs that did not materialize in the marketplace. Hidrue et al. (2011) note that studies of electric and other AFV choice based on SP survey data indicated a substantial willingness to pay to reduce emissions and to save on fuel. The nature of survey response biases is such that they are likely to affect certain types of willingness to pay estimates more than others. Combining SP and RP data to estimate choice models has been proposed as a potential solution or means of ameliorating response bias. In general, actual sales data are used to formulate constraints (moments) to be met by the estimation algorithm. Although this method has merit, it is also limited by the degree to which the RP data contains relevant information.

The recent literature includes many studies that model consumers' willingness to purchase AFVs based on SP survey data. A large fraction aim at providing insights into the market for electric drive vehicles. Tanaka et al. (2014) summarized the attributes included in 21 choice models focused on AFVs. All but one included purchase price, all included some measure of fuel cost, fifteen included measures of performance of which the most common was acceleration. As noted by Hidrue et al. (2011), studies done in the 1990s and later include more attributes specific to battery electric vehicles, such as emission reductions, refueling time and the opportunity for home refueling. Although motorists are thoroughly familiar with the acceleration performance of conventional internal combustion engine vehicles, the acceleration of an EV is qualitatively different. Electric motors deliver almost full torque from 0 rpm and therefore accelerate much more quickly from a full stop than an internal combustion engine vehicle. Among other attributes of special relevance to EVs included in the studies were range (14), fuel availability (12), emissions reduction (11) and fuel type (7). Again, while motorists are familiar with the effect of range on the frequency of refueling, few have any experience with a vehicle that takes hours rather than minutes to refuel but can conveniently be refueled at home. Drivers of gasoline vehicles also lack experience with fuel availability as scarce as 1% to 10% that of gasoline. This general lack of direct experience with novel vehicle technologies makes interpretation of WTP estimates for attributes of AFVs uncertain.

Dimitropoulos et al. (2013) presents a meta-analysis of 33 SP studies that estimated WTP for vehicle range based on surveys conducted between 1978 and 2011. WTP estimates varied widely but the authors concluded that consumers were willing to pay, on average, between $66 and $75 (2005$) for a 1-mile increase in driving range. The distribution of estimates was positively skewed, with a median value of $55 and a range of $8 to $317. The authors present 95% confidence intervals of $49 to $84 (unweighted), $48 to $101 (weighted by observations per data set) and $29 to $104 (weighted by observations per data set and study sample size). The meta-analysis produces several inferences concerning the effects of methods and study design. Studies employing random coefficient models assuming log-normal distributions for both purchase price and driving range produced much higher WTP values than other methods. Studies that focused exclusively on BEVs, not including other types of alternative fuel vehicles, produced higher estimates of WTP for range. In general, WTP for range was lower for studies that included longer driving ranges. Studies that included the option of fast-charging for EVs produced lower WTP estimates. Finally, US-based studies produced higher WTP values than EU-based studies.

Dimitropoulos et al. (2013) point out two important shortcomings of existing studies. In theory, the value of range should decrease at a decreasing rate with increasing range. However, researchers generally formulated models that assumed a constant value per mile of range. Consistent with this, the levels of driving range considered in a study were found to have an important impact on WTP estimates. In addition, the value of range should not be independent of the time required to refuel, a particularly important consideration for battery electric vehicles.

Again, general practice is to estimate WTP for range independent of refueling time. Only three studies considered the dependence of WTP for range on refueling time. These shortcomings undoubtedly contributed to the conclusion that consumers would pay $3,800 (mean value) for an increase in vehicle range from 100 to 150 miles and $17,200 for an increase from 100 to 350 miles. The median WTP values for such increases were $3,200 and $13,100, respectively. Massiani (2013) makes similar criticisms of existing SP surveys of consumers' preferences relative to electric vehicles. Additionally, he points out that concepts such as limited public refueling availability or the convenience of home refueling may not be well understood by respondents because they lack relevant experience. The potential role of an EV as a second or third vehicle in a household portfolio also may affect preferences for different attributes but is rarely considered, nor are relevant EV-specific factors such as the ownership of a garage.

Models embodying Lancaster's theory of consumers' demands for attributes of goods have increased in mathematical complexity over the years, along with increasingly sophisticated estimation methods. At the same time, increasingly diverse and detailed data sources have been developed. Models of consumers' vehicle choices have generally been developed to explain behavior or for policy analysis. Little attention has been given to model validation, either in terms of predictive accuracy or the general plausibility of WTP values implied by model parameters. The predictive accuracy of models is rarely reported in the literature. The few such evaluations available indicate poor predictive ability. Researchers observed that revealed preference data presented serious challenges for estimating vehicle choice models: 1) high collinearity and limited variation in vehicle attributes, 2) problems defining choice sets from the thousands of makes, models, drivetrain and trim configurations and, 3) uncertainty about the attributes of greatest interest to consumers and difficulty in obtaining appropriate measures.

The potential for attribute-based models of consumer demand to predict demand for novel products inspired numerous attempts to develop such models for alternative fuel vehicles. The absence of revealed preference data on alternative fuel vehicle choices led to the development of stated preference surveys. Because stated preference surveys could be structured according to a rigorous experimental design they held the promise of overcoming the statistical challenges presented by revealed preference data. Yet stated preference data has its own issues, especially for estimating demand for novel products. These include well known survey biases such as yea-saying and social desirability bias. Respondents also often have difficulty expressing coherent preferences for attributes with which they are unfamiliar.

All of this makes the usefulness of WTP estimates derived from this literature for conducting policy analyses an open question. This assessment attempts to address that question by deriving WTP estimates from a large set of U.S. studies conducted since 1995.

# SECTION 3.
# DESCRIPTION OF STUDIES AND ATTRIBUTES ANALYZED

We conducted a systematic literature review for peer-reviewed publications and grey literature from academic or research institutions that suggested relevance to the following set of search terms. We identified literature using three different search strategies. We reviewed search engines such as Google Scholar, Science Direct, and Econlit directly using the below search terms. In addition to these databases, we reviewed bibliographies of relevant literature for further sources. Finally, we ran searches on relevant economics, energy, or environment-focused academic journals. A fourth unanticipated strategy was receiving published or working paper suggestions through correspondence with other authors during our data processing and analysis stages.

**Search parameters:**

**Types of literature:** 1) peer reviewed publications, 2) grey literature from academic/research institutions

**Search engines:** Google Scholar, Econlit, Science Direct

**Sample journals:** Energy Economics, Econometrica, American Economic Review, Transportation Research (Parts A-E), Resource and Energy Economics, Review of Economics & Statistics, Transportation Review Board

**Publication Years**: 1980-present

**Region:** primarily US

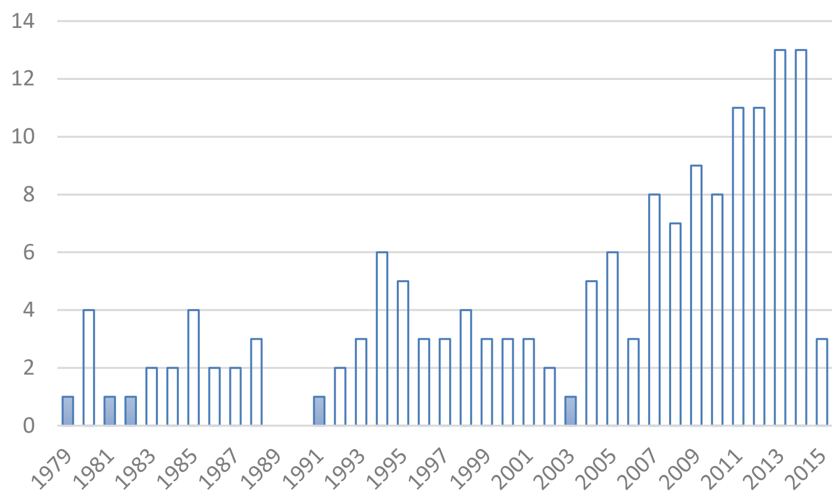
**Search terms**: willingness to pay, WTP, demand, stated preference, revealed preference, vehicle characteristics, vehicle attributes, automobile, design, fuel, choice

We used the search parameters above to produce an initial pool of 160 papers. Figure 3-1 shows the distribution of these studies by publication year and highlights the relative surge in interest and research output in recent years. We then discarded papers that focused primarily on markets outside of the US (n=46), and all but one of those that studied US markets prior to 1995 (n=34 out of the 114 that were focused on the US), leaving us with 80 papers.[2] This latter restriction based on publication year enabled our final sample to better reflect modern vehicle design, empirical modeling strategies, and consumer preferences.

During the calculation stage, we further discarded 28 papers from the remaining sample of 80, as they did not provide enough data to enable calculation of willingness to pay estimates, or proved to be irrelevant upon further examination. Our final sample included 52 relevant papers with sufficient data to calculate WTP values. Nearly all were published from 1995 onward and focused on the U.S. We refer to these 52 papers as our "main sample" (see Appendix A for a full bibliography of these studies).

[2] We retain Lave and Train (1979), the first application of a multinomial discrete choice model to automobile choice, as a useful comparison point despite its publication year falling outside our primary restriction criteria.

**Figure 3-1. Distribution of Initial Pool of Papers Considered by Year of Publication**




*Sample Description*

From our final sample of 52 studies, we calculated 777 estimates of WTP for vehicle attributes, within which there were 142 unique attributes. As Table 3-1 details, the majority of the estimates came from peer-reviewed literature (86.4%); only seven papers from the main sample came from grey literature. We found a mix of data types utilized. About 58.2% of the estimates came from survey data: 19.6% used revealed preference surveys such as the National Household Travel Survey that reflect respondents' actual vehicle purchases (see, e.g., Liu, 2014; Liu, Tremblay, and Cirillo, 2014); 38.6% used stated preference surveys reflecting hypothetical choices (e.g., Brownstone et al., 1996; Brownstone, Bunch, and Train, 2000). About 29.3% came from market data (e.g., Berry, Levinsohn, and Pakes, 1995; Haaf et al., 2014), and another 12.5% from other sources including joint revealed preference-stated preference (RP-SP) data (e.g., Axsen, Mountain, and Jaccard, 2009; Hess et al., 2011) and literature summaries (Greene, 2001; Greene, Duleep, and McManus, 2004). Notably, newer studies tended to rely more heavily on survey data, particularly stated preference surveys, as a mode of ascertaining taste for alternative fuel technologies. The majority of available estimates came from logit models (MNL, NMNL, or MXL).

**Table 3-1. Literature Summary Statistics Based on our Main Sample**

| | |
|---|---|
| Paper count | 52 |
| Observation count | 777 |
| Unique attribute count | 142 |
| Literature type (out of 52) | |
| Peer-reviewed | 86.4% |
| Grey | 13.6% |
| Data type (out of 777) | |
| Revealed preference (RP) survey | 19.6% |
| Stated preference (SP) survey | 38.6% |
| Market data | 29.3% |
| Other | 12.5% |
| Model type (out of 777) | |
| Hedonic demand | 8.8% |
| Multinomial logit (MNL) | .6% |
| Nested multinomial logit (NMNL) | 13.6% |
| Mixed logit (MXL) | 29.3% |
| Berry-Levinsohn-Pakes (BLP) | 6.8% |
| Other | 11.3% |

Table 3-2 describes the data sources for each paper. Most of the data sources represent the entire U.S. market, and vehicle purchases by households predominate. Studies of new vehicle choices are the most common but some are based on only used vehicles and several include both. Notably, sample sizes vary by orders of magnitude. Moreover, sample sizes are not directly comparable across data types. Recently, surveys of household vehicle purchases have become available that include millions of records. On the other hand, studies based on aggregate market sales have smaller sample sizes (e.g., the sum of makes and models over several years) but represent a complete accounting of all vehicle sales. Studies exploring choices of alternative technology vehicles, such as battery electric vehicles, are typically based on stated preference surveys because actual sales volumes have been too small to rely on stated preference survey data. Sample sizes for stated preference surveys range from several hundred to several thousand respondents. Because of the lack of comparability of sample sizes across the different types of data, we do not attempt to weight WTP estimates by sample size.

## Table 3-2. List of Papers Included and Description of Their Data

| Citation | Region | Type of Data | Survey Type (preference) | Market Segment | Sample Size | Start Year | End Year |
|---|---|---|---|---|---|---|---|
| Allcott and Wozny, 2014 | U.S. | Market | Discrete | Households, used vehicles | 1,068,459 | 1999 | 2008 |
| Axsen, Mountain, and Jaccard, 2009 | Canada | Survey | RP & SP | Households, new vehicles | 9,630 | 2006 | 2006 |
| Axsen, Mountain, and Jaccard, 2009 | California | Survey | Revealed | Households, new vehicles | 7,344 | 2006 | 2006 |
| Beresteanu and Li, 2011 | 22 MSAs | Market | Discrete | Households, new vehicles | 139,382 | 1999 | 2006 |
| Berry, Levinsohn, and Pakes, 1995 | U.S. | Market | Aggregate | New vehicles, market | 2,217 | 1971 | 1990 |
| Brownstone and Train, 1999 | California | Survey | Stated | Households, new vehicles | 4,654 | 1993 | 1993 |
| Brownstone et al., 1996 | California | Survey | Stated | Households, new vehicles | 1,156 | 1993 | 1993 |
| Brownstone, Bunch, and Train, 2000 | California | Survey | RP & SP | Households, new vehicles | 5,253 | 1993 | 1995 |
| Busse, Knittel, and Zettelmeyer, 2013 | U.S. | Market | Discrete | Households, new and used | 1,863,403 | 1999 | 2008 |
| Dasgupta, Siddarth, and Silva-Risso, 2007 | California | Market | Discrete | Households, new luxury | 15,556 | 1999 | 2000 |
| Daziano, 2013 | California | Survey | Stated | Households, new vehicles | 7,437 | 1999 | 1999 |
| Dreyfus and Viscusi, 1995 | U.S. | Survey | Revealed | Households, new and used | 2,986 | 1988 | 1988 |
| Espey and Nair, 2005 | U.S. | Market | Aggregate | New vehicles, market | 130 | 2001 | 2001 |
| Fan and Rubin, 2010 | Maine | Survey | Revealed | Households, new vehicles | 2,623 | 2007 | 2007 |
| Feng, Fullerton, and Gan, 2013 | U.S. | Market | Discrete | Households, new vehicles | 9,027 | 1996 | 2000 |
| Fifer and Bunn, 2009 | U.S. | Market | Discrete | Households, new vehicles | 17,627 | 1996 | 2005 |
| Frischknecht, Whitefoot, and Papalambros, 2010 | U.S. | Market | Discrete | Households, new vehicles | 6,563 | 2006 | 2006 |
| Gallagher and Muehlegger, 2011 | U.S. | Market | Discrete | Households, HEVs | 4,781 | 2000 | 2010 |
| Goldberg, 1995 | U.S. | Survey | Revealed | Households, new and used | 20,571 | 1983 | 1987 |
| Gramlich, 2008 | U.S. | Market | Discrete | Households, new vehicles | 4,820 | 1971 | 2007 |
| Greene and Duleep, 2004 | U.S. | Lit Review | | | | | |
| Greene, 2001 | U.S. | Lit Review | | | | | |
| Haaf et al., 2014 | U.S. | Market | Discrete | Households, new vehicles | 3,000 | 2004 | 2006 |
| Helveston et al., 2015 | U.S. | Survey | Stated | Households, new vehicles | 384 | 2013 | 2013 |
| Hess et al., 2012 | California | Survey | RP & SP | Households, new vehicles | 3,274 | 2008 | 2009 |
| Hess, Train, and Polak, 2006 | California | Survey | Stated | Households, new vehicles | 7,437 | 1999 | 1999 |
| Hidrue et al., 2011 | U.S. | Survey | Stated | Households, new vehicles | 3,029 | 2009 | 2009 |
| Kavalec, 1999 | California | Survey | Stated | Households, new vehicles | 4,747 | 1993 | 1993 |
| Klier and Linn, 2012 | U.S. | Market | Aggregate | New vehicles, market | 64,671 | 1978 | 2007 |
| Lave and Train, 1979 | U.S. | Market | Discrete | Households, new vehicles | 541 | 1976 | 1976 |

(continued)

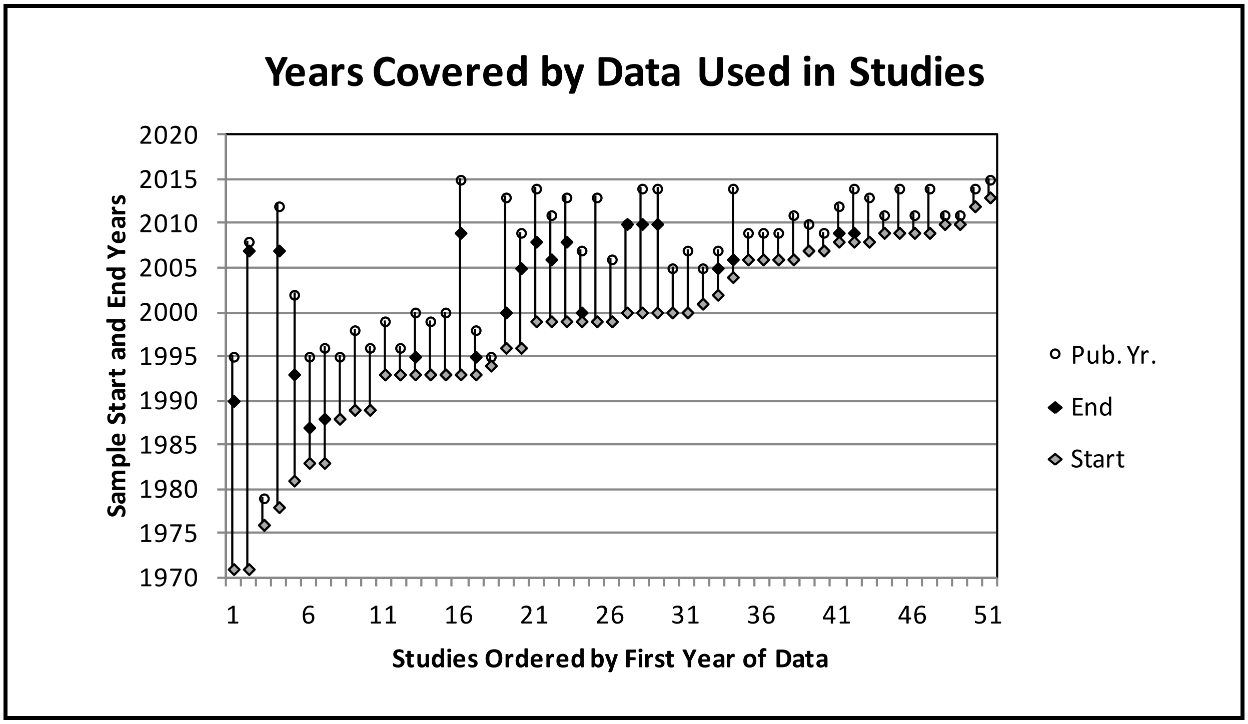
**Table 3-2. List of Papers Included and Description of Their Data**

| Citation | Region | Type of Data | Survey Type (preference) | Market Segment | Sample Size | Start Year | End Year |
|---|---|---|---|---|---|---|---|
| Liu, 2014 | U.S. | Survey | Revealed | Households, new and used | 8,086 | 2008 | 2009 |
| Liu, Tremblay, and Cirillo, 2014 | DC, MD, VA | Survey | Revealed | Households, new and used | 4,525 | 2009 | 2009 |
| McCarthy and Tay, 1998 | U.S. | Survey | Revealed | Households, new vehicles | 33,284 | 1989 | 1989 |
| McCarthy, 1996 | U.S. | Survey | Revealed | Households, new vehicles | 1,564 | 1989 | 1989 |
| McFadden and Train, 2000 | California | Survey | Stated | Households, new vehicles | 4,654 | 1993 | 1993 |
| McManus, 2007 | U.S. | Market | Discrete | Households, new vehicles | 445 | 2002 | 2005 |
| Musti and Kockelman, 2011 | Austin, TX | Survey | Stated | Households, new and used | 608 | 2009 | 2009 |
| Nixon and Saphores, 2011 | U.S. | Survey | Stated | Households, new and used | 835 | 2010 | 2010 |
| Parsons et al., 2014 | U.S. | Survey | Stated | Households, new vehicles | 3,029 | 2009 | 2009 |
| Petrin, 2002 | U.S. | Market | Discrete | Households, new vehicles | 2,407 | 1981 | 1993 |
| Sallee, West, and Fan, 2015 | U.S. | Market | Discrete | Households, used vehicles | 1,429,677 | 1993 | 2009 |
| Segal, 1995 | U.S. | Survey | Stated | Households, new vehicles | 662 | 1994 | 1994 |
| Sexton and Sexton, 2014 | Colorado | Market | Discrete | Households, new and used | 1,053,000 | 2000 | 2010 |
| Sexton and Sexton, 2014 | Washington | Market | Discrete | Households, new and used | 1,050,000 | 2000 | 2010 |
| Shiau, Michalek, and Hendrickson, 2009 | U.S. | Market | Discrete | Households, new vehicles | 1,000 | 2007 | 2007 |
| Skerlos and Raichur, 2013 | U.S. | Market | Discrete | Households, new vehicles | NA | 2008 | 2008 |
| Tanaka et al., 2014 | U.S. | Survey | Stated | Households, new vehicles | 8,202 | 2012 | 2012 |
| Tompkins et al., 1998 | U.S. | Survey | Stated | Households, new vehicles | 7,800 | 1993 | 1995 |
| Train and Weeks, 2005 | California | Survey | Stated | Households, new vehicles | 500 | 2000 | 2000 |
| Train and Winston, 2007 | U.S. | Survey | Revealed | Households, new vehicles | 458 | 2000 | 2000 |
| Walls, 1996 | U.S. | Market | Discrete | Households, new vehicles | 79 | 1983 | 1988 |
| Whitefoot, Fowlie, and Skerlos, 2011 | U.S. | Market | Discrete | Households, new vehicles | 473 | 2006 | 2006 |
| Zhang, Gensler, and Garcia, 2011 | U.S. | Survey | Stated | Households, new vehicles | 7,595 | 2010 | 2010 |

Note: SP=stated preference, RP=revealed preference, MSA=metropolitan statistical area, HEV=hybrid electric vehicle.

Although all but one of the studies in our sample was published after 1994, more than a third of the studies make use of data series that began prior to 1995 (Figure 3-2). Altogether, the studies' data span a 45-year period from 1971 to 2015. For studies based on a single year of survey data, the start and end years are the same. The two literature review papers are not included in Figure 3-2.

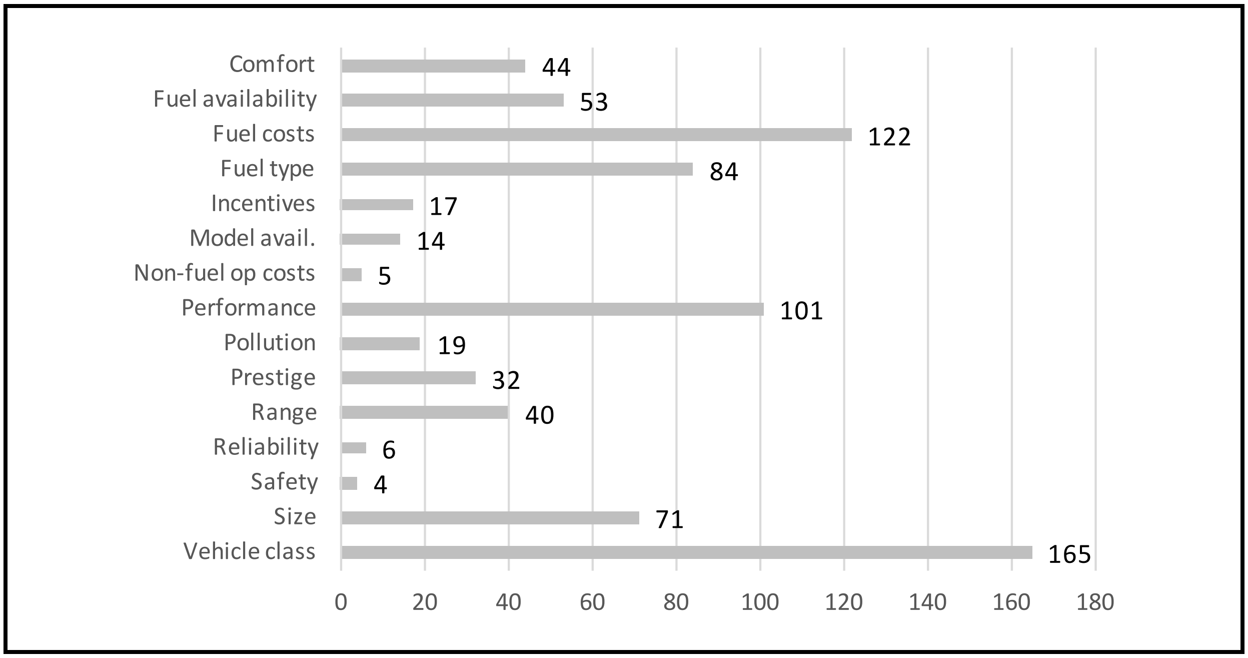
**Figure 3-2. Distribution of Papers Considered by Time Period of Data Used.**




Given the diversity of attribute measures, a significant challenge was standardizing units and measures across studies to enable cross comparison. We initially categorized attributes broadly into fifteen groupings, listed in Figure 3-3, for the purposes of utility and illustration (see Appendix B for a more detailed characterization).[3] These groupings are intended to represent the quality consumers seek or assess in vehicles, via the observed attribute. For example, acceleration time and braking distance are both measures of performance. Miles per gallon is an example of fuel costs. Appendix B lists all attributes under each grouping. We derive the groupings from existing taxonomies in the literature, balancing against author interpretations. We describe methodologies for standardizing attributes for comparison further in Section 5.

[3] Not all the observations identified in Figure 3-3 could be included in our summary calculations (see Table 5-1) due to unit conversion issues that prevented direct comparison with the other measures in that grouping.

**Figure 3-3. Number of Observations by Attribute Grouping**




As shown in Figure 3-3, we find that grouping frequencies often do not map directly onto consumer priorities. Most interesting to note is that key qualities such as safety, reliability, and comfort rarely appear in the literature despite their expected relevance to consumer decision making. In many cases, this is a result of limited data on these characteristics and few available proxies. In other cases, some attributes may signal multiple qualities to consumers that may not be captured in this taxonomy. Vehicle weight, for example, is a measure of size but also correlates strongly with vehicle class.

We find that other core factors such as fuel cost, fuel type, and performance are considered in many studies and provide grounds for comparative analysis. We also see that vehicle class appears in several studies, though these attributes often serve to function as controls or fixed effects rather than variables of interest.

# SECTION 4.
# METHODOLOGY

This section provides an overview of the methodology we used to generate our estimates of WTP based on the literature. Although some papers calculate and report WTP, many do not though they provide sufficient information for WTP to be calculated.

## 4.1 Estimating Central Tendencies of WTP

The literature in the main sample presents three categories of empirical models from which to derive willingness to pay (WTP) estimates:

1. Hedonic price models,
2. Multinomial logit (MNL) and nested multinomial logit (NMNL) models and,
3. Mixed logit (MXL) and other models (e.g., BLP[4]) with random distributions of preferences.

In hedonic price models, vehicle price is the dependent variable and the vehicle's attributes are explanatory variables. In the simplest form, the price of vehicle j, $p_j$, is a linear function of its weighted attributes ($x_{jk}$), with $\gamma_k$s as weights, as shown in Equation 4.1.

$$p_j = \sum_{k=1}^{K} \gamma_k x_{jk} \tag{4.1}$$

Assuming the hedonic price function correctly represents a demand function, the marginal value or willingness to pay for the $k^{th}$ attribute is the derivative of price with respect to attribute $x_{jk}$. In Equation 4.2 this is just the coefficient of $x_{jk}$ (Equation 4.2).[5]

$$\frac{dp_j}{\partial x_{jk}} = \gamma_k \tag{4.2}$$

If attributes are interacted with other variables or if more complex functional forms are used, the derivative will be more complex and may depend on the values of other variables. For example, if all variables are entered as logarithms, the derivative of price would be $\gamma_k/x_{jk}$, and a mean value of $x_k$ would be used to calculate the central tendency WTP.

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[4] Several models use the method of Berry, Levinson, and Pakes (1995) (BLP) to estimate random coefficient models from aggregate sales data. We use the term MXL model to refer to random coefficient models estimated from survey data.

[5] Reduced form hedonic price models have a long-recognized identification problem when used to make inferences about consumers' preferences (e.g., Nerlove, 1995; Rosen, 1974). Observed prices and quantities represent solutions of supply and demand functions. Only with additional information can inferences about one or the other be made with confidence. Many studies assume perfectly elastic supply at exogenous prices.

In MNL and NMNL models, the indirect utility function[6] of consumer *i* is a function of vehicle attributes and, in general, other variables describing the consumer. The derivative of the utility function with respect to an attribute gives the change in utility due to a marginal change in one of its attributes. Purchase price is almost always one of the variables in the utility function. However, the coefficient of any variable that is measured in present value dollars can be used if price is not included. Because purchase price is measured in present value dollars, the negative derivative of the utility function with respect to price is the marginal utility of a dollar of income (since one dollar of price is equivalent to a negative dollar of income). It can be transformed into a monetary utility function by multiplying through by $1/(-\beta)$, where $\beta$ is the coefficient of purchase price, the minus sign being added so that utility is measured in positive dollars. This is illustrated in Equation 4.3 for a simple linear utility function.

$$U_{ij} = \beta p_j + \sum_{k=1}^{K} \alpha_j x_{jk} \Rightarrow \frac{U_{ij}}{-\beta} = -p_j + \sum_{k=1}^{K} -\frac{\alpha_k}{\beta} x_{jk} \tag{4.3}$$

In Equation 4.3, the WTP (in dollars) for a change in attribute $k$ is the derivative of $U_{ij}$ with respect to $x_{jk}$, or $-\alpha_k/\beta$. Although simple linear utility functions such as Equation 4.3 are sometimes encountered, in general, utility functions are more complex and include interactions among variables and transformations of variables. In general, WTP is always obtained by dividing the derivative of utility with respect to an attribute ($\partial U/\partial x$, whose units are utility per unit of the attribute) by the negative of the derivative of utility with respect to a measure of present value dollars such as vehicle price ($-\partial U/\partial p$, whose units are utility per dollar, present value). Although we omit the consumer and vehicle subscripts in Equation 4.4, the derivatives are often a function of consumer attributes and occasionally of vehicle attributes. In such cases, we use measures of central tendency for those variables (e.g., mean household income) for the population appropriate to the sample used in estimating the choice model.

$$WTP_k = -\frac{\partial U/\partial x_k}{\partial U/\partial p} \tag{4.4}$$

In general, both $\alpha_j$ and $\beta$ (or both derivatives in Equation 4.3) are random variables because they are estimated with error. The first order Taylor series approximation to the ratio of two random variables is just the ratio of the random variables. The mean of a ratio of random variables is not generally equal to the ratio of the means because it is influenced by their covariance. However, because published articles almost never provide the variance-covariance matrix for coefficient estimates, we use the first order approximation in all cases to estimate

[6] The utility function is called "indirect" because economists usually define utility as a function of quantities of goods consumed. The indirect utility function is defined as the maximum utility a consumer with a given level of income can achieve given the prices (and attributes) of goods.

WTP. We interpret this measure as the central tendency estimate of the marginal WTP for an attribute conditional on the central tendency estimate of the price derivative. This differs from the expected value of the ratio of the derivatives. On the other hand, it is computable from the information provided in all the papers in our sample and has a meaningful interpretation.

The second order Taylor series approximation is useful for illustrating the potential sources of error in the first order approximation. Consider the second order approximation of the expected value, $E[-\alpha/\beta]$, of the ratio of two random variables, $-\alpha$ and $\beta$ (Seltman, 2016) (Equation 4.5).

$$E\left[\frac{-\alpha}{\beta}\right] \approx \frac{E[-\alpha]}{E[\beta]} - \frac{Cov[-\alpha,\beta]}{E^2[\beta]} + \frac{Var[\beta]E[-\alpha]}{E^3[\beta]} \tag{4.5}$$

If the coefficient estimates are uncorrelated, the second right-hand-side term is zero; otherwise the simple ratio WTP estimate will be biased if the coefficients are correlated. The third term's effect could be either positive or negative. The direction of the bias introduced by excluding the third term when using a first order rather than second order approximation depends on the sign of $-\alpha_j$ ($\beta < 0$) and whether the variance of $\beta$ is less than $E^3[\beta]$.

Daly et al. (2012, p. 336) show that if $\alpha_j$ and $\beta$ are maximum likelihood estimators, their ratio is also a maximum likelihood estimator (MLE) of the ratio of the true parameters. Calculating the variance of the ratio, however, requires knowledge of the variance-covariance matrix of the estimators, and this is almost never available in the published literature. Gatta et al. (2015) demonstrate that the asymptotic property of the ratio of MLE estimators does not preclude large errors when sample sizes are small. Fortunately, most of the papers we analyze are based on relatively large samples (Table 3-2). Furthermore, when the price coefficient is far from zero and its standard error is small, the ratio gives reliable results even when the sample size is small. In the case of mixed logit models, even knowledge of the variance-covariance matrix of estimated coefficients is generally not sufficient. Unbiased WTP estimates must be obtained by simulation methods (e.g., Hensher and Greene, 2003).[7] When authors provide WTP estimates based on their own simulation analyses, we use the authors estimates. When authors do not provide WTP estimates we use the ratio of derivatives method. As a consequence, in general, our central tendency estimates of WTP, like nearly all those in the extant literature, should be

[7] Concerning estimating WTP in mixed logit models, Hensher and Greene (2003, p.163) state: "In deriving WTP estimates based on random parameters one can use all the information in the distribution or just the mean and standard deviation. The former is preferred but is more complicated. Simulation is used in the former case, drawing from the estimated covariance matrix of the parameters." Unfortunately, the necessary information is rarely provided in published articles.

interpreted as conditional on the central tendency estimate of the price derivative. An extended discussion of this issue can be found in Appendix C.

Carson and Czajkowski (C&C) (2013) point out that because coefficient estimates are assumed to be normally distributed, there is always a theoretical probability that the denominator of the WTP ratio will be zero, making the expected value undefined. While this is true in theory, we consider it an artifact of the estimation methods with no practical importance, because it implies that the marginal utility of income has a finite probability of being zero. The solution proposed by C&C is to assume a different distribution for the coefficient estimates (e.g., lognormal) that has no probability density at zero. The problems associated with estimating WTP from ratios of random variables can be avoided by estimating discrete choice models in WTP space rather than preference, or attribute, space. However, only two papers in our sample used the WTP space method (Train and Weeks, 2005; Helveston et al., 2015). Train and Weeks (2005) observed that models estimated in preference space fit the data better.

Frequently, vehicle price is divided by household income (P/Y) in these specifications. The marginal utility of income is expected to decline with increasing income, while sensitivity to vehicle price is declining with income. In the utility equation (Equation 4.6), attributes of the vehicle, $x_{jk}$, are interacted with attributes of the consumer, $z_i$, such as income.

$$U_{ij} = \beta^* \left(\frac{p_j}{Y_i}\right) + \sum_{k=1}^{K} \alpha_j x_{jk} z_i \tag{4.6}$$

In this case, the WTP for attribute $k$ depends on the central tendency values of the coefficients and on both median income, $\bar{Y}_i$, and the mean value of another consumer attribute, $\bar{z}_i$, as shown in Equation 4.7.

$$WTP_k = -\frac{\alpha_j \bar{z}_i}{\beta / \bar{Y}_i} \tag{4.7}$$

More complex formulations are frequently encountered but the WTP remains the negative of the derivative of utility with respect to the attribute divided by the derivative of utility with respect to vehicle price.

The same method used for MNL models is used for NMNL models. NMNL models are more complex than simple MNL models because they represent a hierarchy of nested choices. Choice of make and model may be nested inside (conditional on) choice of vehicle class. However, the price of a vehicle and its attributes are located in the same nest. The derivatives of the utility function at that level defines the tradeoff (marginal rate of substitution) between the attribute and present value dollars (price). Thus, the utility functions of the nests that include the attributes of vehicles and their prices are used in estimating marginal WTP using Equation 4.3. A given attribute may appear in several nests. We include the WTP measures from all nests in our database.

To derive a central tendency estimate of WTP, the central value for income and the other consumer attribute(s) must be known. Frequently, mean values for attributes are provided by a paper's authors but none have provided the joint distributions of income and other consumer attributes. The convention adopted in this paper is to use mean or median values (depending on the data available) for all variables for the relevant population, at the midpoint year of the sample data. When authors do not provide such data, it is often possible to find the appropriate data in other sources (e.g., Census Bureau reports). In such cases, care has been taken to match the relevant year and population whenever possible (e.g., new car buyers or all households? U.S. households or those in California?).

In random coefficient models such as the mixed logit (MXL), some or all coefficients of the indirect utility function are specified as random variables. Commonly, the papers use normal distributions for coefficients of attributes whose marginal values may be either positive or negative, and lognormal distributions are used when marginal values are believed to be either always positive or always negative (e.g., fuel costs). The convention used in this paper is to use mean values for normally distributed random coefficients and median values for lognormally distributed coefficients for the central estimates of those coefficients. Mixed logit models can become exceedingly complex when there are multiple, correlated random coefficients, and vehicle attributes are interacted with several other variables. Some authors provide WTP estimates they have calculated by simulation methods. In that case, we adopt the authors' WTP estimates. Most authors provide sufficient information to derive central tendency WTP measures using the convention describe above.

In this paper we focus exclusively on marginal WTP measures, that is, the willingness to pay for one additional unit of an attribute. In some cases, it is more useful to estimate the WTP for large changes in attributes (e.g., WTP for an increase in a battery electric vehicle's range from 75 to 200 miles; see Dimitropoulos et al., 2013). The majority of papers in our sample are derived from random utility models of consumers' vehicle choices. For many of these models (e.g., MNL and NMNL) WTP measures for large changes in attributes can be readily estimated using logsums (see, e.g., Zhao et al., 2012). For MXL models, simulation methods are required.

### 4.2 Measuring Preference Heterogeneity and Estimation Uncertainty

Although measures of the central tendencies of WTP for vehicle attributes are the first goal of our research, all measures are subject to estimation error. In addition, many models explicitly incorporate heterogeneity of preferences across consumers by estimating probability distributions for coefficients. When preference heterogeneity is not included in a model, we estimate a range of WTP based on estimation error; otherwise we estimate a range of preference heterogeneity but not estimation error. These two measures describe entirely different sources of variability and are therefore presented and analyzed separately. Like our central tendency estimates, our ranges of uncertainty suffer from a lack of knowledge about the covariance of the attribute and price derivatives. In the absence of this information, we hold the price derivative constant and vary only the attribute derivative. Thus, each range is conditional on the central tendency estimate of the price derivative. Because of this, our ranges should not be interpreted as probability or confidence intervals but rather as indicators of the degree of uncertainty in the WTP estimates. A more detailed discussion can be found in Appendix C.

Attribute and price coefficients, as well as the attribute and price derivatives, are estimated with error. Nevertheless, in models where there are no interactions of vehicle attributes with consumer attributes, we calculate a range of uncertainty for WTP using +/- 1 standard error, $s_e$, of only the attribute coefficient (Equation 4.8). This interval will be smaller than an interval that included the error of estimation of the price derivative. However, including variability in the price coefficient would require knowing the correlation between the price and attribute coefficient estimates. In general, such data are not provided in the literature. Instead we focus on the variability of the attribute coefficients, conditional on the central tendency estimate of the price coefficient.

$$WTP_{Low} = \frac{\alpha - s_e}{\beta}, WTP_{High} = \frac{\alpha + s_e}{\beta} \tag{4.8}$$

We use a single standard error range because, in practice, we have found that a two-standard error range is frequently extremely wide, despite the fact that it includes no variability in the price derivative. In our judgment, when a goal is to find a consensus among estimates, it is more appropriate to use bounds that include two thirds of consumers rather than 95% of consumers. Again, the potential correlation of $\alpha$ and $\beta$ is not considered, nor is the uncertainty in the estimate of $\beta$. Furthermore, because we are using only a first order approximation to the ratio $-\alpha/\beta$, the range of uncertainty should be considered only a general indication of the true estimation uncertainty.

It is also important to understand how preferences may vary across the population of vehicle buyers. Where variations in preferences can be reasonably estimated, we attempt to approximate a range of ±1 standard deviation around the mean/median of the preference-related variable (following the same rationale as that applied for using a one standard error range in Equation 4.8). In general, articles do not provide sufficient information on the correlations among preference distributions to precisely estimate the preference heterogeneity implied by the model. Our approach is intended to err on the side of underestimating ranges of heterogeneity.

For the many models in which the price coefficient, β, is interacted with income, we calculate a range indicative of preference heterogeneity based solely on the distribution of income, other consumer characteristics held constant. Of course, other consumer characteristics vary with income, but the data necessary to accurately describe the covariances are either not available for the sample population or would require substantial effort to estimate. Instead, we vary income independently of other consumer characteristics as an indicator of the heterogeneity of consumer preferences. Using Equation 4.7, we substitute the $25^{th}$ and $75^{th}$ percentiles of the income distributions for median or mean income (depending on the data provided in the paper in question). The same caveats noted above for estimation error apply to interpreting this range as a true range of preference heterogeneity. In addition, in cases where attributes are interacted with other consumer characteristics, we have not attempted to estimate the heterogeneity implied by attributes other than income.

In MXL models, preference heterogeneity is a natural result of the distributions of attribute coefficients. In MNL and NMNL models, we estimate preference heterogeneity from the distributions of variables interacted with price and vehicle attributes, as described above. In all cases, the range represents +/- 1 standard deviation of the attribute variable but not the price variable. MXL models frequently assume that the price coefficient is not a random variable but even when it is we use only its central tendency measure (mean or median).

For each paper an individual Excel workbook was used for the WTP calculations and to generate a standard output table. This allowed us to send the worksheet to authors when questions arose about the calculations. Having the correct units for all variables is critically important but not all papers clearly state the units used in model estimation. The spreadsheet format allows assumptions about units to be clearly documented and to be changed if so indicated by an author's response to a query. We are grateful to the many authors who responded promptly and helpfully to our queries.

The standard output for each paper included authors' names, date of publication, type of data and description of sample, category of model, level of choice (e.g., make/model, powertrain, vehicle class), constant dollar year, as well as attribute, price slope, estimated coefficients, standard errors, standard deviations if a random coefficient model was used, and finally low, central and high WTP estimates and the factor used to define the range (standard error, standard deviation or variation in income). The standard Excel™ output tables were combined into a Stata™ database for statistical analysis.

## SECTION 5.
## WILLINGNESS TO PAY FOR THE ATTRIBUTES OF VEHICLES

In the following descriptive analysis, we present findings on the WTP values of key attributes from the literature.[8] Wherever possible, we have converted units to a common metric to facilitate comparison; for example, a unit defined in terms of hundreds of miles per gallon was standardized to miles per gallon. A few less straightforward conversions for fuel costs and performance are explained below. For almost all of the WTP estimates we have calculated low, central and high values. Because determining whether there are consensus values for attributes is a goal of this study, most of the analysis focuses on the central tendency estimates. For estimates based on random coefficients, or where attributes are interacted with each other and the distribution of those attributes in the relevant population is known, the low and high values measure the heterogeneity of preferences and represent +/- 1 standard deviation of the preference distribution. For other estimates, the high and low values represent estimation uncertainty and are equal to +/- 1 standard deviation of the attribute's coefficient estimate. Ranges based on preference heterogeneity and estimation uncertainty are presented separately in figures or are clearly labeled in tables.

As part of the effort to find consensus on attribute values we eliminated relatively few "outliers" to create what we call "trimmed" samples. The National Institute of Standards and Technology (2016) defines an outlier as "…an observation that lies an abnormal distance from other values in a random sample from a population…" Our use of the term differs from this definition in that we did not take a random sample of estimates of attribute values but rather attempted to collect all estimates from U.S. studies published between 1995 and 2015. When we omitted a study, it was because we were unable to calculate attribute values due to missing information. In that sense, every value calculated belongs to the population of interest. There is no rigorous statistical definition of "abnormal distance from other values." We have identified outliers by creating histograms, visually identifying extreme values, and testing to ensure that, once the extreme values were deleted, their distance from the mean of the trimmed sample was greater than three standard deviations of the trimmed sample. For selected attributes, we have included the full sample histograms in the main body of the report (see Appendix D and Appendix E for figures representing untrimmed distributions of central WTP estimates for all attributes, presented in two different ways). It was not possible to define clear rules for making these adjustments; we are using professional judgment. Our intent was to remove a few

[8] All values reported in dollars were converted to 2015$ using the CPI-U index.

observations whose presence profoundly changes the estimated mean and variance of the set of estimates in order to increase the likelihood of finding consensus among the remaining estimates.

As part of this study, we attempted to get feedback from authors of all papers included in our main sample. Recognizing that there are some uncertainties involved in WTP calculations based on the information available from their papers, we wanted to provide them with an opportunity to comment on our methods for calculating WTP estimates based on their papers and provide corrections/comments as appropriate. We started by contacting the corresponding author using the contact information available in the publication or updated contact information when one of the authors of this report was aware of an updated affiliation. In a number of cases, the contact information provided for the corresponding author was no longer accurate and none of the study authors knew their current affiliation, in which case we searched for an updated affiliation and contact information and contacted them using that information where available. In some cases, we could not locate current information and turned to contacting other study authors for multi-authored papers. Detailed information on the comments received and our responses are provided in Appendix F. We thank all authors that responded for their time and interest in our study. Results presented in this section reflect our adjustments in response to all comments received based on our interpretation of the comments received, but any remaining errors in calculation or interpretation of WTP are the responsibility of the report authors and not the authors of the individual studies.

Table 5-1 presents summary statistics for the central WTP values for the 32 individual attributes (out of 142) that had five or more observations as well as aggregates for 1) aggregate fuel cost per mile and 2) acceleration (0–60 mph) time reduction. The mean, standard deviation, skewness, median, interquartile range, minimum and maximum describe the distribution of estimates across studies and model formulations. In Table 5-1 and the other tables below, the statistics presented describe the distributions of the central tendency estimates across studies. Except where explicitly indicated, they are not the standard errors of individual estimates nor do they reflect only heterogeneity of preferences. Instead, they reflect a combination of differences due to time, place and populations included in the study, together with differences due to model formulations, included and excluded variables, ways that attributes are measured and estimation methods. Figures below represent high to low ranges of estimates due to estimation error or preference variation; each line in these graphs represents an individual study and outliers are included.[9] WTP estimates for subcategories of the eight most commonly analyzed attribute

[9] Estimation error and preference variation figures are truncated to focus on most study estimates. As such, lines depicting outlier cases may extend outside the bounds of the graph area.

categories (Comfort, Fuel Availability, Fuel Cost, Fuel Type, Performance, Pollution, and Range) are described below in more detail in Sections 5.1 through 5.8, respectively. We include figures showing the variation in WTP estimates across observations for selected vehicle characteristics as illustrative examples of the variability present across observations (see Appendix D and Appendix E for additional figures). Detailed WTP estimates for all 15 of our general categories by study by model specification can be found in Appendix B.

Although many models include indicator variables for vehicle class, we do not include the WTP estimates for vehicle class in Table 5-1. If all studies defined vehicle classes in the same way, it would be possible to normalize estimates of WTP for vehicle classes by always comparing to the same vehicle class. Unfortunately, definitions of vehicle classes vary considerably across studies, making it impossible to compare the estimates. In contrast, alternative fuel vehicles such as battery electric vehicles, plug-in hybrids and flex-fuel vehicles are consistently compared with conventional gasoline vehicles. In that sense, the WTP estimates are comparable across studies. Studies differ, however, in the way alternative fuel vehicles are described, the alternatives included in the choice sets, and in the design of choice experiments.

## Table 5-1. Summary Statistics from Pooled Central WTP Estimates*

| | | | | | Raw | | | | Trimmed | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grouping | Attribute | N | Units | Out-liers | Mean | SD | Min | Max | Mean | SD | Min | Max | Median | Inter-quartile Range | Skew |
| Comfort | Auto-transmission | 9 | 0/1 | 1 | 1,818.8 | 3,739.3 | -2,987.0 | 9,260.6 | 888.6 | 2,660.8 | -2,987.0 | 5,321.4 | 1,090.3 | 3,262.9 | 0.8 |
| | Rear-wheel drive | 6 | 0/1 | 0 | 32,030.9 | 18,030.7 | 10,069.8 | 62,928.8 | 32,030.9 | 18,030.7 | 10,069.8 | 62,928.8 | 26,778.8 | 16,189.4 | 1.2 |
| | Air conditioning | 13 | 0/1 | 0 | 3,484.2 | 9,627.1 | -15,380.0 | 19,818.5 | 3,484.2 | 9,627.1 | -15,380.0 | 19,818.5 | 3,961.6 | 7,474.0 | 0.9 |
| | Shoulder room | 12 | $/inch | 1 | 1,085.1 | 1,393.7 | 178.4 | 5,266.6 | 705.0 | 478.7 | 178.4 | 1,800.1 | 545.9 | 764.2 | 1.3 |
| Fuel availability | Recharging time | 27 | $/hr | 0 | 2,194.8 | 2,923.1 | -227.4 | 11,947.1 | 2,194.8 | 2,923.1 | -227.4 | 11,947.1 | 930.9 | 2,689.9 | 2.4 |
| | Fuel availability | 18 | $/% | 2 | 834.5 | 2,133.1 | 48.8 | 9,133.3 | 227.8 | 201.4 | 48.8 | 789.6 | 161.7 | 166.7 | 1.9 |
| Fuel costs (value of reduction in costs) | **Aggregate fuel cost per mile** | **117** | **$/cpm** | **7** | **-8,330.7** | **97,820.1** | **-1,052,470** | **64,499.0** | **1,879.7** | **6,875.4** | **-7,425.0** | **64,499.0** | **990.6** | **2,194.2** | **1.9** |
| | *Cost per mile* | *60* | *$/cpm* | *0* | *1,366.3* | *3,318.0* | *-7,425.0* | *19,415.1* | *1,366.3* | *3,318.0* | *-7,425.0* | *19,415.1* | *1,146.5* | *2,546.5* | *1.2* |
| | *Cost per year* | *15* | *$/($/yr)* | *1* | *-63,204.0* | *274,176.8* | *-1,052,470* | *64,499.0* | *7,457.8* | *17,256.0* | *-3,224.1* | *64,499.0* | *1,133.9* | *4,723.8* | *6.6* |
| | *Gallons per mile* | *24* | *$/0.01 gpm* | *3* | *46.1* | *3,090.7* | *-7,472.2* | *4,701.1* | *1,066.3* | *1,483.6* | *-1,094.8* | *4,701.1* | *1,027.1* | *1,816.8* | *1.0* |
| | *Miles per dollar* | *8* | *$/ (10mi/$)* | *3* | *-14,917.7* | *20,600.8* | *-59,618.7* | *-676.5* | *-2,328.4* | *1,795.8* | *-4,985.1* | *-676.5* | *-2,097.0* | *2,349.3* | *1.1* |
| | *Miles per gallon* | *7* | *$/mpg* | *0* | *991.4* | *1,404.0* | *-325.2* | *3,848.9* | *991.4* | *1,404.0* | *-325.2* | *3,848.9* | *800.3* | *1,451.5* | *1.2* |
| | *Other converted units* | *3* | *$/GGE or $/gallon* | *0* | *896.4* | *702.1* | *115.6* | *1,475.9* | *896.4* | *702.1* | *115.6* | *1,475.9* | *1,907.6* | *1,360.3* | *0.8* |
| Fuel type | Electric vehicle | 27 | 0/1 | 1 | -10,525.6 | 22,711.8 | -77,780.3 | 30,651.0 | -7,938.8 | 18,670.1 | -43,983.9 | 30,651.0 | -8,454.0 | 28,385.9 | 0.9 |
| | Hybrid | 27 | 0/1 | 2 | -12,671.0 | 44,878.6 | -180,394.4 | 18,860.1 | -1,436.6 | 18,573.8 | -55,816.5 | 18,860.1 | 2,374.7 | 11,880.8 | -0.6 |
| | Flex fuel | 6 | 0/1 | 0 | 5,166.3 | 5,692.3 | -4,409.9 | 10,975.3 | 5,166.3 | 5,692.3 | -4,409.9 | 10,975.3 | 6,114.4 | 6,298.4 | 0.8 |
| | PHEV | 5 | 0/1 | 0 | 12,337.8 | 12,061.0 | -7,959.3 | 23,809.8 | 12,337.8 | 12,061.0 | -7,959.3 | 23,809.8 | 14,740.0 | 4,877.4 | 0.8 |
| | Methanol | 5 | 0/1 | 0 | 11,134.3 | 2,884.9 | 6,989.4 | 13,962.7 | 11,134.3 | 2,884.9 | 6,989.4 | 13,962.7 | 12,587.2 | 3,461.5 | 0.9 |
| | Natural gas | 7 | 0/1 | 2 | -5,619.6 | 23,691.2 | -55,978.3 | 12,956.4 | 6,187.4 | 3,850.6 | 3,295.7 | 12,956.4 | 5,006.2 | 439.2 | 1.2 |

(continued)

## Table 5-1. Summary Statistics from Pooled Central WTP Estimates* (continued)

| | | | | | Raw | | | | Trimmed | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Grouping** | **Attribute** | **N** | **Units** | **Out-liers** | **Mean** | **SD** | **Min** | **Max** | **Mean** | **SD** | **Min** | **Max** | **Median** | **Inter-quartile Range** | **Skew** |
| Model Availability | Make-model availability | 14 | $/# of models | 2 | 898.8 | 2,281.3 | 0.5 | 6,841.5 | 5.9 | 7.6 | 0.5 | 22.1 | 2.1 | 8.2 | 2.8 |
| Performance | **Aggregate acceleration (0–60) time reduction** | **48** | **$/s** | **0** | **953.7** | **1,259.2** | **-1,546.9** | **5,543.5** | **953.7** | **1,259.2** | **-1,546.9** | **5,543.5** | **1,004.9** | **1,199.5** | 0.9 |
| | *Acceleration (0–30) time reduction* | *11* | *$/s* | *0* | *1,045.2* | *1,122.8* | *-1,546.9* | *3,287.5* | *1,045.2* | *1,122.8* | *-1,546.9* | *3,287.5* | *1,140.6* | *608.9* | *0.9* |
| | *Acceleration (0–60) time reduction* | *8* | *$/s* | *0* | *1,095.6* | *627.4* | *34.6* | *2,200.1* | *1,095.6* | *627.4* | *34.6* | *2,200.1* | *1,182.7* | *497.8* | *0.9* |
| | *Horsepower/ weight* | *29* | *$/0.01hp/ lb* | *0* | *879.8* | *1,448.5* | *-860.4* | *5,543.5* | *879.8* | *1,448.5* | *-860.4* | *5,543.5* | *198.4* | *1,558.1* | *4.4* |
| | Horsepower | 11 | $/hp | 0 | 53.6 | 108.8 | 0.0 | 355.0 | 53.6 | 108.8 | 0.0 | 355.0 | 9.2 | 38.2 | 5.8 |
| | Top speed | 9 | $/mph | 0 | 100.1 | 58.3 | 27.6 | 209.7 | 100.1 | 58.3 | 27.6 | 209.7 | 54.2 | 86.5 | 1.8 |
| Pollution | Emissions reduction | 19 | $/10% | 0 | 48,007.8 | 69,595.8 | -66,982.0 | 168,535.7 | 48,007.8 | 69,595.8 | -66,982.0 | 168,535.7 | 1,491.3 | 132,083.1 | 32.2 |
| Range | Range | 40 | $/mi | 0 | 86.3 | 51.5 | -20.1 | 242.6 | 86.3 | 51.5 | -20.1 | 242.6 | 87.3 | 62.5 | 1.0 |

*Attributes in italics are combined into aggregate measures.

## 5.1 Comfort Grouping

### *5.1.1 Automatic Transmission*

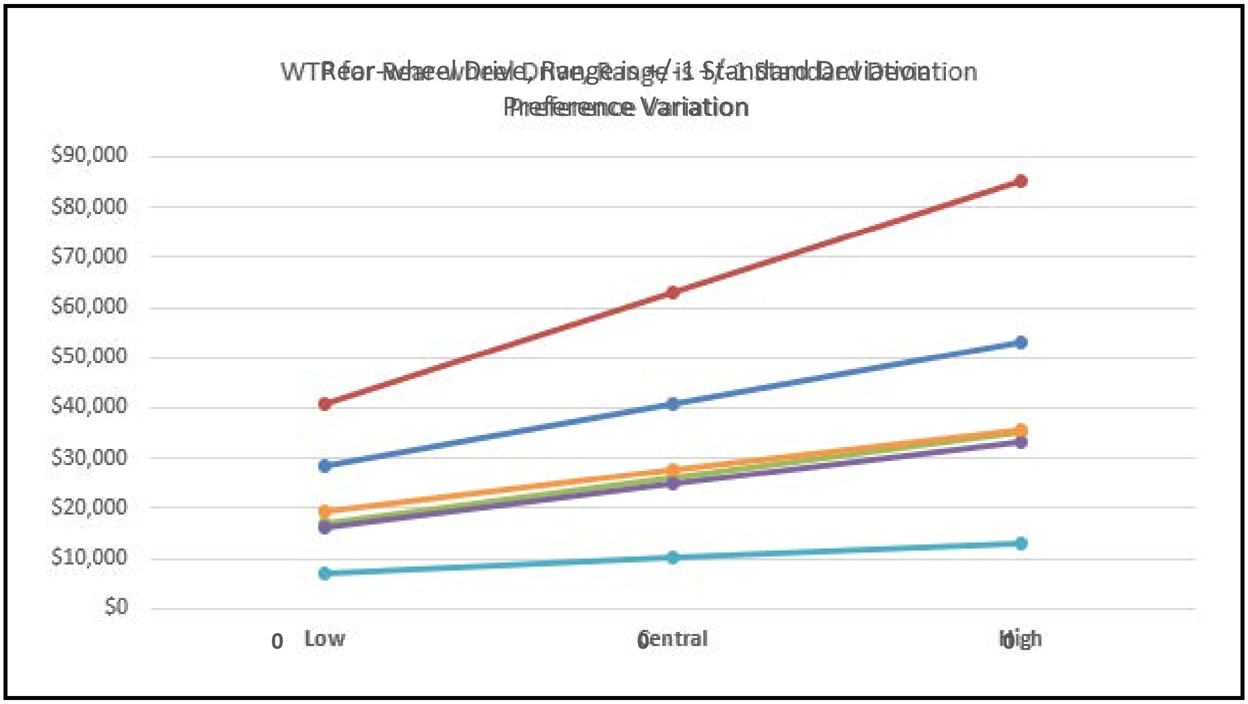
There were nine WTP observations for automatic transmission in the surveyed literature, pulled from four studies. A dummy indicator reflected preference for automatic transmission as opposed to manual, or stick-shift, transmission. After dropping one extreme value greater than $9,000, we found a trimmed mean of $889 for automatic transmission, although a relatively large spread remained: the interquartile range spanned −$983 to $2,280. The slight negative skew comes primarily from the two negative estimates from the Haaf et al (2014) study. The remaining estimates reflect the anticipated positive sign and cluster close to the median value of $1,090. WTP estimates for automatic transmission draw from either market data or revealed preference surveys, and were produced using a variety of estimation strategies (e.g., hedonic, MNL, MXL, NMNL). No studies attempted to capture population heterogeneity in taste for transmission systems.

### *5.1.2 Rear-wheel Drive vs. Front-wheel Drive*

We find six estimates for WTP for rear-wheel drive, all of which come from the same Petrin (2002) study.[10] Petrin employs a BLP model on market data from 1981–93. Estimated WTP for rear-wheel drive is consistently positive and very large, with a mean of $32,031, and an interquartile range of $16,189 (Figure 5-1). The transition during this period to very high penetration of FWD, which has persisted, is difficult to reconcile with the generally large WTP estimates for real-wheel drive. It seems likely that this parameter is aliasing other factors with which it is correlated, such as the use of rear-wheel drive in high-performance vehicles. Differences among the six estimates are due to different price coefficients for each of three income tertiles, which vary by a factor of four, and from two different estimation methods whose attribute coefficients vary by more than a factor of two. In general, WTP for rear-wheel drive is greatest for the lowest income tertile and least for the highest. Given that all six estimates come from the same study, it is difficult to make a judgment on the typical WTP for rear-wheel drive, particularly as WTP is sensitive to the estimation method and may be aliasing other factors. The estimates do indicate substantial consumer heterogeneity related to income; high and low WTP for a given model specification differ by more than $10,000 on average. The Low (-1 std. dev.), Central, and High (+1 std. dev.) estimates from each observation are shown in Figure 5-1.

[10] Petrin (2002) directly includes a dummy variable for FWD, but we used the opposite of the sign to represent the WTP for having rear-wheel drive because we were trying to standardize having as many of our WTP measures represent positive valuations for attributes as possible.

**Figure 5-1. Rear-Wheel Drive Preference Variation, Range is +/- 1 Standard Deviation**




Note: Each line represents the range calculated for an observation of an estimate of WTP for a particular vehicle attribute.

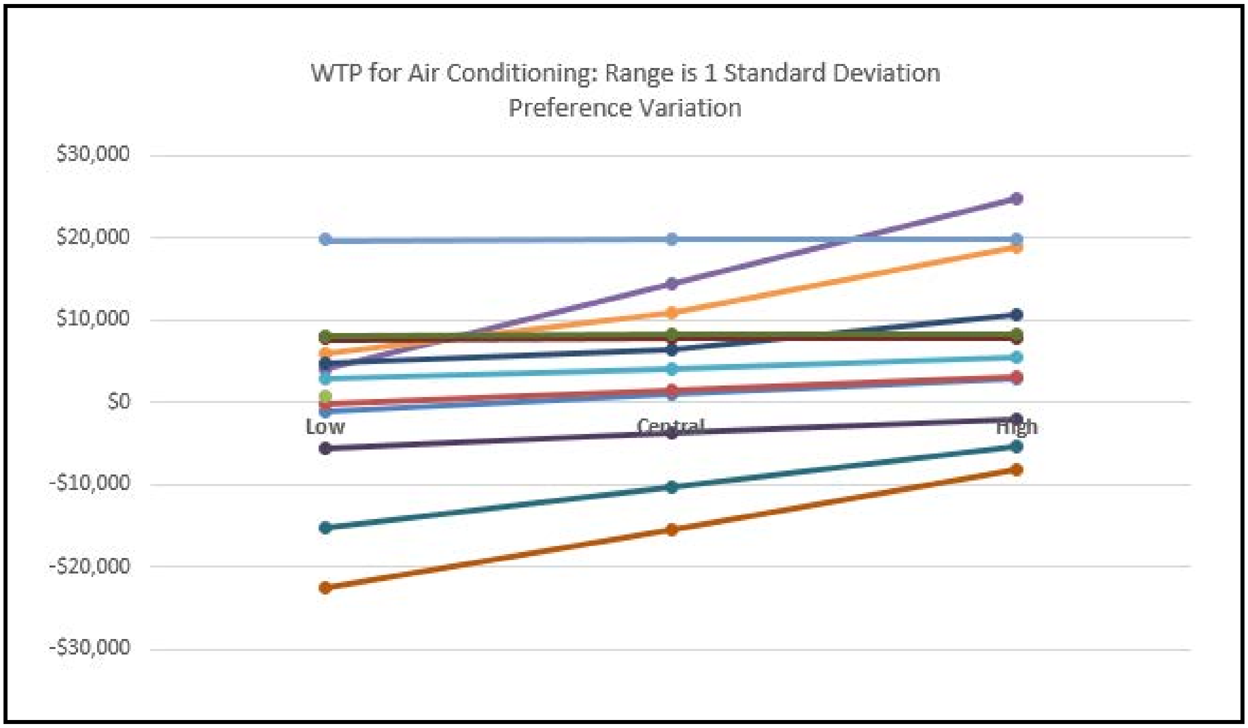
### *5.1.3 Air Conditioning*

There are 13 observations for air conditioning. The mean is $3,484, with no clear outliers but a high standard deviation of $9,627. Estimates cross over both positive and negative values, but the majority have positive values. All negative values come from the Petrin (2002) paper. Data are either from revealed preference surveys or are market data. Aside from one study (Haaf et al., 2014, which used data from 2004–2006), all data fall between 1971 and 1993, reflecting developments in vehicle design as air conditioning became a standard feature and thus a weak source of variation amongst vehicles manufactured in the last few decades.

No clear divergences emerge in the observations due to estimation strategy. A variety of models are tested: BLP, NMNL, hedonic, MNL. In models that allowed variation in population taste, high and low estimates vary considerably. Two studies present near zero variation in population taste; others produce differences in population taste on the order of several thousand dollars. This latter variation is particularly notable for the Petrin (2002) paper.

WTP for air conditioning is generally positive and valued in the thousands of dollars (see Figure 5-2), though the data are outdated in the surveyed literature and show no clear convergence in value. Valuation for this attribute is particularly challenging and perhaps inconsequential in studies on new vehicles.

**Figure 5-2. Population Taste Heterogeneity for Air Conditioning**




Note: Each line represents the range calculated for an observation of an estimate of WTP for a particular vehicle attribute (combination of study and model specification; a single study can have multiple observations).

### *5.1.4 Shoulder Room*

WTP for shoulder room is presented as dollars per additional inch. There are twelve observations, all of which are from the Liu et al. (2014) paper using revealed preference survey data and a multinomial logit estimation technique. The initial mean is $1,085 per additional inch; we remove one extreme value greater than $5,000 to produce a trimmed mean closer to $700 and a lower standard deviation of $478. Liu et al. (2014) produce their range of estimates by estimating WTP by characterizing households by vehicle fleet size (1–4 car households) and low-, medium-, and high-income segments. As expected, WTP rises for higher income brackets; no clear pattern emerges in WTP based on household fleet size, though more extreme values occur in fringe cases (e.g., high income households with one car have an average WTP of $5,267 per inch of shoulder room).

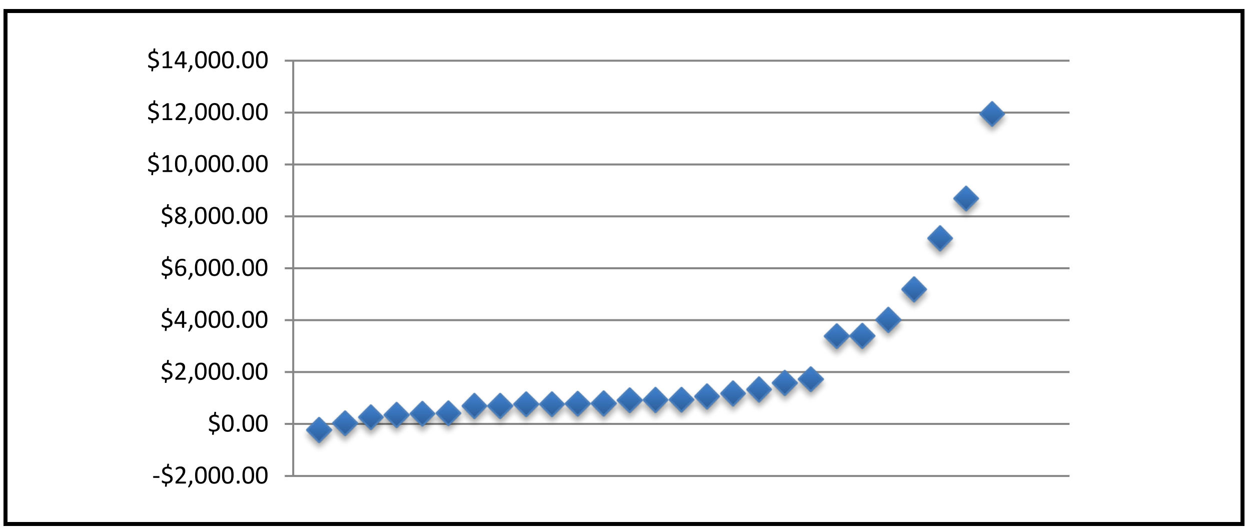
## 5.2 Fuel Availability

### *5.2.1 Recharging Time*

There were 27 estimates in the literature from which we could calculate willingness to pay for recharging time. These electric vehicle studies relied almost entirely on stated preference surveys (aside from one market data set). Thirteen of the estimates came from the same 2008-9 web survey (Parsons et al., 2014; Hidrue et al., 2011). Units were normalized to willingness to pay for a one-hour reduction in charging time. For simplicity, we assumed a linear relationship between willingness to pay and percentage reductions in charging time when performing unit conversions.

The 27 estimates span from −$227 to $11,947, as shown in Figure 5-3 below. The variation may be due to differences in willingness to pay for specific charge times. Most estimates were not continuous and had been converted from dummy variables (e.g., charge time of 15 hours versus 5 hours). We find that the value of further reducing charge time from lower charge times (e.g., less than 10 hours) produce willingness to pay values beyond $1,000 per hour, while the value of reducing charge time for most 15- and 20-hour charge times are valued between $400 and $950 per hour. It is reasonable to expect that marginal willingness to pay for charge times at higher levels of range would be lower, reflecting a decreasing marginal utility of reducing charging time as range increases. This literature could benefit from the study of additional data sets, but we tentatively find that there are increasing returns to reducing EV charge times below ten hours.

**Figure 5-3. WTP for a One Hour Reduction in Charge Time Across Studies**




Note: Each point represents one of the 27 studies estimating the WTP for reduction in charge time (normalized to one hour reduction).

### *5.2.2 Fuel Availability*

There were eighteen recoverable estimates of willingness to pay for fuel or station availability within the literature. As with charge time, we assume a linear relationship between WTP and percent increases in fuel availability to convert to common units. Final units are in WTP for one percent increases in station availability. After dropping two outlier values of $2,242 and $9,133, we find a median value of $161.74 for a 1% increase in station availability. Half of the estimates fall between $105.70 and $272.43 per 1% increase in availability.

Fuel availability data came from the Brownstone et al. (1996) California household survey (12 observations), other stated preference studies (3 observations, 1 dropped), and a literature review (3 observations, 1 dropped). Models were specified as nested multinomial logits or mixed logits. Mixed logits tended to produce central WTP values on the lower end of the distribution, from $48.75 to $144.35. We only have enough information to estimate preference heterogeneity for two of the trimmed sample observations. In both of these cases, the high-low range of one standard deviation spans over $200, crossing over zero.

## 5.3 Fuel Cost

In the literature reviewed, we focus on fuel cost measured in five different ways (see Table 5-1 and subsections below).[11] Willingness to pay for reductions in fuel cost in $ or cents per mile (fuel price/mpg), fuel cost per year ($/year) and gallons per mile of fuel consumption (1/mpg) are expected to be positive, as is WTP for increases in miles per gallon. Results for each of these measures are presented below. To increase the number of estimates that can be directly compared, we have also converted gallons per mile to cents per mile by multiplying by the price of fuel and report values both in the native units used in the studies as well as for a common cost per mile metric in Table 5-1.

### *5.3.1 Reduction in Fuel Cost per Mile*

The effective sample of estimates can be increased by converting different fuel cost metrics to a common metric, when it can be done straightforwardly and transparently. There were a total of 60 observations of estimates of WTP for reductions in fuel costs per mile. The most frequently used metrics are fuel cost per mile (fuel price/mpg) and gallons per mile (1/mpg). WTP for an increase in fuel consumption of 0.01 gal./mi. can be converted to WTP for a $0.01/mile decrease in fuel cost by dividing by the price of gasoline. Between 1985 and 2014, the annual average price of gasoline in 2015 dollars ranged from a low of $1.62 to a high of

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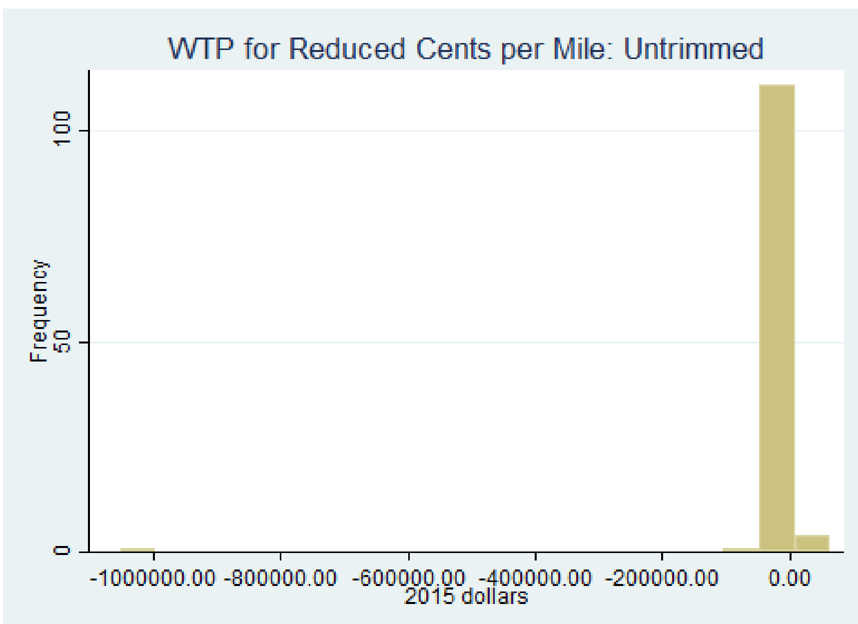
[11] We dropped five observations from the aggregate fuel cost per mile calculation (going from 122 to 117) because they could not be converted from their native units to comparable $/cpm measures.

$3.81 per gallon. A five-year backward moving average ranges from $1.82 to $3.55 and the simple average for the 1985–2015 period is $2.45. We round to $2.50 and assume that as our expected gasoline price for all studies.[12] In the figures and tables below, the WTP for 0.01 gallons per mile (gpm) has been converted to WTP for $0.01/mile by dividing by 2.5.

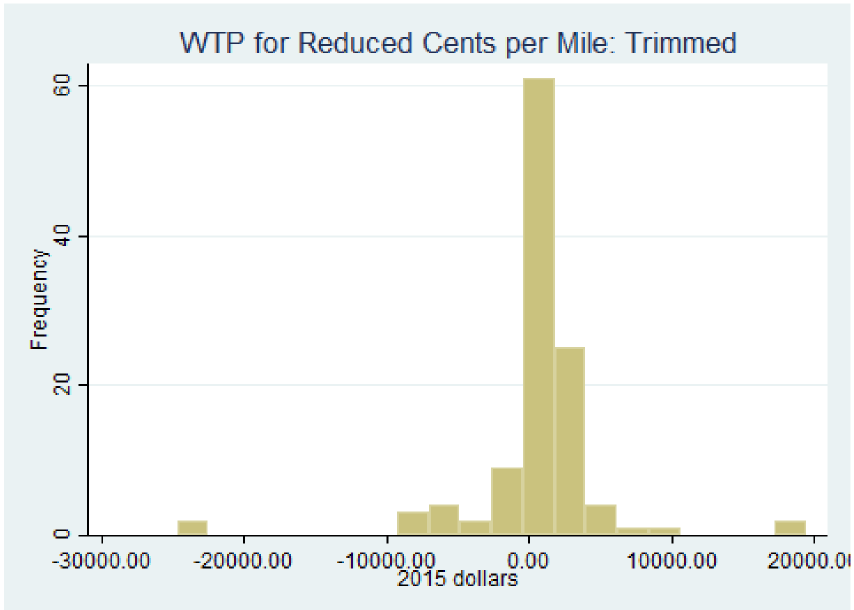
The distribution of the combined central WTP estimates is shown in Figure 5-4. The discounted present value of fuel consumption for a typical U.S. light-duty vehicle provides a useful reference point for identifying outliers. Using NHTSA (2006)'s estimated expected miles by vehicle age for passenger cars and light trucks, discounted at 6% per year, the "present value" miles are 110,382 for a passenger car and 123,458 for a light truck, and the simple average for the two vehicle types is 116,920. Thus, a reasonable reference point for the value of a $0.01/mile decrease in fuel costs would be $1,169. Seven estimates less than −$50,000 or greater than $20,000 were deleted as outliers, resulting in the trimmed distribution shown in Figure 5-5.

**Figure 5-4. Willingness to Pay for $0.01/mile Decrease in Fuel Cost: All Estimates (2015$)**




[12] Ideally, one would want to use gasoline prices that align with those used in each individual study, but we do not have that information for all studies.

**Figure 5-5. Willingness to Pay for $0.01/mile Decrease in Fuel Cost: Trimmed Sample (2015$)**




Statistics for the combined metric ($0.01/mile) are shown in Table 5-2. The central tendency estimates vary widely, even after being "trimmed" of outliers. Standard deviations range from about 70% of the mean for evidence from studies combining revealed and stated preference (RP & SP) surveys to almost eight times the mean for trimmed estimates based on market sales data. Second, although the distributions of most estimates are less skewed after trimming, in most cases the skewness is still great enough to favor use of the median over the mean as a measure of central tendency. In general, the interquartile ranges (75$^{th}$ percentile–25$^{th}$ percentile) are also large relative to the median values.

All the means and medians of the trimmed samples are positive (decreased fuel cost has positive value) as expected. For most types of data, the magnitudes of the medians are between zero and two times a reference estimate of the value of fuel costs to a typical light-duty vehicle in the U.S. ($1,169). The total, median trimmed estimate is $991. A closer examination reveals that the median estimates based on stated preference or SP & RP data provide a much greater willingness to pay ($1,400 to $1,900) than those based on RP surveys ($580 to $690) or market sales data ($100 to $275). Mean RP survey and market sales estimates are much greater than medians, though still less than the SP survey mean.

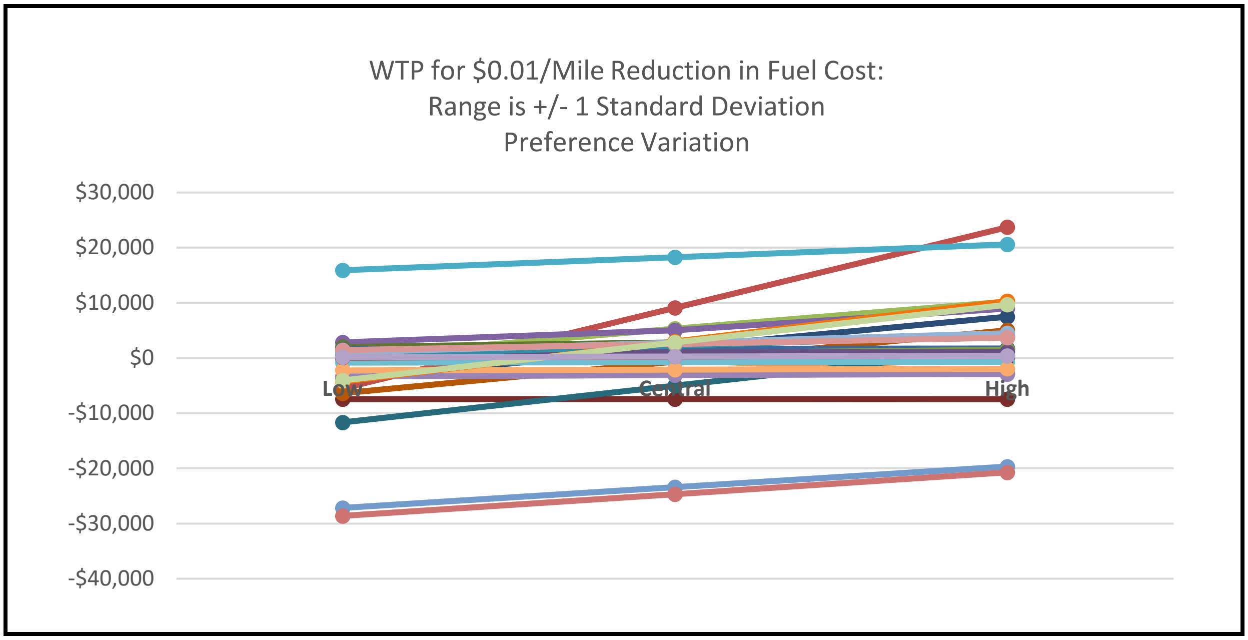
**Table 5-2. Willingness to Pay for $0.01/mile Decrease in Fuel Cost—Combined GPM and $0.01/mile Values**

| Data Type | Mean | Standard Deviation | Skew-ness | Median | P75-P25 | Minimum | Maximum | Number of Observations |
|---|---|---|---|---|---|---|---|---|
| Literature Review (no outliers removed) | 916.12 | 552.69 | 0.69 | 635.30 | 992.62 | 560.22 | 1,552.84 | 3 |
| RP & SP Surveys (no outliers removed) | 1,712.86 | 1,166.82 | 1.00 | 1,417.13 | 1,845.78 | 602.49 | 3,918.48 | 7 |
| *RP Survey (untrimmed)* | *-66,796.13* | *27,275.00* | *-3.47* | *583.27* | *3,229.95* | *-1,052,470.00* | *19,415.06* | *15* |
| RP Survey (trimmed) | 3,609.11 | 6,579.91 | 1.89 | 691.80 | 3,191.61 | -325.22 | 19,415.06 | 14 |
| SP Survey (no outliers removed) | 3,809.16 | 12,214.37 | 4.23 | 1,888.55 | 2,817.04 | -7,425.04 | 64,498.98 | 29 |
| *Market Sales (untrimmed)* | *-1,554.82* | *8,868.82* | *-5.07* | *97.71* | *1,946.94* | *-59,618.71* | *4,701.15* | *63* |
| Market Sales (trimmed) | 544.429 | 1,632.17 | -0.54 | 274.61 | 1,394.43 | -4,985.11 | 4,701.15 | 57 |
| *Total Untrimmed* | *-8,330.70* | *97,820.05* | *-10.52* | *737.76* | *1,912.29* | *-1,052,470.00* | *64,498.98* | *117* |
| Total Trimmed | 1,879.67 | 6,875.42 | 7.18 | 990.63 | 2,194.24 | -7,425.04 | 64,498.98 | 110 |

Note: To differentiate between summary statistics based on trimmed and untrimmed samples for data types where outliers were removed (RP Survey and Market Sales), we present both sets of values in the table, italicizing the untrimmed values.

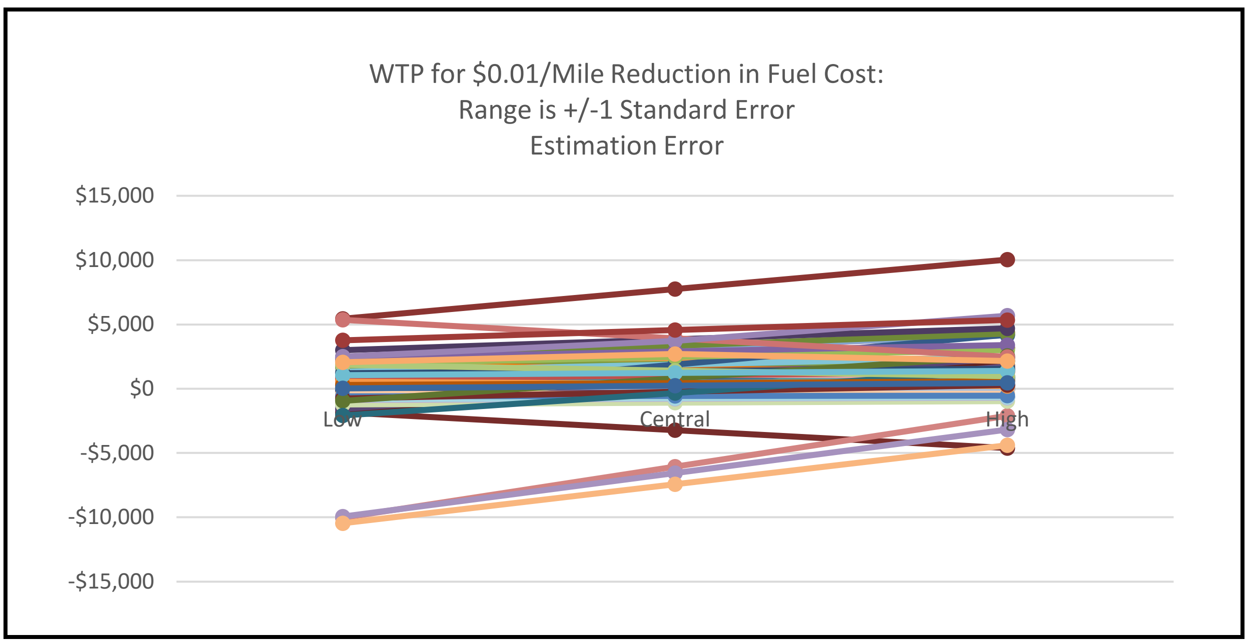
The Low, Central and High estimates for each observation (combination of study and model specification) are shown graphically in Figures 5-6 and 5-7. Each paper is represented by a single line. Outliers have not been removed. Not all papers provided sufficient information to calculate a range of estimates so the sample sizes are smaller. Figure 5-6 contains estimates from random coefficient models and the range from low to high represents +/- 1 standard deviation of the estimated distribution of preferences. For estimates with varied income, the range approximates an interquartile range for the relevant income distribution. Figure 5-7 shows the estimates from fixed coefficient models and illustrates the uncertainty due to estimation error. The range from low to high is +/- 1 standard error of the attribute coefficient. Although the range across estimates is large for both preference heterogeneity and estimation error, for a given paper the range of estimation error is generally smaller with a few exceptions. Preference heterogeneity in fuel costs should be expected if for no other reason than the variation in vehicle usage across households.

**Figure 5-6. Range of Reduction in Fuel Cost per Mile WTP Estimates Describing Preference Heterogeneity**




Note: Each line represents the range calculated for an observation of an estimate of WTP for a particular vehicle attribute (combination of study and model specification; a single study can have multiple observations).

**Figure 5-7. Range of Reduction in Fuel Cost per Mile WTP Estimates Describing Estimation Uncertainty**




Note: Each line represents the range calculated for an observation of an estimate of WTP for a particular vehicle attribute (combination of study and model specification; a single study can have multiple observations).

In general, the median estimates of willingness to pay for a reduction in fuel cost per mile fall within a range of two times the reference estimate ($1,169 x 2 = $2,338) to minus one times the reference estimate (i.e., within a range of −$1,169 to $2,338). In general, the range of estimates is large relative to measures of central tendency. Estimates are typically skewed, suggesting that the median is a better measure of central tendency than the mean. Median WTP estimates from stated preference surveys provide a much greater willingness to pay for fuel savings than median estimates based on revealed preference data ($1,889 versus $692, see Table 5-2). The median of central tendency WTP estimates based on stated preference data is 60% greater than the present value of lifetime fuel costs for a typical new light-duty vehicle in the U.S. The corresponding median WTP estimate based on revealed preference data is about 60% of the discounted present value of lifetime fuel costs for a typical new light-duty vehicle in the U.S. This pattern suggests that hypothetical bias (e.g., Loomis, 2014) may be present in the inferences from stated preference surveys. The median WTP estimate from studies using market sales data is smaller still ($275), only about one-fourth of the reference value.

### *5.3.2 Dollars per Year*

Fifteen observations measured fuel costs in dollars per year ($/yr). Six of the 15 come from Axsen et al.'s (2009) study based on Californian and Canadian survey data. The remaining nine come from seven papers, of which three (accounting for 4 of the 9 estimates) made use of the same California stated preference survey. When considering WTP estimates, the valuation that might be expected from an economically rational consumer provides a useful reference point. However, it should not be considered the correct value because the assumptions used to generate it will always be uncertain to a greater or lesser extent. For a rational consumer, the value of reducing fuel cost by one dollar per year would be calculated by summing across the savings provided over the expected years of vehicle life, discounted to present value. Discounting vehicle survival probabilities from (NHTSA, 2006) at 6% per year, the discounted expected life of a passenger car is 8.9 years (12.8 years undiscounted) and 9.2 years for a light truck (14.6 undiscounted). A reasonable reference point for WTP for a $1/year decrease in fuel costs would therefore be about $9. Removing estimates less than −$400 leaves 14 data points with a mean of $65 and a standard deviation of $150. The median value is $10 with an interquartile range of $41.

### *5.3.3 Gallons per Mile*

There are twenty-four estimates of willingness to pay for a 0.01 gallon per mile (gpm) decrease in fuel consumption. Twenty-two are from studies using market sales data, and one each from studies based on revealed preference and stated preference surveys. The estimates based on market sales include three data points less than −$12,500; we identify these as outliers. Including the outliers, the mean estimate of WTP for a 0.01 gpm reduction in fuel consumption is $215 with a standard deviation of $7,577. In the presence of outliers, the median is a better measure of central tendency, $1,954. Trimming three extreme values produces a mean estimate of $2,697 with a standard deviation of $3,744, and the median becomes $2,835. Even in the trimmed sample, the interquartile range is $4,542.

#### *5.3.4 Miles per Dollar*

Eight estimates of the WTP for tens of miles per dollar come from two papers (Berry et al., 1995; Petrin, 2002). Both papers estimate random coefficient models using the method of Berry et al. (1995). In theory, the WTP for 10 miles per dollar can be derived from the WTP for mpg by multiplying by 10 and dividing by the price of fuel. Thus, if the WTP for 1 mile per gallon is $450 and gasoline costs $2.50/gallon, the WTP for 10 miles per dollar would be $1,800. The estimated mean WTP from the full sample is −$18,006. Removing three outliers of less than −$29,000 results in a mean estimate of −$3,270 with a standard deviation of $2,953. The median estimate is also negative, at −$2,486. One would expect a positive WTP for an increase in miles per dollar; the negative values may indicate that the variable is aliasing less desirable other factors correlated with miles per dollar.

#### *5.3.5 Miles per Gallon*

Seven observations used miles per gallon (mpg) to represent vehicle fuel consumption. Because the marginal value of a mile per gallon depends strongly on the initial mpg, estimates should be expected to vary over time and from one consumer to another, as well as with the price of fuel. Using expected annual vehicle travel by vehicle age from NHTSA (2006) and discounting at 6% per year, a typical US passenger car would accumulate 110,332 discounted lifetime miles, while the corresponding figure for a typical light truck would be 123,458 for a simple average of 116,920. If gasoline costs $2.50 per gallon and the typical light-duty vehicle gets 25 miles per gallon, the economically rational reference point would be a WTP of $450 for one additional MPG. Again, this should not be interpreted as the correct WTP but merely as a known reference point.

The mean estimate of WTP for an additional mpg based on the full sample of estimates is $991 with a standard deviation of $1,404. The distribution of estimates is skewed (1.24) and the median estimated WTP is $800. The interquartile range is also very large relative to the median: $1,452.

## 5.4 Fuel Type

As noted above, the WTP estimates for alternatively fueled vehicles are all relative to a conventional gasoline vehicle.

### *5.4.1 Electric Vehicles (EVs)*

The sizeable sample of 27 estimates of WTP for electric vehicles produced a trimmed mean of approximately −$7,940 and a standard deviation of about $19,000. The estimates are distributed across negative and positive values; they are primarily negative. The interquartile range spans from −$20,378 to $8,008. The wide variation suggests little agreement in the literature on consumer valuation of EVs.

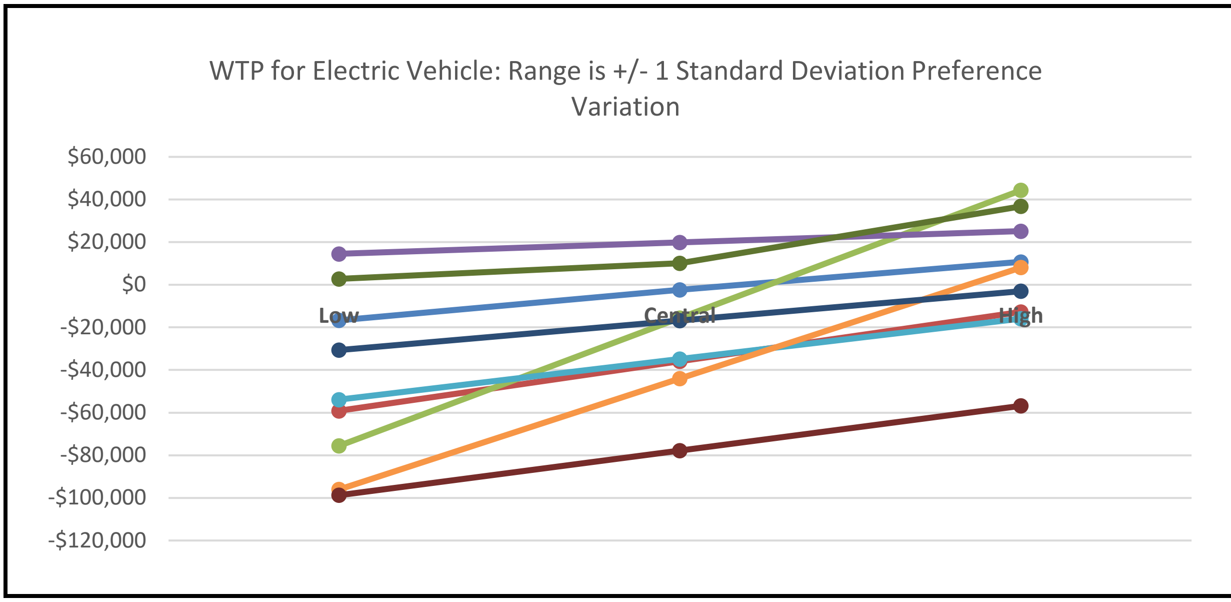
All data are from survey data, primarily stated preference surveys. Over half of the estimates make use of the same Brownstone et al. (1996) survey data from a phone-based California study. Of the remaining observations, several others draw from California surveys. The majority of studies employ mixed logit models. Notably, the few positive estimates come from studies in which authors restricted the sample using 'early adopter' indicators, or designated 'EV-oriented' classes based on consumer characteristics.

Valuation of EVs varies considerably within a sample. Figure 5-8 below reflects low, central, and high WTP estimates for each study that allowed some variation across the population, either using random coefficients, or in some cases, including income interactions. Each line represents high and low WTP values produced by adding or subtracting one standard deviation from the EV coefficient. We see high slopes indicating large variation across a population for many of these studies, even within the California-centric data.

### *5.4.2 Hybrid Vehicles*

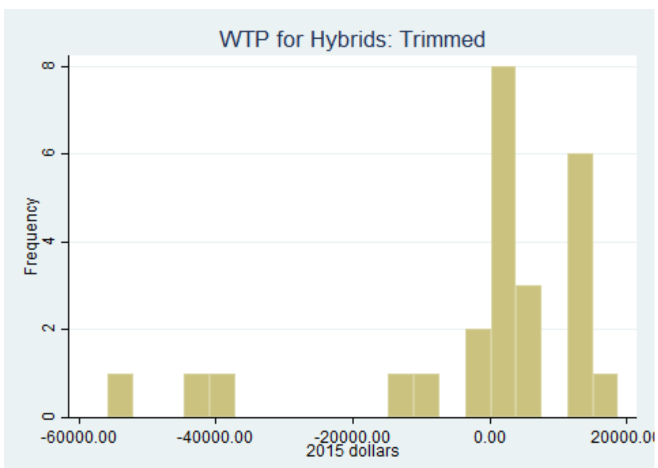
Out of 27 estimates for WTP for hybrid vehicles in our sample, we found two extreme negative values. After restricting results to greater than −$100,000, the mean increases to −$1,437. Results are nonetheless scattered, as reflected in a trimmed standard deviation of over $18,000 (Figure 5-9). The median may be a more appropriate measure of central tendency at $2,375, given the strong negative skew still remaining after trimming the sample. Within the interquartile range, values are largely positive, falling between −$425 and $11,456.

**Figure 5-8. Population Taste Heterogeneity for Electric Vehicles**




Note: Each line represents the range calculated for an observation of an estimate of WTP for a particular vehicle attribute (combination of study and model specification; a single study can have multiple observations).

**Figure 5-9. Distribution of Trimmed Central WTP Estimates for Hybrid Vehicles**




The relatively large sample of WTP estimates for hybrid vehicles may represent the surge in interest in alternatives to conventional gas vehicles in the past fifteen years. All data are post–2000, given the recent introduction of the technology. Studies primarily rely on MNL and MXL models. There is some mix of stated and revealed preference surveys and market data. There is high inconsistency in the results produced by different data types and models utilized. Three studies use national market sales data within the same period from 2006–2008, all utilize MXL models, and produce widely scattered central WTP estimates of −$35,000, −$7,000, and $11,000. Notably, most positive values come from stated preference surveys, ranging from approximately $2,000–$3,000 to $10,000. In many of these cases, the authors analyze revealed preference data from the same sample and find strong negative valuations of hybrid vehicles, suggesting some dissonance between hypothetical and practical preferences for hybrids among consumers. Estimating the WTP for hybrids from market data is challenging because hybrids were a relatively novel technology during the time period of the studies. In general, market-based studies did not explicitly control for consumers' aversion to the risk of novel technologies and their general unfamiliarity with hybrid vehicles. These perceptions are likely to change as hybrids become more common, which would make early market-based WTP estimates misleading if applied to future markets.

The estimated range of preference heterogeneity varies across the studies that allow variation in taste (Figure 5-10). In general, high and low estimates of WTP based on random coefficient models are considerably spread, on the order of several thousand dollars. Several observations produce near-zero slopes—indicating limited variation in taste across a population; each of these observations with limited variation come from Liu (2014). Liu produced separate sets of estimates by income subset, and so the variation in taste within each income subset is minimal.

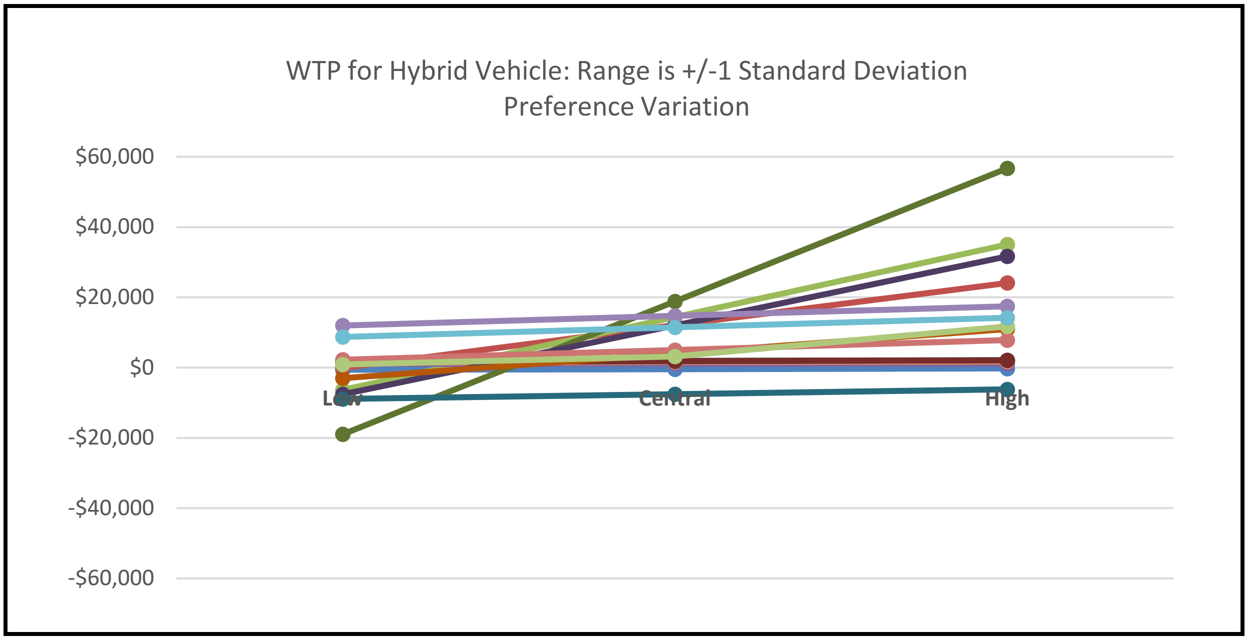
Despite widespread interest in alternative vehicle technologies, the literature has yet to agree on a central valuation for hybrid vehicles among consumers. Future work should account for differences due to the data type (particularly for survey data), modeling strategy, and study sample.

### *5.4.3 Flexible Fuel*

We find six estimates of willingness to pay for flexible fuel vehicles in the literature. Each estimate comes from a stated preference survey. Five out of six of the studies were conducted between 1996 and 1999; Hess et al. conducted the only recent study in 2012 incorporating flexible fuel vehicles.

There is considerable variation in the central values across papers, ranging from −$4,410 to $10,975. Only one study (Tompkins et al., 1998) finds a negative central value, but two other studies find negative WTP values within one standard error from the mean. Researchers used a range of modeling strategies—multinomial logits, nested logits, mixed logits—that produced values spanning the distribution. None of the studies interacted household characteristics with the flexible-fuel dummy. We do not find emergent patterns in the limited pool of observations to explain the variation.

**Figure 5-10. Population Taste Heterogeneity for Hybrid Vehicles (excluding outliers)**




Note: Each line represents the range calculated for an observation of an estimate of WTP for a particular vehicle attribute (combination of study and model specification; a single study can have multiple observations).

### *5.4.4 Plug-in Electric Vehicles (PHEVs)*

We find five WTP estimates of plug-in electric vehicles (PHEVs) from four different stated preference studies. Each study was published after 2010, reflecting the relatively recent development and popularity of this technology. There is one negative central WTP value; the four other estimates range from $13,112 to $23,810.

The five estimates provide some insight into heterogeneity in consumer preferences within each sample. Three of the estimates were income-interacted and two were estimated using a mixed logit specification. Varying the income interaction by one standard deviation produces differences in willingness to pay of $915 to $2,400. Tanaka et al.'s (2014) mixed logit specification produces differences of $344 for one standard deviation. Zhang & Gensler's (2011) mixed logit produces much larger differences of $13,333. This latter study produced the only negative central WTP value of −$7,959. We see that some subset of the sample does positively value PHEVs despite the negative central tendency.

As with other alternative fuel technologies, we are limited to a small pool of studies and reliance on stated preference surveys. The literature does suggest that individuals tend to positively value PHEVs, even after considering error bounds on the central tendencies (not shown in Table 5-1).

### *5.4.5 Methanol*

There were five estimates of WTP for methanol vehicles. The estimates came from three studies (Kavalec, 1999, Brownstone et al., 1999, Brownstone et al., 2000) that analyzed the same 1996 survey data of California households. Every study used a mixed logit model, varying in its incorporation of SP and RP data, the variables included, and socioeconomic interactions (e.g., age, college education). Central tendencies ranged from $6,989 to $13,963. Consumer preferences varied considerably within each sample. One standard deviation from the mean produces differences of $9,000 to $15,000.

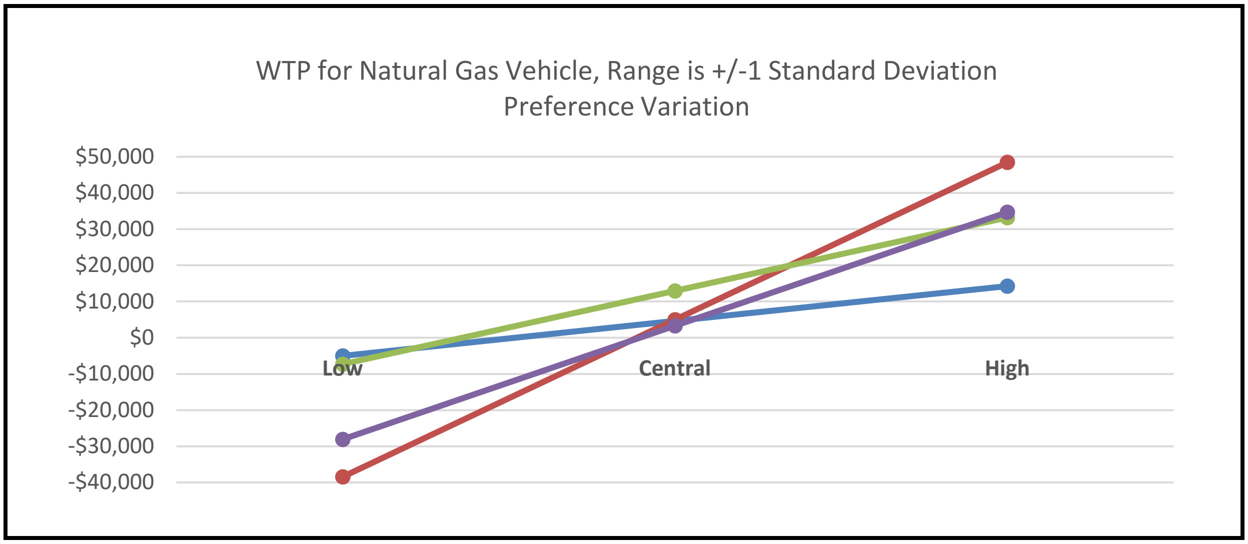
### *5.4.6 Natural Gas*

Seven estimates of WTP for natural gas vehicles were identified. We trim an initial mean of −$5,620 to $6,187 by removing two extreme values lower than −$9,000. In the trimmed sample of five estimates, we see a narrow interquartile range from $4,620 to $5,059. The majority of estimates are positive.

All estimates draw from survey data—mostly stated preference and a few revealed preference. Data are primarily from California; in some studies, separate results are presented for California and the US excluding California. These latter estimates reveal stark differences in consumer WTP based on the study sample: Tompkins et al (1998) find a WTP of −$9,000 for natural gas vehicles in a national survey (excluding California), and WTP of approximately $3,000 for California. Their estimate for California accords well with the remaining WTP estimates for California, which cluster around the same value of $3,000 despite varying modeling strategies.

Even with confluence in central WTP values, we find high variation in population taste from models employing random coefficients (Figure 5-11). Estimates span both positive and negative values; the range between high and low estimates is on the order of tens of thousands of dollars. This large variation arises at the same time that there is little diversity in study samples and the data used is primarily from the 1990s.

**Figure 5-11. Natural Gas Vehicle Preference Variation: Range is +/- 1 Standard Deviation**




Note: Each line represents the range calculated for an observation of an estimate of WTP for a particular vehicle attribute (combination of study and model specification; a single study can have multiple observations).

## 5.5 Performance

With 68 estimates,[13] performance is the third most frequently measured vehicle attribute, after vehicle price and fuel economy. We use five different measures of performance (Table 5-1) that have at least 5 observations each. Three of the metrics are useful measures of acceleration performance. Willingness to pay for reductions in the number of seconds required to accelerate from 0–30 mph (11 observations) and 0–60 mph (8 observations) and WTP for horsepower/weight (hp/lb, 29 observations) can each be used as measures of acceleration performance, and WTP for each should be positive. WTP values for top speed (mph) (9 observations) and horsepower (11 observations) are also expected to be positive. Horsepower is an ambiguous measure of performance since horsepower must increase with vehicle mass and size to maintain constant acceleration. It thus partially measures vehicle size. The mean willingness to pay for 1 additional horsepower based on estimates from 11 papers is $54 with a standard deviation of $109. The median WTP estimate of $9 is considerably less than the mean but the interquartile range of $38 is much larger than the median. Another less than ideal measure of performance is top speed. The mean WTP for an additional 1 mph of top speed is $100 and the median is $54, indicative of a mild skewness of the distribution of the 9 estimates.

[13] Of the 101 original performance estimates, we dropped 33 estimates that could not readily be converted to reduction in 0–60 acceleration time. There are a number of measures, each of which generally uses units with low numbers of observations: percent improvements in acceleration (total of 6); braking distance (1); cylinders (2); displacement (3); "high" or "low" performance (total of 8); horsepower when measured in other units (% of base vehicle or change, hp/cid; total of 12); and turning circle (1).

The interquartile range is $86. All four papers that estimated a WTP for top speed used data from stated preference surveys.

As with fuel economy, the effective sample size can be increased by converting to a common metric when it is reasonable to do so. Willingness to pay for seconds 0–30 can be approximately converted to WTP for seconds 0–60 by dividing by 2.5. In general, it takes longer to accelerate from 30–60 mph than from 0–30 mph so the conversion factor should be greater than 2.0. The ratios of 0–60 to 0–30 mph acceleration times for 15 recent model year GM, Ford and Chrysler vehicles measured by the State of Michigan (2016) averaged 2.54 with a standard deviation of 0.1. The ratio of rated engine horsepower to vehicle weight has been shown to be an accurate predictor of 0–60 mph acceleration times (EPA, 2015). EPA (2015) provides 0–60 acceleration times and hp/wt ratios for light-duty vehicles by model year from 1978 to 2014. A power function fit of hp/wt to seconds 0–60 mph produced the following equation:

$$hp/wt = 0.3542(\text{seconds } 0\text{–}60)^{-0.88} \quad R^2 = 0.97 \tag{5-1}$$

Solving the equation for the change in seconds 0–60 corresponding to an 0.01 increase in hp/wt from the 1995 to 2014 average for light-duty vehicles (EPA, 2015, Table 3.5) gives an approximate value for the reduction in 0–60 mph acceleration time of 1.68 seconds. In Table 5-3, the WTP for seconds 0–30 mpg is converted to WTP for seconds 0–60 by dividing by 2.5. The WTP for a 0.01 increase in hp/lb is converted to WTP for seconds 0–60 by dividing by 1.68.

Even after conversion to seconds to accelerate from 0–60 mph, the hp/lb metric differs from the 0–30 and 0–60 metrics. The median estimate based on hp/lb is only $198, only one fifth of the median willingness to pay implied by the 0–30 and 0–60 metrics. Six of the eleven 0–30 mph estimates were inferred from stated preference survey data, as were three of the eight 0–60 estimates. All of the more numerous hp/lb estimates are based on market sales data or revealed preference survey data. All but the 0–60 mph estimates are skewed (Table 5-3). The large difference between the mean and the median of the 0–60 mph estimates is due to the small sample size.

The distribution of central WTP estimates for the 0–30 mph, 0–60 mph and hp/wt metrics converted to 0–60 seconds is shown in Figure 5-12. There is no obvious reference point for WTP for acceleration performance.

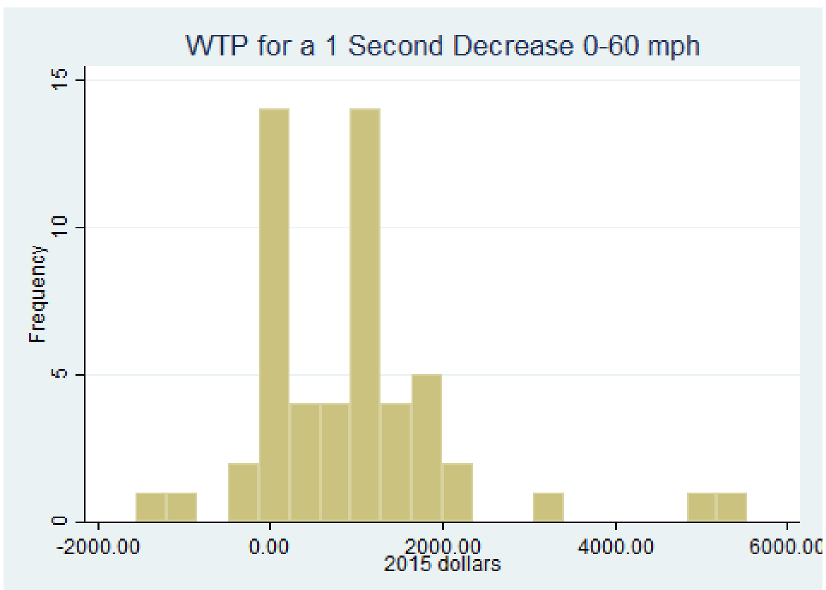
**Table 5-3. Willingness to Pay for a One Second Decrease in 0–60 mph Time: Combined 0–30, 0–60, and hp/lb Normalized Metrics**

| Native Attribute | Mean | Standard Deviation | Skewness | Median | P75-P25 | Minimum | Maximum | Number of Observations |
|---|---|---|---|---|---|---|---|---|
| Seconds 0–30 mph* | $1,045 | $1,123 | -0.46 | $1,141 | $609 | -$1,547 | $3,288 | 11 |
| Seconds 0–60 mph | $1,096 | $627 | -0.01 | $1,183 | $498 | $35 | $2,200 | 8 |
| hp/lb** | $880 | $1,449 | 1.91 | $198 | $1,558 | -$860 | $5,544 | 29 |

*A one second reduction in 0–30 mph acceleration is assumed to correspond to 2.5 seconds reduction for 0–60 mph acceleration time. Thus, the WTP for a one second reduction in 0–30 mph time is divided by 2.5 to obtain the value of a one second reduction in 0–60 mph time.

**An increase of 0.01 hp/lb at the 1995–2014 average hp/wt of 0.0507 is estimated to correspond to a reduction in 0–60 mph time of 1.68 seconds. Thus, the WTP for an increase of 0.01 hp/lb is divided by 1.68 to estimate the value of a one second reduction in 0–60 mph time.

**Figure 5-12. Frequency Distribution of WTP Estimates: Normalized 0–60 Times**



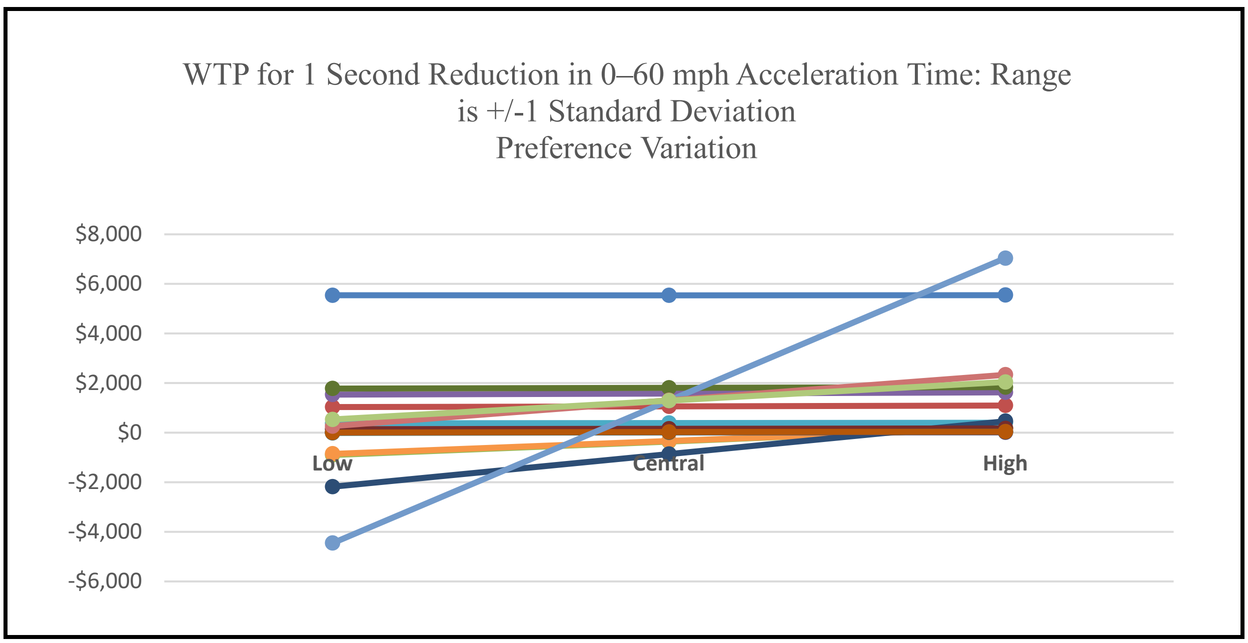

Although there may be greater consistency in the measures of central tendency for performance than for fuel economy, the dispersion of estimates is still large relative to the central tendency measures. As was the case for fuel cost, the performance WTP estimates based on market data indicate lower WTP than those based on stated or revealed preference survey data (see Table 5-4). Tests for differences in the median estimates by data type rejected the null hypothesis of equal medians at the 0.03 level.

**Table 5-4. Comparison of Stated and Revealed Preference Estimates of WTP for One Second Decrease in 0–60 mph Time**

| Willingness to Pay for One Second Decrease in 0–60 mph Time by Type of Data—Normalized Metrics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Data Type** | **Mean** | **Std. Dev.** | **Skewness** | **Median** | **P75-P25** | **Minimum** | **Maximum** | **N. Obs.** |
| Stated Preference | $918 | $892 | -2.4 | $1,227 | $202 | -$1,547 | $1,514 | 10 |
| Revealed Preference | $1,838 | $1,826 | 1.05 | $1,380 | $2,073 | $22 | $5,544 | 8 |
| Revealed and Stated Preference (Combined) | $1,050 | $ 2 | 0 | 1,050 | $3 | $1,049 | $1,052 | 2 |
| Market Data | $723 | $1,199 | 1.81 | $198 | $1,267 | -$860 | $4,946 | 26 |
| Literature Review | $497 | $51 | 0 | $497 | $72 | $461 | $533 | 2 |
| Total | $947 | $1,198 | 1.0 | $950 | $1,135 | -$1,547 | $5,544 | 48 |

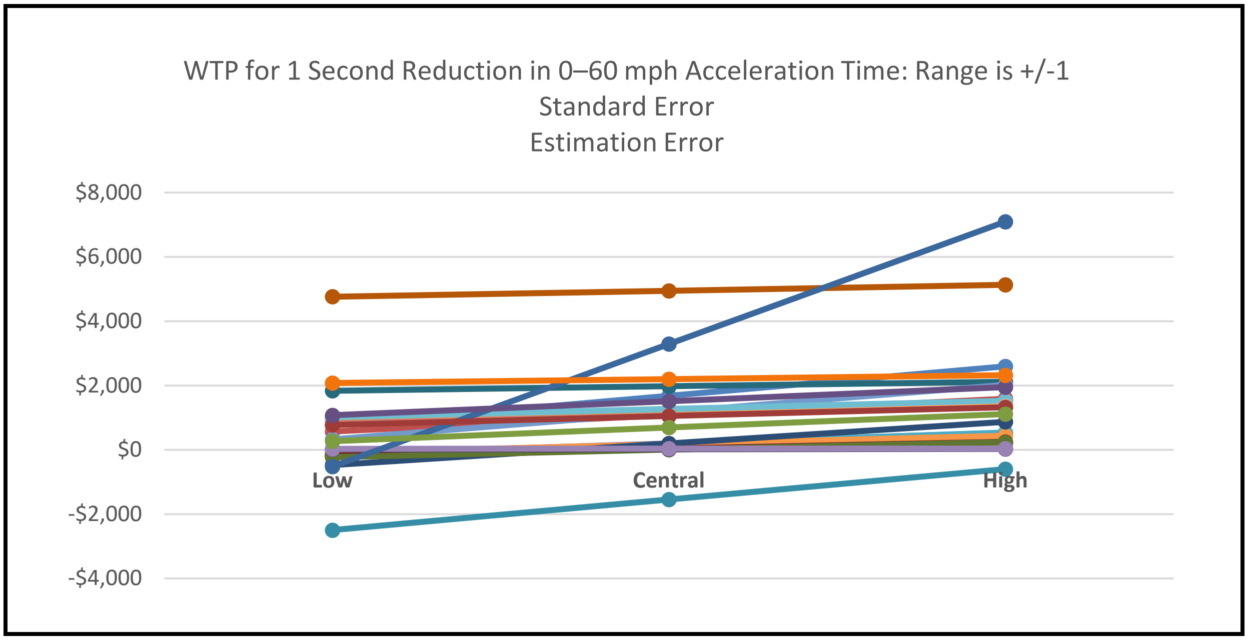
The variation in estimates of WTP for acceleration performance are shown in Figures 5-13 and 5-14. In most cases, the variation from low to high for a given estimate (the slope of each line) is far smaller than the variation across estimates (vertical spread of the lines). The scale of the variation across estimates hides some of the relative variation within an estimate. For example, in one case the high estimate is $15 while the low estimate is less than half that, $7, but the set appears to be a level line in Figure 5-13. On the other hand, it is not uncommon to find a range of estimation error on the order of $1,000 (Figure 5-14).

**Figure 5-13. WTP for One Second Decrease in 0–60 mpg Time: Preference Heterogeneity**




Note: Each line represents the range calculated for an observation of an estimate of WTP for a particular vehicle attribute (combination of study and model specification; a single study can have multiple observations).

**Figure 5-14. WTP for One Second Decrease in 0–60 mpg Time: Estimation Error**




Note: Each line represents the range calculated for an observation of an estimate of WTP for a particular vehicle attribute (combination of study and model specification; a single study can have multiple observations).

## 5.6 Pollution

We found 19 estimates of WTP for emissions reductions. Units were converted from WTP for a variety of different levels of vehicle emissions reductions relative to a traditional gasoline engine into WTP for a consistent measure, defined as a 10% decrease in emissions relative to a contemporary gas vehicle to allow for comparison across studies. We assumed WTP to vary linearly for this transformation (e.g., multiply by 10 to convert from a 1% reduction or by 0.2 for a 50% reduction), though recognizing that may be a strong assumption. Central estimates range widely from −$66,982 to $168,536. Studies using older stated preference data from 1993–1996 tended to find higher willingness to pay for emissions reductions. Newer studies using data from 2009 and 2012 (Hidrue et al., 2011 and Tanaka et al., 2014, respectively) found WTP values ranging from $297 to $582 for a ten-percent reduction in emissions. The Hidrue et al. study found that WTP for that 10 percent reduction generally increased for higher-level reductions (e.g., 95% lower emissions), suggesting the assumption of linearity when converting to common units may hide variation in consumer tastes. Additional surveys or the study of market data could provide additional insight on current preferences.

## 5.7 Range

We use 40 estimates of WTP for range in the literature, all of which were estimated in terms of dollars per mile or based on a certain number of miles of range. There were three papers

(Helveston et al., 2015; Hidrue et al., 2011; and Parsons et al., 2014) that had a total of 27 coefficients for range. However, all the range variables in these three studies were (0,1) representing, for example, a vehicle with a 75 mile range, a 150 mile range and a 200 mile range (the exact numbers actually vary across the papers). We do not feel there is a reasonable way to estimate the marginal value of adding a mile of range ($/mi) for the lowest range included in any of these papers. The reason is that we are estimating value per mile of changes in range, but do not think that it is reasonable to calculate value per mile in that way when examining the difference between a range of 0 miles (useless for transportation) and a positive range. Instead, we include only estimates for ranges where we can take the difference between values reported for different levels of range and calculate the average change in value per mile of range for that change in range. This is an average value over the difference in range rather than a true marginal value, but the best estimate we could calculate and a meaningful measure of changes in range valuation with the magnitude of range.[14] The observations produce a mean of $86 per mile, and an interquartile range of $54–117. Greene (2001) derived a value of range based on the assumption that is it a savings in refueling time and effort and shows that its value is a function of the inverse of range. None of the papers estimate the value of range in this form, however. In this framework, variations in the value of range would depend chiefly on the consumers' value of time and the range of the vehicles under consideration.

The observations are drawn from 16 different papers and all but one (Greene, 2001) utilize survey data. Approximately half of the estimates use the same two-round phone survey in California, first published by Brownstone et al (1996). Several other estimates draw from California surveys. Authors primarily employ MNL and MXL estimation strategies, though no significant divergences are obvious by either estimation strategy, data type, or time frame.

In models that permit variation in taste across a population, we find varying levels of heterogeneity (Figure 5-15). Several studies have high and low values that cross zero and represent a spread of several hundred dollars per mile. As several of these observations utilize the same data (i.e., the Brownstone et al. [1996] survey), these divergences seem to emerge from the formulation employed by the authors. Figure 5-16 summarizes variation in estimates for those available values that reflect estimation error.

[14] The effect of this adjustment on the number of observations included from Helveston et al. (2015), Hidrue et al. (2011), and Parsons et al. (2014) is that we drop 9 of their 27 reported observations (lowest range with values reported) and include the 18 where we can calculate differences and convert to a $/mile of range estimate consistent with the other observations. This adjustment is reflected throughout all figures and tables in the report presenting summary statistics.

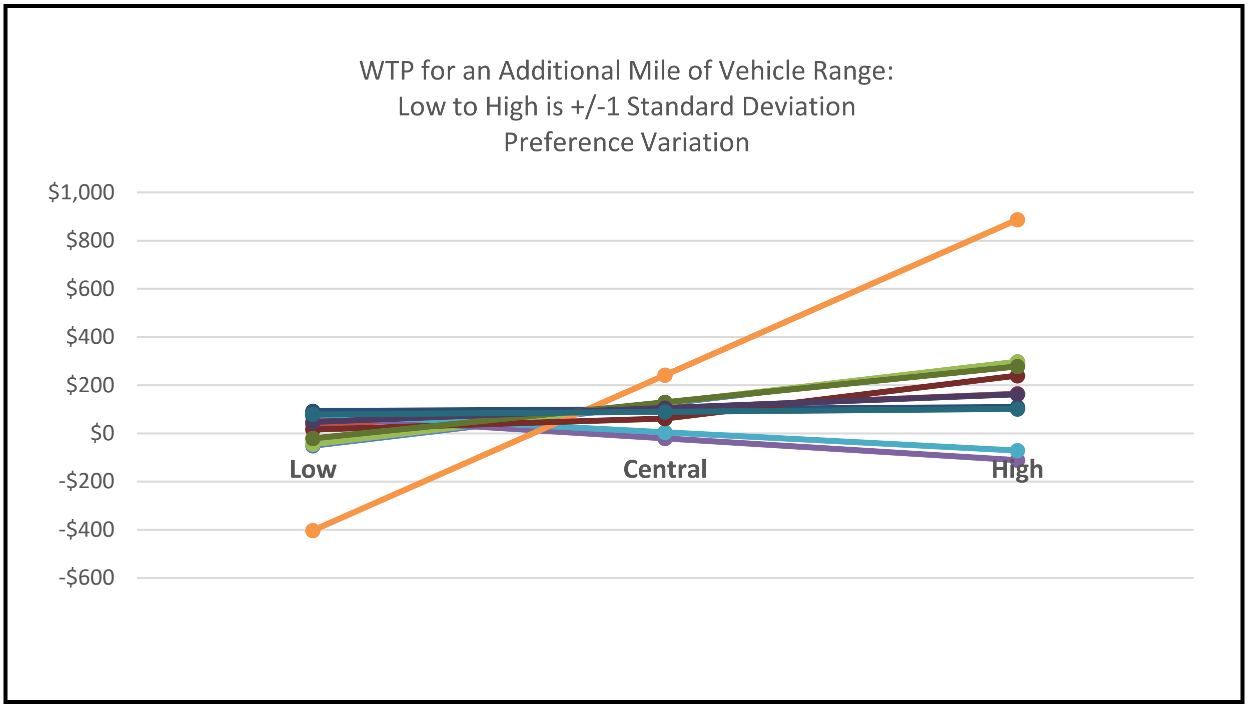
## 5.8 Size

### *5.8.1 Footprint*

We remove one extreme value of $680,000 per square foot from our sample of 19 observations and produce a trimmed mean of $3,398 per square foot, and a standard deviation of $4,381. The distribution is somewhat balanced with an interquartile range of $477–$4,411 (Figure 5-17).

For one paper, units are unclearly marked so we assume them to be square feet as standard in most market data sources.[15] Our trimmed sample includes two more extreme cases, which we retain nonetheless as their inclusion does not skew the findings regarding the central tendency of the sample.

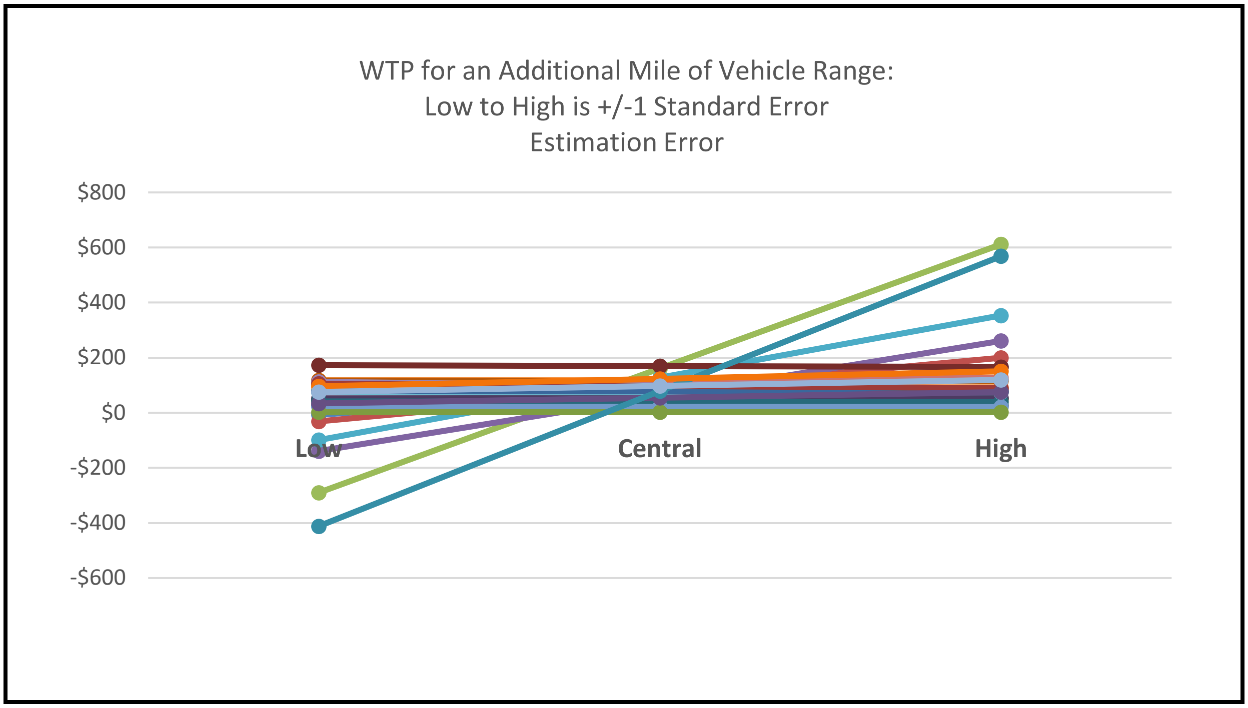
**Figure 5-15. WTP for Range in $/mile: Preference Variation, +/1 One Standard Deviation**




Note: Each line represents the range calculated for an observation of an estimate of WTP for a particular vehicle attribute (combination of study and model specification; a single study can have multiple observations).

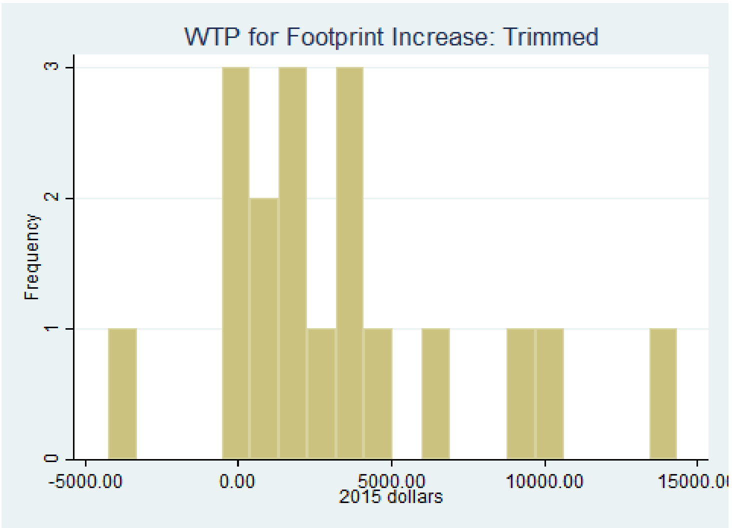
[15] We requested feedback from the study author, including a specific clarifying question about the units used in their study, but did not receive a response.

**Figure 5-166. WTP for Range in $/mile: Estimation Error, +/1 One Standard Error**




Note: Each line represents the range calculated for an observation of an estimate of WTP for a particular vehicle attribute (combination of study and model specification; a single study can have multiple observations).

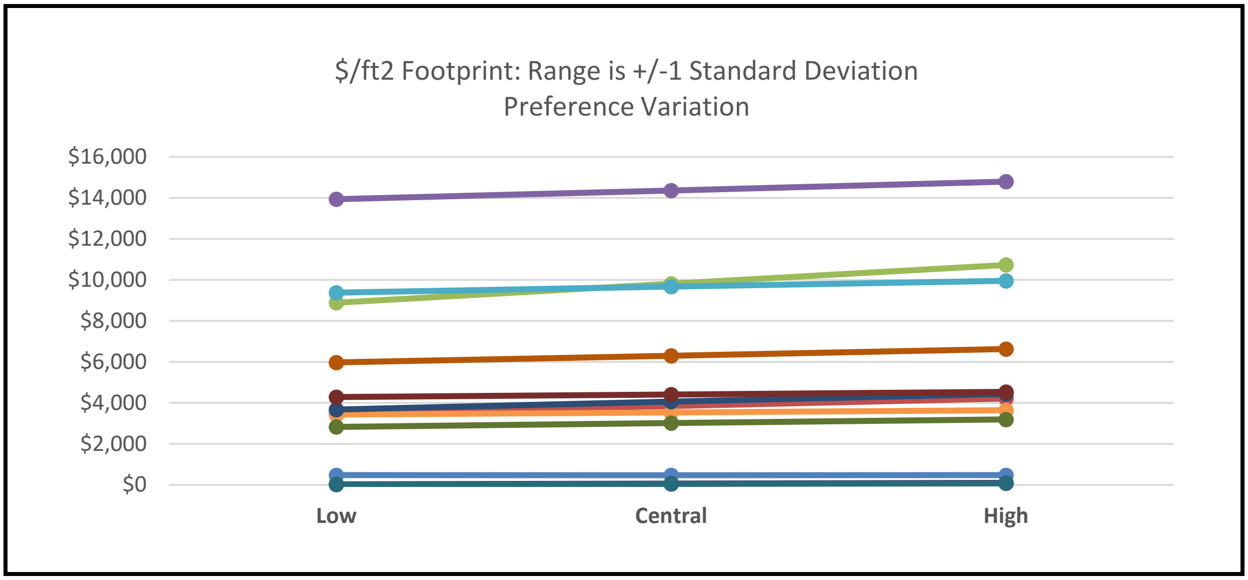
**Figure 5-177. Trimmed Central WTP Estimates for Vehicle Footprint**



The eighteen estimates in the trimmed sample are based primarily on market data (there is one observation based on RP survey data) and reflect a variety of estimation strategies, including BLP, MNL, NMNL, and MXL. Six of these estimates come from Petrin (2002), which uses different subsets of sales data from 1981–93 to produce WTP values ranging from $3,500–$14,500. Haaf et al. (2014) produce four estimates of WTP for vehicle footprint using different modeling formulations; their outputs cluster more closely between $900–$1,500.

Population heterogeneity is relatively limited across the studies that allow variation in taste. The largest difference between low and high values is $1,842, but for most, the range is a few hundred dollars (Figure 5-18). We generally find that there is low variation in valuation of footprint size across populations, and that additional square footage is positively valued.

**Figure 5-188. WTP for Footprint: Preference Variation, +/- One Standard Deviation**




Note: Each line represents the range calculated for an observation of an estimate of WTP for a particular vehicle attribute (combination of study and model specification; a single study can have multiple observations).

### *5.8.2 Luggage Space*

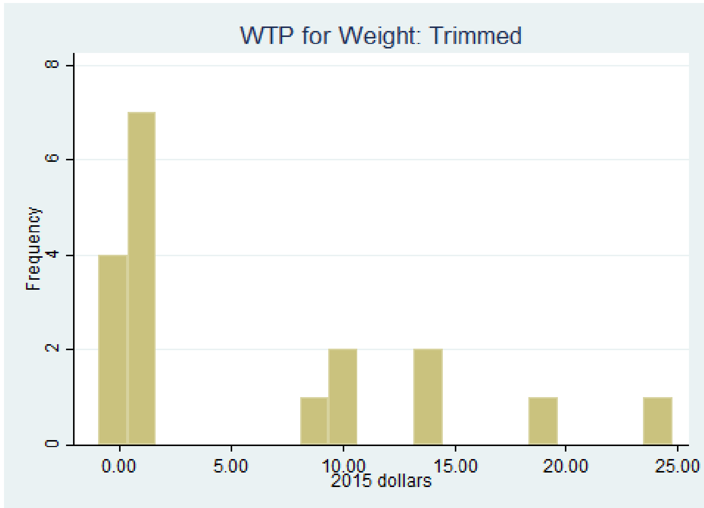
From an initial pool of twelve estimates for luggage space, we remove one extreme value near $30,000. The remaining estimates produce a balanced distribution centered around $1,445 per cubic foot. We see a moderate positive skew, with a median of $1,100, and an interquartile range between $619 and $2,365.

The trimmed estimates draw from four different studies, one of which is a literature review (Greene, 2001). The latter produces a lower estimate of $270 per cubic foot. One other estimate is of an unanticipated negative sign. The majority of remaining estimates are from Liu et al. (2014)'s study using revealed preference survey data and a MNL modeling strategy. Liu et al. (2014) produce estimates based on household fleet size and income segment. For the most common cases (1 or 2 cars, medium income) and nearby cases, WTP ranges between $1,000–$2,000 per cubic foot. One other estimate from McCarthy (1998) using 1989 data produces a similar value of WTP. In general, consumers positively value additional space, with preferences strengthening for households owning fewer vehicles in the study by Liu et al (2014); households owning only one car were estimated to have a greater WTP than households with multiple vehicles.

### *5.8.3 Weight*

Although weight may have value to some consumers, it is often used by modelers as a convenient proxy for vehicle capacity and size which complicates the interpretation of WTP estimates. We remove one outlier from an initial pool of 19 observations and produce a trimmed mean of $5.70 per pound, from an initial mean of $10 per pound. Despite trimming, the distribution is still highly skewed. There are 25% of estimates between $0.41 and $0.50, with the next quartile spreading over $0.51 to $10.23 dollars (Figure 5-19). The cluster of values near zero comes solely from Klier and Linn (2012), a study using a linear instrumental variable least squares technique. They produce varying estimates based on inclusion and exclusion of different covariates. The other observations of WTP for weight come from hedonic studies and one MNL model. These estimates tend to fall between $10–15 per pound, and draw from a mix of market and revealed preference survey data. Within this further restricted sample of data points, formulations focusing solely on trucks tend to produce lower WTP estimates. Disregarding the Klier and Linn estimates, we find tentative consensus in the literature of consumer weight valuation around $10–15 per pound. These figures are limited by the small sample of studies. We are unable to estimate taste heterogeneity because our sample has only fixed coefficient models. Modelers tend to employ weight as a proxy for qualities that may be more difficult to quantify, such as size, comfort or handling.

**Figure 5-199. Trimmed Distribution of Central WTP for Weight**



# SECTION 6.
# DISCUSSION: WHY THE LACK OF CONSENSUS ON WTP?

This project suggests some challenges for research that models consumer demand for vehicles and their attributes. Modeling results seem to be highly sensitive to a number of factors, including sources of underlying data, modeling techniques, included and omitted variables, and functional form. As discussed above, results vary widely not only across studies, but even within individual papers. This field of research will inspire more confidence in its policy relevance if it can identify greater convergence of values, or at least greater understanding of the factors that contribute to the wide variation in values.

The most conspicuous feature of the central tendency WTP estimates for nearly all attributes is their dispersion. This generalization holds true for the trimmed as well as the untrimmed estimates. Outliers are common but not numerous, and removing them still leaves a diverse set of estimates. For 24 of the 34 individual attributes and both of the aggregate measures shown in Table 5-1, one standard deviation of the trimmed distribution is larger than the mean value, and in only one case is it less than half of the mean. The distributions of estimates are skewed, as a rule, making the medians better measures of central tendency than the means. These two facts make it difficult to interpret overall measures of central tendency, even when at least one of the measures of central tendency corresponds reasonably well to a constructed reference point estimate.

A non-negligible number of the central WTP estimates violate prior expectations, e.g., willingness to pay less for a vehicle with improved fuel economy or higher horsepower/weight. Still, in the great majority of cases the signs of WTP estimates agree with prior expectations.

The most commonly estimated attribute value categories, fuel cost and acceleration performance, were examined in greater detail, taking advantage of the ability to convert variables to a comparable metric. In the case of fuel costs, median estimates based on stated preference survey data indicated a greater preference for reduced fuel costs compared to revealed preference data. Estimates based on market sales data indicated an even lower willingness to pay for lower fuel costs. However, the same result was not found for the estimates of WTP for acceleration performance. It appears that the relationship between stated and revealed preference WTP estimates differs depending on the attribute in question.

High and low estimates for each observation were calculated based on +/- 1 standard error in the case of fixed parameter models and +/- 1 standard deviation in the distribution of preferences in the case of random coefficient models or models in which preferences depended on household income. These results indicate both wide variation in consumers' preferences and substantial uncertainty in estimation.

This report has focused on presenting descriptive statistics for the various attributes found in the literature and has not conducted systematic analysis of why those differences arise. Subsequent research will attempt to analyze why WTP estimates vary both across studies and for model formulations within studies. It is possible that further meta-analysis of the WTP estimates may help explain their variability.

Probably the most salient feature of the WTP estimates found in the literature is their variation. On the one hand, variability is to be expected because circumstances and preferences do vary from person to person and over time. On the other hand, wide variation is seen in estimates of central tendency for entire populations across studies, and many estimates designed to reflect differences across individuals are puzzling and contradict expectations. Studies that provide estimates from various model formulations or estimation methods using the same data set may provide insights into the reasons for the great variability of WTP estimates.

Haaf et al. (2014) estimated a variety of discrete choice models, including MNL, NMNL and random coefficient models, using the same data set of sales of makes and models in the U.S. from 2004–2006. The estimated coefficients of vehicle price (in 10,000s of $) ranged from −0.19 to −0.61, except for one model estimated using the method of BLP which produced a coefficient estimate of −1.56. Coefficients of vehicle attributes were even more varied. In the six models that represented fuel cost as gallons per mile, three coefficients had a negative sign (as expected) while three had a positive sign. In addition to model form and estimation method, the models differed with respect to the measures of vehicle size included. Those with positive signs used width and length*width/height while those with negative signs included only length*width. Length*width/height has been used in a few studies as a proxy for "style." In fact, it measures the flatness of a vehicle. The variables were chosen based on objective measures of model fit and adequacy, rather than the modelers' judgment. The results illustrate how inferences about the values of attributes based on aggregate, revealed preference data can be strongly influenced by the selection of attributes to include, how they are measured, model form and estimation method.

Klier and Linn (2012) provide results for 14 different estimations of vehicle choice models at the make and model level using U.S. sales data for 2000–2008. The authors compare estimates made by means of ordinary least squares (OLS) with estimates using two different sets of instrumental variables (IV). The OLS estimates are very different from the IV estimates: the price coefficient is about one fifth as large, the coefficient of cost per mile is positive and that of hp/wt is more than two orders of magnitude smaller than that obtained by the IV methods. The authors clearly state that they believe that the OLS estimates are biased. Nonetheless, the exercise demonstrates how strongly the method of estimation can influence results. So also can the instruments of the IV method. Instruments similar to those used by BLP produced a coefficient estimate for hp/wt of 9.53, while those created by the authors based on engine characteristics produced an estimate of 38.75. Other coefficients do not vary as much between the two sets of IVs (e.g., the coefficient of log of price is −1.86 for the BLP instruments and −1.28 for the engine instruments) but the focus of the Klier and Linn paper is understanding the tradeoff between performance and fuel economy so a difference greater than a factor of three is important.

Some estimates may be robust to changes in a model's formulation while other are highly sensitive. Klier and Linn (2012) also compare seven sets of coefficient estimates from models differing with respect to variables included, except for one that employed a different error structure. The four that measured performance as hp/wt had similar coefficient estimates for both hp/wt (47.20, 38.75, 40.74 and 42.18) and the log of price (−1.79, −1.28, −1.34 and −1.49, in the same order). On the other hand, the four models showed much greater differences in the estimated coefficients of fuel cost per mile (−13.24, −11.05, −22.94 and −3.29). Models including hp and weight as separate variables produced a different set of estimates for the coefficients of the log of price (−0.99, −0.60 and −1.06) and fuel cost (−3.95, −0.98 and +0.43) than when hp/wt was used. A consequence of the sensitivity of estimates to choice of variables and instruments is that the Klier and Linn estimates of the WTP for 0.01 hp/lb fall into two clusters: ($303, $264, $303 and $283) and ($52, $51 and $8). The authors express a preference for the higher WTP estimates, which are consistent with their preferred model formulation using IV estimation and the engine instruments they constructed.

Augmenting aggregate revealed preference data with data on consumer attributes can also lead to dramatic changes in WTP estimates. Random coefficient models are compared with fixed coefficient logit models by Petrin (2002) who also augments vehicle sales data with data from the Consumer Expenditures Survey (CES) describing the average attributes of consumers purchasing new vehicles by income group. Vehicle price is specified as the log of (consumer income minus vehicle price). Four estimation methods were compared: OLS, IV, and a Generalized Method of Moments algorithm, all used to estimate a random coefficient (RC) logit model and the same model augmented (ARC) by fitting aggregate data on new vehicle purchasers from the CES. In the RC models, separate price coefficients are estimated for three income tertiles. Petrin reports that a Wald test rejects the OLS and IV estimated fixed coefficient models in favor of the random coefficient models. While many of the coefficient estimates are similar among the four models the estimated coefficient of Miles/Dollar (miles per gallon/fuel price) for the OLS, IV, RC, and ARC models are, respectively: 0.18, 0.05, −0.54 and −15.79. Only the estimated coefficient of the ARC model is statistically significant, however. The coefficient of miles per dollar is expected to be positive, and although the RC model estimates are the mean of a probability distribution the estimated standard deviations are only 0.04 (RC) and 2.58 (ARC), implying that nearly all consumers would prefer fewer miles per dollar.

Petrin's preferred model (random coefficients estimated by augmenting market sales data with data from the CES) produced mean WTP estimates for miles per dollar for the lowest, middle and highest income tertiles of −\$33,890, −\$13,313, and −\$14,018, respectively. The model estimated without using the CES data produced mean WTP estimates of −\$1,771, −\$1,192 and −\$436 for the income tertiles. Estimated standard deviations describing taste heterogeneity implied one standard deviation ranges of less than +/- 20% for the ARC model and less than +/- 10% for the RC model. For the ARC model, the mean WTP estimates for an increase of 0.01 hp/lb. (faster acceleration) were: −\$607, −\$239, and −\$251 for low, middle and high income tertiles. For the RC model the corresponding WTP estimates were: \$1,115, \$751 and \$275, a reversal of sign. However, only the standard deviation coefficient in the ARC model was statistically significantly different from zero. In that model +/- one standard deviation of WTP implied ranges of (−\$1,539 to +\$324), (−\$605 to +\$127) and (−\$637 to +\$134) for the three income tertiles, implying that most consumers would prefer slower acceleration.

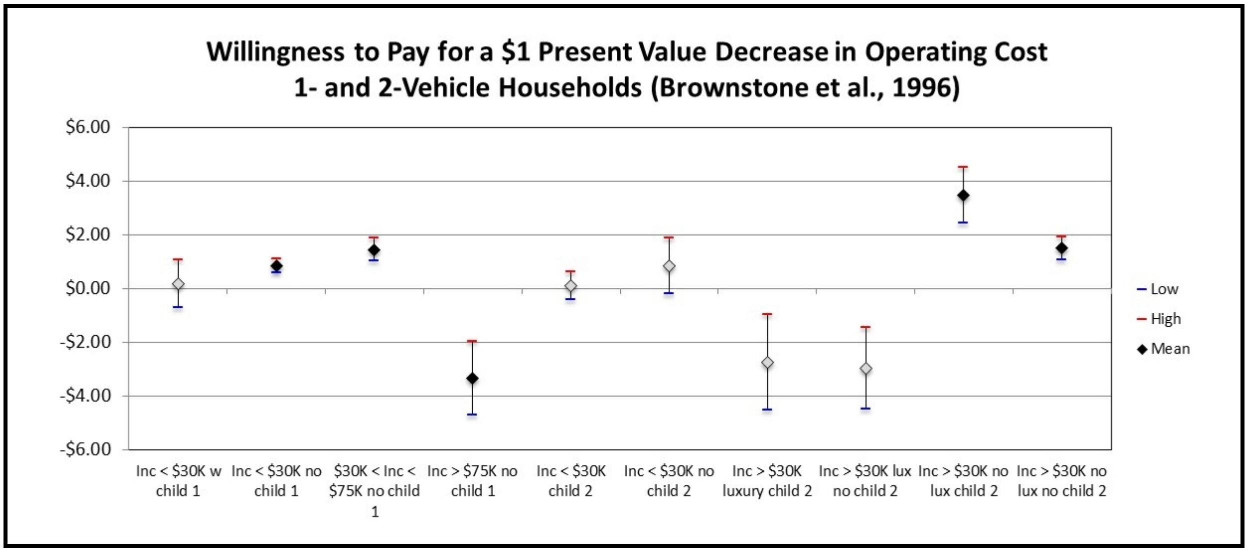
Modelers are aware of the challenges to obtaining robust estimates of attribute coefficients in vehicle choice models. Brownstone et al. (2000) point out several severe shortcomings of models estimated solely with RP data: 1) high collinearity and limited variation in vehicle attributes, 2) problems defining choice sets from the thousands of makes, models, drivetrain and trim configurations, and 3) problems accurately linking vehicle attributes to the vehicles described by households. The authors note: "Under these difficult conditions RP model estimates are often unstable, and can have theoretically incorrect signs." Because stated preference surveys can be designed to avoid strong correlations among the attributes of an alternative, can attempt to minimize the effects of unobserved attributes, and can clearly define choice sets using a rigorous experimental design, they should be more likely to produce consistent results. One hundred and forty-eight of the 786 WTP estimates considered in this study come from five research papers that used the same survey of stated preferences for alternative fuel vehicles conducted in California in 1993 (McFadden and Train, 2000; Brownstone et al., 2000; Brownstone and Train, 1999; Kavalec, 1999; Brownstone et al., 1996). A comparison of these studies sheds some light on the strengths and weaknesses of models estimated using SP data. The studies are briefly described below, followed by a comparison of their WTP estimates.

The California survey began with an initial computer-aided telephone interview of 7,387 households, 4,747 of whom completed a follow-up mailed survey. Respondents were asked to choose among four fuel types: gasoline, compressed natural gas, methanol and battery electric. For each, two body types were offered, described by six attributes. Respondents were instructed to assume all attributes not specifically described were identical for all vehicles. An orthogonal main effects design was used to structure the choice alternatives.

Brownstone et al. (1996) estimated MNL models to predict vehicle transactions (add, replace, dispose of a vehicle) rather than vehicle holdings. Separate models were estimated for 1,153 households owning one and 1,156 households owning two vehicles. Vehicle price was interacted with household income category and the presence and age of children. Because WTP estimates are derived by dividing the derivative of the utility function with respect to an attribute by its derivative with respect to income, the interactions create a multiplicity of WTP estimates for different income groups and household compositions. Estimates of the willingness to pay for a $1 present value decrease in operating cost are shown in Figure 6-1. High and low WTP estimates reflect +/- one standard error of the operating cost coefficient. The number of vehicles owned by the household is shown in the horizontal axis labels, and luxury or lux indicates the household owns at least one luxury vehicle. Although several of the estimates are close to $1, as would be expected, others are negative, suggesting that at least three categories of consumers would prefer higher operating costs. This result is due to positive coefficient estimates for vehicle purchase price for three of the household categories. Positive coefficients on vehicle price might represent a genuine preference to pay more for a vehicle (e.g., a Giffen good), but more likely indicate shortcomings of the survey design, model specification and estimation. The positive price coefficients create similarly anomalous WTP estimates for other attributes for these household categories.

Kavalec (1999) used the 1993 California data to explore the effects of an aging population on demand for gasoline through their vehicle purchase decisions. The focus was on estimating the influence of age on consumers' preferences for different vehicle attributes. Random coefficients were estimated for four fuel types and two vehicle size classes. The results implied that the values of fuel cost and acceleration were only slightly affected by the respondent's age but the value of top speed decreased steeply and linearly with increasing age and the value of range first increased with increasing age but then decreased rapidly beyond the age of 65.

**Figure 6-1. Willingness to Pay for a $1 Present Value Decrease in Operating Cost: 1- and 2-vehicle Households (Estimates derived from Brownstone et al., 1996)**




Brownstone and Train (1999) used the same 1993 California survey data to estimate a MXL model of alternative fuel vehicle choice. Because the mixed logit model represents heterogeneity in consumers' preferences by means of random coefficients, the model includes many fewer interactions between household attributes and vehicle attributes. The coefficient of vehicle purchase price was assumed not to be a random variable but purchase price is divided by the logarithm of household income and so varies systematically with income. Random coefficients were estimated for choices between other vehicle types and electric and compressed natural gas vehicles and for vehicle size class and luggage space.

Brownstone et al. (2000) combined the 1993 California survey data with revealed preference data comprised of the actual purchases of 874 households who purchased a vehicle between two waves of the survey. An MXL model was estimated. The authors note that the RP data appeared to be essential to estimating a model that could realistically predict body type choices and the appropriate volumes of purchases. Only the alternative fuel constants and fuel cost were assumed to have random coefficients.

McFadden and Train (2000) estimated an MXL model using the 1993 California survey data. They used the same variables and transformations as Brownstone et al. (1996). Random coefficients were estimated for choices between other fuels and EVs and CNG vehicles, and for size, luggage space, operating cost and refueling station availability. The latter two were identified by new specification tests derived by the authors and expand on the set of random coefficients estimated by Brownstone and Train (1999).

Estimates of willingness to pay for fuel cost from the five studies are shown in Table 6-1. Comparable estimates for Brownstone et al. (1996) are shown in Figure 6-1 (highlighted individually to show the variation present within that single study). All but one of the models is mixed logit. The ranges of WTP estimates are based either on +/- one standard error of the coefficient estimate if an MNL model or on +/- one standard deviation of the random coefficient estimate if an MXL model was used. In the case of the Kavalec model, +/- one standard deviation of the age distribution of respondents was used since the coefficient was interacted with the respondent's age. The central tendency estimates are relatively consistent, ranging from $2,564 to $3,239 for the four models. In general, this seems to support the claim that SP survey data should provide more consistent estimates than RP data. The low and high ranges are less consistent, with the High estimates for MXL models ranging from $2,147 to $10,308. The same models' Low estimates range from $2,058 for Kavalec's age-interacted WTP to −$4,275 for McFadden and Train's random coefficient model. In the case of Brownstone et al. (1996) we extracted the lowest, median and highest from the full set of estimates shown in Figure 6-1.

**Table 6-1. Willingness to Pay for $0.01/mile Decrease in Fuel Costs from Studies Using the Same CA Survey**

| | | | WTP for $0.01/mile | | |
|---|---|---|---|---|---|
| **Paper** | **Model** | **Variation** | **Low** | **Central** | **High** |
| Brownstone & Bunch, 2000 | MXL | Std. Dev. | 1,437.73 | 2,564.42 | 3,691.11 |
| Brownstone & Bunch, 2000 | MNL | Std. Err | 2,098.43 | 3,239.98 | 4,381.53 |
| Brownstone & Bunch, 2000 | MXL | Std. Dev. | -4,068.99 | 2,799.65 | 9,668.29 |
| Brownstone & Train, 1999 | MXL | Std. Dev. | 1,012.73 | 2,749.85 | 4,486.98 |
| Brownstone et al., 1996 | MNL | Std. Err. | 5,440.98 | 7,739.32 | 10,037.66 |
| Kavalec, 1999 | MXL | Age | 2,057.94 | 2,706.64 | 2,147.42 |
| McFadden & Train, 2000 | MXL | Std. Dev. | -4,274.85 | 3,016.68 | 10,308.20 |

Estimates of WTP for a 1 second decrease in 0–60 mph acceleration time for the five studies are shown in Table 6-2. The range of central tendency estimates is relatively larger than that of the fuel cost estimates in Table 6-1: −$1,547 to $3,288. Only one of the nine Low-High ranges includes zero. The effect of the few positive price coefficients in Brownstone et al. (1996) can be seen in the set of positive estimates ranging from $690 to $3,288, implying that that market segment would prefer vehicles with slower acceleration.

**Table 6-2. Willingness to Pay for a 1 Second Decrease in 0-to–60 Acceleration Time**

| | | | WTP for 1 Second Decrease in 0–60 mph Acceleration Time | | |
|---|---|---|---|---|---|
| **Paper** | **Model** | **Variation** | **Low** | **Central** | **High** |
| Brownstone & Bunch, 2000 | MXL | Std. Err. | $772.73 | $1,048.70 | $1,324.67 |
| Brownstone & Bunch, 2000 | MNL | Std. Err. | -$519.61 | $3,287.55 | $7,094.71 |
| Brownstone & Bunch, 2000 | MXL | Std. Err. | $776.74 | $1,066.25 | $1,355.76 |
| Brownstone et al., 1996 | NMNL | Std. Err. | $267.44 | $690.17 | $1,112.90 |
| Brownstone et al., 1996 | NMNL | Std. Err. | -$2,494.35 | -$1,546.88 | -$599.42 |
| Brownstone et al., 1996 | NMNL | Std. Err. | $1,077.34 | $1,513.61 | $1,949.89 |
| Brownstone & Train, 1999 | MXL | Std. Dev. | $265.02 | $1,299.02 | $2,333.02 |
| Kavalec, 1999 | MXL | Age | $674.62 | $1,140.64 | $1,606.66 |
| McFadden & Train, 2000 | MXL | Std. Err. | $1,009.62 | $1,261.54 | $1,514.43 |

There is similar variation among the five studies with respect to alternative fuel vehicle attributes that are likely to be unfamiliar to respondents. Table 6-3 shows estimates of willingness to pay for alternative refueling station availability equal to that of gasoline. Central tendency estimates range from $94 to $314 per vehicle. The MXL central tendency estimates are quite similar, ranging from only $108 to $144. Two of the MXL models indicate a negative Low WTP estimate, suggesting that some consumers would prefer not to have greater availability of refueling stations. The High WTP estimates range from $143 to $346. The central tendency estimates seem low, especially for methanol and CNG vehicles which cannot operate without fueling stations offering their fuel. Since that would render the vehicles useless from a practical point of view, one might expect WTP for full availability versus no availability to be on the order of the full price of a vehicle. The explanation for this may lie in the fact that the studies enter fuel availability linearly, whereas Nicolas et al. (2004) have shown that the cost of limited fuel availability in terms of access time is exponential in relative availability.

**Table 6-3. Willingness to Pay for Alternative Fuel Availability Equivalent to Gasoline**

| Paper | Model | Variation | WTP for Availability = Gasoline | | |
|---|---|---|---|---|---|
| | | | Low | Central | High |
| Brownstone & Bunch, 2000 | MXL | Std. Err. | $73.08 | $108.43 | $143.78 |
| Brownstone et al., 1996 | NMNL | Std. Err. | $32.84 | $179.12 | $325.40 |
| Brownstone et al., 1996 | NMNL | Std. Err. | $179.94 | $313.53 | $447.11 |
| Brownstone et al., 1996 | NMNL | Std. Err. | $23.02 | $93.53 | $164.03 |
| Brownstone et al., 1996 | NMNL | Std. Err. | $44.94 | $182.56 | $320.18 |
| Brownstone et al., 1996 | NMNL | Std. Err. | $80.20 | $231.33 | $382.47 |
| Brownstone et al., 1996 | NMNL | Std. Err. | $36.14 | $197.11 | $358.08 |
| Brownstone & Train, 1999 | MXL | Std. Dev. | -$33.09 | $140.62 | $314.33 |
| Kavalec, 1999 | MXL | Std. Err. | $106.17 | $144.35 | $182.54 |
| McFadden & Train, 2000 | MXL | Std. Err. | -$111.58 | $117.44 | $346.43 |

There is greater variation in the estimates of the value of reducing the emissions of a typical gasoline vehicle to zero (Table 6-4). The negative estimates (preference for higher emissions) are shown in italics and come from Brownstone et al.'s (2000) model estimates that used the RP survey wave of the 1993 California Survey. All the others are based on either the SP data or a combination of the two. Perhaps one explanation for the reversal of signs on WTP for reduced emissions for the SP results is the tendency of survey respondents to provide answers they believe are the desired answers or the answers that reflect well on them (a.k.a., social desirability bias).

The California SP studies all used the same database and most used the same set of variables. Differences are due to small variations in the formulation of variables and estimation methods. As expected, estimates of central tendency based on the SP surveys were more consistent than seen above when RP surveys were used. WTP estimates for less familiar attributes varied more than the estimates for familiar attributes. Estimates of the variation of preferences across the population sometimes included counterintuitive preferences (e.g., preferring less fuel availability). A study that combined RP data with the California SP data reversed the sign on WTP for emission reductions, suggesting that "yea-saying" bias may be present in inferences about certain attributes, although there are other possible explanations.

**Table 6-4. Willingness to Pay for Reducing the Emissions of a Typical Gasoline Vehicle to Zero**

| | | | WTP for Reduction to Zero Emissions | | |
|---|---|---|---|---|---|
| Paper | Model | Variation | Low | Central | High |
| Brownstone et al., 1996 | MXL | Std. Err. | $76,777 | $168,536 | $260,294 |
| Brownstone et al., 1996 | NMNL | Std. Err. | $103,065 | $144,803 | $186,540 |
| Brownstone et al., 1996 | NMNL | Std. Err. | $8,357 | $76,601 | $144,846 |
| Brownstone et al., 1996 | NMNL | Std. Err. | -$72,273 | $8,213 | $88,699 |
| Brownstone et al., 2000 | NMNL | Std. Err. | $47,823 | $75,954 | $104,085 |
| *Brownstone et al., 2000* | *NMNL* | *Std. Err.* | -$83,602 | -$66,982 | -$50,362 |
| Brownstone et al., 2000 | NMNL | Std. Err. | $51,604 | $81,736 | $111,867 |
| Brownstone & Train, 1999 | MXL | Std. Dev. | -$28,709 | $145,004 | $318,716 |
| Kavalec, 1999 | MXL | Std. Err. | $102,201 | $141,968 | $181,735 |
| McFadden & Train, 2000 | MXL | Std. Err. | $100,047 | $132,461 | $164,892 |

## SECTION 7.
## CONCLUDING OBSERVATIONS

A goal of this study was to identify consensus estimates of the values of various vehicle attributes through a comprehensive analysis of empirical estimates in the published literature. Unfortunately, we have found very little useful consensus. Frequently, standard deviations are of the same magnitude as, or greater than, mean values. In general, medians differ markedly from means and interquartile ranges are as large, or larger than, medians. Typically, estimates based on stated preference surveys do not agree with estimates based on revealed preference surveys or market sales data. For example, fuel cost is the most frequently included attribute in vehicle choice studies after purchase price. The mean estimate of central tendency estimates of WTP for a one cent per mile decrease in fuel costs, based on 27 stated preference estimates, is $3,914 with a standard deviation of $12,655. The mean of 15 estimates using revealed preference data is −$66,796 ($3,609 trimmed) with a standard deviation of $272,752 ($6,580 trimmed). The medians and interquartile ranges for stated and revealed preference studies are, respectively, $1,889 and $2,817 (SP), $583 ($692 trimmed) and $3,230 ($3,192 trimmed) (RP). This is the variability of the central tendency estimates from the 42 (41 trimmed) estimates and does not reflect standard errors of estimation nor preference heterogeneity in the population. Some consistency can be found in the fact that most estimates are positive (consumers would prefer lower fuel costs). This "consensus" however, encompasses such a wide range of values that it is of little use for informing policy decisions. Unfortunately, the results for other attributes are often just as divergent.

In the authors' judgment, the magnitude of uncertainty exhibited in the recent literature reflects the inherent difficulty of estimating how much consumers value vehicle attributes. Motor vehicles are complex, multi-attribute commodities. Consider just one of the more important attributes for consumers: safety. Dimensions of safety include frontal, side, offset and rear crashworthiness, occupant protection for the driver as well as front and rear passengers, rollover propensity, handling, braking distance and anti-lock braking, traction control and, more recently, an increasing array of intelligent warning and control systems. As a rule, it is not possible to include all the relevant safety dimensions in a statistical model. Furthermore, safety is just one of several important dimensions that include price, capacity to carry people and cargo, reliability, performance, fuel economy, cost of maintenance and insurance, comfort, style, etc. All of these major dimensions are themselves multi-dimensional. As a general rule, it will not be possible to include all these measures nor will it be possible to find metrics that accurately reflect consumers' perceptions. Styling is important to consumers and yet few studies attempt to explicitly include it.[16] In statistical terms, there will inevitably be omitted variables and errors in variables. Finally, many of the attributes are correlated. Performance, comfort and size, for example, are correlated with each other and with purchase price. Omitted variables, errors in variables and correlated variables cause coefficient estimates to be biased. The nature of the biases will depend on which variables are included or excluded. Thus, the coefficient estimates obtained will depend on how a model is formulated.

Finally, the model of rational economic decision making that underlies all the studies we analyzed may not be an adequate representation of consumers' decision-making processes. Especially when faced with multi-dimensional, complex choices, consumers often employ simpler, heuristic choice methods (e.g., Kahneman, 2011). Consumers often focus on a small number of key attributes and satisfice less salient ones. Behavioral psychology has shown that the context of the consumers' decision strongly affects choices. The models reviewed generally assume that context need not be considered.

Given the large number of possible explanatory variables, and especially in models that include interactions between consumer and vehicle attributes, overfitting is likely. Some statistically significant variables may be fitting quirks or idiosyncrasies in the sample data rather than meaningful relationships. An overfitted model will statistically "explain" or fit well the data on which it is estimated, but will not necessarily predict well beyond the sample. Haaf et al. (2014) meticulously tested a variety of common vehicle choice model types on market sales data. The experiment found none that could predict sales shares for the following year better than a naïve model that assumed that shares would remain unchanged, However, in that study, the attribute-based models could predict better than the naïve assumption that sales shares would remain the same as the older year when predicting farther into the future or for new vehicle designs.

The WTP estimates described in this report strongly suggest that the results obtained depend importantly on decisions made by the analyst. WTP estimates for the same attribute vary widely across and even within studies. WTP values vary with the type of data: stated preference survey, revealed preference survey and market sales. Results are also sensitive to estimation methods. Instrumental variables estimates are frequently strikingly different from OLS estimates. Multinomial logit and nested logit forms with demographic variables interacted with vehicle attributes to create heterogeneity often differ markedly from mixed logit models that represent heterogeneity with random coefficients.

[16] In a rare exception, one study included length*width/height, literally the flatness of a vehicle, as a measure of style.

This creates a dilemma for the analyst. On the one hand, theory can help distinguish among functional forms and provide definitive expectations for signs and even magnitudes of coefficients and WTP estimates. On the other hand, the premises embedded in theories can make analysts susceptible to confirmation bias, "…the seeking or interpreting of evidence in ways that are partial to existing beliefs, expectations, or a hypothesis in hand," usually by "…unwitting selectivity in the acquisition and use of evidence" (Nickerson, 1993). The large variations in WTP values suggest the possibility that analysts may focus on a few variables of special interest, preferring formulations that provide values for these variables that are consistent with prior expectations. Other variables in the model may be overlooked or unexpected values for these variables may be explained by acknowledging that they are aliasing other attributes that are not of interest. Alternative specifications that lead to conflicting inferences may not be presented. In the previous section we discussed several studies that do provide numerous alternative results. These studies provide valuable insights that help understand why estimates from different studies can vary so markedly.

This paper has examined the willingness to pay for vehicle attributes that can be derived from these studies. Although measures of central tendency generally agree on signs, the variability in estimates across studies is almost always very large relative to the mean or median of the WTP estimates for any given attribute. Further analysis of these existing studies is needed to understand why such large differences in WTP estimates arise.

At this point we can only hypothesize about what might be causing the frequently extreme dispersion of estimates. Our estimates come from 20 years of published literature using data that cover an even greater period of time. While all are from the U.S., some pertain only to California and a few others to a limited number of states or metropolitan areas. Some of the data sources are stated preference surveys, others are revealed preference surveys or market sales, and researchers occasionally use combinations of these. Researchers estimate different types of models and use different estimation methods. Functional forms and the ways the same attribute is measured differ. A statistical meta-analysis of the WTP database we have created may lead to useful insights into the wide variability of existing estimates.

The lack of consensus we have found in the literature points to major challenges for researchers attempting to model consumer preferences for vehicles and their attributes. Modeling results seem to be sensitive to a number of factors, including sources of underlying data, modeling techniques, included and omitted variables, and functional form. As discussed above, results vary widely not only across studies, but even within individual papers. This field of research will inspire more confidence in its policy relevance if it can identify greater convergence of values, or at least greater understanding of the factors that contribute to the wide variation in values.

Recognizing the difficulty of the problem researchers in this area face, we offer a few recommendations that might eventually lead to greater consensus. First, model and parameter validation should become a key focus of future research. More studies should analyze the ability of vehicle choice models to predict outside of the data on which they were estimated. The robustness of coefficient estimates to alternative formulations of variables, model functional forms and estimation methods should be an important criterion for evaluation.

We recommend that authors routinely provide WTP estimates implied by their models. Authors have access to key information (e.g., variance-covariance matrices of coefficient estimates or joint probability distributions of coefficients in random parameter models) that are generally not available in published articles. In general, this enables authors to more accurately estimate marginal WTP than we have been able to do. In this report we focused exclusively on marginal WTP estimates. Estimates of WTP over intervals can also be calculated (e.g., Dimitropoulos et al., 2013) by means of logsums (e.g., Zhao et al., 2012). Routine reporting of WTP estimates would facilitate comparisons across studies, as well as alerting researchers and readers to possible model deficiencies.

It would also be helpful to pay special attention to aliasing effects, for example, by identifying variables believed to be proxies for omitted variables and those believed not to be, and providing supporting evidence. Researchers could pay greater attention to how attributes are represented in their models and provide explicit interpretations of interactions between vehicle and consumer attributes and the values they imply. In studies based on stated preference data, researchers could attempt to establish how well consumers understand the attributes they are asked to consider, and greater attention could be given to identifying potentially biased responses and their implications. Finally, it may be useful to explore alternatives to the economically rational, continuous trade-off model of consumer choice for understanding how consumers value vehicle attributes.

## SECTION 8.
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## APPENDIX A:
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# APPENDIX B:
# WILLINGNESS TO PAY RESULTS BY ATTRIBUTE GROUPING

## Comfort

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Berry | Levinsohn | 1995 | Econometrica | market data | 1983 | BLP | air conditioning | | 0.58 | 0.63 | 0.58 | 1.22 | 0/1 | -1031.32 | 976.18 | 2983.68 | random coef. |
| Berry | Levinsohn | 1995 | Econometrica | market data | 1983 | BLP | air conditioning | | 1.52 | 0.89 | 1.52 | 1.82 | 0/1 | -239.51 | 1397.70 | 3034.92 | random coef. |
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | AT | | 0.03 | 0.01 | | | 0/1 | 199.06 | 345.03 | 491.01 | standard error |
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | comfort rating | | 1024.10 | 149.07 | | | scale [1,5] | 1171.35 | 1370.90 | 1570.45 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | AT | | 0.06 | 0.01 | | | 0/1 | 1707.61 | 2158.67 | 2609.74 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | AT | | 0.04 | 0.02 | | | 0/1 | 943.49 | 1522.10 | 2100.71 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | air conditioning | | 5.78 | 0.26 | | | 0/1 | 2858.51 | 3961.64 | 5370.75 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | air conditioning | | 3.47 | 0.53 | | | 0/1 | 5921.01 | 11004.47 | 18930.18 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | air conditioning | | 8.96 | 0.43 | | | 0/1 | 4714.37 | 6479.66 | 10603.26 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | AT | | 0.88 | 0.28 | | | 0/1 | 332.29 | 658.41 | 1303.16 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | AT | | 3.52 | 0.23 | | | 0/1 | 1704.37 | 2401.11 | 3329.70 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | AT | | 1.69 | 0.30 | | | 0/1 | 2816.23 | 5321.43 | 9416.98 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | powersteering | | 5.53 | 0.36 | | | 0/1 | 2854.54 | 3990.39 | 6651.30 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | powersteering | | 0.62 | 0.20 | | | 0/1 | 215.69 | 396.04 | 724.45 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | powersteering | | -1.59 | 0.62 | | | 0/1 | -10416.58 | -4520.05 | -1960.07 | standard error |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | air conditioning | | 0.09 | | | | 0/1 | | 723.78 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | AT | | -0.10 | | | | 0/1 | | -2987.03 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | AT | | -0.07 | | | | 0/1 | | -2311.02 | | |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | shoulder room | income | 0.03 | 0.01 | | | $/inch | 0.15 | 0.18 | 0.21 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | shoulder room | income | 0.03 | 0.01 | | | $/inch | 0.44 | 0.53 | 0.63 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | shoulder room | income | 0.03 | 0.01 | | | $/inch | 4.34 | 5.27 | 6.19 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | shoulder room | income | 0.05 | 0.00 | | | $/inch | 0.32 | 0.34 | 0.36 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | shoulder room | income | 0.05 | 0.00 | | | $/inch | 0.70 | 0.73 | 0.77 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | shoulder room | income | 0.05 | 0.00 | | | $/inch | 1.11 | 1.17 | 1.23 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | shoulder room | income | 0.05 | 0.00 | | | $/inch | 0.29 | 0.31 | 0.32 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | shoulder room | income | 0.05 | 0.00 | | | $/inch | 0.52 | 0.55 | 0.57 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | shoulder room | income | 0.05 | 0.00 | | | $/inch | 1.70 | 1.80 | 1.90 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | shoulder room | income | 0.07 | 0.01 | | | $/inch | 0.36 | 0.41 | 0.45 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | shoulder room | income | 0.07 | 0.01 | | | $/inch | 0.57 | 0.64 | 0.70 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | shoulder room | income | 0.07 | 0.01 | | | $/inch | 0.99 | 1.10 | 1.22 | standard error |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | air conditioning | | | | 3.88 | 0.01 | 0/1 | 7765.51 | 7785.18 | 7804.84 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | air conditioning | | | | 3.88 | 0.01 | 0/1 | 8177.08 | 8197.79 | 8218.49 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | air conditioning | | | | -1.97 | 0.95 | 0/1 | -5574.90 | -3785.78 | -1996.67 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | air conditioning | | | | -1.97 | 0.95 | 0/1 | -15239.89 | -10349.05 | -5458.20 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | air conditioning | | | | -1.97 | 0.95 | 0/1 | -22648.48 | -15380.04 | -8111.60 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | air conditioning | | | | 3.88 | 0.01 | 0/1 | 19768.42 | 19818.47 | 19868.53 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | AWD | | | | -5.24 | 1.61 | 0/1 | 28591.26 | 40909.35 | 53227.43 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | AWD | | | | -12.32 | 4.42 | 0/1 | 40803.59 | 62928.77 | 85053.95 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | AWD | | | | -12.32 | 4.42 | 0/1 | 16878.14 | 26030.08 | 35182.02 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | AWD | | | | -12.32 | 4.42 | 0/1 | 16028.64 | 24719.95 | 33411.26 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | AWD | | | | -5.24 | 1.61 | 0/1 | 13101.89 | 10069.80 | 7037.72 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | AWD | | | | -5.24 | 1.61 | 0/1 | 19238.72 | 27527.41 | 35816.11 | random coef. |
| Train | Winston | 2007 | Int. Econ. Rev. | RP survey | 2000 | MXL | AT | | 0.65 | 0.28 | | | 0/1 | 5355.25 | 9260.61 | 13165.96 | standard error |
| Walls | | 1996 | RE Stat | market data | 1990 | Hedonic | air conditioning | | 0.72 | 23.40 | | | 0/1 | 4019.92 | 14464.17 | 24908.41 | standard error |

# Fuel Availability

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | refuel time reduction | | 0.00 | 0.00 | | | $/hr | -207.15 | 920.66 | 2048.48 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | refuel time reduction | | 0.00 | 0.00 | | | $/hr | -95.28 | 1071.92 | 2239.12 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | station availability 1% | fuel type | 0.57 | 0.48 | | | $/% | 32.84 | 179.12 | 325.40 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | station availability 1% | fuel type | 0.58 | 0.45 | | | $/% | 44.94 | 182.56 | 320.18 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | station availability 1% | fuel type | 0.74 | 0.49 | | | $/% | 80.20 | 231.33 | 382.47 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | station availability 1% | fuel type | 0.63 | 0.53 | | | $/% | 36.14 | 197.11 | 358.08 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | station availability 1% | fuel type | 1.00 | 0.44 | | | $/% | 179.94 | 313.53 | 447.11 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | station availability 1% | fuel type | 0.30 | 0.23 | | | $/% | 23.02 | 93.53 | 164.03 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | station availability 1% | | 0.91 | 0.30 | | | $/% | 73.08 | 108.43 | 143.78 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | station availability 1% | | 0.53 | 0.17 | | | $/% | 69.75 | 102.97 | 136.18 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | station availability 1% | | 0.67 | | 0.83 | | $/% | -33.09 | 140.62 | 314.33 | random coef. |
| Greene | | 2001 | Grey | Lit. Review | 1990 | NMNL | home refuel | | -168.40 | | | | $/(min or hr?) | | 37.26 | | |
| Greene | | 2001 | Grey | Lit. Review | 1990 | Other | home refuel | | 0.08 | | | | 0/1 | | 171.88 | | |
| Greene | | 2001 | Grey | Lit. Review | 1990 | Other | station availability 1% | | | | | | $/% | | 2242.30 | | |
| Greene | | 2001 | Grey | Lit. Review | 1990 | Other | station availability 1% | | | | | | $/% | | 365.71 | | |
| Greene | | 2001 | Grey | Lit. Review | 1990 | Other | station availability 1% | | | | | | $/% | | 48.76 | | |
| Greene | Duleep | 2004 | Grey | Lit. Review | 2002 | Other | station availability 1% | midsize | | | | | $/% | | 578.75 | | |
| Greene | Duleep | 2004 | Grey | Lit. Review | 2002 | Other | station availability 1% | smallSUV | | | | | $/% | | 789.60 | | |
| Greene | Duleep | 2004 | Grey | Lit. Review | 2002 | Other | station refuel time 300h | smallSUV | | | | | $/hr | | 698.70 | | |
| Greene | Duleep | 2004 | Grey | Lit. Review | 2002 | Other | station refuel time 300h | midsize | | | | | $/hr | | 419.47 | | |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MXL | charge time reduction EV | | | | 0.03 | 26.24 | $/hr | -26126.71 | 30.52 | 26187.75 | random coef. |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MNL | charge time reduction EV | | 3.34 | 1.48 | | | $/hr | 1927.35 | 3400.85 | 4874.36 | standard error |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MXL | charge time reduction PHEV | | | | 3.33 | 8.88 | $/hr | -5466.35 | 3388.65 | 12243.64 | random coef. |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MNL | charge time reduction PHEV | | 3.94 | 1.33 | | | $/hr | 2686.30 | 4012.25 | 5338.21 | standard error |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | Plug-in at work/other | | 0.12 | 0.12 | | | 0/1 | -107.52 | 3476.54 | 7060.61 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | station availability 1% | | 0.31 | 0.13 | | | $/% | 5230.18 | 9133.30 | 13036.41 | varied income |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | charge time reduction | | 2.20 | 0.52 | | | $/hr | 5495.55 | 7168.10 | 8840.66 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | charge time reduction | | 0.80 | 0.05 | | | $/hr | 11161.32 | 11947.10 | 12732.89 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | charge time reduction | | 0.55 | 0.05 | | | $/hr | 1059.52 | 1173.38 | 1287.23 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | charge time reduction | | 2.00 | 0.50 | | | $/hr | 702.85 | 930.92 | 1159.00 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | charge time reduction | | 0.07 | 0.05 | | | $/hr | 85.77 | 348.46 | 611.14 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | charge time reduction | | 1.60 | 0.55 | | | $/hr | 1150.49 | 1737.72 | 2324.95 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | home refuel | | 0.67 | 0.26 | | | 0/1 | 6133.75 | 9991.46 | 13849.17 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | refuel time reduction | | 0.00 | 0.00 | | | $/hr | -419.85 | 268.43 | 956.70 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | refuel time reduction | | -0.01 | 0.00 | | | $/hr | 2486.68 | 5189.59 | 7892.51 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | station availability 1% | | 0.97 | 0.26 | | | $/% | 106.17 | 144.35 | 182.54 | standard error |
| McFadden | Train | 2000 | J. Applied Econometrics | SP survey | 1993 | MXL | station availability 1% | | | | 0.70 | 1.40 | $/% | -111.58 | 117.44 | 346.43 | random coef. |
| Nixon | Saphores | 2011 | Grey | market data | 2010 | MNL | charge time reduction | | | | -0.42 | | $/hr | 2063.63 | 8692.80 | 36617.50 | random coef. |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | charge time reduction | GV-oriented | 0.07 | 0.19 | | | $/hr | -859.09 | -227.41 | 404.28 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | charge time reduction | | | | | | $/hr | 199.27 | 765.58 | 1331.89 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | charge time reduction | EV-oriented | -0.23 | 0.07 | | | $/hr | 1075.59 | 1587.78 | 2099.96 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | charge time reduction | GV-oriented | -0.43 | 0.20 | | | $/hr | 209.06 | 399.12 | 589.18 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | charge time reduction | | | | | | $/hr | 530.40 | 698.70 | 866.99 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | charge time reduction | EV-oriented | -0.48 | 0.08 | | | $/hr | 796.47 | 946.75 | 1097.03 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | charge time reduction | EV-oriented | -0.69 | 0.08 | | | $/hr | 704.69 | 793.89 | 883.09 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | charge time reduction | | | | | | $/hr | 670.43 | 782.55 | 894.66 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | charge time reduction | GV-oriented | -1.42 | 0.26 | | | $/hr | 629.06 | 768.85 | 908.64 | standard error |
| Segal | | 1995 | Energy Journal | SP survey | 1994 | MNL | charge time reduction | | -0.18 | | | | $/hr | | 1344.86 | | |
| Segal | | 1995 | Energy Journal | SP survey | 1994 | MNL | home or station refuel | | 0.12 | | | | 0/1 | | 859.22 | | |
| Segal | | 1995 | Energy Journal | SP survey | 1994 | MNL | home refuel | | -0.54 | | | | 0/1 | | -4019.63 | | |
| Segal | | 1995 | Energy Journal | SP survey | 1994 | MNL | refuel 12-6am | | -0.06 | | | | 0/1 | | -478.17 | | |
| Segal | | 1995 | Energy Journal | SP survey | 1994 | MNL | refuel any but 2-9pm | | -0.71 | | | | 0/1 | | -5282.31 | | |
| Tanaka | Ida | 2014 | TR-A | SP survey | 2012 | MXL | station availability 1% | | 0.01 | 0.00 | | | $/% | 49.41 | 51.10 | 52.78 | standard error |

# Fuel Costs

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | fuel cost per mile reduction | | 0.00 | 0.00 | | | $/cpm | 555.52 | 583.27 | 611.02 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | fuel cost per mile reduction | | 0.00 | 0.00 | | | $/cpm | 1278.14 | 1549.26 | 1820.38 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | fuel cost per mile reduction | | 0.00 | 0.00 | | | $/cpm | 675.16 | 718.64 | 762.11 | standard error |
| Axsen | Mountain | 2009 | REE | SP survey | 2006 | MNL | fuel cost per mile reduction | | -0.03 | 0.00 | | | $/cpm | 577.92 | 606.79 | 635.65 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | fuel cost per mile reduction | | 0.00 | | | | $/cpm | | 602.49 | | standard error |
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | fuel cost per mile reduction | | -0.04 | 0.00 | | | $/cpm | 2151.33 | 2258.79 | 2366.25 | standard error |
| Allcott | Wozny | 2014 | RE Stat | market data | 2005 | Other | fuel cost per mile reduction | | 0.76 | 0.05 | | | $/cpm | -1224.65 | -1094.77 | -964.90 | standard error |
| Allcott | Wozny | 2014 | RE Stat | market data | 2005 | Other | fuel cost per mile reduction | | 0.55 | 0.03 | | | $/cpm | -882.62 | -792.27 | -701.92 | standard error |
| Allcott | Wozny | 2014 | RE Stat | market data | 2005 | Other | fuel cost per mile reduction | | 0.51 | 0.03 | | | $/cpm | -816.53 | -734.65 | -652.77 | standard error |
| Beresteanu | Li | 2011 | Int. Econ. Rev. | market data | 2006 | BLP | fuel cost per mile reduction | | -2.93 | 1.24 | -2.93 | 2.11 | $/cpm | 76.03 | 256.09 | 436.15 | random coef. |
| Beresteanu | Li | 2011 | Int. Econ. Rev. | market data | 2006 | BLP | fuel cost per mile reduction | | -8.62 | 1.18 | 5.77 | 1.24 | $/cpm | 309.40 | 899.19 | 1488.97 | random coef. |
| Berry | Levinsohn | 1995 | Econometrica | market data | 1983 | BLP | fuel cost per mile reduction | | -0.49 | 0.16 | -0.49 | 0.67 | $/cpm | -11665.16 | -4985.11 | 1694.94 | random coef. |
| Berry | Levinsohn | 1995 | Econometrica | market data | 1983 | BLP | fuel cost per mile reduction | | -0.12 | 0.32 | -0.12 | 1.05 | $/cpm | -6382.44 | -676.51 | 5029.43 | random coef. |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | fuel cost per mile reduction | 30K< Inc < 75K nochild | -0.08 | 0.02 | | | $/cpm | 2293.20 | 3221.85 | 4150.50 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | fuel cost per mile reduction | 30K< Inc luxury child | -0.08 | 0.05 | | | $/cpm | -10032.96 | -6068.32 | -2103.69 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | fuel cost per mile reduction | <30K child | -0.01 | 0.05 | | | $/cpm | -909.79 | 233.28 | 1376.35 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | fuel cost per mile reduction | 30K< Inc luxury no child | -0.08 | 0.04 | | | $/cpm | -9940.07 | -6557.68 | -3175.30 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | fuel cost per mile reduction | <30K no child | -0.08 | 0.02 | | | $/cpm | 1327.59 | 1888.38 | 2449.17 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | fuel cost per mile reduction | >75K no child | -0.13 | 0.05 | | | $/cpm | -10456.93 | -7425.04 | -4393.15 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | fuel cost per mile reduction | <30K no child | -0.03 | 0.04 | | | $/cpm | -424.92 | 1888.55 | 4202.03 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | fuel cost per mile reduction | >30K no lux child | -0.08 | 0.02 | | | $/cpm | 5440.98 | 7739.32 | 10037.66 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | fuel cost per mile reduction | >30K no lux no child | -0.08 | 0.02 | | | $/cpm | 2413.86 | 3352.58 | 4291.31 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | fuel cost per mile reduction | <30K child | -0.01 | 0.04 | | | $/cpm | -1578.77 | 404.81 | 2388.39 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | fuel cost per mile reduction | | -0.13 | 0.03 | 0.26 | 0.06 | $/cpm | 1437.73 | 2564.42 | 3691.11 | random coef. |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | fuel cost per mile reduction | | -0.24 | 0.05 | 0.58 | 0.15 | $/cpm | -4068.99 | 2799.65 | 9668.29 | random coef. |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | fuel cost per mile reduction | | -0.19 | 0.07 | | | $/cpm | 2098.43 | 3239.98 | 4381.53 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | fuel cost per mile reduction | | -1.32 | | 0.83 | | $/cpm | 1012.73 | 2749.85 | 4486.98 | random coef. |
| Busse | Knittel | 2013 | AER | market data | 2008 | Other | fuel cost per mile reduction | | -1170.00 | | | | $/cpm | | 266.61 | | |
| Busse | Knittel | 2013 | AER | market data | 2008 | Other | fuel cost per mile reduction | | -1973.00 | | | | $/cpm | | 1027.08 | | |
| Busse | Knittel | 2013 | AER | market data | 2008 | Other | fuel cost per mile reduction | | -5801.00 | | | | $/cpm | | 969.34 | | |
| Busse | Knittel | 2013 | AER | market data | 2008 | Other | fuel cost per mile reduction | | -4571.00 | | | | $/cpm | | 1381.45 | | |
| Dasgupta | Siddarth | 2007 | J. Marketing Research | market data | 2000 | MXL | fuel cost per mile reduction | | -32721.40 | 9243.33 | 14301.50 | 4783.11 | $/cpm | 154.59 | 274.61 | 394.63 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | fuel cost per mile reduction | | -0.05 | | | | $/cpm | 155.44 | 5307.06 | 10236.63 | random coef. |
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | fuel cost per mile reduction | | 0.69 | 0.03 | | | $/cpm | -1096766.00 | -1052469.50 | -1008173.06 | standard error |
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | fuel cost per mile reduction | | -257560.00 | 32074.72 | | | $/cpm | 1207.38 | 1379.12 | 1550.87 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | fuel cost per mile reduction | SUV | -0.87 | 0.26 | | | $/cpm | -945.64 | 800.32 | 2546.28 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | fuel cost per mile reduction | van | 1.10 | 0.25 | | | $/cpm | 2997.47 | 3848.93 | 4700.38 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | fuel cost per mile reduction | pickup | -1.20 | 0.26 | | | $/cpm | -2079.69 | -325.22 | 1429.25 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | fuel cost per mile reduction | | 0.17 | 0.06 | | | $/cpm | 291.11 | 439.30 | 587.50 | standard error |
| Fifer | Bunn | 2009 | Grey | market data | 2002 | Hedonic | fuel cost per mile reduction | | | | | | $/cpm | 747.12 | 1036.11 | 1325.09 | standard error |
| Fifer | Bunn | 2009 | Grey | market data | 2002 | Hedonic | fuel cost per mile reduction | van | -468153.00 | 103508.60 | | | $/cpm | 1921.84 | 2467.38 | 3012.92 | standard error |
| Fifer | Bunn | 2009 | Grey | market data | 2002 | Hedonic | fuel cost per mile reduction | pickup | -549569.00 | 95167.13 | | | $/cpm | 2394.91 | 2896.48 | 3398.06 | standard error |
| Fifer | Bunn | 2009 | Grey | market data | 2002 | Hedonic | fuel cost per mile reduction | cars+SUVs | -87349.10 | 40142.99 | | | $/cpm | 248.80 | 460.37 | 671.94 | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | fuel cost per mile reduction | | -0.88 | 0.03 | 1.03 | 0.03 | $/cpm | -0.07 | 0.43 | 0.94 | random coef. |
| Gallagher | Muehlegger | 2011 | JEEM | market data | 2011 | Other | fuel cost per mile reduction | | 0.00 | 0.00 | | | $/cpm | -284.36 | -469.79 | -655.21 | standard error |
| Gallagher | Muehlegger | 2011 | JEEM | market data | 2011 | Other | fuel cost per mile reduction | | 0.00 | 0.00 | | | $/cpm | -1833.40 | -3224.11 | -4614.83 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | fuel cost per mile reduction | | -1.38 | 0.74 | | | $/cpm | 23.86 | 10.04 | 4.27 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | fuel cost per mile reduction | | 0.23 | 0.93 | | | $/cpm | 32.36 | -7.80 | -54.30 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | fuel cost per mile reduction | | -7.14 | 0.74 | | | $/cpm | 70.12 | 48.37 | 35.01 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | fuel cost per mile reduction | | -0.075 | 0.17 | | | $/cpm | -757.59 | -231.91 | 293.76 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | fuel cost per mile reduction | small | -4.70 | 0.66 | | | $/cpm | 1399.31 | 1627.91 | 1856.52 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | fuel cost per mile reduction | CUV | -9.07 | 2.95 | | | $/cpm | 2119.75 | 3141.53 | 4163.30 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | fuel cost per mile reduction | van | -3.65 | 0.70 | | | $/cpm | 1021.78 | 1264.23 | 1506.69 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | fuel cost per mile reduction | large | -4.68 | 0.65 | | | $/cpm | 1395.85 | 1620.99 | 1846.12 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | fuel cost per mile reduction | SUV | -8.10 | 1.13 | | | $/cpm | 2414.16 | 2805.55 | 3196.95 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | fuel cost per mile reduction | specialty | -4.02 | 0.44 | | | $/cpm | 1239.99 | 1392.39 | 1544.79 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | fuel cost per mile reduction | midsize | -5.55 | 0.55 | | | $/cpm | 1731.82 | 1922.32 | 2112.83 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | fuel cost per mile reduction | truck | -4.17 | 0.70 | | | $/cpm | 1201.89 | 1444.34 | 1686.80 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | fuel cost per mile reduction | Luxury | -2.13 | 0.43 | | | $/cpm | 588.82 | 737.76 | 886.69 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | fuel cost per mile reduction | | | | | | $/cpm | 1860.93 | 1568.22 | 1275.50 | standard error |
| Greene | | 2001 | Grey | Lit. Review | 1990 | Other | fuel cost per mile reduction | | -0.70 | | | | $/cpm | | 1552.84 | | |
| Greene | Duleep | 2004 | Grey | Lit. Review | 2002 | Other | fuel cost per mile reduction | smallSUV | | | | | $/cpm | | 635.30 | | |
| Greene | Duleep | 2004 | Grey | Lit. Review | 2002 | Other | fuel cost per mile reduction | midsize | | | | | $/cpm | | 560.22 | | |

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | fuel cost per mile reduction | | 50.67 | | | | $/cpm | | -6356.81 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | fuel cost per mile reduction | | 87.68 | | | | $/cpm | | -7457.56 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | fuel cost per mile reduction | | -14.97 | | | | $/cpm | | 1788.63 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | fuel cost per mile reduction | | -19.41 | | | | $/cpm | | 2563.25 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | fuel cost per mile reduction | | -41.22 | | | | $/cpm | | 4701.15 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MXL | fuel cost per mile reduction | | 90.83 | 0.01 | 90.83 | 0.01 | $/cpm | -7471.38 | -7472.19 | -7473.00 | random coef. |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | fuel cost per mile reduction | | 0.03 | | | | $/cpm | | -2.04 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | fuel cost per mile reduction | | 0.02 | | | | $/cpm | | 1188.93 | | |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MXL | fuel cost per mile reduction | | | | -1.63 | 0.08 | $/cpm | 1578.37 | 1654.14 | 1729.91 | random coef. |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MNL | fuel cost per mile reduction | | -1.60 | 0.11 | | | $/cpm | 1519.98 | 1625.65 | 1731.33 | standard error |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | fuel cost per mile reduction | | 0.02 | 0.00 | | | $/cpm | 1054.11 | 1219.60 | 1385.08 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | fuel cost per mile reduction | | -0.13 | 0.05 | | | $/cpm | 5353.82 | 3918.48 | 2483.14 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | fuel cost per mile reduction | | -0.05 | 0.02 | | | $/cpm | 1861.38 | 1417.13 | 972.89 | varied income |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | fuel cost per mile reduction | | 0.04 | | 0.04 | | $/cpm | 2838.44 | 5045.82 | 8969.81 | random coef. |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | fuel cost per mile reduction | | -0.17 | 0.23 | | | $/cpm | 273.03 | 115.63 | -41.76 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | fuel cost per mile reduction | | -0.35 | 0.04 | | | $/cpm | 1207.40 | 1097.64 | 987.88 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | fuel cost per mile reduction | age | | | | | $/cpm | 2057.94 | 2706.64 | 2147.42 | varied interaction |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | home refueling cost reduction | | -0.02 | 0.01 | | | $/cpm | 25.56 | 238.60 | 451.64 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | fuel cost per mile reduction | | -0.98 | 6.68 | | | $/cpm | -1435.55 | 17.98 | 1471.51 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | fuel cost per mile reduction | | -12.96 | 4.32 | | | $/cpm | -226.51 | 76.71 | 379.94 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | fuel cost per mile reduction | | -3.29 | 13.70 | | | $/cpm | -1176.11 | 24.31 | 1224.73 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | Other | fuel cost per mile reduction | | -14.11 | 2.59 | | | $/cpm | -114.96 | 97.71 | 310.37 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | fuel cost per mile reduction | | -3.95 | 6.26 | | | $/cpm | -781.61 | 43.93 | 869.47 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | fuel cost per mile reduction | | -11.05 | 8.40 | | | $/cpm | -761.73 | 95.05 | 951.83 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | fuel cost per mile reduction | | -12.52 | 2.63 | | | $/cpm | -116.11 | 77.88 | 271.87 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | fuel cost per mile reduction | | -11.05 | 20.64 | | | $/cpm | -2010.18 | 95.05 | 2200.27 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | fuel cost per mile reduction | | 0.43 | 7.36 | | | $/cpm | -910.97 | -4.47 | 902.04 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | fuel cost per mile reduction | | -12.44 | 2.44 | | | $/cpm | -110.06 | 83.01 | 276.07 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | fuel cost per mile reduction | | -13.24 | 9.94 | | | $/cpm | -643.55 | 81.44 | 806.43 | standard error |
| Lave | Train | 1979 | TR-A | market data | 1976 | MNL | fuel cost per mile reduction | | -0.35 | -0.22 | | | $/cpm | 2498.16 | 3729.28 | 5676.85 | varied income |
| Liu | | 2014 | Energy Economics | RP survey | 2009 | MXL | fuel cost per mile reduction | | | | -0.08 | 0.01 | $/cpm | 15912.01 | 18254.69 | 20597.38 | random coef. |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | fuel cost per mile reduction | income | 0.00 | 0.01 | | | $/MPG | -0.06 | 0.03 | 0.11 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | fuel cost per mile reduction | income | 0.00 | 0.01 | | | $/MPG | -0.18 | 0.08 | 0.33 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | fuel cost per mile reduction | income | 0.00 | 0.01 | | | $/MPG | -1.74 | 0.77 | 3.28 | standard error |
| McCarthy | | 1996 | RE Stat | RP survey | 1989 | MNL | fuel cost per mile reduction | | -0.52 | -0.45 | | | $/cpm | 2925.20 | 19415.06 | 35904.92 | standard error |
| McCarthy | Tay | 1998 | TR-E | RP survey | 1989 | NMNL | fuel cost per mile reduction | | -0.52 | 0.12 | | | $/cpm | 111.31 | 144.57 | 177.82 | standard error |
| McFadden | Train | 2000 | J. Applied Econometrics | SP survey | 1993 | MXL | fuel cost per mile reduction | | | | -0.18 | 0.45 | $/cpm | -4274.85 | 3016.68 | 10308.20 | random coef. |
| McManus | | 2007 | Business Economics | market data | 2002 | Hedonic | fuel cost per mile reduction | | -768.00 | 4.82 | | | $/cpm | 1005.58 | 1011.93 | 1018.28 | standard error |
| Nixon | Saphores | 2011 | Grey | SP survey | 2010 | MXL | fuel cost per mile reduction | | | | 0.18 | | $/cpm | -67.17 | -423.28 | -2667.27 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | fuel cost per mile reduction | | | | -15.79 | 2.58 | $/cpm | -27169.79 | -23419.68 | -19669.56 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | fuel cost per mile reduction | | | | -15.79 | 2.58 | $/cpm | -28609.77 | -24660.90 | -20712.03 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | fuel cost per mile reduction | | | | -15.79 | 2.58 | $/cpm | -69165.26 | -59618.71 | -50072.17 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | fuel cost per mile reduction | | | | -0.54 | 0.04 | $/cpm | -3342.58 | -3116.36 | -2890.13 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | fuel cost per mile reduction | | | | -0.54 | 0.04 | $/cpm | -822.77 | -767.09 | -711.40 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | fuel cost per mile reduction | | | | -0.54 | 0.04 | $/cpm | -2249.18 | -2096.96 | -1944.73 | random coef. |
| Sallee | West | 2015 | NBER | market data | 2008 | Other | fuel cost per mile reduction | | 0.69 | 0.01 | | | $/cpm | -403.81 | -398.16 | -392.50 | standard error |
| Sallee | West | 2015 | NBER | market data | 2008 | Other | fuel cost per mile reduction | | 0.98 | 0.04 | | | $/cpm | -588.12 | -565.50 | -542.88 | standard error |
| Segal | | 1995 | Energy Journal | SP survey | 1994 | MNL | fuel cost per mile reduction | | -0.94 | | | | $/cpm | | 1475.91 | | |
| Shiau | Michalek | 2009 | TR-A | market data | 2007 | MXL | fuel cost per mile reduction | | | | -0.18 | 0.15 | $/cpm | 488.07 | 2270.95 | 4053.84 | random coef. |
| Skerlos | Raichur | 2013 | Grey | market data | 2008 | Other | fuel cost per mile reduction | | -17.31 | 7.83 | 1.17 | 1.32 | $/cpm | 959.25 | 1028.79 | 1098.33 | random coef. |
| Tanaka | Ida | 2014 | TR-A | SP survey | 2012 | MXL | charger cost $100 reduction | | -0.06 | 0.00 | | | 0/1 | 212.09 | 218.80 | 225.51 | standard error |
| Tanaka | Ida | 2014 | TR-A | SP survey | 2012 | MXL | fuel cost % reduction | | 0.01 | 0.00 | | | $/% | 47.76 | 51.10 | 54.43 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MXL | fuel cost per mile reduction | | -0.08 | 0.01 | | | $/cpm | 2374.51 | 2770.26 | 3166.01 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | home refueling cost reduction | EV | -0.13 | 0.02 | | | $/cpm | 3761.08 | 4554.55 | 5348.03 | standard error |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | fuel cost per mile reduction | | | | -0.49 | 0.05 | $/cpm | 57635.18 | 64498.98 | 71362.77 | random coef. |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | fuel cost per mile reduction | | | | -0.04 | 0.05 | $/cpm | -5505.50 | 9101.08 | 23707.66 | random coef. |
| Train | Winston | 2007 | Int. Econ. Rev. | RP survey | 2000 | MXL | fuel cost per mile reduction | | | | -32.00 | -102.00 | $/cpm | -3859.27 | 1817.20 | 7493.67 | random coef. |
| Whitefoot | Fowlie | 2011 | Grey | market data | 2006 | BLP | fuel cost per mile reduction | | -0.37 | 0.17 | | | $/cpm | 545.26 | 376.69 | 208.12 | standard error |
| Zhang | Gensler | 2011 | J. Product Innov. Mgmt. | SP survey | 2010 | MXL | fuel cost per mile reduction | | -92.98 | | -92.98 | 28.08 | $/cpm | 2003.74 | 2846.30 | 3688.86 | random coef. |

# Fuel Type

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | Hybrid | | -2.79 | 0.23 | | | 0/1 | -66335.73 | -55816.47 | -45297.21 | standard error |
| Axsen | Mountain | 2009 | REE | SP survey | 2006 | MNL | Hybrid | | 0.22 | 0.06 | | | 0/1 | 3696.39 | 4155.70 | 4615.01 | standard error |
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | Hybrid | | -2.83 | 0.23 | | | 0/1 | -51783.79 | -43437.06 | -35090.33 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | Hybrid | | -6.43 | 1.15 | | | 0/1 | -211963.47 | -180394.44 | -148825.41 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | Hybrid | | -2.37 | -0.23 | | | 0/1 | -147825.23 | -125808.72 | -103792.19 | standard error |
| Axsen | Mountain | 2009 | REE | SP survey | 2006 | MNL | Hybrid | | -2.57 | 0.28 | | | 0/1 | -16598.21 | -14126.14 | -11654.06 | standard error |
| Axsen | Mountain | 2009 | REE | SP survey | 2006 | MNL | Hybrid | | 0.30 | 0.05 | | | 0/1 | 1959.12 | 2374.69 | 2790.26 | standard error |
| Axsen | Mountain | 2009 | REE | SP survey | 2006 | MNL | Hybrid | | 0.17 | 0.06 | | | 0/1 | 3314.61 | 3770.62 | 4226.62 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | flex fuel | | 0.11 | 0.14 | | | 0/1 | -798.18 | 3547.46 | 7893.10 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | flex fuel | | 0.28 | 0.21 | | | 0/1 | 2136.93 | 8681.29 | 15225.64 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | EV | sport | 0.51 | 0.19 | | | 0/1 | -31927.98 | -20378.31 | -8828.64 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | EV | college | -0.19 | 0.10 | | | 0/1 | -16227.85 | -5442.05 | 5343.76 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | EV | sport | -0.41 | 0.38 | | | 0/1 | -33619.55 | -21246.51 | -8873.47 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | EV | truck | -0.30 | 0.14 | | | 0/1 | -29431.94 | -19953.45 | -10474.97 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | EV | truck | -0.26 | 0.23 | | | 0/1 | -27910.74 | -19008.01 | -10105.28 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | EV | college | 0.92 | 0.35 | | | 0/1 | -17497.83 | -5516.26 | 6465.30 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | methanol | | 0.64 | 0.17 | 0.84 | 0.44 | 0/1 | 3973.87 | 12587.18 | 21200.49 | random coef. |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | methanol | | 1.18 | 0.32 | 1.33 | 0.92 | 0/1 | -1850.62 | 13962.67 | 29775.96 | random coef. |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | natural gas | | 0.24 | 0.15 | 2.07 | 0.49 | 0/1 | -5018.84 | 4619.87 | 14258.57 | random coef. |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | natural gas | | 0.42 | 0.26 | 3.66 | 0.98 | 0/1 | -38447.77 | 5006.16 | 48460.08 | random coef. |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | EV | short commute | 0.36 | 0.16 | | | 0/1 | -23513.54 | -11391.65 | 730.23 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | EV | college | 0.77 | 0.22 | | | 0/1 | -16086.01 | -2816.62 | 10452.78 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | methanol | | 0.48 | 0.15 | | | 0/1 | 8488.87 | 12796.83 | 17104.79 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | methanol | college | 0.34 | 0.13 | | | 0/1 | 4318.81 | 6989.38 | 9659.95 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | natural gas | | 0.62 | 0.15 | 0.97 | 0.41 | 0/1 | -7302.34 | 12956.44 | 33215.22 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | EV | | -0.21 | | | | 0/1 | -16694.51 | -2419.02 | 10766.28 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | Hybrid | | 1.05 | | | | 0/1 | -92.68 | 12143.78 | 24076.70 | random coef. |
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | diesel | | 0.00 | 0.04 | | | 0/1 | -517.55 | -53.08 | 411.39 | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | Hybrid | | -3.27 | 0.34 | 1.22 | 0.39 | 0/1 | -55137.40 | -40155.75 | -25174.09 | random coef. |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MXL | Hybrid | | | | -0.42 | 0.19 | 0/1 | -612.66 | -425.23 | -237.81 | random coef. |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MNL | Hybrid | | -1.18 | 1.16 | | | 0/1 | -2353.92 | -1196.35 | -38.78 | standard error |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | diesel | | 0.21 | 0.13 | | | 0/1 | 2364.35 | 6304.92 | 10245.50 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | EV | | -2.64 | 0.71 | | | 0/1 | -98745.38 | -77780.33 | -56815.28 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | flex fuel | | 0.31 | 0.10 | | | 0/1 | 6447.77 | 9251.15 | 12054.52 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | Hybrid | | 0.17 | 0.10 | | | 0/1 | 2239.13 | 5038.04 | 7836.96 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | natural gas | | -1.90 | 0.90 | | | 0/1 | -82634.58 | -55978.27 | -29321.95 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | PHEV | | 0.45 | 0.08 | | | 0/1 | 10722.59 | 13110.70 | 15498.80 | varied income |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | EV | | -1.98 | 0.21 | 1.28 | 0.13 | 0/1 | -59106.41 | -35920.68 | -12734.95 | random coef. |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | Hybrid | | 0.79 | 0.10 | 1.14 | 0.10 | 0/1 | -6345.04 | 14351.07 | 35047.18 | random coef. |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | EV | | 0.54 | 0.13 | | | 0/1 | -476.33 | 2538.76 | 5553.85 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | EV | | -7.46 | -1.52 | | | 0/1 | -19445.11 | -24306.39 | -29167.66 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | EV | | -1.05 | 0.53 | 4.02 | 4.40 | 0/1 | -75577.19 | -15628.43 | 44320.32 | random coef. |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | flex fuel | | 0.20 | 0.31 | | | 0/1 | -1660.89 | 2952.70 | 7566.29 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | methanol | | 0.63 | 0.36 | 1.61 | 3.01 | 0/1 | -14718.76 | 9335.30 | 33389.37 | random coef. |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | natural gas | | 0.22 | 0.25 | 2.10 | 2.88 | 0/1 | -28080.47 | 3295.69 | 34671.85 | random coef. |
| Liu | | 2014 | Energy Economics | RP survey | 2009 | MXL | Hybrid | income (<25k) | | | | | 0/1 | 1020.50 | 1063.47 | 1106.45 | random coef. |
| Liu | | 2014 | Energy Economics | RP survey | 2009 | MXL | Hybrid | income (>100k) | | | | | 0/1 | 1672.82 | 1897.60 | 2122.38 | random coef. |
| Liu | | 2014 | Energy Economics | RP survey | 2009 | MXL | Hybrid | income (25-50k) | | | | | 0/1 | 1452.36 | 1615.38 | 1778.39 | random coef. |
| Liu | | 2014 | Energy Economics | RP survey | 2009 | MXL | Hybrid | income (76-99k) | | | | | 0/1 | 1634.11 | 1847.08 | 2060.05 | random coef. |
| Liu | | 2014 | Energy Economics | RP survey | 2009 | MXL | Hybrid | income (50-76k) | | | | | 0/1 | 1651.61 | 1869.84 | 2088.07 | random coef. |
| McFadden | Train | 2000 | J. Applied Econometrics | SP survey | 1993 | MXL | EV | | -1.57 | 0.58 | | | 0/1 | -35812.02 | -26284.78 | -16757.54 | standard error |
| McFadden | Train | 2000 | J. Applied Econometrics | SP survey | 1993 | MXL | EV | short commute | 0.48 | 0.22 | | | 0/1 | 4336.81 | 8007.56 | 11678.31 | standard error |
| McFadden | Train | 2000 | J. Applied Econometrics | SP survey | 1993 | MXL | EV | education | 1.05 | 0.31 | | | 0/1 | 12500.48 | 17598.92 | 22697.37 | standard error |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | Hybrid | multiple | 1.01 | 0.22 | | | 0/1 | 11969.59 | 14703.78 | 17437.96 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | Hybrid | multiple | 1.01 | 0.22 | | | 0/1 | 8721.43 | 11455.61 | 14189.80 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | PHEV | multiple | 2.59 | 0.54 | | | 0/1 | 17072.58 | 17988.12 | 18903.65 | varied interaction |

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | PHEV | multiple | 2.59 | 0.54 | | | 0/1 | 13824.42 | 14739.95 | 15655.49 | varied interaction |
| Nixon | Saphores | 2011 | Grey | SP survey | 2010 | MXL | CGV | early adopter | 0.23 | | | | 0/1 | 17095.11 | 4685.74 | 1284.35 | varied income |
| Nixon | Saphores | 2011 | Grey | SP survey | 2010 | MXL | EV | early adopter | 0.49 | | | | 0/1 | 36783.33 | 10082.25 | 2763.53 | varied income |
| Nixon | Saphores | 2011 | Grey | SP survey | 2010 | MXL | fuel cell | early adopter | 0.24 | | | | 0/1 | 18271.75 | 5008.26 | 1372.76 | varied income |
| Nixon | Saphores | 2011 | Grey | SP survey | 2010 | MXL | Hybrid | early adopter | 0.16 | | | | 0/1 | 11736.49 | 3216.95 | 881.76 | varied income |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | EV | | | | | | 0/1 | 6407.65 | 10351.81 | 14295.96 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | EV | EV-oriented | 2.50 | 0.14 | | | 0/1 | 28743.96 | 30650.97 | 32557.98 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | EV | GV-oriented | -2.07 | 0.99 | | | 0/1 | -20568.57 | -14164.10 | -7759.62 | standard error |
| Segal | | 1995 | Energy Journal | SP survey | 1994 | MNL | CGV | | 0.81 | | | | 0/1 | | 6059.34 | | |
| Segal | | 1995 | Energy Journal | SP survey | 1994 | MNL | EV | | 0.39 | | | | 0/1 | | 2883.98 | | |
| Shiau | Michalek | 2009 | TR-A | market data | 2007 | MXL | Hybrid | | 0.99 | 0.01 | | | 0/1 | 12347.45 | 12421.23 | 12495.00 | standard error |
| Skerlos | Raichur | 2013 | Grey | market data | 2008 | MXL | Hybrid | | -1.27 | 0.61 | 0.23 | 0.16 | 0/1 | -8914.99 | -7548.02 | -6181.06 | random coef. |
| Tanaka | Ida | 2014 | TR-A | SP survey | 2012 | MXL | CGV | | | | 6.58 | 3.85 | 0/1 | 9642.31 | 22635.05 | 35627.80 | random coef. |
| Tanaka | Ida | 2014 | TR-A | SP survey | 2012 | MXL | EV | | | | 5.77 | 1.58 | 0/1 | 14526.99 | 19854.82 | 25182.65 | random coef. |
| Tanaka | Ida | 2014 | TR-A | SP survey | 2012 | MXL | PHEV | | | | 6.92 | 0.10 | 0/1 | 23466.09 | 23809.76 | 24153.43 | random coef. |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | EV | | 0.34 | 0.15 | | | 0/1 | 6515.46 | 11812.59 | 17109.71 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | flex fuel | | 0.32 | 0.25 | | | 0/1 | 2400.85 | 10975.31 | 19549.77 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | flex fuel | | -0.13 | 0.27 | | | 0/1 | -13597.23 | -4409.91 | 4777.41 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | natural gas | | -0.41 | 0.13 | | | 0/1 | -18849.53 | -14296.50 | -9743.48 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | natural gas | | 0.15 | 0.10 | | | 0/1 | 1640.77 | 5059.04 | 8477.31 | standard error |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | EV | | | | -2.54 | 1.41 | 0/1 | -53887.19 | -34894.48 | -15901.77 | random coef. |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | EV | | | | -1.95 | 1.28 | 0/1 | -96054.99 | -43983.86 | 8087.27 | random coef. |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | Hybrid | | | | 0.83 | 1.19 | 0/1 | -18990.48 | 18860.06 | 56710.59 | random coef. |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | Hybrid | | | | 0.87 | 1.46 | 0/1 | -7604.20 | 12026.50 | 31657.21 | random coef. |
| Zhang | Gensler | 2011 | J. Product Innov. Mgmt. | SP survey | 2010 | MXL | CGV | | 1.34 | | 1.34 | 1.57 | 0/1 | -1532.10 | 10255.29 | 22042.67 | random coef. |
| Zhang | Gensler | 2011 | J. Product Innov. Mgmt. | SP survey | 2010 | MXL | EV | | -2.20 | | -2.20 | 1.84 | 0/1 | -30646.25 | -16837.04 | -3027.82 | random coef. |
| Zhang | Gensler | 2011 | J. Product Innov. Mgmt. | SP survey | 2010 | MXL | Hybrid | | 0.52 | | 0.52 | 0.93 | 0/1 | -3016.00 | 3979.66 | 10975.32 | random coef. |
| Zhang | Gensler | 2011 | J. Product Innov. Mgmt. | SP survey | 2010 | MXL | PHEV | | -1.04 | | -1.04 | 1.78 | 0/1 | -21291.86 | -7959.33 | 5373.20 | random coef. |

## Incentives

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | purchase subsidy | | 0.00 | 0.00 | | | $/$ CAN | 0.71 | 0.83 | 0.95 | standard error |
| Beresteanu | Li | 2011 | Int. Econ. Rev. | market data | 2006 | BLP | purchase subsidy | | 0.72 | 0.47 | 0.00 | 0.00 | 0/1 | 2747.43 | 7512.34 | 12277.25 | random coef. |
| Beresteanu | Li | 2011 | Int. Econ. Rev. | market data | 2006 | BLP | purchase subsidy | | 0.52 | 0.58 | | | 0/1 | -404.83 | 4564.98 | 9534.78 | random coef. |
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | no gas guzzler tax ($1000) | | -2526.10 | 394.09 | | | 0/1 | 2854.00 | 3381.54 | 3909.08 | standard error |
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | no gas guzzler tax ($1300) | | -1488.80 | 285.21 | | | 0/1 | 1611.17 | 1992.97 | 2374.76 | standard error |
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | no gas guzzler tax ($1700) | | 185.72 | 309.53 | | | 0/1 | -662.97 | -248.61 | 165.74 | standard error |
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | no gas guzzler tax ($2100) | | -3477.60 | 434.16 | | | 0/1 | 4074.08 | 4655.26 | 5236.44 | standard error |
| Gallagher | Muehlegger | 2011 | JEEM | market data | 2011 | Other | HOV access | | -0.06 | 0.06 | | | 0/1 | -333.07 | -170.73 | -8.38 | standard error |
| Gallagher | Muehlegger | 2011 | JEEM | market data | 2011 | Other | HOV access | | 0.65 | 0.23 | | | 0/1 | 9269.72 | 14114.01 | 18958.30 | standard error |
| Gallagher | Muehlegger | 2011 | JEEM | market data | 2011 | Other | tax credit | | 0.02 | 0.02 | | | $/$1000s | 0.00 | 0.07 | 0.14 | standard error |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | free parking | | 0.03 | 0.05 | | | 0/1 | -680.11 | 901.54 | 2483.20 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | HOV access | | 0.05 | 0.06 | | | 0/1 | -245.40 | 1390.62 | 3026.64 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | purchase subsidy | | 0.06 | 0.06 | | | 0/1 | 16.36 | 1652.83 | 3289.30 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | tax credit | | 0.16 | 0.05 | | | 0/1 | 3108.99 | 4625.57 | 6142.15 | varied income |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | cashback | GV-oriented | 0.30 | 0.05 | | | $/1000s | 1.65 | 1.95 | 2.24 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | cashback | EV-oriented | 0.19 | 0.02 | | | $/1000s | 2.37 | 2.62 | 2.88 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | cashback | | | | | | $/1000s | 2.04 | 2.32 | 2.59 | standard error |

## Model Availability

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | number of models | | 0.69 | 0.08 | | | $/MakeModel | 5009.03 | 5670.91 | 6332.79 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | number of models | | 0.72 | 0.08 | | | $/MakeModel | 6113.66 | 6841.48 | 7569.29 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | number of models | income | 1.38 | 0.05 | | | $/MakeModel | 0.72 | 0.75 | 0.78 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | number of models | income | 1.38 | 0.05 | | | $/MakeModel | 2.16 | 2.23 | 2.31 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | number of models | income | 1.38 | 0.05 | | | $/MakeModel | 21.36 | 22.12 | 22.89 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | number of models | income | 0.80 | 0.02 | | | $/MakeModel | 0.55 | 0.56 | 0.58 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | number of models | income | 0.80 | 0.02 | | | $/MakeModel | 1.18 | 1.21 | 1.24 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | number of models | income | 0.80 | 0.02 | | | $/MakeModel | 1.89 | 1.94 | 1.98 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | number of models | income | 0.82 | 0.02 | | | $/MakeModel | 0.53 | 0.54 | 0.55 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | number of models | income | 0.82 | 0.02 | | | $/MakeModel | 0.93 | 0.96 | 0.98 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | number of models | income | 0.82 | 0.02 | | | $/MakeModel | 3.07 | 3.15 | 3.23 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | number of models | income | 1.18 | 0.07 | | | $/MakeModel | 0.67 | 7.09 | 7.52 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | number of models | income | 1.18 | 0.07 | | | $/MakeModel | 1.04 | 11.11 | 11.78 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | number of models | income | 1.18 | 0.07 | | | $/MakeModel | 1.81 | 19.26 | 20.41 | standard error |

## Non-fuel Operating Costs

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dasgupta | Siddarth | 2007 | J. Marketing Research | market data | 2000 | MXL | maintenance cost reduction | | -7.47 | 2.48 | | | $/($/yr) | 4.19 | 6.27 | 8.35 | standard error |
| Greene | | 2001 | Grey | Lit. Review | 1990 | Other | battery cost reduction | | 0.00 | | | | $/$ | | 0.93 | | |
| Greene | | 2001 | Grey | Lit. Review | 1990 | Other | maintenance cost reduction | | 0.00 | | | | $/($/yr) | | 1.00 | | |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | battery cost reduction | EV | 0.00 | 0.00 | | | $/yr | 23.12 | 28.69 | 34.26 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | maintenance cost reduction | | 0.00 | 0.00 | | | $/($/yr) | 12.38 | 16.21 | 20.04 | standard error |

## Performance

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | horsepower | | 0.01 | 0.00 | | | $/s | 878.12 | 938.64 | 999.16 | standard error |
| Axsen | Mountain | 2009 | REE | SP survey | 2006 | MNL | horsepower | | -0.03 | | | | $/s | | 934.73 | | standard error |
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | horsepower | | -0.03 | 0.00 | | | $/s | 1596.09 | 1706.09 | 1816.09 | standard error |
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | horsepower | | -0.03 | 0.00 | | | $/s | 998.17 | 1059.61 | 1121.06 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | horsepower | | -0.03 | 0.01 | | | $/s | 412.19 | 677.94 | 943.69 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | horsepower | | 0.00 | 0.00 | | | $/s | 43.31 | 46.30 | 49.28 | standard error |
| Beresteanu | Li | 2011 | Int. Econ. Rev. | market data | 2006 | BLP | horsepower | | 0.00 | 0.00 | 5.73 | 0.34 | $/hp | -58630.89 | 0.00 | 58630.89 | random coef. |
| Beresteanu | Li | 2011 | Int. Econ. Rev. | market data | 2006 | BLP | horsepower | | 0.00 | 0.00 | 0.00 | 7.57 | $/hp | -64778.51 | 0.00 | 64778.51 | random coef. |
| Berry | Levinsohn | 1995 | Econometrica | market data | 1983 | BLP | acceleration (0-60) s faster | | 2.88 | 2.02 | 2.88 | 4.63 | $/s | -9.04 | 15.77 | 40.58 | random coef. |
| Berry | Levinsohn | 1995 | Econometrica | market data | 1983 | BLP | acceleration (0-60) s faster | | 2.19 | 0.90 | 2.19 | 1.59 | $/s | 6.33 | 21.93 | 37.53 | random coef. |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | acceleration (0-60) s faster | | -0.04 | 0.02 | | | $/s | 267.44 | 690.17 | 1112.90 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | acceleration (0-60) s faster | income | -0.08 | 0.02 | | | $/s | 1077.34 | 1513.61 | 1949.89 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | acceleration (0-60) s faster | income | 0.08 | -0.05 | | | $/s | -2494.35 | -1546.88 | -599.42 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | top speed | | 0.00 | 0.00 | | | $/mph | -26.51 | 27.62 | 81.75 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | top speed | | 0.00 | 0.00 | | | $/mph | 29.02 | 74.88 | 120.75 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | acceleration (0-60) s faster | | -0.15 | 0.04 | | | $/s | 776.74 | 1066.25 | 1355.76 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | acceleration (0-60) s faster | | -0.33 | 0.38 | | | $/s | -519.61 | 3287.55 | 7094.71 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | acceleration (0-60) s faster | | -0.09 | 0.02 | | | $/s | 772.73 | 1048.70 | 1324.67 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | top speed | | 0.63 | 0.24 | | | $/mph | 46.03 | 74.97 | 103.92 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | top speed | | 1.25 | 2.63 | | | $/mph | -231.67 | 209.68 | 651.02 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | top speed | | 0.39 | 0.14 | | | $/mph | 48.45 | 75.37 | 102.28 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | acceleration (0-60) s faster | | -1.05 | | 0.83 | | $/s | 265.02 | 1299.02 | 2333.02 | random coef. |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | top speed | | 0.36 | | 0.83 | | $/mph | -98.39 | 75.32 | 249.03 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | high perf | | 0.21 | | | | 0/1 | -2722.56 | 2405.12 | 7779.57 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | low perf | | -0.60 | | | | 0/1 | -11488.04 | -6896.77 | -1743.60 | random coef. |

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | acceleration (0-60) s faster | | 0.27 | 0.10 | | | $/s | 13.59 | 21.56 | 29.54 | standard error |
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | acceleration (0-60) s faster | | -1643.50 | 90.60 | | | $/s | 2078.77 | 2200.06 | 2321.34 | standard error |
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | braking distance | | -115.88 | 10.90 | | | $/ft | -169.71 | -155.12 | -140.53 | standard error |
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | turning circle | | -901.00 | 50.17 | | | $/ft | -1273.27 | -1206.12 | -1138.96 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | acceleration (0-60) s faster | van | 0.26 | 0.12 | | | $/s | 516.87 | 961.20 | 1405.52 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | acceleration (0-60) s faster | SUV | 0.20 | 0.13 | | | $/s | 766.53 | 1681.36 | 2596.20 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | acceleration (0-60) s faster | pickup | 0.23 | 0.13 | | | $/s | 569.28 | 1078.82 | 1588.37 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | acceleration (0-60) s faster | | 0.61 | 0.04 | | | $/s | 1835.44 | 1976.24 | 2117.05 | standard error |
| Feng | Fullerton | 2013 | J. Regulatory Economics | market data | 2000 | Hedonic | cylinders | | 1993.56 | 411.23 | | | $/# of cylinders | -56.20 | 1277.26 | 2610.72 | standard error |
| Feng | Fullerton | 2013 | J. Regulatory Economics | market data | 2000 | Hedonic | cylinders | | 3150.55 | 288.44 | | | $/# of cylinders | 36.11 | 1004.75 | 1973.38 | standard error |
| Fifer | Bunn | 2009 | Grey | market data | 2002 | Hedonic | displacement | | 3954.07 | 406.95 | | | $/in^3 | 4673.74 | 5209.94 | 5746.14 | standard error |
| Fifer | Bunn | 2009 | Grey | market data | 2002 | Hedonic | horsepower | | 29.91 | 6.06 | | | $/hp | 31.42 | 39.41 | 47.40 | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | acceleration (0-60) s faster | | 0.61 | 0.13 | 0.02 | 0.35 | $/s | 12.15 | 12.58 | 13.02 | random coef. |
| Greene | | 2001 | Grey | Lit. Review | 1990 | Other | acceleration (0-60) s faster | | -0.35 | | | | $/s | | 460.84 | | |
| Greene | | 2001 | Grey | Lit. Review | 1990 | Other | acceleration (0-60) s faster | | -0.24 | | | | $/s | | 532.66 | | |
| Greene | Duleep | 2004 | Grey | Lit. Review | 2002 | Other | horsepower | midsize | | | | | $/hp | | 13.84 | | |
| Greene | Duleep | 2004 | Grey | Lit. Review | 2002 | Other | horsepower | smallSUV | | | | | $/hp | | 13.81 | | |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | horsepower/cid | | 3.58 | 0.86 | | | hp/cid | 1509.64 | 2651.14 | 5005.93 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | horsepower/cid | | -0.02 | 0.59 | | | hp/cid | -529.54 | -12.46 | 497.46 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | horsepower/cid | | 0.17 | 1.16 | | | hp/cid | -4581.32 | 587.78 | 6233.86 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | horsepower/cid | young | 0.51 | 2.18 | | | hp/cid | -7685.62 | 1736.31 | 12567.25 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | horsepower/cid | young | -0.20 | 0.90 | | | hp/cid | -969.49 | -140.50 | 607.70 | standard error |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | horsepower/cid | young | 0.28 | 1.76 | | | hp/cid | -1639.50 | 199.88 | 2261.46 | standard error |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | acceleration (0-60) s faster | | 9.90 | | | | $/s | | 1760.21 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | acceleration (0-60) s faster | | 13.60 | | | | $/s | | 651.02 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | acceleration (0-60) s faster | | 13.70 | | | | $/s | | 2325.13 | | |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MXL | acceleration (0-60) s faster | | | | -1.27 | 5.77 | $/s | -4457.51 | 1290.96 | 7039.43 | random coef. |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MNL | acceleration (0-60) s faster | | -1.17 | 0.26 | | | $/s | 938.06 | 1192.28 | 1446.51 | standard error |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | acceleration (0-60) s faster | | -0.04 | 0.01 | | | $/s | 1241.66 | 1051.80 | 861.95 | varied income |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | high perf | | 0.18 | 0.06 | 0.61 | 0.09 | 0/1 | -7711.40 | 3332.01 | 14375.42 | random coef. |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | low perf | | -0.49 | 0.06 | 0.55 | 0.10 | 0/1 | -18925.83 | -8926.68 | 1072.46 | random coef. |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | acc. (1% faster) | | 2.20 | 0.88 | | | $/% | 2462.26 | 4049.78 | 5637.29 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | acc. (1% faster) | | 0.59 | 0.06 | | | $/% | 4469.79 | 4977.96 | 5486.13 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | acc. (1% faster) | | 1.97 | 0.82 | | | $/% | 8631.22 | 14587.98 | 20544.74 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | acc. (1% faster) | | 0.33 | 0.06 | | | $/% | 9129.39 | 11200.41 | 13271.43 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | acc. (1% faster) | | 0.15 | 0.05 | | | $/% | -3309.21 | -5091.10 | -6872.98 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | acc. (1% faster) | | 1.10 | 0.79 | | | $/% | -2443.67 | -8145.57 | -13847.47 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | acceleration (0-60) s faster | age | | | | | $/s | 674.62 | 1140.64 | 1606.66 | varied interaction |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | top speed | age | | | | | $/mph | 4.03 | 68.90 | 133.77 | varied interaction |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | acceleration (0-60) s faster | | 8.25 | 5.36 | | | $/s | -115.39 | 34.00 | 183.39 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | acceleration (0-60) s faster | | 38.75 | 9.51 | | | $/s | -130.85 | 198.40 | 527.65 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | acceleration (0-60) s faster | | 42.18 | 11.84 | | | $/s | -166.62 | 185.52 | 537.67 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | acceleration (0-60) s faster | | 47.20 | 10.70 | | | $/s | -92.09 | 172.81 | 437.71 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | acceleration (0-60) s faster | | 38.75 | 19.41 | | | $/s | -473.60 | 198.40 | 870.40 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | acceleration (0-60) s faster | | 9.53 | 9.13 | | | $/s | -183.95 | 33.58 | 251.10 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | acceleration (0-60) s faster | | 0.01 | 0.00 | | | $/s | -229.55 | 5.30 | 240.14 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | displacement | | 0.00 | 0.00 | | | $/in^3 | 0.00 | 0.00 | 0.00 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | displacement | | 0.00 | 0.00 | | | $/in^3 | -0.01 | 0.00 | 0.01 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | horsepower | | 0.01 | 0.00 | | | $/hp | -967.30 | 9.18 | 985.65 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | horsepower | | 0.00 | 0.00 | | | $/hp | -109.09 | 1.24 | 111.58 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | horsepower | | 0.01 | 0.00 | | | $/hp | -360.17 | 8.31 | 376.79 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | horsepower | | 0.00 | 0.00 | | | $/hp | -117.03 | 1.33 | 119.70 | standard error |
| Lave | Train | 1979 | TR-A | market data | 1976 | MNL | acceleration (0-60) s faster | age | -0.02 | -0.01 | | | $/s | 157.70 | 250.93 | 343.81 | varied interaction |
| Liu | | 2014 | Energy Economics | RP survey | 2009 | MXL | acceleration (0-60) s faster | | | | 0.14 | 0.01 | $/s | 140.92 | 156.35 | 171.78 | random coef. |
| McCarthy | | 1996 | RE Stat | RP survey | 1989 | MNL | horsepower | | 0.01 | 0.00 | | | $/hp | 297.02 | 355.01 | 412.99 | standard error |
| McFadden | Train | 2000 | J. Applied Econometrics | SP survey | 1993 | MXL | acceleration (0-60) s faster | | -0.13 | 0.03 | | | $/s | 1009.62 | 1261.54 | 1514.43 | standard error |
| McManus | | 2007 | Business Economics | market data | 2002 | Hedonic | acceleration (0-60) s faster | | 630.61 | 23.67 | | | $/s | 4760.20 | 4945.84 | 5131.49 | standard error |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | acceleration (0-60) s faster | | | | 3.40 | 0.10 | $/s | 1032.53 | 1063.17 | 1093.82 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | acceleration (0-60) s faster | | | | -2.83 | 4.43 | $/s | -901.90 | -355.91 | 190.08 | random coef. |

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | acceleration (0-60) s faster | | | | 3.40 | 0.10 | $/s | 1534.47 | 1580.01 | 1625.56 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | acceleration (0-60) s faster | | | | 3.40 | 0.10 | $/s | 377.71 | 388.92 | 400.13 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | acceleration (0-60) s faster | | | | -2.83 | 4.43 | $/s | -856.51 | -338.00 | 180.51 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | acceleration (0-60) s faster | | | | -2.83 | 4.43 | $/s | -2180.39 | -860.43 | 459.52 | random coef. |
| Shiau | Michalek | 2009 | TR-A | market data | 2007 | MXL | acceleration (0-60) s faster | | | | 0.24 | 0.00 | $/s | 1778.05 | 1807.32 | 1836.60 | random coef. |
| Skerlos | Raichur | 2013 | Grey | market data | 2008 | MXL | acceleration (0-60) s faster | | -19.99 | 11.71 | 0.41 | 1.24 | $/s | 533.97 | 1289.14 | 2044.31 | random coef. |
| Skerlos | Raichur | 2013 | Grey | market data | 2008 | MXL | horsepower | | 2.49 | 1.00 | 0.08 | 0.05 | $/hp | 143.23 | 147.99 | 152.74 | random coef. |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | acceleration (0-60) s faster | | -0.06 | 0.01 | | | $/s | 1025.67 | 1275.23 | 1524.78 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | top speed | | 0.00 | 0.00 | | | $/mph | 58.17 | 115.19 | 172.22 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | top speed | | 0.01 | 0.00 | | | $/mph | 140.00 | 178.99 | 217.99 | standard error |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | high perf | | | | 0.55 | 0.96 | 0/1 | -17169.44 | 12392.61 | 41954.66 | random coef. |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | high perf | | | | 0.60 | 1.95 | 0/1 | -18035.85 | 8322.76 | 34681.37 | random coef. |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | low perf | | | | 0.36 | 0.76 | 0/1 | -5268.29 | 4932.82 | 15133.93 | random coef. |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | low perf | | | | 0.25 | 1.18 | 0/1 | -31511.12 | 5731.10 | 42973.32 | random coef. |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | low perf | | | | 0.36 | 0.76 | 0/1 | -5268.29 | 4932.82 | 15133.93 | random coef. |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | low perf | | | | 0.25 | 1.18 | 0/1 | -31511.12 | 5731.10 | 42973.32 | random coef. |
| Train | Winston | 2007 | Int. Econ. Rev. | RP survey | 2000 | MXL | acceleration (0-60) s faster | | | | 0.03 | 0.00 | $/s | 5542.56 | 5543.53 | 5544.51 | random coef. |
| Walls | | 1996 | RE Stat | market data | 1990 | Hedonic | acceleration (0-60) s faster | | 8.20 | 5.55 | | | $/s | 326.01 | 1173.02 | 2020.03 | standard error |
| Whitefoot | Fowlie | 2011 | Grey | market data | 2006 | BLP | acceleration (0-60) s faster | | 1.13 | 0.40 | | | $/s | 31.18 | 34.64 | 38.71 | standard error |

# Pollution

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | emissions reduction | children | -0.25 | 0.22 | | | $/10% | 8356.52 | 76601.44 | 144846.36 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | emissions reduction | children | -0.46 | 0.14 | | | $/10% | 103065.41 | 144802.64 | 186539.88 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | emissions reduction | children | -0.54 | 0.30 | | | $/10% | 76777.36 | 168535.66 | 260293.97 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | emissions reduction | children | -0.03 | 0.26 | | | $/10% | -72273.29 | 8212.87 | 88699.03 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | emissions reduction | | -0.69 | 0.25 | | | $/10% | 51603.76 | 81735.61 | 111867.46 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | emissions reduction | | 0.40 | 0.10 | | | $/10% | -83601.63 | -66982.03 | -50362.43 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | emissions reduction | | -0.39 | 0.14 | | | $/10% | 47822.73 | 75953.74 | 104084.76 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | emissions reduction | | -0.70 | | 0.83 | | $/10% | -28708.63 | 145003.63 | 318715.88 | random coef. |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | emissions reduction | | 0.75 | 0.47 | | | $/10% | 189.38 | 488.73 | 788.08 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | emissions reduction | | 0.12 | 0.06 | | | $/10% | 173.55 | 358.41 | 543.28 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | emissions reduction | | 0.19 | 0.06 | | | $/10% | 262.46 | 378.32 | 494.19 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | emissions reduction | | 0.90 | 0.36 | | | $/10% | 237.72 | 390.99 | 544.25 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | emissions reduction | | 1.20 | 0.39 | | | $/10% | 281.46 | 411.57 | 541.67 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | emissions reduction | | 0.37 | 0.06 | | | $/10% | 489.70 | 581.64 | 673.57 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | emissions reduction | | -0.95 | 0.27 | | | $/10% | 102201.19 | 141968.19 | 181735.19 | standard error |
| McFadden | Train | 2000 | J. Applied Econometrics | SP survey | 1993 | MXL | emissions reduction | | -0.79 | 0.20 | | | $/10% | 100047.31 | 132461.39 | 164891.88 | standard error |
| Tanaka | Ida | 2014 | TR-A | SP survey | 2012 | MXL | emissions reduction | | 0.01 | 0.00 | | | $/10% | 266.26 | 297.28 | 328.30 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | emissions reduction | | 0.00 | 0.00 | | | $/10% | 1158.43 | 1491.32 | 1824.20 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | emissions reduction | | 0.00 | 0.00 | | | $/10% | -975.74 | -543.99 | -112.25 | standard error |

# Prestige

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | foreign | | -0.29 | 0.11 | | | 0/1 | -7806.36 | -5696.53 | -3586.70 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | foreign | | -0.26 | 0.13 | | | 0/1 | -6547.12 | -4381.53 | -2215.95 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | new | | 1.07 | 0.25 | | | 0/1 | 13799.31 | 18012.96 | 22226.62 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | new | | 0.77 | 0.23 | | | 0/1 | 10612.34 | 15034.14 | 19455.95 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | used | | 0.23 | 0.23 | | | 0/1 | 0.00 | 4463.26 | 8926.52 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | used | | 0.47 | 0.25 | | | 0/1 | 3626.09 | 7822.96 | 12019.83 | standard error |
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | American Motors | | -0.12 | 0.09 | | | 0/1 | -2800.09 | -1645.55 | -491.01 | standard error |
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | Chrysler | | 0.06 | 0.01 | | | 0/1 | 544.09 | 729.88 | 915.67 | standard error |

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | German | | 0.40 | 0.03 | | | 0/1 | 4936.64 | 5308.22 | 5679.79 | standard error |
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | GM | | 0.02 | 0.01 | | | 0/1 | 159.25 | 291.95 | 424.66 | standard error |
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | Japanese | | 0.24 | 0.01 | | | 0/1 | 3012.41 | 3198.20 | 3383.99 | standard error |
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | resale value retained | | 0.12 | 0.04 | | | $/% | 1141.27 | 1605.74 | 2070.21 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | luxury | | 0.24 | 0.03 | | | 0/1 | 7519.90 | 8386.90 | 9253.90 | standard error |
| Feng | Fullerton | 2013 | J. Regulatory Economics | market data | 2000 | Hedonic | foreign | | 2371.11 | 894.32 | | | 0/1 | -809.84 | 2219.46 | 5248.76 | standard error |
| Feng | Fullerton | 2013 | J. Regulatory Economics | market data | 2000 | Hedonic | foreign | | 1417.36 | 1584.27 | | | 0/1 | | 1289.31 | | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | Chrysler | | 0.11 | 0.04 | | | 0/1 | 810.48 | 1350.80 | 1891.13 | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | European | | -0.25 | 0.06 | | | 0/1 | -3782.25 | -3070.01 | -2357.77 | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | GM | | -0.35 | 0.04 | | | 0/1 | -4764.66 | -4298.02 | -3831.37 | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | Japanese | | 0.19 | 0.04 | | | 0/1 | 1866.57 | 2333.21 | 2799.85 | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | Korean | | -0.51 | 0.06 | | | 0/1 | -6987.35 | -6262.82 | -5538.30 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | Asian | | -0.06 | 0.01 | | | 0/1 | -2424.55 | -2078.19 | -1731.82 | standard error |
| Gramlich | | 2008 | Grey | market data | 2007 | NMNL | European | | 0.14 | 0.03 | | | 0/1 | 3810.01 | 4849.11 | 5888.20 | standard error |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | 1-2 yrs | | -0.17 | 0.08 | | | 0/1 | -7365.05 | -5126.43 | -2887.81 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | 3+ yrs | | -0.38 | 0.06 | | | 0/1 | -13112.15 | -11313.50 | -9514.85 | varied income |
| Sexton | Sexton | 2014 | JEEM | market data | 2010 | Other | prius | | | | | | 0/1 | 199.19 | 1122.69 | 2046.19 | standard error |
| Sexton | Sexton | 2014 | JEEM | market data | 2010 | Other | prius | | | | | | 0/1 | 1759.10 | 3658.92 | 5558.74 | standard error |
| Sexton | Sexton | 2014 | JEEM | market data | 2010 | Other | prius | | | | | | 0/1 | 732.95 | 1524.54 | 2316.13 | standard error |
| Sexton | Sexton | 2014 | JEEM | market data | 2010 | Other | prius | | | | | | 0/1 | 248.99 | 1403.37 | 2557.75 | standard error |
| Sexton | Sexton | 2014 | JEEM | market data | 2010 | Other | prius | | | | | | 0/1 | 2198.86 | 4573.64 | 6948.41 | standard error |
| Sexton | Sexton | 2014 | JEEM | market data | 2010 | Other | prius | | | | | | 0/1 | 83.00 | 467.79 | 852.58 | standard error |
| Shiau | Michalek | 2009 | TR-A | market data | 2007 | MXL | foreign | | -0.83 | 0.00 | | | 0/1 | -10426.05 | -10413.76 | -10401.46 | standard error |
| Walls | | 1996 | RE Stat | market data | 1990 | Hedonic | European | | 0.26 | 0.04 | | | 0/1 | 1473.47 | 5301.73 | 9129.98 | standard error |

# Range

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | range | | 0.01 | 0.00 | | | $/mi | -138.95 | 60.95 | 260.85 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | range | | 0.01 | 0.00 | | | $/mi | -99.08 | 127.16 | 353.40 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | range | | 1.00 | 0.24 | | | $/mi | -7.32 | 79.09 | 165.50 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | range | | 1.78 | 0.50 | | | $/mi | -31.20 | 84.35 | 199.89 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | range | | 2.48 | 1.61 | | | $/mi | -289.92 | 160.82 | 611.57 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | range | | 0.59 | | 0.83 | | $/mi | -51.03 | 122.68 | 296.39 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | range | | 1.17 | | | | $/mi | 37.45 | 104.32 | 164.91 | random coef. |
| Greene | | 2001 | Grey | Lit. Review | 1990 | Other | range | | -233.90 | | | | $/mi | | 3.23 | | |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MXL | range BEV | | | | -18.95 | 1.90 | $/mi | -211.67 | -192.75 | -173.83 | random coef. |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MNL | range BEV | | -19.50 | 1.98 | | | $/mi | -218.11 | -198.33 | -178.55 | standard error |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MXL | range BEV | | | | -12.73 | 10.49 | $/mi | -156.01 | -86.31 | -16.62 | random coef. |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MNL | range BEV | | -13.69 | 1.96 | | | $/mi | -105.87 | -92.85 | -79.83 | standard error |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MXL | range BEV | | | | -18.45 | 4.18 | $/mi | -305.80 | -250.30 | -194.80 | random coef. |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MNL | range BEV | | -20.14 | 1.98 | | | $/mi | -299.43 | -273.14 | -246.85 | standard error |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MXL | range PHEV | | | | 0.82 | 2.20 | $/mi | -135.41 | 83.62 | 302.65 | random coef. |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MNL | range PHEV | | 0.03 | 1.78 | | | $/mi | -174.91 | 2.75 | 180.40 | standard error |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MXL | range PHEV | | | | 3.21 | 8.66 | $/mi | -268.76 | 163.12 | 595.01 | random coef. |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MNL | range PHEV | | 1.70 | 1.75 | | | $/mi | -1.07 | 86.22 | 173.50 | standard error |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MXL | range PHEV | | | | 3.30 | 7.14 | $/mi | -93.95 | 84.03 | 262.01 | random coef. |
| Helveston | Liu | 2015 | TR-A | SP survey | 2013 | MNL | range PHEV | | 2.65 | 1.77 | | | $/mi | 23.18 | 67.40 | 111.61 | standard error |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | range | | 0.24 | 0.17 | | | $/mi | 16.76 | 53.21 | 89.65 | varied income |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | range | | 0.56 | | 0.07 | | $/mi | 92.98 | 100.96 | 109.63 | random coef. |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | range | | 1.32 | 0.73 | | | $/mi | 13.06 | 28.67 | 44.28 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | range | | 0.53 | 0.06 | | | $/mi | 47.02 | 52.77 | 58.51 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | range | | 1.94 | 0.72 | | | $/mi | 20.13 | 31.60 | 43.08 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | range | | 0.92 | 0.06 | | | $/mi | 64.46 | 68.70 | 72.93 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | range | | 1.28 | 0.07 | | | $/mi | 60.47 | 63.72 | 66.97 | standard error |
| Hidrue | Parsons | 2011 | REE | SP survey | 2009 | Other | range | | 2.60 | 0.70 | | | $/mi | 20.76 | 28.24 | 35.72 | standard error |

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | range | age | | | | | $/mi | 124.77 | 162.05 | 181.44 | varied interaction |
| McFadden | Train | 2000 | J. Applied Econometrics | SP survey | 1993 | MXL | range | | 0.01 | 0.00 | | | $/mi | 96.78 | 113.19 | 127.95 | standard error |
| Nixon | Saphores | 2011 | Grey | SP survey | 2010 | MXL | range | | | | 0.03 | | $/mi | 16.07 | 62.12 | 240.19 | random coef. |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | range | GV-oriented | 0.26 | 0.19 | | | $/mi | 3.86 | 13.51 | 23.17 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | range | EV-oriented | -0.17 | 0.07 | | | $/mi | -26.77 | -18.78 | -10.79 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | range | | | | | | $/mi | -12.89 | -4.15 | 4.59 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | range | EV-oriented | -0.79 | 0.08 | | | $/mi | -483.21 | -436.29 | -389.38 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | range | | | | | | $/mi | -432.36 | -371.69 | -311.03 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | range | GV-oriented | -1.13 | 0.30 | | | $/mi | -370.96 | -293.68 | -216.39 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | range | GV-oriented | -0.37 | 0.19 | | | $/mi | -48.84 | -32.05 | -15.27 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | range | EV-oriented | -0.44 | 0.07 | | | $/mi | -94.43 | -81.00 | -67.57 | standard error |
| Parsons | Hidrue | 2014 | Energy Economics | SP survey | 2009 | Other | range | | | | | | $/mi | -73.78 | -58.83 | -43.88 | standard error |
| Segal | | 1995 | Energy Journal | SP survey | 1994 | MNL | range | | 0.01 | | | | $/mi | | 59.77 | | |
| Tanaka | Ida | 2014 | TR-A | SP survey | 2012 | MXL | range | | 0.00 | 0.00 | | | $/mi | 1.93 | 2.20 | 2.47 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | range | non-large*multifuel | 0.00 | 0.00 | | | $/mi | 34.10 | 54.64 | 75.18 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | range | non-large*onefuel | 0.00 | 0.01 | | | $/mi | -411.70 | 78.42 | 568.54 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | range | large*onefuel | 0.00 | 0.00 | | | $/mi | 96.35 | 123.49 | 150.63 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | range | large*multifuel | 0.00 | 0.00 | | | $/mi | 75.64 | 97.57 | 119.49 | standard error |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | range | | | | 0.57 | 0.36 | $/mi | -20.51 | 128.89 | 278.30 | random coef. |
| Train | Weeks | 2005 | Book | SP survey | 2000 | MXL | range | | | | 0.76 | 0.43 | $/mi | 47.68 | 105.10 | 162.52 | random coef. |
| Zhang | Gensler | 2011 | J. Product Innov. Mgmt. | SP survey | 2010 | MXL | range | | 0.01 | | 0.01 | 0.00 | $/mi | 78.67 | 90.31 | 101.95 | random coef. |

## Reliability

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | reliability index (>=2) | | 0.03 | 0.01 | | | 0/1 | 278.68 | 451.20 | 623.72 | standard error |
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | reliability index | | 103.94 | 76.99 | | | $/scale [1,5] | 36.07 | 139.14 | 242.20 | standard error |
| McCarthy | | 1996 | RE Stat | RP survey | 1989 | MNL | reliability index | | 0.01 | 0.00 | | | $/scale [1,5] | 228.94 | 317.97 | 407.01 | standard error |
| McCarthy | Tay | 1998 | TR-E | RP survey | 1989 | NMNL | reliability index | | 0.01 | 0.00 | | | $/scale [1,5] | 108.67 | 178.27 | 247.87 | standard error |
| Train | Winston | 2007 | Int. Econ. Rev. | RP survey | 2000 | MXL | reliability index | female | 0.39 | 0.06 | | | $/scale [1,5] | 4788.26 | 5606.34 | 6424.42 | standard error |
| Walls | | 1996 | RE Stat | market data | 1990 | Hedonic | reliability index | | 0.04 | 3.56 | | | $/scale [1,5] | 195.24 | 702.49 | 1209.75 | standard error |

## Safety

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | crash test rating (front + side) | | 191.25 | 70.31 | | | $/scale [1,10] | 161.89 | 256.02 | 350.14 | standard error |
| Fifer | Bunn | 2009 | Grey | market data | 2002 | Hedonic | airbags | | 138.27 | 447.02 | | | 0/1 | -406.82 | 182.18 | 771.19 | standard error |
| McCarthy | | 1996 | RE Stat | RP survey | 1989 | MNL | safety index | | 0.24 | 0.08 | | | 0/1 | 6067.90 | 9011.73 | 11955.56 | standard error |
| McCarthy | Tay | 1998 | TR-E | RP survey | 1989 | NMNL | airbags | | 0.22 | 0.07 | | | 0/1 | 4171.75 | 6100.20 | 8028.65 | standard error |

## Size

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Beresteanu | Li | 2011 | Int. Econ. Rev. | market data | 2006 | BLP | footprint | | 3.26 | | | 8.77 | $/ft^2 | 4285.86 | 4411.90 | 4537.95 | random coef. |
| Beresteanu | Li | 2011 | Int. Econ. Rev. | market data | 2006 | BLP | footprint | | 2.68 | | 0.00 | 9.36 | $/ft^2 | 2827.38 | 3010.67 | 3193.96 | random coef. |
| Berry | Levinsohn | 1995 | Econometrica | market data | 1983 | BLP | footprint | | 2.60 | 0.29 | 2.60 | 1.51 | $/ft^2 | 27.29 | 63.22 | 99.15 | random coef. |
| Berry | Levinsohn | 1995 | Econometrica | market data | 1983 | BLP | footprint | | 3.46 | 0.61 | 3.46 | 2.06 | $/ft^2 | 19.12 | 45.79 | 72.45 | random coef. |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | luggage space (%) | | 0.49 | 0.35 | | | $/% | 4587.65 | 15292.18 | 25996.71 | standard error |
| Brownstone | Bunch | 1996 | Transportation Econ. | SP survey | 1993 | NMNL | luggage space (%) | | 0.62 | 0.35 | | | $/% | 8885.52 | 19504.79 | 30124.07 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | luggage space (%) | | 1.56 | 0.46 | 5.38 | 1.29 | $/% | -79637.24 | 32610.17 | 144857.58 | random coef. |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | size (index) | | 1.54 | 0.53 | 6.81 | 2.07 | 0 to 0.3 scale | -109889.80 | 32151.16 | 174192.13 | random coef. |

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | luggage space | | -0.04 | 0.01 | | | $/ft^3 | -663.53 | -530.82 | -398.12 | standard error |
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | weight | | 18.50 | 0.61 | | | $/lb | 23.95 | 24.76 | 25.58 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | weight | pickup | -0.87 | 0.34 | | | $/lb | 3.66 | 8.24 | 12.82 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | weight | | 1.81 | 0.11 | | | $/lb | 17.25 | 18.35 | 19.45 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | weight | van | 2.05 | 0.33 | | | $/lb | 12.03 | 14.29 | 16.56 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | weight | SUV | -0.58 | 0.34 | | | $/lb | 5.63 | 10.23 | 14.82 | standard error |
| Fifer | Bunn | 2009 | Grey | market data | 2002 | Hedonic | weight | | 7.61 | 0.51 | | | $/lb | 9.35 | 10.03 | 10.70 | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | footprint | | | | | | $/ft^2 | 5975.44 | 6301.47 | 6627.49 | random coef. |
| Goldberg | | 1995 | Econometrica | RP survey | 1982 | NMNL | footprint | | -1.34 | 1.71 | | | $/ft^2 | -15537.91 | -4247.82 | 3595.18 | standard error |
| Greene | | 2001 | Grey | Lit. Review | 1990 | Other | luggage space | | 0.12 | | | | $/ft^3 | | 272.08 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | footprint | | 0.05 | | | | $/ft^2 | | 1430.79 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | footprint | | 0.05 | | | | $/ft^2 | | 1554.98 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | footprint | | 0.05 | | | | $/ft^2 | | 390.04 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | footprint | | 0.05 | | | | $/ft^2 | | 1539.68 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | size (index) | | 0.11 | | | | $/100ft | | 2417.67 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | size (index) | | 0.10 | | | | $/100ft | | 2985.83 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MXL | size (index) | | 9.62 | 0.00 | 0.10 | 0.00 | $/100ft | 1978.49 | 1978.49 | 1978.49 | random coef. |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | width | | 0.99 | | | | $/ft | | 21050.94 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MNL | width | | 0.72 | | | | $/ft | | 22581.92 | | |
| Haaf | Michalek | 2014 | J. Mechanical Design | market data | 2004 | MXL | width | | 0.95 | 0.19 | 0.95 | 0.19 | $/ft | 15708.63 | 19538.09 | 23367.56 | random coef. |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | luggage space (%) | | 1.26 | 0.85 | | | $/% | 6179.23 | 18789.91 | 31400.58 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | length | | 0.42 | 0.12 | | | $/ft ? | -1.18 | 0.39 | 1.95 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | length | | 0.18 | 0.01 | | | $/ft ? | 0.02 | 0.06 | 0.09 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | weight | | -0.25 | 0.27 | | | $/lb | -0.57 | -0.14 | 0.29 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | weight | | 1.62 | 0.49 | | | $/lb | 0.07 | 0.48 | 0.89 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | weight | | 1.47 | 0.29 | | | $/lb | 0.22 | 0.51 | 0.79 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | weight | | 1.28 | 0.17 | | | $/lb | 0.27 | 0.43 | 0.59 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | weight | | 1.14 | 1.20 | | | $/lb | -0.98 | 0.49 | 1.96 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | weight | | -0.99 | 0.33 | | | $/lb | -1.77 | -0.91 | -0.05 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | weight | | 1.28 | 0.18 | | | $/lb | 0.24 | 0.40 | 0.56 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | weight | | -0.18 | 0.29 | | | $/lb | -0.52 | -0.09 | 0.34 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | weight | | 0.82 | 0.80 | | | $/lb | -0.54 | 0.30 | 1.14 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | weight | | 1.14 | 0.53 | | | $/lb | -0.16 | 0.49 | 1.14 | standard error |
| Klier | Linn | 2012 | Rand J. Econ. | market data | 2008 | MNL | weight | | 1.47 | 0.68 | | | $/lb | -0.14 | 0.45 | 1.05 | standard error |
| Lave | Train | 1979 | TR-A | market data | 1976 | MNL | weight | age | 0.69 | 0.42 | | | $/lb | 38.90 | 87.36 | 129.74 | varied income |
| Liu | | 2014 | Energy Economics | RP survey | 2009 | MXL | volume | | | | 0.00 | 0.00 | $/ft^3 | 1.18 | 1.18 | 1.19 | random coef. |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | luggage space | income | 0.22 | 0.03 | | | $/ft^3 | 1.01 | 1.17 | 1.33 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | luggage space | income | 0.22 | 0.03 | | | $/ft^3 | 3.03 | 3.50 | 3.97 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | luggage space | income | 0.22 | 0.03 | | | $/ft^3 | 29.96 | 34.61 | 39.26 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | luggage space | income | 0.16 | 0.03 | | | $/ft^3 | 0.91 | 1.10 | 1.29 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | luggage space | income | 0.16 | 0.03 | | | $/ft^3 | 1.97 | 2.36 | 2.76 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | luggage space | income | 0.16 | 0.03 | | | $/ft^3 | 3.14 | 3.78 | 4.42 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | luggage space | income | 0.10 | 0.02 | | | $/ft^3 | 0.49 | 0.62 | 0.75 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | luggage space | income | 0.10 | 0.02 | | | $/ft^3 | 0.77 | 0.97 | 1.17 | standard error |
| Liu | Tremblay | 2014 | TR-A | RP survey | 2009 | MNL | luggage space | income | 0.10 | 0.02 | | | $/ft^3 | 1.33 | 1.68 | 2.03 | standard error |
| McCarthy | | 1996 | RE Stat | RP survey | 1989 | MNL | length | | 0.02 | 0.00 | | | $/ft | 42.36 | 51.75 | 61.14 | standard error |
| McCarthy | Tay | 1998 | TR-E | RP survey | 1989 | NMNL | length | | 0.05 | 0.00 | | | $/ft | 93.56 | 104.92 | 116.28 | standard error |
| McCarthy | Tay | 1998 | TR-E | RP survey | 1989 | NMNL | luggage space | | 0.04 | 0.01 | | | $/ft^3 | 741.89 | 974.92 | 1207.95 | standard error |
| McFadden | Train | 2000 | J. Applied Econometrics | SP survey | 1993 | MXL | luggage space (%) | | | | 2.26 | 7.62 | $/% | -86983.26 | 37809.32 | 162601.89 | random coef. |
| McFadden | Train | 2000 | J. Applied Econometrics | SP survey | 1993 | MXL | size (index) | | | | 5.78 | 26.93 | 0 to 0.3 scale | -344278.22 | 96627.10 | 537530.81 | random coef. |
| McManus | | 2007 | Business Economics | market data | 2002 | Hedonic | weight | | 10.50 | 15.00 | | | $/lb | -5.93 | 13.83 | 33.60 | standard error |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | footprint | | | | 4.80 | 0.46 | $/ft^2 | 3490.65 | 3852.46 | 4214.27 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | footprint | | | | 4.80 | 0.46 | $/ft^2 | 8886.03 | 9807.08 | 10728.13 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | footprint | | | | 4.60 | 0.14 | $/ft^2 | 13936.66 | 14365.11 | 14793.57 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | footprint | | | | 4.60 | 0.14 | $/ft^2 | 9377.81 | 9666.11 | 9954.42 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | footprint | | | | 4.60 | 0.14 | $/ft^2 | 3430.50 | 3535.96 | 3641.43 | random coef. |
| Petrin | | 2002 | J. Political Economy | market data | 1983 | BLP | footprint | | | | 4.80 | 0.46 | $/ft^2 | 3675.65 | 4056.64 | 4437.62 | random coef. |
| Shiau | Michalek | 2009 | TR-A | market data | 2007 | MXL | footprint | | | | 0.04 | 0.00 | $/ft^2 | 476.90 | 477.15 | 477.40 | random coef. |
| Skerlos | Raichur | 2013 | Grey | market data | 2008 | MXL | footprint | | 0.79 | 2.00 | 0.31 | 0.21 | $/ft^2 | 410802.69 | 676112.75 | 941422.81 | random coef. |

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Train | Winston | 2007 | Int. Econ. Rev. | RP survey | 2000 | MXL | length-WB | | 0.03 | 0.01 | | | $/ft | 3584.08 | 4736.07 | 5888.06 | standard error |
| Train | Winston | 2007 | Int. Econ. Rev. | RP survey | 2000 | MXL | wheelbase | | 0.05 | 0.01 | | | $/ft | 6670.36 | 8790.69 | 10911.02 | standard error |
| Walls | | 1996 | RE Stat | market data | 1990 | Hedonic | volume | | 0.01 | 0.00 | | | $/ft^3 | 33.93 | 122.09 | 210.24 | standard error |
| Whitefoot | Fowlie | 2011 | Grey | market data | 2006 | BLP | footprint | | 2.45 | 0.75 | | | $/ft^2 | 633.86 | 905.08 | 1176.29 | standard erro |

# Vehicle Class

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | large | | 0.00 | 0.00 | | | 0/1 | -30755.80 | -27322.92 | -23890.04 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | large | | -1.24 | 0.17 | | | 0/1 | -39464.71 | -34793.76 | -30122.82 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | large | | 0.01 | 0.00 | | | 0/1 | -16413.96 | -14622.68 | -12831.41 | standard error |
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | large | | 0.02 | 0.00 | | | 0/1 | -9924.20 | -8749.60 | -7574.99 | standard error |
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | large | | 0.01 | | | | 0/1 | -12516.59 | -11017.05 | -9517.51 | standard error |
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | SUV | | -1.38 | 0.19 | | | 0/1 | -11023.30 | -9778.73 | -8534.17 | standard error |
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | SUV | | -1.12 | 0.15 | | | 0/1 | -8011.78 | -7192.20 | -6372.62 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | SUV | | -1.45 | 0.18 | | | 0/1 | -14361.96 | -12937.39 | -11512.83 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | SUV | | -1.13 | 0.13 | | | 0/1 | -35414.14 | -31791.40 | -28168.66 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | SUV | | -1.33 | -0.17 | | | 0/1 | -27391.92 | -24754.98 | -22118.04 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | truck | | -2.18 | 0.24 | | | 0/1 | -67623.48 | -61113.56 | -54603.64 | standard error |
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | truck | | -2.68 | 0.77 | | | 0/1 | -22220.96 | -20081.81 | -17942.66 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | truck | | -1.17 | 0.15 | | | 0/1 | -30409.66 | -28165.57 | -25921.48 | standard error |
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | truck | | -1.04 | 0.14 | | | 0/1 | -24466.40 | -22633.29 | -20800.18 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | truck | | -0.87 | -0.18 | | | 0/1 | -53388.63 | -48708.76 | -44028.90 | standard error |
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | van | | -0.92 | 0.11 | | | 0/1 | -26856.72 | -20981.81 | -15106.91 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | van | | -0.68 | 0.20 | | | 0/1 | -24530.72 | -19164.63 | -13798.53 | standard error |
| Axsen | Mountain | 2009 | REE | RP survey | 2006 | MNL | van | | -1.22 | 0.16 | | | 0/1 | -9466.87 | -8332.69 | -7198.52 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | van | | -1.21 | -0.13 | | | 0/1 | -21521.43 | -17934.52 | -14347.62 | standard error |
| Axsen | Mountain | 2009 | REE | RP & SP | 2006 | MNL | van | | -1.28 | 0.14 | | | 0/1 | -13284.06 | -11766.77 | -10249.48 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | luxury | | -0.28 | 0.21 | | | 0/1 | -8175.50 | -4700.49 | -1225.49 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | luxury | | -0.24 | 0.17 | | | 0/1 | -8121.12 | -4737.32 | -1353.52 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | small | | -0.47 | 0.15 | | | 0/1 | -12101.46 | -9220.16 | -6338.86 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | small | | -0.07 | 0.07 | | | 0/1 | -1648.95 | -782.95 | 83.04 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | small | | -0.45 | 0.15 | | | 0/1 | -10173.21 | -7621.51 | -5069.82 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | sport | hhsize>3 | 0.87 | 0.30 | | | 0/1 | 11158.15 | 17030.87 | 22903.58 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | sport | hhsize>3 | 0.85 | 0.31 | | | 0/1 | 9048.45 | 5136.97 | 19322.38 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | sport | | -0.73 | 0.27 | | | 0/1 | -14773.48 | -9042.57 | -3311.67 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | sport | hhsize>3 | -1.07 | 0.39 | | | 0/1 | -17331.75 | -12717.06 | -8102.38 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | station wagon | | -1.53 | 0.07 | | | 0/1 | -18921.38 | -18114.70 | -17308.02 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | station wagon | | -0.94 | 0.25 | | | 0/1 | -23299.85 | -18342.44 | -13385.02 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | SUV | | -1.40 | 0.64 | | | 0/1 | -39977.15 | -27484.29 | -14991.43 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | SUV | | -1.18 | 0.79 | | | 0/1 | -33172.05 | -19876.37 | -6580.69 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | SUV | | 0.37 | 0.42 | | | 0/1 | -593.15 | 4353.70 | 9300.54 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | SUV | | 0.39 | 0.39 | | | 0/1 | 0.00 | 6547.12 | 13094.23 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | SUV | | 0.25 | 0.18 | | | 0/1 | 1415.04 | 4952.65 | 8490.26 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | SUV | | 0.94 | 0.15 | | | 0/1 | 9395.44 | 11198.61 | 13001.78 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | van | | | | | | 0/1 | 2366.87 | 3409.37 | 4451.87 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | van | | | | | | 0/1 | 2900.37 | 3227.79 | 3555.20 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | van | hhsize>3 | 0.88 | 0.27 | | | 0/1 | 10290.72 | 14823.34 | 19355.96 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | van | hhsize>3 | 1.05 | 0.27 | | | 0/1 | 15298.67 | 20574.07 | 25849.47 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | van | | | | | | 0/1 | 3518.69 | 4732.04 | 5945.38 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | van | hhsize>3 | 1.18 | 0.12 | | | 0/1 | 12610.30 | 14033.85 | 15457.40 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | truck | | -0.39 | 0.41 | | | 0/1 | -13396.41 | -6580.69 | 235.02 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | truck | | -0.38 | 0.16 | | | 0/1 | -10538.26 | -7438.77 | -4339.28 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP survey | 1995 | MNL | van | | -0.36 | 0.44 | | | 0/1 | -13312.47 | -6009.92 | 1292.64 | standard error |
| Brownstone | Bunch | 2000 | TR-B | RP & SP | 1995 | MXL | van | | -0.45 | 0.20 | | | 0/1 | -12670.82 | -8711.19 | -4751.56 | standard error |
| Brownstone | Bunch | 2000 | TR-B | SP survey | 1993 | MXL | van | | -1.21 | 0.08 | | | 0/1 | -15243.87 | -14342.29 | -13440.70 | standard error |

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | non-compact | hh>2 | 0.25 | | 0.83 | | 0/1 | -12238.72 | 5132.50 | 22503.73 | random coef. |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | sport | | 0.70 | 0.16 | | | 0/1 | 11162.15 | 14562.95 | 17963.76 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | station wagon | | -1.51 | 0.07 | | | 0/1 | -32860.53 | -31462.66 | -30064.78 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | SUV | | 0.90 | 0.15 | | | 0/1 | 15606.15 | 18714.86 | 21823.57 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | truck | | -1.09 | 0.06 | | | 0/1 | -23993.40 | -22825.03 | -21656.66 | standard error |
| Brownstone | Train | 1999 | J. Econometrics | SP survey | 1993 | MXL | van | | -0.82 | 0.06 | | | 0/1 | -18255.85 | -17087.48 | -15919.10 | standard error |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | large | | -0.48 | | | | 0/1 | -19574.63 | -5565.61 | 7685.73 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | small | | -3.65 | | | | 0/1 | -69405.58 | -42316.69 | -15225.48 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | small | | -1.69 | | | | 0/1 | -33585.96 | -19565.36 | -7086.77 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | SUV | | -0.16 | | | | 0/1 | -21256.82 | -1862.93 | 16553.16 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | SUV | | 0.46 | | | | 0/1 | -7068.23 | 5303.78 | 15651.82 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | SUV | | -0.97 | | | | 0/1 | -25124.01 | -11182.19 | 907.13 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | truck | | -1.53 | | | | 0/1 | -32976.57 | -17707.07 | -2631.04 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | truck | | -0.84 | | | | 0/1 | -26540.90 | -9674.93 | 5833.23 | random coef. |
| Daziano | | 2013 | REE | SP survey | 1999 | MXL | van | | -0.56 | | | | 0/1 | -24797.31 | -6507.50 | 11934.08 | random coef. |
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | convertible | | 0.35 | 0.06 | | | 0/1 | 3861.73 | 4618.15 | 5374.57 | standard error |
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | luxury | | 0.21 | 0.01 | | | 0/1 | 2654.11 | 2826.63 | 2999.14 | standard error |
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | station wagon | | 0.05 | 0.03 | | | 0/1 | 278.68 | 703.34 | 1128.00 | standard error |
| Dreyfus | Viscusi | 1995 | J. Law and Economics | RP survey | 1988 | Hedonic | two-seater | | -0.07 | 0.07 | | | 0/1 | -1924.23 | -955.48 | 13.27 | standard error |
| Espey | Nair | 2005 | Contemp. Econ. Policy | market data | 2001 | Hedonic | luxury | | 15853.00 | 593.08 | | | 0/1 | 20427.55 | 21221.47 | 22015.39 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | large | | -0.21 | -0.03 | | | 0/1 | -8145.06 | -7087.96 | -6030.86 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | midsize | | -0.11 | -0.02 | | | 0/1 | -4394.39 | -3677.12 | -2959.84 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | SUV | | 8.19 | 3.67 | | | 0/1 | 156041.16 | 278377.44 | 400713.69 | standard error |
| Fan | Rubin | 2010 | TRR | RP survey | 2007 | Hedonic | truck | | 11.45 | 3.66 | | | 0/1 | 267391.03 | 389271.59 | 511152.16 | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | small | | -0.06 | 0.27 | 1.32 | 0.26 | 0/1 | -16983.30 | -773.64 | 15436.02 | random coef. |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | SUV | children | 0.86 | 0.13 | | | 0/1 | 122.80 | 3070.01 | 6017.22 | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | truck | rural | 2.26 | 0.21 | | | 0/1 | 4052.41 | 8227.63 | 12402.84 | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | van | children | 2.08 | 0.27 | | | 0/1 | -43102.96 | -32664.92 | -22226.88 | standard error |
| Frischknecht | Whitefoot | 2010 | J. Mechanical Design | market data | 2006 | MXL | van | | -4.49 | 0.50 | 2.65 | 0.40 | 0/1 | -87679.52 | -55137.40 | -22595.28 | random coef. |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | large | | -0.16 | 0.18 | | | 0/1 | -10076.09 | -4772.88 | 530.32 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | midsize | | 0.24 | 0.11 | | | 0/1 | 3672.96 | 7012.01 | 10351.07 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | small | | -0.11 | 0.11 | | | 0/1 | -6540.62 | -3270.31 | 0.00 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | sport | | 0.00 | 0.14 | | | 0/1 | -3937.63 | 39.77 | 4017.18 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | SUV | | 0.39 | 0.17 | | | 0/1 | 6434.14 | 11460.81 | 16487.49 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | SUV | | 0.36 | 0.21 | | | 0/1 | 4440.53 | 10694.80 | 16949.06 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | SUV | | 0.26 | 0.15 | | | 0/1 | 3231.25 | 7719.11 | 12206.96 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | SUV | | 0.10 | 0.18 | | | 0/1 | -2381.62 | 2910.87 | 8203.36 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | SUV | | 0.40 | 0.12 | | | 0/1 | 8194.71 | 11667.05 | 15139.39 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | SUV | | 0.27 | 0.16 | | | 0/1 | 3351.80 | 8072.66 | 12793.51 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | truck | | 0.03 | 0.16 | | | 0/1 | -3905.71 | 857.35 | 5620.41 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | truck | | -0.10 | 0.18 | | | 0/1 | -8199.13 | -2943.28 | 2312.58 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | van | | 0.00 | -0.28 | | | 0/1 | -8421.19 | -83.38 | 8254.44 | varied income |
| Hess | Fowler | 2012 | Transportmetrica | RP & SP | 2009 | NMNL | van | | -0.55 | 0.28 | | | 0/1 | -24391.33 | -16233.70 | -8076.06 | varied income |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | large | | -0.46 | 0.17 | 1.18 | 0.27 | 0/1 | -29862.45 | -8399.89 | 13062.68 | random coef. |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | small | | -2.98 | 0.23 | 1.94 | 0.31 | 0/1 | -89256.65 | -54128.45 | -19000.25 | random coef. |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | small | | -1.33 | 0.17 | 1.12 | 0.29 | 0/1 | -44374.10 | -24057.33 | -3740.56 | random coef. |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | SUV | | -0.80 | 0.16 | 0.76 | 0.28 | 0/1 | -28197.03 | -14443.62 | -690.21 | random coef. |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | SUV | | -0.16 | 0.24 | 1.58 | 0.41 | 0/1 | -31574.35 | -2898.01 | 25778.32 | random coef. |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | SUV | | 0.33 | 0.15 | 0.78 | 0.33 | 0/1 | -8102.59 | 6010.79 | 20124.18 | random coef. |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | truck | | -1.29 | 0.18 | 1.04 | 0.28 | 0/1 | -42243.60 | -23404.23 | -4564.87 | random coef. |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | truck | | -0.77 | 0.19 | 1.59 | 0.31 | 0/1 | -42823.14 | -13995.21 | 14832.72 | random coef. |
| Hess | Train | 2006 | TR-B | SP survey | 1999 | MXL | van | | -0.48 | 0.19 | 1.50 | 0.25 | 0/1 | -35915.82 | -8688.60 | 18538.62 | random coef. |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | large | | 0.35 | 0.15 | | | 0/1 | 3097.64 | 5279.07 | 7460.50 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | midsize | | 0.31 | 0.10 | | | 0/1 | 3056.49 | 4608.00 | 6159.52 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | small | | -0.42 | 0.27 | | | 0/1 | -10301.49 | -6293.13 | -2284.77 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | small | | -0.28 | 0.16 | | | 0/1 | -6504.82 | -4130.80 | -1756.78 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | sport | | 0.75 | 0.16 | | | 0/1 | 8680.63 | 11139.73 | 13598.83 | standard error |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | station wagon | age | | | | | 0/1 | -20594.34 | -9465.79 | -6725.59 | varied interaction |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | SUV | | 0.97 | 0.15 | | | 0/1 | 12197.37 | 14435.42 | 16673.47 | standard error |

| First Author | Second Author | Pub Year | Journal | Data Type | Dollar Year | Stat Model | Attribute | Interaction | Coeff. | SE | mu | sigma | Standard Units | Low WTP | Central WTP | High WTP | Range Desc. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | truck | age | | | | | 0/1 | -21101.37 | -13048.55 | -10364.27 | varied interaction |
| Kavalec | | 1999 | Energy Journal | SP survey | 1993 | MXL | van | age | | | | | 0/1 | -38489.48 | -20146.96 | -15225.79 | varied interaction |
| McCarthy | | 1996 | RE Stat | RP survey | 1989 | MNL | luxury | | -0.49 | 0.13 | | | 0/1 | -23393.44 | -18494.81 | -13596.18 | standard error |
| McCarthy | | 1996 | RE Stat | RP survey | 1989 | MNL | sport | | -1.28 | 0.27 | | | 0/1 | -57731.49 | -47770.78 | -37810.06 | standard error |
| McCarthy | | 1996 | RE Stat | RP survey | 1989 | MNL | truck | | 1.45 | 0.30 | | | 0/1 | 43019.11 | 54055.42 | 65091.74 | standard error |
| McCarthy | Tay | 1998 | TR-E | RP survey | 1989 | NMNL | SUV | | 2.73 | 0.33 | | | 0/1 | 66959.95 | 76099.33 | 85238.71 | standard error |
| McCarthy | Tay | 1998 | TR-E | RP survey | 1989 | NMNL | truck | | 1.79 | 0.32 | | | 0/1 | 41164.92 | 49915.81 | 58666.71 | standard error |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | large | multiple | 0.00 | 0.00 | | | 0/1 | 1830.95 | 2629.16 | 2852.19 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | large | multiple | 0.00 | 0.00 | | | 0/1 | -1417.22 | -619.01 | -395.98 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | luxury | multiple | 2.18 | 0.44 | | | 0/1 | | 12114.57 | | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | luxury | multiple | 2.18 | 0.44 | | | 0/1 | | 8866.40 | | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | small | multiple | 0.00 | 0.00 | | | 0/1 | 5039.77 | 8572.17 | 11529.38 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | small | multiple | 0.00 | 0.00 | | | 0/1 | 1791.60 | 5324.00 | 8281.21 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | small | multiple | -2.14 | 0.22 | | | 0/1 | -10121.01 | -9322.80 | -9099.77 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | small | multiple | -2.14 | 0.22 | | | 0/1 | -6872.84 | -6074.63 | -5851.60 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | small | multiple | -1.96 | 0.22 | | | 0/1 | -5383.20 | -1850.80 | 1106.41 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | small | multiple | -1.96 | 0.22 | | | 0/1 | -2135.03 | 1397.37 | 4354.58 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | SUV | multiple | -1.38 | 0.21 | | | 0/1 | 1652.26 | 4386.44 | 7120.63 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | SUV | multiple | -1.38 | 0.21 | | | 0/1 | -1595.91 | 1138.27 | 3872.46 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | truck | multiple | 0.00 | 0.00 | | | 0/1 | -7242.00 | -4634.23 | -2026.45 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | truck | multiple | 0.00 | 0.00 | | | 0/1 | -3993.83 | -1386.06 | 1221.71 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | van | multiple | 0.00 | 0.00 | | | 0/1 | 5317.16 | 6005.98 | 6694.81 | varied interaction |
| Musti | Kockelman | 2011 | TR-A | SP survey | 2009 | MNL | van | multiple | 0.00 | 0.00 | | | 0/1 | 2068.99 | 2757.82 | 3446.64 | varied interaction |
| Shiau | Michalek | 2009 | TR-A | market data | 2007 | MXL | large | | 0.10 | 0.00 | | | 0/1 | 1204.73 | 1217.03 | 1229.33 | standard error |
| Shiau | Michalek | 2009 | TR-A | market data | 2007 | MXL | luxury | | 0.56 | 0.00 | | | 0/1 | 6963.92 | 6988.51 | 7013.10 | standard error |
| Shiau | Michalek | 2009 | TR-A | market data | 2007 | MXL | small | | 0.03 | 0.00 | | | 0/1 | 301.37 | 313.67 | 325.96 | standard error |
| Shiau | Michalek | 2009 | TR-A | market data | 2007 | MXL | small | | -0.12 | 0.00 | | | 0/1 | -1580.38 | -1555.79 | -1531.20 | standard error |
| Shiau | Michalek | 2009 | TR-A | market data | 2007 | MXL | sport | | 0.11 | 0.00 | | | 0/1 | 1355.80 | 1392.68 | 1429.57 | standard error |
| Shiau | Michalek | 2009 | TR-A | market data | 2007 | MXL | two-seater | | -0.77 | 0.00 | | | 0/1 | -9647.40 | -9598.22 | -9549.04 | standard error |
| Skerlos | Raichur | 2013 | Grey | market data | 2008 | MXL | sport | | -0.30 | 0.38 | | | 0/1 | -4041.46 | -1783.00 | 475.47 | standard error |
| Skerlos | Raichur | 2013 | Grey | market data | 2008 | MXL | SUV | nochildren | -0.05 | 0.34 | | | 0/1 | -2317.90 | -297.17 | 1723.56 | standard error |
| Skerlos | Raichur | 2013 | Grey | market data | 2008 | MXL | SUV | children | 0.44 | 0.05 | | | 0/1 | 0.00 | 2317.90 | 4635.79 | standard error |
| Skerlos | Raichur | 2013 | Grey | market data | 2008 | MXL | truck | rural | 1.11 | 0.06 | | | 0/1 | -4338.63 | -416.03 | 3506.56 | standard error |
| Skerlos | Raichur | 2013 | Grey | market data | 2008 | MXL | truck | urban | -1.18 | 0.60 | | | 0/1 | -10579.12 | -7013.12 | -3447.13 | standard error |
| Skerlos | Raichur | 2013 | Grey | market data | 2008 | MXL | van | children | 0.89 | 0.14 | | | 0/1 | -12718.72 | -8796.12 | -4873.53 | standard error |
| Skerlos | Raichur | 2013 | Grey | market data | 2008 | MXL | van | nochildren | -2.37 | 0.52 | | | 0/1 | -17176.21 | -14085.68 | -10995.15 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | large | | 0.38 | 0.10 | | | 0/1 | 9596.64 | 13099.06 | 16601.48 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | large | | -0.17 | 0.14 | | | 0/1 | -10558.57 | -5865.87 | -1173.17 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | luxury | | 0.56 | 0.06 | | | 0/1 | 17344.93 | 19395.15 | 21445.38 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | small | | -0.11 | 0.06 | | | 0/1 | -5870.70 | -3781.49 | -1692.27 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | small | | -0.64 | 0.10 | | | 0/1 | -25454.82 | -22123.04 | -18791.26 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | SUV | | 0.12 | 0.12 | | | 0/1 | -127.76 | 4130.97 | 8389.70 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | SUV | | 0.44 | 0.10 | | | 0/1 | 11652.64 | 15271.48 | 18890.31 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | SUV | | 0.33 | 0.09 | | | 0/1 | 8011.08 | 11241.36 | 14471.63 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | SUV | | 0.74 | 0.09 | | | 0/1 | 22216.62 | 25404.08 | 28591.54 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | van | | -0.34 | 0.11 | | | 0/1 | -15443.37 | -11676.69 | -7910.02 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | van | | -0.61 | 0.13 | | | 0/1 | -25459.88 | -21077.80 | -16695.72 | standard error |
| Tompkins | Bunch | 1998 | UC ITS | SP survey | 1995 | MNL | truck | | -0.64 | 0.07 | | | 0/1 | -24691.18 | -22202.15 | -19713.12 | standard error |
| Train | Winston | 2007 | Int. Econ. Rev. | RP survey | 2000 | MXL | luxury | leased | 0.61 | 0.75 | | | 0/1 | 6813.61 | 7674.82 | 21900.77 | standard error |
| Train | Winston | 2007 | Int. Econ. Rev. | RP survey | 2000 | MXL | SUV | children | 2.80 | 0.90 | | | 0/1 | 40585.50 | 50384.63 | 76537.37 | standard error |
| Train | Winston | 2007 | Int. Econ. Rev. | RP survey | 2000 | MXL | truck | | | | 0.07 | 6.85 | 0/1 | -94249.92 | 1060.50 | 96370.93 | random coef. |
| Train | Winston | 2007 | Int. Econ. Rev. | RP survey | 2000 | MXL | van | children | 2.11 | 0.88 | | | 0/1 | 6965.98 | 14022.23 | 37639.06 | standard error |
| Whitefoot | Fowlie | 2011 | Grey | market data | 2006 | BLP | sport | | -0.47 | 0.31 | | | 0/1 | -1977.30 | -1191.95 | -406.60 | varied income |
| Whitefoot | Fowlie | 2011 | Grey | market data | 2006 | BLP | SUV | | 1.09 | 0.25 | | | 0/1 | 1176.92 | 1708.02 | 2239.11 | varied income |
| Zhang | Gensler | 2011 | J. Product Innov. Mgmt. | SP survey | 2010 | MXL | sedan | | 0.55 | | 0.55 | 0.92 | 0/1 | -2705.52 | 4209.26 | 11124.04 | random coef. |
| Zhang | Gensler | 2011 | J. Product Innov. Mgmt. | SP survey | 2010 | MXL | SUV | | 0.05 | | 0.05 | 2.14 | 0/1 | -15650.79 | 382.66 | 16416.12 | random coef. |
| Whitefoot | Fowlie | 2011 | Grey | market data | 2006 | BLP | truck | | 0.04 | 0.31 | | | 0/1 | -492.70 | 112.69 | 718.08 | varied income |
| Whitefoot | Fowlie | 2011 | Grey | market data | 2006 | BLP | van | | 1.28 | 0.30 | | | 0/1 | -9203.53 | -14034.57 | -13273.56 | varied income |

## APPENDIX C:
## DISCUSSION OF THE POTENTIAL BIAS FROM ESTIMATING WTP FROM RATIOS OF ATTRIBUTE AND PRICE DERIVATIVES

Our general method for estimating the willingness to pay for an attribute is to divide the derivative of the utility function with respect to the quantity of the attribute by the derivative with respect to the price of a vehicle, and reversing the sign. Typically, the derivatives are linear functions of the parameter estimates, so that the expected values of the derivative functions are functions of the expected values of the estimated coefficients. In the case of mixed logit models (MXL), the coefficients are assumed to be random variables with the variance representing heterogeneity of preferences across the population. In the case of fixed coefficient models like multinomial logit (MNL) or nested multinomial logit (NMNL), the coefficient estimates are random variables with the variance representing the uncertainty of estimation from a sample. In either case, our method requires calculating the ratio of two random variables or functions of random variables. It is important to know whether that ratio is a good or a poor estimate of the central tendency of preferences in the population.

It is also useful to describe the uncertainty associated with WTP estimates. In the case of MNL or NMNL models, the standard errors of the coefficient estimates provide a basis for characterizing their uncertainty. In the case of MXL models, the standard deviations of random parameter estimates are intended to describe the heterogeneity of preferences in the sample population. In either case, estimating a confidence interval for a WTP estimate would require estimating the variance of a ratio of random variables. In general, published articles do not provide sufficient information to calculate valid estimates of the variance of WTP estimates. Rather than providing no information on uncertainty or heterogeneity, we provide ranges of uncertainty based on the variance of the estimated attribute coefficient *conditional* on specific values of the price derivative. While this method is less than ideal, until authors routinely provide the covariances of coefficient estimates or simulated distributions of WTP estimates, we believe it is preferable to no description of uncertainty.

In general, the expected value of the ratio of two random variables, is not equal to the ratio of their expected values, $E(\alpha/\beta) \neq \rho = E(\alpha)/E(\beta) = \mu_\alpha/\mu_\beta$. Since $\alpha/\beta$ is undefined at $\beta = 0$, $E(\alpha/\beta)$ is also undefined if there is probability density > 0 at $\beta = 0$. Although many methods of estimating price coefficients allow finite probability density at $\beta = 0$, it can be neglected for practical purposes.[17]

The ratio of two random variables is a non-linear function. A widely used approach to estimate non-linear functions of random variables is the delta method. The delta method approximates a non-linear function of random variables by means of Taylor series expansions. It can be shown that the ratio of expected values, $\rho$, is a *first* order Taylor Series expansion estimate of $\rho$. However, $\rho$ is a biased estimate of $E(\alpha/\beta)$ in general even if the covariance of $\alpha$ and $\beta$ is zero. The second order Taylor Series expansion of $E(\alpha/\beta)$ is usually preferred because it includes an estimate of the bias of $\rho$.

Define $VAR(\alpha) = \sigma_\alpha^2$, $VAR(\beta) = \sigma_\beta^2$ and $Cov(\alpha,\beta) = \sigma_{\alpha\beta}$, then

$$E\left({}^{\alpha}/_{\beta}\right) \approx \rho + \frac{1}{[E(\beta)]^2}\left(\rho\sigma_\beta^2 - \sigma_{\alpha\beta}\right) \qquad \text{(C-1)}$$

Unfortunately, in studies basing calculations on the information available in the literature, it is rarely possible to use the second order approximation because although almost all journal articles provide standard errors for estimated coefficients, hardly any provide estimated covariances of parameter estimates. Only one of the studies in our main sample provided covariances, and only the variance-covariance matrix of the logarithms of the coefficient estimates was provided.

Because lack of information prevents use of the second order approximation we rely on the first order approximation to calculate our WTP values. However, below we incorporate reasonable values into a second order approximation for a specific example in this Appendix to illustrate the likely magnitude of bias caused by using the first order approximation for estimating WTP from discrete choice models.

We can get a sense of how large the bias of $\alpha/\beta$ might be by substituting estimated coefficient values and standard errors for the population values in Equation C-1. First, consider the case of fixed coefficient MNL or NMNL models where the randomness of $\alpha$ and $\beta$ are a result of estimation uncertainty. If the coefficients are statistically significant, then their standard

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[17] MXL models sometimes assume a log-normal distribution for the price coefficient to avoid this potential problem. In a simple MNL model, the price elasticity of choice of vehicle type i, $\eta_i$, is given by the following equation:

$$\eta_i = \beta P_i(1 - s_i)$$

where $P_i$ is vehicle price and $s_i$ is market share or choice probability. As a general rule, prices are on the order of $10^4$, $s << 1$, and $\eta$ is on the order of $10^0$ (new vehicle prices in recent decades are tens of thousands of dollars and elasticities typically range from about -5 to -2). As a result, typical values for $\beta$ when price is measured in dollars are on the order of -0.0001.

errors will be half and more frequently less than half of the value of the coefficient. This implies that $\sigma_\alpha \leq \alpha/2$ and $\sigma_\beta \leq |\beta|/2$. The covariance of two coefficient estimates is a function of their correlation, $0 \leq c \leq 1$.

$$Cov(\alpha, \beta) = c_{\alpha\beta}\sigma_\alpha\sigma_\beta \tag{C-2}$$

Substituting these relationships into Equation C-1, we get the following approximation of the maximum bias for statistically significant coefficients.

$$\mathrm{E}\left({}^{\alpha}/_{\beta}\right) \approx \frac{\mu_\alpha}{\mu_\beta}\left[1 + \frac{1}{4}\left(1 - c_{\alpha\beta}\right)\right] \tag{C-3}$$

Equation C-3 implies that for uncorrelated coefficient estimates the bias will be smaller than one fourth of the ratio of the coefficients and that the bias will disappear as the correlation between coefficient estimates increases. For two coefficients with t-statistics of about 3.3, with a correlation coefficient of 0.5, the bias would be about 5%.

For mixed logit models the bias is less easily bounded and could be important. In many mixed logit models, the price coefficient is not assumed to be randomly distributed. In such models, the uncertainty in the price derivative arises from estimation uncertainty while the uncertainty in the attribute derivative arises from preference heterogeneity, as well as estimation uncertainty. Assuming that the price coefficient is statistically significant, we again have $\sigma_\beta \leq |\beta|/2$. In that case, Equation C-1 becomes approximately the following.

$$E\left({}^{\alpha}/_{\beta}\right) \approx \frac{\mu_\alpha}{\mu_\beta} + \frac{1}{4}\frac{\mu_\alpha}{\mu_\beta} - c_{\alpha\beta}\frac{\sigma_\alpha}{2|\beta|} \tag{C-4}$$

As Equation C-4 shows, it is not possible to make meaningful statements about the importance of the bias term without knowing the correlation, or covariance, of the attribute and price coefficients. Clearly, when the coefficients are uncorrelated, the bias will be approximately one fourth or less of the ratio of the expected values. But when the coefficients are correlated one cannot even know whether the bias is greater or less than that amount without knowing the covariance. A partial correction excluding the term that includes the covariance could increase or decrease the bias. When the price coefficient is itself randomly distributed across the population, it is even more difficult to make statements about the size of bias. For many MXL models, the only way to obtain valid estimates of the expected value of WTP for attributes is via a simulation using the data set on which the model was estimated. The lack of availability of variance-covariance matrices for all models from all the authors make performing such calculations infeasible. Because of this, we calculate the ratios of the attribute and price derivatives using mean values but caution that the resulting WTP estimates contain an unknown bias.

One of the studies in our main sample, Nixon and Saphores, 2011, provided a variance-covariance matrix for the four random parameters of its mixed logit model of alternative fuel vehicle choice. Unfortunately, the variances and covariances are for the logarithms of the lognormally distributed coefficients and not for the coefficients themselves. Recovering the means, medians and variances of the lognormal coefficients is straightforward but untangling the covariances, unfortunately, is not. Fortunately, Nixon and Saphores report the results of a model simulation consisting of 500,000 draws repeated 100 times, by which they estimated trade-offs between vehicle price and three other vehicle attributes. They state, "We chose to report the median trade-off because it is less sensitive than the mean to large values in the tail of a lognormal distribution" (Nixon and Saphores, 2011, p. 32). They estimated that a $1,000 increase in the price difference between an AFV and a conventional vehicle corresponded to a $300 increase in annual fuel savings, a 17.5 mile increase in vehicle range, and 7.8 minute reduction in refueling time. Converting their reported coefficients to the median of the corresponding lognormal distribution (median = exp(coefficient)) and taking simple ratios of the resulting values produced estimates of $295 per year in fuel costs, 17.5 miles of range and 7.5 minutes of refueling time. The implied biases are 1.7%, 0% and 3.8% of the simulated values, respectively. While this is only one example, it gives us some confidence that our use of the ratio of medians in MXL models with lognormal coefficients may produce useful indicators of the central tendency of WTP for vehicle attributes in these models.

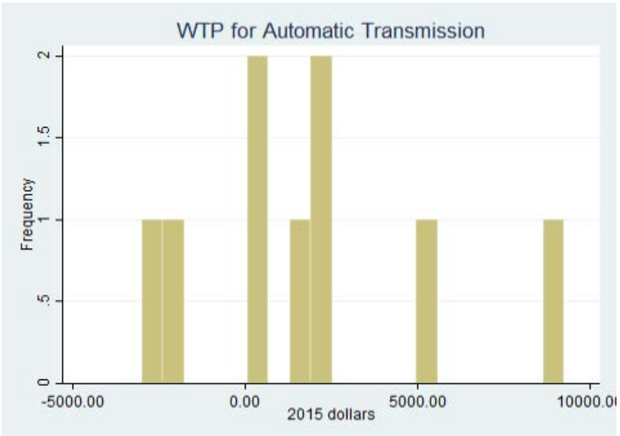
The uncertainty or heterogeneity of WTP estimates depends on the variance of the ratio of the derivatives with respect to the attribute in question and vehicle price, both of which are random variables. Let a and b be estimates of the population parameters $\alpha$ and $\beta$. The second order approximation to the variance of a/b is given by Equation C-5.

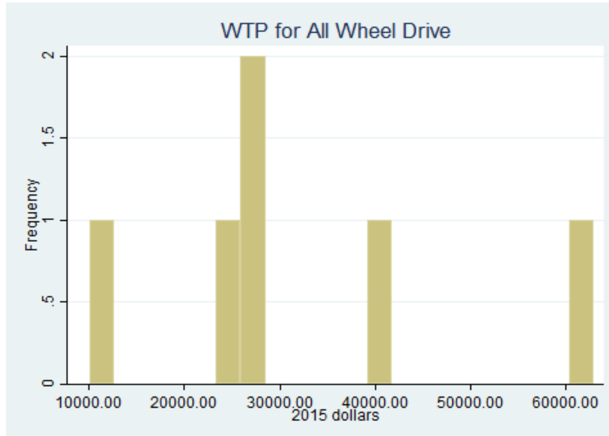
$$V\left(\frac{a}{b}\right) = \frac{\sigma_\alpha^2 + \left(\frac{\alpha}{\beta}\right)^2 \sigma_\beta^2 - 2\left(\frac{\alpha}{\beta}\right)\sigma_{\alpha\beta}}{\beta^2} \tag{C-5}$$

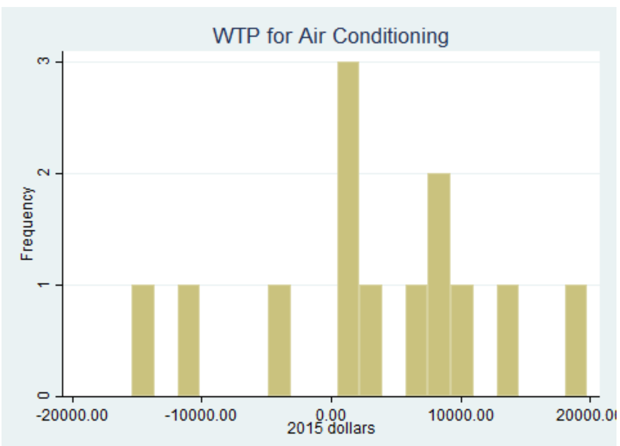
Unfortunately, in general, Equation C-5 cannot be calculated because the covariance of a and b is almost never provided. Omitting the term in the numerator involving the covariance would be as likely to increase bias as to decrease it. Instead, we provide an uncertainty or heterogeneity interval conditional on the value of the price derivative. This is not a confidence interval for WTP. The confidence interval could be larger or smaller, depending in large part on whether the coefficient estimates in the cases of MNL or NMNL models, or population preference distributions in the case of MXL models, are correlated positively or negatively. We acknowledge that such conditional uncertainty intervals are less than ideal, yet we believe they are preferable to providing no indication of uncertainty. In the future, we encourage researchers to routinely calculate WTP measures for vehicle choice models and to provide accurate confidence intervals for the WTP measures.

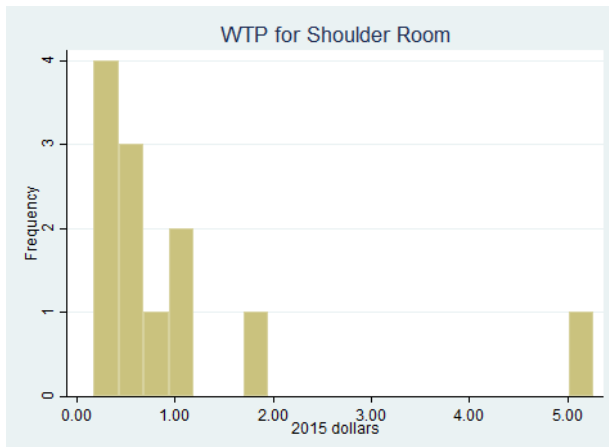
# APPENDIX D:
# HISTOGRAMS OF UNTRIMMED CENTRAL WTP ESTIMATES BY ATTRIBUTE

## Comfort

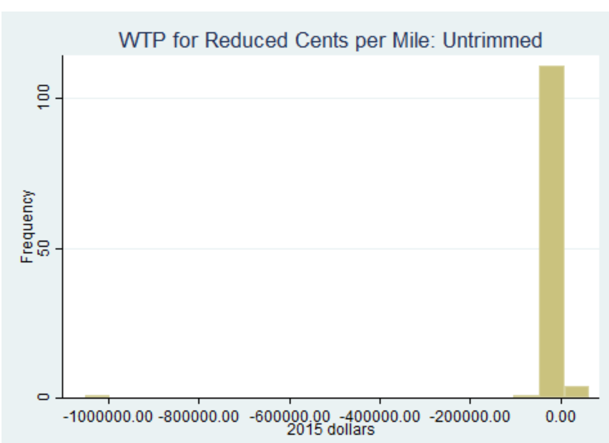


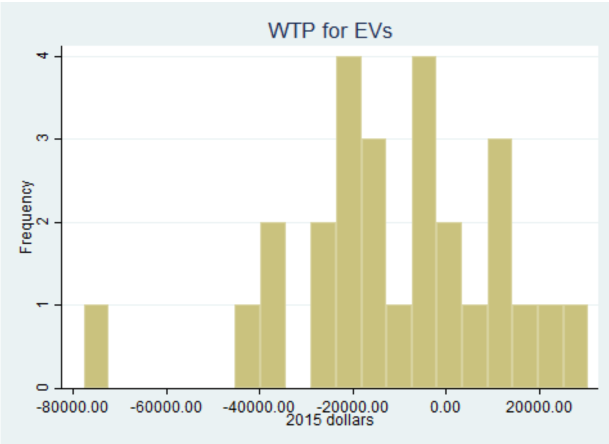



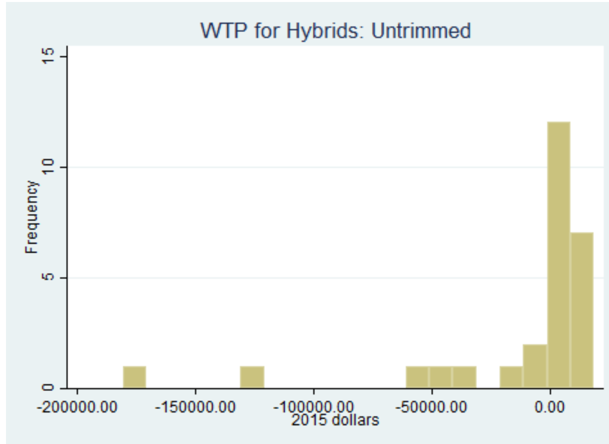



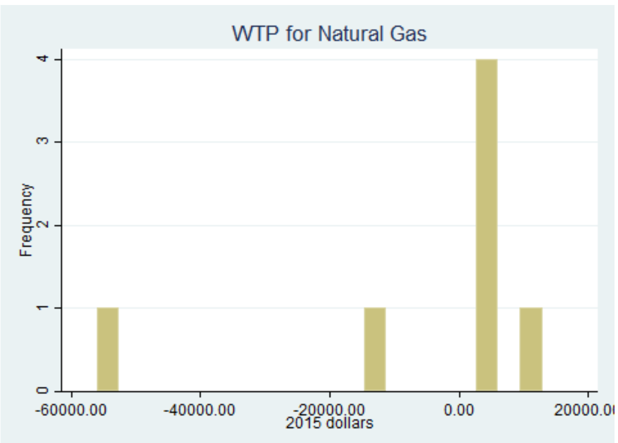

## Fuel Cost

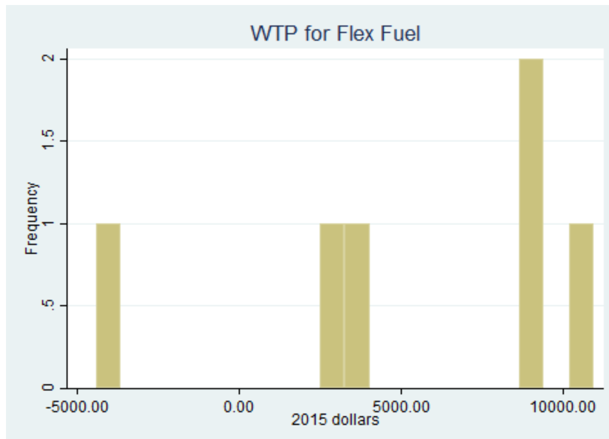


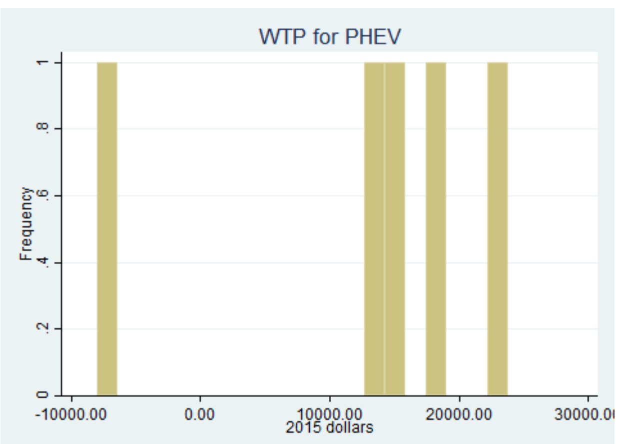
## Fuel Type


WTP for EVs
Frequency
0
1
2
3
4
-80000.00
-60000.00
-40000.00
-20000.00
0.00
20000.00
2015 dollars

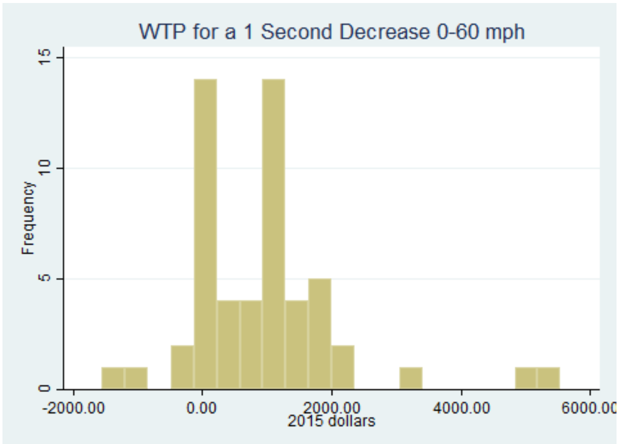

WTP for Hybrids: Untrimmed
Frequency
0
5
10
15
-200000.00
-150000.00
-100000.00
-50000.00
0.00
2015 dollars

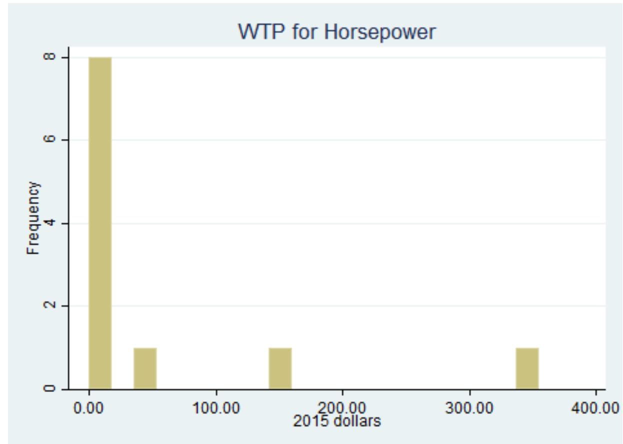

WTP for Natural Gas
Frequency
0
1
2
3
4
-60000.00
-40000.00
-20000.00
0.00
2015 dollars


WTP for Flex Fuel
Frequency
0
.5
1
1.5
2
-5000.00
0.00
5000.00
10000.00
2015 dollars

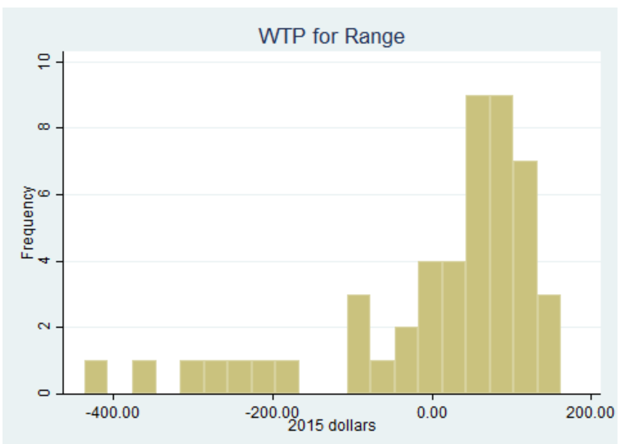

WTP for PHEV
Frequency
0
.2
.4
.6
.8
1
-10000.00
0.00
10000.00
20000.00
2015 dollars

## Performance

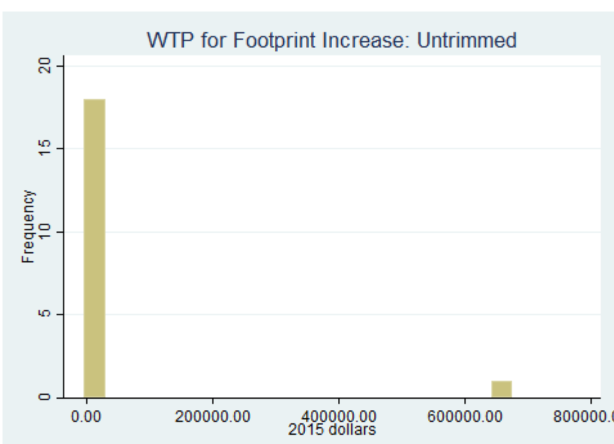


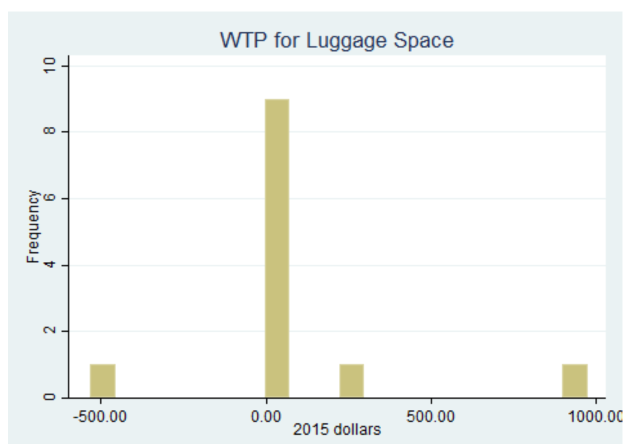




## Range



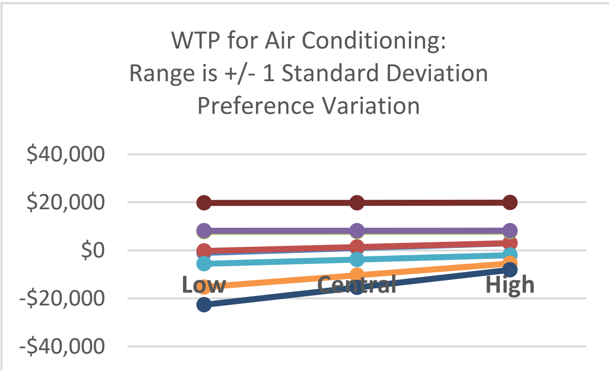

## Size

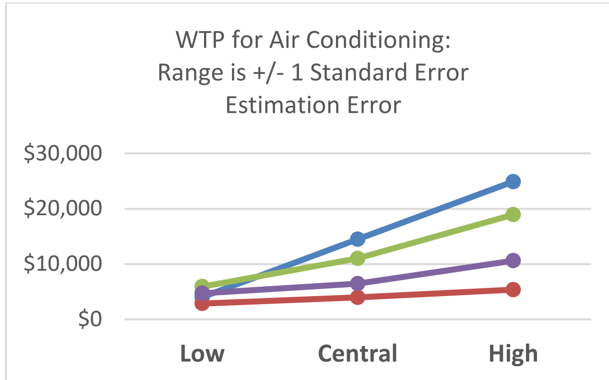


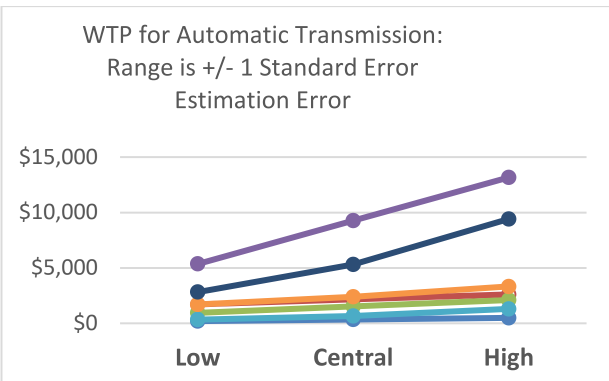



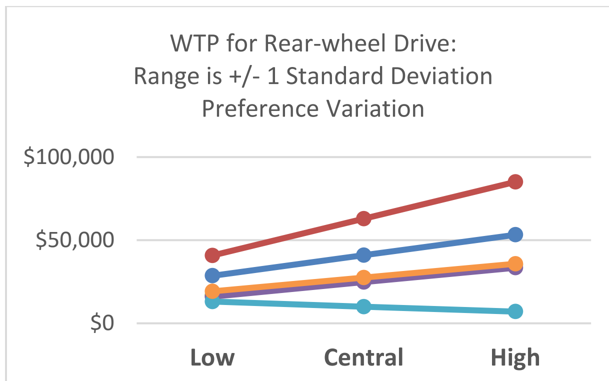
# APPENDIX E:
# UNTRIMMED DISTRIBUTIONS OF CENTRAL WTP ESTIMATES BY ATTRIBUTE

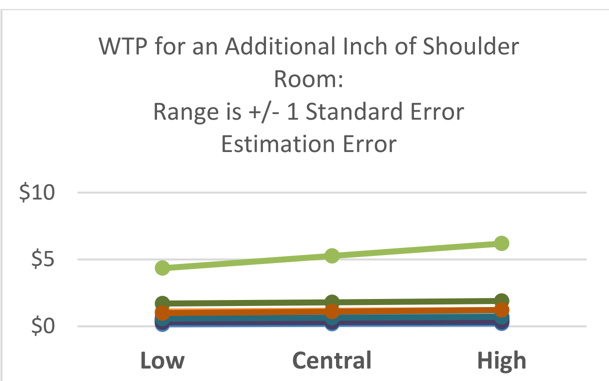
## Comfort



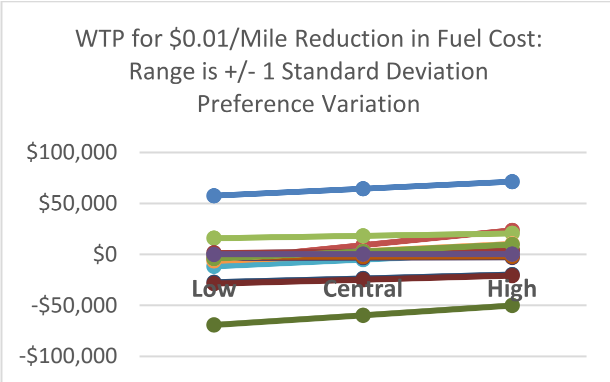



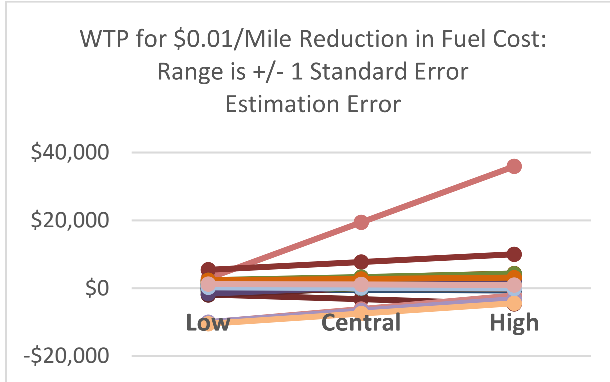



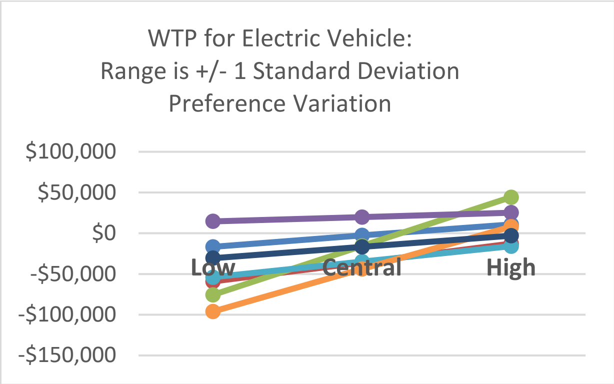



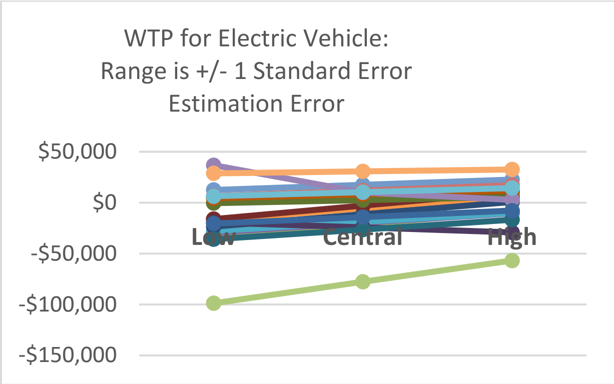
## Fuel Costs

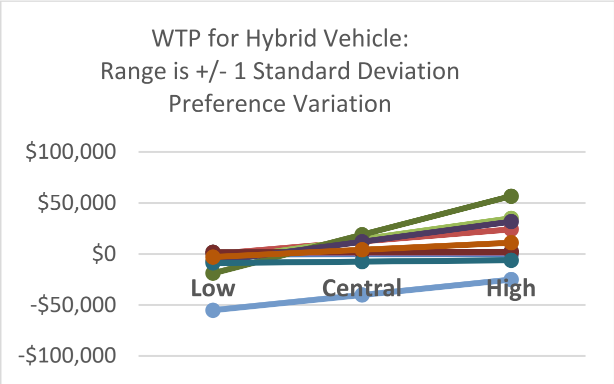

WTP for $0.01/Mile Reduction in Fuel Cost:
Range is +/- 1 Standard Deviation
Preference Variation
$100,000
$50,000
$0
-$50,000
-$100,000
Low
Central
High

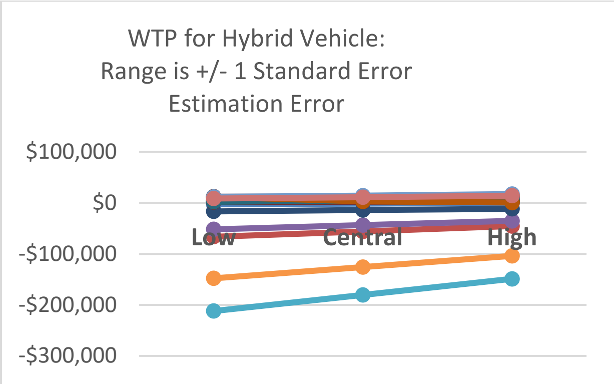

WTP for $0.01/Mile Reduction in Fuel Cost:
Range is +/- 1 Standard Error
Estimation Error
$40,000
$20,000
$0
-$20,000
Low
Central
High

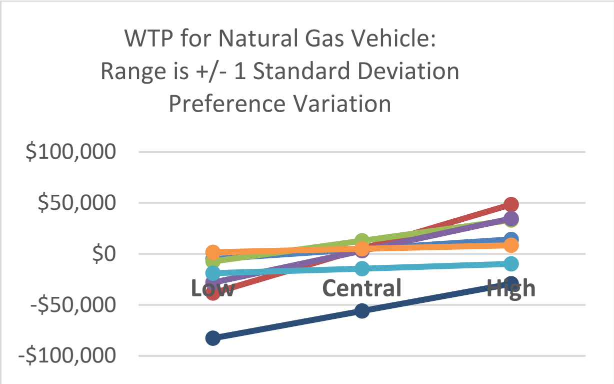
## Fuel Type


WTP for Electric Vehicle:
Range is +/- 1 Standard Deviation
Preference Variation
$100,000
$50,000
$0
-$50,000
-$100,000
-$150,000
Low
Central
High

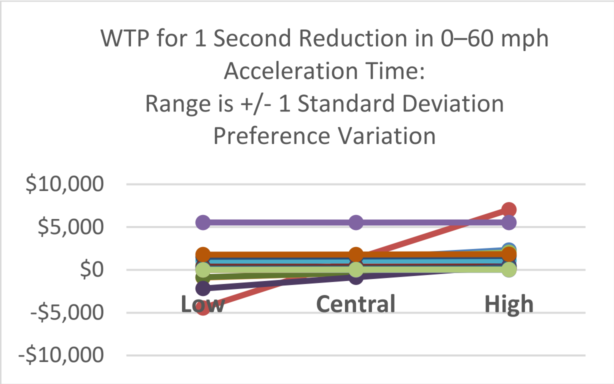

WTP for Electric Vehicle:
Range is +/- 1 Standard Error
Estimation Error
$50,000
$0
-$50,000
-$100,000
-$150,000
Low
Central
High

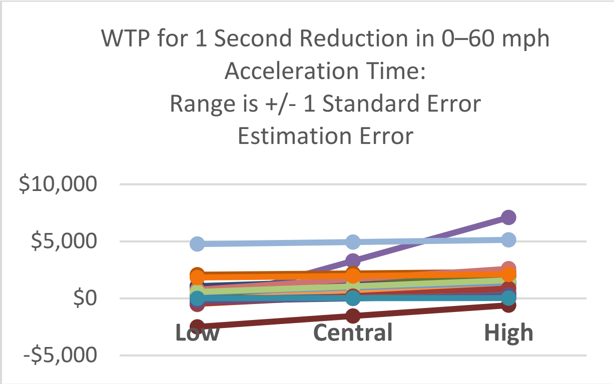

WTP for Hybrid Vehicle:
Range is +/- 1 Standard Deviation
Preference Variation
$100,000
$50,000
$0
-$50,000
-$100,000
Low
Central
High

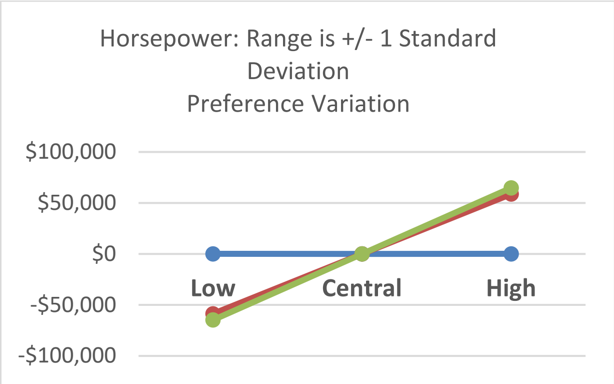

WTP for Hybrid Vehicle:
Range is +/- 1 Standard Error
Estimation Error
$100,000
$0
-$100,000
-$200,000
-$300,000
Low
Central
High

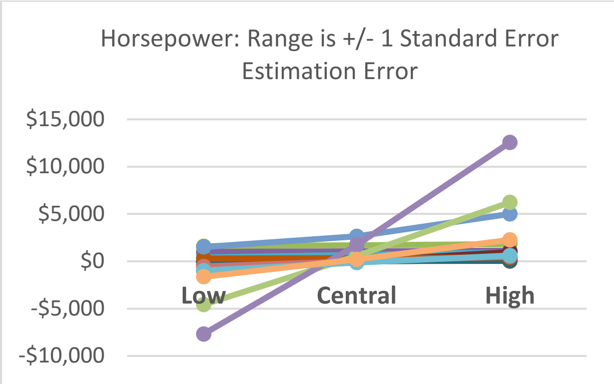

WTP for Natural Gas Vehicle:
Range is +/- 1 Standard Deviation
Preference Variation
$100,000
$50,000
$0
-$50,000
-$100,000
Low
Central
High

## Performance

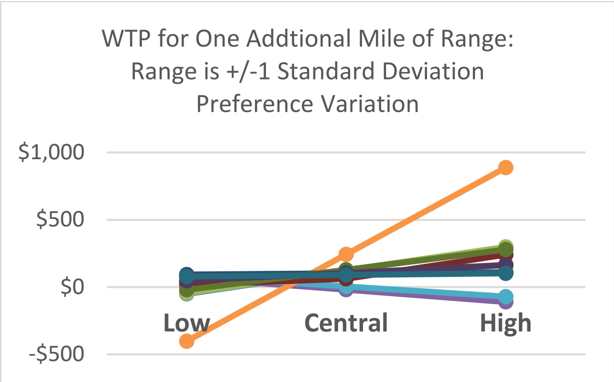


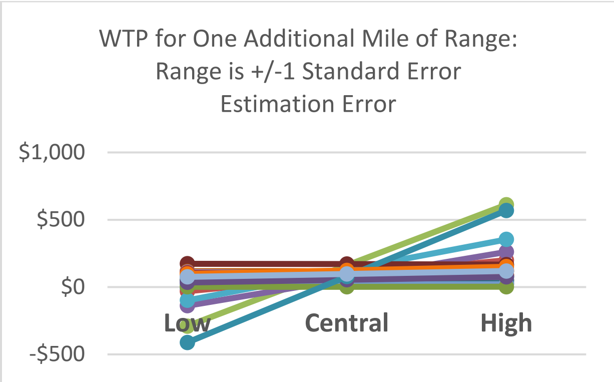



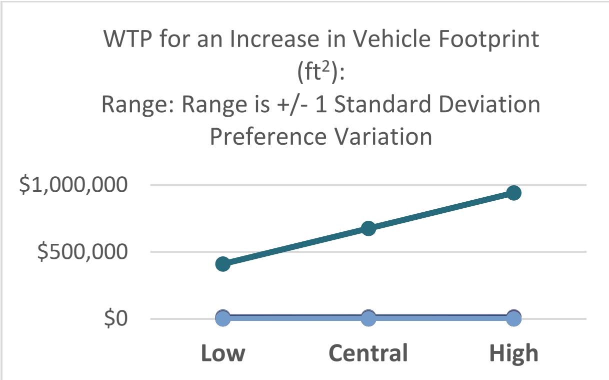



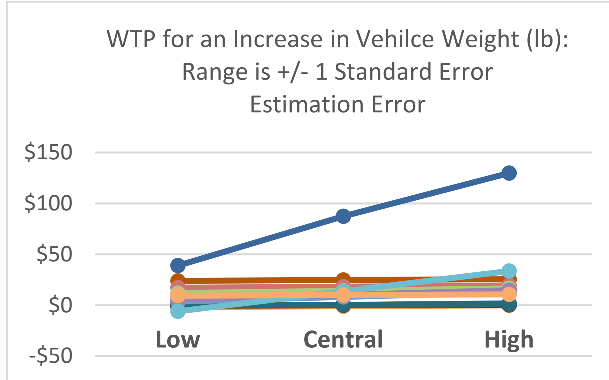

## Range

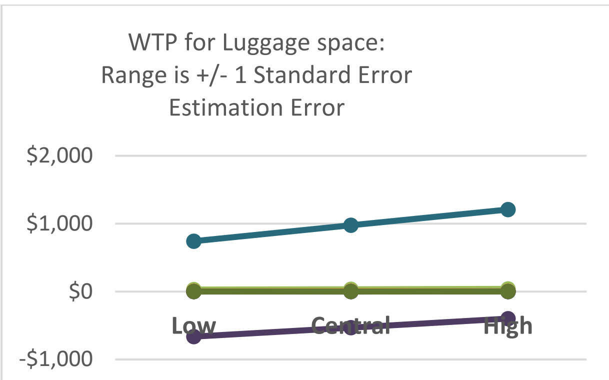


## Size


WTP for an Increase in Vehicle Footprint ($ft^2$):
Range: Range is +/- 1 Standard Deviation Preference Variation
$1,000,000
$500,000
$0
Low
Central
High


WTP for an Increase in Vehilce Weight (lb):
Range is +/- 1 Standard Error Estimation Error
$150
$100
$50
$0
-$50
Low
Central
High


WTP for Luggage space:
Range is +/- 1 Standard Error Estimation Error
$2,000
$1,000
$0
-$1,000
Low
Central
High

## APPENDIX F:
## AUTHOR FEEDBACK RECEIVED AND RESPONSE TO COMMENTS

There are a number of steps required to calculate WTP estimates from many of the papers in the literature that do not report those values directly. In many cases, it is necessary to make assumptions regarding the details of the calculations made by the authors where they are not fully specified in the literature, which is common given limitations on journal paper length. In this project, we made an effort to contact authors of each of the papers included in our sample via email. We contacted the corresponding author where possible, but contact information on some of the publications was out of date. In that case, we attempted to find updated contact information for each corresponding author. In cases where we could not find their current contact information, we reached out to the other authors of the paper for multi-authored studies. We asked each of the authors contacted to review our WTP calculations for their publication(s) (some authors were involved in multiple papers included within our main sample). There were cases where neither the corresponding author nor coauthors responded to the initial or follow-up requests for feedback. Table F-1 summarizes the outcome of our request, comments received, and actions that we took in response.

## Table F-1. Summary of Author Feedback Received and Response to Comments

| Paper | Contacted | Responded | Provided Comments | Comments | Response |
|---|---|---|---|---|---|
| Allcott and Wozny (2014) | Yes | Yes | Yes | No adjustments suggested | NA |
| Axsen, Mountain, and Jaccard (2009) | Yes | Yes | Yes | No adjustments suggested, provided more recent papers with WTP coefficients | NA |
| Beresteanu and Li (2011) | Yes | Yes | No | Indicated they would try to provide feedback, but we did not receive any | NA |
| Berry, Levinsohn, and Pakes (1995) | Yes | No | No | NA | NA |
| Brownstone and Train (1998) | Yes | Yes | Yes | Notes that this paper was primarily methodological rather than focused on parameter estimation and recommends Brownstone, Bunch and Train as preferred source of WTP estimates among their papers | NA |
| Brownstone, Bunch, and Train (2000) | Yes | Yes | Yes | No adjustments suggested; identified this paper as preferred source of estimates among their papers | NA |
| Brownstone et al. (1996) | Yes | Yes | Yes | No adjustments suggested | NA |
| Busse, Knittel, and Zettelmeyer (2013) | Yes | Yes | Yes | Provided suggested modifications to our spreadsheet calculations | Adjusted calculations |
| Dasgupta, Siddarth, and Silva-Risso (2007) | Yes | No | No | NA | NA |
| Daziano (2013) | Yes | Yes | Yes | Provided suggested modifications to our spreadsheet calculations | Adjusted calculations |
| Dreyfus and Viscusi (1995) | Yes | Yes | Yes | Verified that the values used from their study were correct, but did not find the WTP calculations sufficiently transparent to check | NA |
| Espey and Nair (2005) | Yes | Yes | Yes | No adjustments suggested | NA |
| Fan and Rubin (2010) | Yes | Yes | Yes | Provided suggested modifications to our spreadsheet calculations | Adjusted calculations |
| Feng, Fullerton, and Gan (2013) | Yes | Yes | No | Indicated they did not have time to complete the review | NA |
| Fifer and Bunn (2009) | No contact information identified | NA | No | NA | NA |
| Frischknecht, Whitefoot, and Papalambros (2010) | Yes | Yes | Yes | Provided numerous comments suggesting modifications to our calculations as well as suggesting that we use Monte Carlo simulations to generate distributions around our WTP estimates | Adjusted calculations to the extent possible, though some were not feasible due to lack of data and/or project resources, e.g., conducting Monte Carlo simulations for parameter data from all papers |
| Gallagher and Muehlegger (2011) | Yes | Yes | Yes | Provided some caveats to the calculations, but agreed they were correct overall | NA |
| Goldberg (1995) | Yes | Yes | Yes | Suggested that we review units and calculations | Reviewed calculations and determined that they were consistent with the descriptions in the 1995 paper so we made no adjustments |
| Gramlich (2008) | Yes | Yes | Yes | Raised questions about the sign of the WTP estimates we were calculating and suggested we review units | Adjusted calculations |
| Greene (2001) | Yes | Yes | NA | NA, author is involved in this project | NA |
| Greene, Duleep, and McManus (2004) | Yes | Yes | NA | NA, author is involved in this project | NA |
| Haaf et al. (2014) | Yes | Yes | Yes | Provided a corrected supplement to their paper and suggested modifications to our spreadsheet calculations | Adjusted calculations |
| Helveston et al. (2015) | Yes | Yes | Yes | Noted sign of a parameter was incorrect in their published paper so suggested adjustment for that as well as updating our assumption regarding gasoline price to align with their assumption; suggested more discussion of uncertainty and heterogeneity and more information on our methods and interpretation | Adjusted calculations; added more discussion in the report as suggested |

(continued)

## Table F-1. Summary of Author Feedback Received and Response to Comments (continued)

| Paper | Contacted | Responded | Provided Comments | Comments | Response |
|---|---|---|---|---|---|
| Hess, Train, and Polak (2006) | Yes | Yes | Yes | Asked about methods for calculating WTP, but no adjustments suggested | NA |
| Hess et al. (2011) | Yes | Yes | Yes | Asked about methods for calculating WTP, but no adjustments suggested | NA |
| Hidrue et al. (2011) | Yes | Yes | Yes | Provided suggested modifications to our spreadsheet calculations | Adjusted calculations |
| Kavalec (1999) | No contact information identified | NA | No | NA | NA |
| Klier and Linn (2012) | Yes | Yes | Yes | Suggested that we use delta method for deriving standard errors and asked us to focus on their main instrumental variables (IV) estimate | Added discussion of the rationale and potential implications of our using the ratio of random variables to estimate WTP in both the main body of the report and Appendix C; continued using the range of results reported for consistency with other papers and to show the importance of specification |
| Lave and Train (1979) | Yes | Yes | Yes | Provided suggested adjustments to our spreadsheet calculations | Adjusted calculations |
| Liu, Tremblay, and Cirillo (2014) | Yes | Yes | Yes | Indicated that WTP should be adjusted because of the income scaling used in their model | Adjusted calculations |
| Liu (2014) | No contact information identified | NA | No | NA | NA |
| McFadden and Train (2000) | Yes | Yes | Yes | Provided suggested adjustments to our spreadsheet calculations | Adjusted calculations |
| McCarthy (1996) | Yes | Yes | Yes | Requested clarification of spreadsheet calculations; no adjustments suggested | Provided clarification; no changes made to spreadsheets |
| McCarthy and Tay (1998) | Yes | Yes | Yes | Requested clarification of spreadsheet calculations; no adjustments suggested | Provided clarification; no changes made to spreadsheet |
| McManus (2007) | Yes | Yes | Yes | No adjustments suggested | NA |
| Musti and Kockelman (2011) | Yes | Yes | No | Requested additional clarification regarding the review request | NA |
| Nixon and Saphores (2011) | Yes | Yes | No | Indicated they would try to provide feedback, but we did not receive any | NA |
| Parsons et al. (2014) | Yes | Yes | Yes | Provided suggested modifications to our spreadsheet calculations | Adjusted calculations |
| Petrin (2002) | Yes | Yes | No | Requested additional clarification regarding the review request, which was provided but we did not receive review comments | NA |
| Sallee, West, and Fan (2016) | Yes | Yes | Yes | Provided suggested modifications to our spreadsheet calculations | Adjusted calculations |
| Segal (1995) | No contact information identified | NA | No | NA | NA |
| Sexton and Sexton (2014) | Yes | No | No | NA | NA |
| Shiau, Michalek, and Hendrickson (2009) | Yes | Yes | Yes | Suggested more discussion of uncertainty and heterogeneity, our use of the ratio of random variables to estimate WTP, and the interpretation of these values | Added discussion in the main body of the report and Appendix B of the rationale and potential implications of our using the ratio of random variables to estimate WTP |
| Skerlos and Raichur (2013) | Yes | No | No | NA | NA |
| Tanaka et al. (2014) | Yes | No | No | NA | NA |
| Tompkins et al. (1998) | Yes | Yes | Yes | Cautioned against using WTP values from SP models in general | NA |
| Train and Sonnier (1995) | Yes | Yes | Yes | Suggested dropping this paper from the analysis because Train and Weeks (2005) reports the same information but with the authors' calculation of WTP | NA |

(continued)

## Table F-1. Summary of Author Feedback Received and Response to Comments (continued)

| Paper | Contacted | Responded | Provided Comments | Comments | Response |
|---|---|---|---|---|---|
| Train and Weeks (2005) | Yes | Yes | Yes | Provided suggested modifications to our spreadsheet calculations | Adjusted calculations |
| Train and Winston (2007) | Yes | Yes | Yes | Provided suggested modifications to our spreadsheet calculations | Adjusted calculations |
| Walls (1996) | Yes | No | No | NA | NA |
| Whitefoot, Fowlie, and Skerlos (2011) | Yes | Yes | Yes | Provided several adjustments and expressed concern regarding the endogeneity of the attributes and the effect on WTP | Adjusted calculations |
| Zhang, Gensler, and Garcia (2011) | Yes | Yes | No | Requested additional clarification regarding the review request | NA |