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The Green Light on Buying a Car: How Consumer Decision-Making Interacts with Environmental Attributes in the New Vehicle Purchase Process

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Abstract

Although it is commonly understood that the average U.S. new vehicle buyer ranks price and safety above environmental attributes, a stated ranking of one shopping criterion above another is not necessarily maintained when consumers make an actual purchase decision. In fact, the distribution of shopping criteria rankings is not well understood, and it is unclear how rankings translate to the attributes of purchased vehicles. This raises several related questions:

- What is the distribution of shopping criteria rankings across the U.S. and how do they differ among demographic groups and purchasers of different vehicle fuel types or body styles?
- How do consumers weigh their purchase criteria?
- How does the environmental impact of a vehicle rank as a purchase criterion for U.S. new vehicle buyers, and its importance differ among gender, age, or income groups?
- Do purchase criteria differ for consumers who state that they value the environment?
- Is a consumer's shopping criteria ranking of environmental attributes reflected in the vehicles they consider and ultimately purchase?

We explore these issues using data from an extensive survey of new vehicle buyers in 2014, 2015, and 2016 (approximately 250,000 respondents per year). We broadly find the environmental criterion outranked by preference for safety and performance, but different patterns emerge

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across groups defined by household income, purchased vehicle fuel type, and other measures of respondent attitude toward the environment. Stated preferences for environmental attributes align with higher fuel economy and greater likelihood of electric or hybrid fuel type within considered and purchased vehicles.

1 Introduction

From 2004–2019, the air pollution impacts of the overall U.S. light duty vehicle (LDV) fleet improved considerably; calculations from U.S. Environmental Protection Agency data show emissions declined substantially for sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, particulate matter up to 10 microns, and carbon dioxide. This greening of the U.S. LDV fleet has taken place in the context not only of regulations addressing fuel economy and emissions, but also complex vehicle choice decisions made by a heterogeneous group of consumers, who each have different valuations of individual vehicle attributes.

Consumers select vehicles based on many attributes including vehicle features, availability, purchase price, expected cost of ownership, and available incentives. It is commonly assumed that U.S. consumers want affordable, fuel efficient, powerful, comfortable, and safe vehicles. In addition, U.S. consumers on average rank criteria like price and safety above environmental attributes. Furthermore, purchasing a vehicle is often deeply personal and emotional. Vehicles reflect and represent our personal ethos, self-perception, hobbies, lifestyle, politics, and so on, not just demographics. However, there is little consensus around the relative importance of these vehicle attributes in the purchase decision, how such rankings may differ across the broader population, and the impact of vehicle attribute criteria rankings on consumers' choice sets and eventual purchase of a vehicle. Better understanding of the distribution of shopping criteria rankings by U.S. consumers could reveal the importance of consumer heterogeneity in the greening of the U.S. fleet. Specifically, we investigated the role of the environmental attribute within the broader set of vehicle attributes that influence consumer purchase criteria for light-duty passenger vehicles. This paper aims to address the following questions:

- What is the distribution of shopping criteria rankings across the United States and how do they differ between broad demographic groups, as well as purchasers of different vehicle drive trains or body styles?
- How do consumers weigh their purchase criteria?
- How does the environmental impact of a vehicle rank as a purchase criterion for the U.S. new vehicle purchasing population, and does the importance of this criterion differ among demographic groups?
- Do purchase criteria differ for consumers who state that they value the environment?
- Are consumers' rankings of environmental attributes reflected in the vehicles they consider and ultimately purchase?

Using data from an extensive survey of U.S. new vehicle purchasers, Strategic Vision's New Vehicle Experience Study (NVES, 2014–2016), we shed light on the distribution of criteria rankings and their connections to purchase decisions. Weighted to correspond to vehicle registrations, this data set reflects the composition of the new vehicles added to U.S. household fleets in a given year, in terms of the distribution of vehicle makes and models.

When comparing the vehicles purchased and considered by respondents across vehicles types, we found that the majority (in some cases plurality) of up to three vehicles alternatively considered were of the same body style as the purchased vehicle, reinforcing the idea that many consumers fix on a body style early in their vehicle purchase decision process, and then subsequently select within body style using attribute-related criteria. To a lesser degree, we observed a similar tendency to select from alternatively considered vehicles within a fuel type or closely related fuel types (e.g., BEV and PHEV).

Based on results of Exploratory Factor Analysis (EFA) and findings from our literature review involving vehicle selection criteria, we selected ten attribute-based vehicle selection criteria, including design, performance, power, durability, safety, value, comfort, image, environment, and fuel economy. We then applied the Analytical Hierarchy Process (AHP), revealing the relative importance of those ten vehicle attribute-related criteria. We identified notable differences in the preferred order of criteria and weights across several groups of respondents, including income level, different framings of environmental attitudes, and fuel type of purchased vehicle. We also found evidence of heterogeneous patterns for weighing environment, performance, value, and durability. Recognizing that, particularly in the context of the environmental attribute, stated preferences, revealed preferences, and real-world impacts of choices and behaviors do not necessarily align [1], we also examined the fuel economy and fuel type of purchased and considered vehicles across respondents with differing AHP criteria weights. We found broad consistency between stated and revealed preferences for environment and fuel economy.

The paper proceeds in four parts. In the remainder of section 1, we define the terminology we use to describe traits of vehicles and consumers, and we summarize vehicle purchase criteria as discussed in existing literature. In section 2, we describe our data sources in detail and outline the analytical methods we use, including EFA and AHP. We present our findings in section 3 and conclude with discussion in section 4.

1.1 Terminology surrounding vehicles and consumers

Throughout this paper, we refer to traits of vehicles and of the consumers who purchase them. When discussing traits of a person, such as demographics, we use the term "characteristics." When discussing physical components of vehicles, such as anti-lock brakes, we use the term "features." Features combine to form the broader "attributes" of a vehicle, such as safety.

Consumers develop "criteria," which are consumer decision rules that weight the relative importance of vehicle attributes (and the features that relate to them). We consider criteria at the level of attributes in order to maintain a manageable scope of analysis, but we note that some consumers may develop criteria specific to vehicle features (e.g., must seat seven).

Consumers apply their purchase decision criteria when selecting which of the available vehicles to purchase. The available vehicles that a consumer evaluates in the context of their criteria is their "consideration set," and the vehicles within this set can change over time as a consumer eliminates models from consideration or learns of new options.

When we discuss our methods and analysis process, we refer to "variables." We use this term to refer to data items in the NVES survey data or other data items that we have merged into the dataset to capture additional vehicle features and attributes. Within our analyses, "variable" may refer to data representing features, attributes, criteria, or respondent characteristics.

We were particularly interested in a vehicle's environmental performance as an attribute-related purchase criterion. This concept can encompass such vehicle aspects as fuel economy and CO_2 emissions, emissions of particulate matter and other pollutants, lifecycle impacts of materials (e.g., batteries, recycled versus new materials), and likely takes on other and subtly different meanings across vehicle buyers. In the NVES data, respondents separately score the importance of "environmental friendliness" and "fuel economy" to their purchase decision; the NVES questionnaire frames fuel economy as a sub-topic within environmental friendliness. We retained this broad framing of the concept of a vehicle's environmental friendliness, while also looking more concretely at fuel type of purchased and considered vehicles, as well as fuel economy (importance to purchase decision and measured fuel economy of vehicles). Of the various aspects of environmental friendliness, fuel economy has long been the most visible and readily understandable metric, though recent vehicle window stickers have provided information on smog-forming emissions as well; the EPA fuel economy label began to specify smog and greenhouse gas information in 2013 [2]. Consumer Reports recently began to leverage this information in their new "Green Choice" designation, which factors in fuel economy and smog-forming emissions and provides information on this metric to a large consumer audience; such changes to the consumer informational landscape may change the context of vehicle environmental attributes going forward [3]. We therefore anticipate that respondent conceptualization of "environmental friendliness" will primarily encompass consideration of both the greenhouse gas emissions related to fuel economy and smog-forming emissions, and may possibly extend to other vehicle lifecycle impacts. We recognize that the importance of fuel economy touches on financial considerations, as well as environmental; this is a topic we address in further detail in discussion of the set of attribute-related decision criteria we analyze.

1.2 Vehicle purchase, decision criteria, and consideration sets in the literature

The five-step consumer purchase decision process model provides a useful framework in which to consider the implications of a consumer's valuation of a vehicle's environmental friendliness [4,5]. This framework decomposes the vehicle purchase decision into five sequential steps, with possible iteration and feedback: 1) problem recognition, 2) search, 3) alternative evaluation, 4) purchase, 5) post-purchase behavior. Our current focus is on the third step, alternative evaluation, and how the criteria developed therein manifest in the fourth step, purchase.

When considering which of the many available vehicles to purchase, consumers must weigh a variety of factors relating to their planned vehicle uses, household composition and lifestyle, personality and aesthetic preferences, etc. Decision rules describe the evaluation methodologies used by consumers to identify vehicles that could suit their needs and to rank these vehicles in terms of their degree of preference. They can be broadly categorized as compensatory and non-compensatory [6]. A compensatory decision rule involves the consumer "trading off" attributes of a product (e.g., low price outweighs an ugly color). A non-compensatory decision rule involves a non-negotiable attribute (e.g., vehicle must have all-wheel drive).

Inferred decision rules are not explicitly stated by the consumer as a reason they began the process of searching for a new vehicle or a feature of importance to their purchase. Instead, some decision rules can be deduced from an array of question responses. For example, if all of the vehicles that a consumer considered were electric or hybrid drive, we could infer that energy and/or environmental attributes were important to the decision.

Criteria rankings, feasible consideration sets, and final vehicle selection are expected to differ based on respondent characteristics such as demographics, personality, and household/family composition. Also, a newly purchased vehicle is often an addition to or substitution within a household fleet of vehicles. As of 2019, approximately 59% of U.S. households own more than one vehicle [7]. The other vehicles owned by a household reflect the household's transportation capabilities and needs, and will affect the criteria used to select a new vehicle [8]. Additionally, many vehicle purchases involve the sale or trade-in of a previously-owned vehicle as a way of paying part of the cost of the new vehicle. The purchaser may intend the new vehicle as a substitute for the "disposed" vehicle, or for a different purpose.

We evaluated existing literature on the topic of attributes important to the vehicle purchase decision to inform our expectations and to aid in our definition of selection criteria within our analysis. We here summarize the findings of several relevant studies. Vrkljan and Anaby examined Canadian drivers' preferences for eight vehicle attributes: storage, mileage, safety, price, comfort, performance, design, reliability [9]. They applied ANOVA tests to evaluate differences in importance across attributes and across driver demographics. They found that safety and reliability were most important, while design and performance were least, as well as finding differences across age and gender. Koppel et al. found a similar preference for safety among respondents to a survey conducted in Spain and Sweden [10]. They noted that respondents favored safety over other vehicle attributes (which they refer to as "factors") including price and reliability, and safety-related features (e.g., airbags) were favored over non-safety-related features (e.g., air-conditioning).

In their multi-criteria decision making (MCDM) model of automobile purchases, Raut et al. include the following criteria: Technology (including high-tech add-on features like rain sensors); Style (e.g., alloy wheels, stylized cladding); Comforts (e.g., seating adjustability, HVAC controls and zones); Convenience (e.g., power steering, interior illumination, fuel lid opener); Safety (e.g., anti-lock braking, additional airbags, child locks); Economical aspects (e.g., price/cost, fuel consumption); Manufacturer (encompassing brand and country

of origin); Social aspects (e.g., advertisement, satisfaction); Tools availability (i.e., spare parts); and Aesthetics view (internal and external design and color) [11]. They identified the following criteria of highest importance, respectively: technology, economical aspects, style, comfort, and safety. In another MCDM study, Byun performed an AHP analysis of vehicle selection, and included the following vehicle attributes: exterior, convenience, performance, safety, economic aspect, dealer, and warranty [12]. These broad attribute categories were each aggregations of individual vehicle features relating to the attribute (e.g., "performance" included torque, speed, cornering). Environment was not explicitly addressed the above studies. In Byun's study; the only possible representation of environmental friendliness among these attributes is the operating cost within "economic aspect." In this study, attribute rankings were elicited from dealership salespersons, rather than from prospective or actual new vehicle buyers. Based on a survey of 13 dealership experts, Byun found that safety, performance, and economics were the top three criteria, respectively. In a stated preference survey regarding EV purchase, Mandys identified purchase cost, performance and power, maximum range, positive effect on the environment, and fully electric operation as key attributes [13]

Attribute preferences may differ across consumer groups. While addressing the related topic of how preference for vehicle body styles relates to consumer acceptance of electric vehicles, Higgins et al. measured consumer valuation of the following vehicle attributes and features: "excellent" fuel economy, reduced tailpipe emissions, no tailpipe emissions, performance, luxury styling, passenger room, "ample" cargo space, maintenance cost, technology [14]. They identified significant differences in stated willingness to purchase EVs across consumers seeking different vehicle body styles, and simultaneously found that attributes of greatest importance differed between these consumer groups (e.g., consumers seeking economy vehicles were most sensitive to purchase price while those seeking minivans were most sensitive to maintenance cost).

A consumer's stated preference for an attribute, such as environmental performance, will not necessarily be revealed through their purchased vehicle. Through open-ended discussion, Hafner et al. found the following criteria of highest importance to recent vehicle purchasers: practicality and finance [15]. The authors also note that they observed a lesser focus on environment and greater focus on image than noted in previous research in their region of interest, the U.K, and they call into question the presumed alignment between consumers stated and revealed preferences for vehicle attributes. Van Rijnsoever et al. also addressed the potential for difference between stated criteria rankings and the sets of preferences revealed through purchase, discussing the gap between stated and revealed preferences for "environmental," "performance," and "convenience" attributes in vehicle purchase [16]. They performed a survey in the Netherlands in which respondents stated how important specific vehicle aspects were when purchasing a new car, which they associated with three overarching attributes: environmental (CO_2 emissions, other pollutants, etc.), performance (engine size, speed, etc.), convenience (comfort, volume of car, type of car, etc.). They also asked about the presence of features on respondents' vehicles related to environment friendliness, performance, and convenience. Of the three attributes studied, they found the largest discrepancy between stated preferences and revealed preferences based on vehicle features for environmental friendliness, with 66% of their sample displaying a positive

attitude toward the environment, but only 11.5% owning vehicles with features related to environmental friendliness.

Disentangling the importance of vehicle attributes to the purchase decision is complicated by the tendency for consumer perception of one attribute to influence their assessment of another attribute, such as design influencing perceptions of comfort (see, e.g., Erol et al. for a discussion of the influence of visual appearance on perceptions of vehicle seat comfort [17], or Bi et al. on the influence of vehicle silhouette on consumer perceptions of environmental friendliness and safety [18]).

2 Data and Analysis Methods

Here we describe the data used in our analyses, including data sources, cleaning and processing methods, definition of key variables, and summary statistics. We also describe the factor analysis and AHP methods that we used to examine purchase criteria.

2.1 Data

Our primary data source was Strategic Vision's New Vehicle Experience Study (NVES), covering the years 2014–2016 with a combined sample size of 842,212 responses. The NVES contains a wealth of information regarding the preferences, opinions, knowledge, search methods, reasons for buying, buying experiences, vehicle choices, and post-purchase experiences of recent vehicle buyers. The primary component of the NVES is a detailed questionnaire sent to new vehicle owners within the first six months since purchase. In each year, there are several hundred thousand responses, covering more than 90% of the makes and models of vehicles purchased in the U.S. market. The questionnaire addresses: 1) the vehicle purchasing process including problem recognition, search, alternative evaluation, purchase, and post-purchase experience; 2) set of vehicles considered, vehicles replaced, household fleet composition, and perceptions of vehicles features and attributes; 3) purchasing experience at the dealership; and 4) buyer attributes (e.g., demographics, psychographics). In our analyses, we are primarily concerned with three categories of data describing vehicles: objective characteristics, subjective characteristics, and stated decision rules. We also note that while the total number of responses across the three survey years is over 800,000, some individual survey sections are provided to a smaller subsample of respondents.

Objective characteristics include the presence of vehicle features (e.g., leather seats) and measurements such as cubic feet of cargo capacity or fuel economy in miles per gallon. Some objective characteristics can be easily identified by consumers (e.g., visible features, stated measurements). Other objective characteristics cannot be as easily verified by a consumer and may require additional information sources (e.g., time required to go from 0 to 60 mph). Subjective characteristics are those that depend on a consumer's personal preferences and perspective. A vehicle that one consumer considers "stylish" or "comfortable" may not be appealing to another. While each consumer will differently define what makes a vehicle "stylish" to them, we can observe and compare the importance that they ascribe to these attributes in their comparison of vehicle models.

All respondents (about 200,000+ annually) take Survey Part 1 between 1 – 16 weeks after purchase. Questions in Part 1 do not address ownership experience and focus on aspects that will not change based on survey timing. Survey Part 1 addresses: a) demographics, b) price/financing, c) purchase reasons, d) vehicles features (desired, and of purchased vehicle), e) source of sales, vehicle disposal, f) other models considered, g) household fleet, h) purchase/lease information, and i) loyalty, avoidance, and defection reasons.

Respondents who complete Part 1 have the opportunity to complete Part 2; about 50% do so (100,000+ annually). Respondents take Survey Part 2 between 12 – 16 weeks after purchase. These questions focus on the ownership experience and provide a comprehensive view of the customer, vehicle, and sales/service experience. It includes: a) overall evaluation of vehicle experience, b) type of vehicle and features (purchased, desired), c) involvement in purchase decision, d) uses and MPG estimates, e) financial information, f) exhaustively comprehensive rating of vehicle feature/attribute experience, g) vehicle evaluation against core values, and h) sales and early service information.

Respondents who complete Parts 1 and 2 may complete Part 3; about 45% do so (40,000 – 50,000 annually). Survey Part 3 occurs at least 6 months after the purchase of their vehicle. These questions focus on customer lifestyles and behaviors, and the fit between the vehicle and their core values. Part 3 addresses: a) media usage, b) hobbies and lifestyle, c) technology usage, c) self, ideal self, ideal vehicle values, d) future brand and product consideration, and e) desire for alternative powertrains and willingness to spend on future technologies.

For this analysis, we work primarily with a section of the questionnaire from the Part 2 Survey addressing: “Your purchase decision…Why did you decide to purchase or lease the particular model you did rather than some other model? How important was each of the following in your decision?” The respondent rates the importance of about 80 aspects of vehicles to their purchase decision (on a 1–5 scale, 5 representing high importance). These aspects include the presence of features (e.g., navigation system), assessment of features (e.g., seat comfort), attributes derived from features (e.g., “overall power and pickup” derives from engine cylinder alignment, gear train, etc.), financial aspects (e.g., leasing terms), other influencing factors (e.g., advice of friends), and “overall” attributes (e.g., overall performance, overall value). The scored vehicle aspects differ in terms of objectivity or subjectivity, with the presence of a feature being objective and the assessment thereof being subjective. To facilitate analysis of decision rules regarding vehicle attributes, we focused on the “overall” attributes presented in this section (Table 1). In the subsequent criteria ranking analysis, we further reduced the number of overall attributes considered to ten based on the literature review, exploratory factor analysis, and our own research questions.

Based on vehicle make, model, and trim level, we were able to match EPA measured combined fuel economy, in terms of miles per gallon (MPG) or miles per gallon equivalent (MPGe) to the majority of respondents’ purchased vehicles, collected from fueleconomy.gov. After aggregating to the make-model level of specificity, we also mapped these fuel economy values to the alternatively considered vehicles listed by respondents.

The NVES dataset identifies newly purchased (or leased) vehicles and up to three other vehicles that respondents also considered, but ultimately did not select. Approximately 40% of respondents report between one and three alternatively considered vehicles. Respondents who do not report an alternative may represent non-response within the survey to some degree; however, this group also includes those respondents who determined their desired vehicle - including its body style and fuel type - early enough in their alternative evaluation process that they do not feel there was another vehicle they seriously considered. We also note that due to the massive scale of NVES, we retain a sizable sample of respondents who do list at least one alternative.

Comparing considered vehicles provides insight into consideration set formation and the process by which consumers recategorize specific models from general consideration into “evoked” (i.e., models that they are familiar with and feel positively toward), “inert” (i.e., models they view with indifference), or “inept” (i.e., rejected) sets. The set to which a specific model belongs changes over time, as a consumer deliberates and absorbs additional information (e.g., test drive, special offer); this changeableness adds complexity.

NVES categorizes respondents’ first alternatively considered vehicles into twelve body styles. We aggregated these in order to simplify the number of vehicle categories we analyzed. First, we distinguished between pickup trucks and passenger vehicles. Within passenger vehicles, we aggregated several specific body styles as shown in Figure 1. The potentially non-compensatory nature of vehicle body style is suggested by work such as Higgins et al. (and citations therein), in which the authors draw attention to the importance of including market segments such as body style when interpreting consumer preferences for EVs that are due to differences in demographics and vehicle attribute preferences within these market segments [14].

The alternatively considered vehicles that we see in the NVES data were at one point in time in the respondent’s evoked or inert sets. Vehicles that the respondent immediately knew to be unsuitable for their needs and wants would have been rejected early in the process or never thought of in the first place, and thus not occurred to the respondent to provide on the questionnaire. Through the process of alternative evaluation, all but the purchased vehicle moves from the evoked or inert sets to the inept set. For some respondents, for example those who list alternatively considered vehicles of only one body style or one fuel type, reasonable hypotheses could be formed regarding the types of vehicles making up the bulk of their inept set.

2.2 Summary and exploratory analysis

To supplement our cross-tabulations of NVES variables, we performed an exploratory factor analysis of the “overall” importance variables we used to define purchase criteria. This factor analysis aided us in the process of streamlining the set of overall importance variables (i.e., in Table 1) into the ten that we ultimately evaluated in the AHP analysis.

Based on previous literature and vehicle expert review information (e.g. caranddriver.com), we theorized that certain variables, such as those related to vehicle performance, may interrelate. Exploratory factor analysis (EFA) is a descriptive analytical technique that aims

to reveal the "number and nature of latent [factors] that explain the variation and covariation in a set of measured variables" [19]. We performed an EFA in order to identify associations among the many vehicle attributes potentially important to the purchase decision included in NVES. As opposed to a confirmatory factor analysis, the EFA explores relationships among variables without assuming a priori a fixed number of factors.

In EFA, each measured variable, y_j, corresponded to one questionnaire item (i.e., importance score of an "overall" vehicle attribute). Latent factors, η_m, and factor loadings, λ_{jm}, indicate how strongly the importance of a vehicle attribute, y_j, relates to each factor:

$$y_j = \lambda_{j1}\eta_1 + \lambda_{j2}\eta_2 + \cdots + \lambda_{jM}\eta_M + \varepsilon_j$$

with error term, ε_j. Large factor loadings indicate a strong association between the factor and the measured variable (i.e., survey item). When the items with large loadings in a single factor were also representative of similar types of vehicle attribute (e.g., interior styling and interior design), we averaged the contributing attributes to create the composite attributes that we carry into the AHP analysis. When seemingly diverse and disparate vehicles attributes loaded on the same factor, particularly those of interest due to their prominence in the literature, we retained multiple attributes individually in the AHP analysis.

2.3 Analytical Hierarchy Process

Consumers consider numerous aspects of a vehicle before purchasing, thus the consumer selection of a vehicle can be represented as a form of multi-criteria decision-making (MCDM). We use AHP to assess the relative importance ascribed to vehicle purchase criteria across consumers [20]. We focus on purchase criteria relating to the following vehicle attributes: design, performance, power, durability, safety, value, comfort, image, environment, and fuel economy. We first examine the full set of NVES respondents, and then compare across consumer groups to highlight differences.

AHP provides a way to structure the analysis of the potential tradeoffs involved in a decision across choices that each have a number of key attributes (e.g., design, performance,). AHP has been used to study decision making across multiple criteria in numerous fields of research, including both the manufacture and purchase of vehicles [12,21] and other durable goods [22].

The goal of AHP is to construct relative overall importance degrees for each of the attribute-based criteria considered by the consumer in the purchase decision; then we assess the weight of each criterion. The calculation is based on the normalized geometric mean of pair-wise comparison metric for a given criterion. First, we construct a pairwise comparison matrix (A) of elements for our $n = 10$ criteria. We convert the 5 point Likert scale scores provided by NVES respondents to the 1 to 9 scale proposed by Saaty (1980) [20] yielding the relative importance of criterion i compared to criterion j. There are $n(n-1)/2$ comparisons required to populate the matrix where n is the total number of elements being compared.

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix}$$

Each element of A is computed as $a_{ij} = \frac{c_i}{c_j}$, for all $i = 1 \ldots n,\ j = 1 \ldots n$, where each c is the Saaty score ascribed to each criterion. Then, the relative importance degrees for each criterion, w_i, is calculated using the normalization of the geometric mean method.

$$w_i = \frac{\left(\prod_{j=1}^{n} a_{ij}\right)^{1/n}}{\sum_{i=1}^{n} \left(\prod_{j=1}^{n} a_{ij}\right)^{1/n}},\ i,\ j = 1,2,\ldots,n$$

The w_i can then be compared to determine which criteria rank of lesser or greater importance, along with the degree of preference for certain criteria, which we henceforth refer to as the "criteria weight." We first summarized criteria weights across all NVES respondents, then looked at differences in criteria order and degree of preference between groups within the population, in terms of respondent characteristics and purchased vehicle categories.

3 Results

Here we report on several groups of findings from analysis of NVES data. First, we present cross-tabulations that inform our selection of purchased vehicle groupings. Next, we present the outcomes of our AHP analysis, first for the sample as a whole, and then split by vehicle and demographic groups.

3.1 Cross-tabulations and Exploratory Factor Analysis

To gain insight into likely non-compensatory vehicle decision factors, we examined the relationship between purchased and alternatively considered vehicles across body styles and fuel types. Both body style and fuel type appear to be non-compensatory decision criteria. Looking at respondents who listed one other vehicle that they considered, we found it is common for a respondent's purchased and alternatively considered vehicles to share a body style (Table 2, top). The left column of Table 2 lists the body style of vehicle purchased, while each row shows the percentages of alternatively considered vehicles associated with each purchased vehicle body style, with bolded values denoting the most common combination. Consistency between purchased and considered vehicles was particularly dramatic for pickup trucks, where we found that among respondents who purchased a pickup truck, their first alternatively considered vehicle was also a pickup truck in over 90% of cases. Though to a lesser degree than for pickup trucks, the majority of those who purchased other vehicle types also listed an alternative vehicle within the same body style. Previous research has investigated underlying factors affecting consumer preference for vehicle type and body style, identifying a combination socio-demographics,

personal preferences, household responsibilities, and built environment [8,23]. These findings indicate that body style is likely a non-compensatory decision criterion for many purchasers and vehicle attribute-related criteria may be compared within a chosen body style. Thus, we later examined AHP relative criteria weights summarized by body style.

We also found evidence of respondents' tendency to select from vehicles with the same or similar fuel types (Table 2, bottom). This tendency was most dramatic for those who purchased gas-fueled vehicles, who listed another gas-fueled vehicle as their first alternative 94% of the time. Those who purchased battery electric vehicles (BEV), hybrid electric vehicles (HEV), and plug-in hybrid electric vehicles (PHEV) considered another vehicle of the same fuel type a plurality of the time. We also observed some overlap between these fuel types, with BEV buyers also considering HEV and PHEV to a notable extent, and similarly PHEV buyers considering BEV and HEV. The closest substitute for HEV buyers, however, appears to be gas, which they alternatively considered at close to the same level as other HEV models. Buyers of diesel and flexible fuel vehicles were outliers in that they most often considered a gas vehicle as their alternative. Those who purchased a diesel-fueled vehicle most commonly considered a gas fueled vehicle or diesel-fueled vehicle as an alternative. As these findings broadly indicated that respondents may compare vehicle criteria within a chosen fuel type, we later examined AHP relative criteria weights summarized by fuel types.

The above discussion focuses on the body styles and fuel types of the purchased and the first alternative vehicle, but the trends observed also apply to second and third alternative vehicles for those who reported up to three alternatives. We extended our investigation to up to three alternatively considered vehicles in Figure 2, which visually depicts the shares of considered vehicle type for each category of purchased vehicle. The segment between the first and second columns graphically replicates the information in Table 2, showing that the bulk of first alternative vehicles are of the same body style as the purchased vehicle. The next segments show that between first and second alternatives, as well as second and third alternatives, a high proportion of sets of vehicles continue to share a body style, as demonstrated by the wide segments continuing horizontally across the alternatives.

An exploratory factor analysis helped us to reduce the number of variables feeding into our AHP analysis of attribute-related criteria rankings. From the "overall" importance scores, we identify 4 factors that align broadly with the concepts of "design," "pragmatic" aspects such as value, durability, and safety, "image," and "dealership experience" (Table 3). As the dealership-related variables do not align with our current investigation of vehicle attribute-related criteria, we set them aside from the analysis. We examined the "overall" importance scores for criteria separately for buyers of passenger vehicles and pickup trucks. Given the broad similarity we see between the two vehicle sets in terms of the "design" and "image" factors, we proceeded with the same set of criteria for both passenger vehicles and pickup trucks in the AHP analysis. We note that a criterion with low loadings across all factors does not necessarily imply that it is unimportant to the respondent's purchase decision. Rather, it shows that respondent-reported importance of the particular criterion is not strongly systematically related to importance of other criteria.

Of import to the following analyses, we found that respondents considered various aspects of vehicle design and workmanship jointly, which supported our use of a single “design” criterion in AHP; similarly, EFA results supported the use of a single “image” criterion representing both vehicle and brand image. Based on the combined findings from our review of previous research involving vehicle selection criteria and our exploratory analyses, we proceeded to the AHP analysis with the ten attribute-based vehicle selection criteria listed in Table 4.

Note that fuel economy was not framed as an “overall” questionnaire item, but we include it as a separate criterion because it is important to our overarching questions regarding environmental attributes. We took the average of design-related criteria with high loadings (“overall interior design”, “overall interior styling”, “overall interior workmanship”, “overall exterior workmanship” and “overall exterior styling”) to represent the concept of design and the average of “overall brand image” and “overall vehicle image” to represent the concept of image.

We recognize that there is the potential for some degree of overlap among these attributes. For example, the “value” and “fuel economy” attributes are related, as fuel economy contributes to expected operating cost of the vehicle. In addition, the significance of fuel economy as an indicator of environmental versus monetary values is under debate within the literature (e.g., Xie and Lin for a monetary framing [24], Flamm for an environmental framing [25]). We are not unique in considering the environmental aspect of a preference for fuel economy; Higgins et al., for example, consider the importance their respondents place on “fuel economy and emissions” when identifying a consumer segment composed of those “who care about the environment” [14]. In their examination of knowledge, attitudes, and behavior in the context of vehicle selection and use, Flamm found that “respondents who know more about the environmental impacts of owning and using vehicles own more fuel-efficient vehicles,” supporting the notion that preference for fuel economy pertains to preferences for environmental friendliness [25]. Within NVES data, we found a correlation of 0.56 between the importance of fuel economy and the overall importance of environmental friendliness and also a correlation of 0.56 between importance of fuel economy and the importance of overall value, suggesting that both aspects of fuel economy are present in respondent considerations.

We did not identify a clear analog to the “power” attribute in previous research. We note that “performance” in this context captures such things as handling and maneuverability, while “power” addresses acceleration and passing capability. However, neither “power” nor “performance” emerge as distinct latent factors in the EFA. Rather, these related but discrete attributes are each captured in a single survey item.

3.2 Results of the AHP analysis

Recall that the Analytical Hierarchy Process is one type of multi-criteria decision making method. It involves a pairwise comparison of criteria weights to determine the order and degree of preferences. Generally, the higher the weight for a criterion, the greater its relevance to the purchase decision. Differences in criteria weighting are of interest to us: a) among the ten attribute-related criteria for a given respondent or group of respondents,

and b) between groups of respondents, either as absolute measures of weight or as measured against the weight of other criteria. Since we are comparing the relative weights among 10 criteria, a weight of 0.1 (1/10) is a useful reference point which means equal importance across all criteria. If lower than 0.1, respondents care relatively less about a particular criterion; if higher than 0.1, respondents care relatively more. Throughout this section, mention of significance denotes a t-test comparison of means between groups with $p<0.05$. Due to our large sample size, even small differences between group means are statistically significant.

Between passenger vehicle purchasers and pickup truck purchasers, the differences in relative weights for all attributes are statistically significant. Specifically, pickup truck purchasers weigh safety, environmental friendliness, and fuel economy much lower than passenger vehicle purchasers but weigh power much higher. Across all purchasers of passenger vehicles, safety was the top weighted criteria, with performance and value next, followed by durability and then fuel economy and comfort (Figure 3). Of notably lower weighting were power, image, design, and finally environmental friendliness. For purchasers of pickup trucks, we found performance was the top criterion, followed closely by durability, value, safety, and power. Comfort, image, design, and fuel economy were weighted substantially lower, with environmental friendliness again taking the lowest relative weight.

We next examined differences in criteria weights after grouping respondents by the fuel type of their purchased vehicle (Figure 4). The ranking of relative weights for gas-fueled vehicles closely mirrors that which we observed for the sample overall, as gas is by far the most common fuel type. We also looked at three other broad fuel type categories: battery electric vehicles (BEV), hybrid electric vehicles (HEV), and diesel-fueled vehicles. Here we found clear differences in criteria weights compared to purchasers of gas-fueled vehicles. Purchasers of BEV, HEV, and diesel-fueled vehicles had the highest relative criteria weight for fuel economy. For BEV and HEV, we found that environment no longer received the lowest weight, ranking in the middle of the ten criteria for HEV purchasers and achieving a three-way tie with performance and safety for second highest weight for BEV purchasers. While diesel purchasers strongly weighted fuel economy, the broader environment criterion received the second lowest weight, similar to the value of purchasers of gas or flexible fuel vehicles.

The top weighted criteria varied dramatically when we grouped respondents by the basic body style of their purchased vehicle; however, the environment criterion received the lowest weight across all vehicle body styles (Figure 5). Respondents who purchased 2-door cars or convertibles rated performance the highest. Respondents who purchased minivans and SUVs had the highest relative weights for safety, followed by value for minivan purchasers and performance for SUV purchasers. Respondents who purchased 4-door cars showed a comparatively high weight for fuel economy compared to purchasers of all other vehicle body styles, especially the purchasers of convertibles and 2-door cars.

As passenger vehicles account for more than 90 percent of new vehicle purchases in our survey sample and that the demographic composition of passenger vehicle and pickup truck

purchasers is very different, here we summarize criteria weights by gender and income group of the passenger vehicle sample only (Figure 6).

Among passenger vehicle buyers, male and female respondents have very similar criteria ranking, with performance, durability, safety and value among the highest ranked criteria and environmental friendliness being the lowest ranked criterion (Figure 6, top). While the rank order is the same, we observed small but significant gender differences across criteria weights except for value, to which male and female passenger vehicle purchasers ascribe similar weight. Female passenger vehicle purchasers weighed safety, environmental friendliness and fuel economy higher than their male counterparts did, while male passenger vehicle purchasers placed higher importance on design, power, performance, durability, comfort and image ($p < 0.05$).

Examining the annual household income of passenger vehicle purchasers, we found an inverse relationship between income and the weights of environment and fuel economy criteria. We aggregated purchasers of passenger vehicles into four income groups, ranging from an annual household income of less than $35,000 to $150,000 or more (Figure 6, bottom). Relative weights for certain criteria were broadly similar across income groups, but we observed significant a decrease in the weighting of environmental friendliness and fuel economy as household income increases. This finding is particularly stark when comparing the lowest and highest income groups. We also examined criteria weights across age groups and level of educational attainment within the passenger vehicle sample. We observed small differences between these groups, with younger respondents showing slightly higher weighting of environment and fuel economy compared to older, and we found criteria weights for environment and fuel economy to decrease somewhat as educational attainment increased; this second findings mirrors what we observed for income groups.

Next, we examined relative criteria weights across the passenger vehicle sample, grouped by expressed environmental sentiments, which were elicited in terms of the social responsibility of environmental friendliness, willingness to pay for environmental friendliness, and, conversely, their agreement with a statement that “environmental issues are overblown.” Respondents who agreed with “environmental friendliness is a social responsibility” also agreed with “willingness to pay more for environmental friendliness,” while disagreeing with the statement that “environmental concerns are overblown.” Respondents who agreed with pro-environmental statements also weighted environment and fuel economy criteria more heavily. This suggests that respondents exhibit consistent preferences with regard to positive and negative framing of environmental-related statements. In Figure 7, elements of each row reflect the criteria weights of respondents who stated each level of agreement with the statement, with 1 equating to weakest agreement and 5 equating to strongest agreement.

Relative weights of environment and fuel economy both increased strongly with respondents’ agreement with the statements that environmental friendliness in a vehicle is a “social responsibility” and something that they are willing to pay more for, while they decreased with the strength of agreement that environmental concerns are “overblown.” These findings revealed directionally consistent preferences for the fuel economy and environmental criteria across framings. However, while the effect moved in the same

direction for both the environment and fuel economy criteria, we observed the greatest shift in criteria weight for environment. Of note are respondents who strongly agreed that they would pay significantly more for an environmentally friendly vehicle; for this group, we observed a comparatively high weight for the environmental criterion, and we note that in contrast to virtually every other cross-section of respondents, the AHP weights for this group cluster right around 0.1, showing approximately equal weight between environment, fuel economy, and other criteria.

3.3 Comparing stated preferences to the attributes of vehicle consideration sets

In this section, we focused on the fuel types and measured fuel economy of vehicles within respondents' consideration sets in order to investigate whether the stated preferences for fuel economy and environmental performance were revealed in real-world purchase decisions. Since body style is largely non-compensatory, we also examined these relationships grouped by body style. In Figure 8, we present the fuel economy of purchased and considered vehicles across respondents with low, moderate, and high AHP weights for fuel economy and environment. Drawing from our earlier discussion of the interpretation of AHP weights, define "low" as those with AHP weight less than 0.1, "moderate" as AHP weight of 0.1, and "high" as AHP weight greater than 0.1.

We include findings for respondents who listed one alternatively considered vehicle, as they comprise the bulk of the data. However, these findings also hold for respondents who listed two and three alternatives. In addition, we also focus on 4-door cars and SUVs, as these are the most commonly purchased body styles.

For 4-door cars, we observed mean and median MPG of purchased vehicles higher than considered vehicles across low, moderate, and high AHP weight groups. The highest overall mean and median MPG was observed in the purchased vehicles of respondents who highly weight the environment criterion. For SUVs, we also found increasing MPG going from low to high criteria weight, but we observed higher MPG in considered vehicles than in purchased vehicles. The highest MPG observed for SUVs came from the alternatively considered vehicles for respondents with high AHP weights for environment, suggesting that even for those SUV buyers with highly weighted environment and/or fuel economy criteria, the importance of other criteria on average ultimately balance the purchase decision in favor of the less fuel efficient vehicle in their consideration set. For 4-door purchasers with low, moderate, or high environment or fuel economy AHP weights, the MPG of the purchased vehicle exceeds the MPG of their first alternative more often than not; In contrast, among SUV purchasers, the MPG of the first alternative exceeded the MPG of the purchased vehicle more often than not for low, moderate, and high AHP weights on environment and fuel economy

We also examined the association between AHP weights for environment and fuel economy and the likelihood of purchasing or considering an alternative fuel vehicle. Of all respondent groups we examined, respondents with high environment AHP weights were the most likely to have considered or purchased BEV, HEV, and PHEV. Similar to Figure 8, in Figure 9, we present the distribution of fuel types of purchased and considered vehicles across respondents with low, moderate, and high AHP weights (as defined above). In this case,

we limit the context to 4-door cars because this was a common body style with many BEV, HEV, and PHEV models available during the analysis period. While gas is by far the most common fuel type for all groups of respondents, we observed that substantially higher proportions of BEVs, PHEVs, and especially HEVs were considered and purchased by respondents with high weights for fuel economy and environment. We observed a slightly stronger relationship between high AHP weight for environment and alternative fuel type than between high AHP weight for fuel economy and alternative fuel type.

4 Discussion

Using the extensive NVES and additional merged data, we investigated vehicle shopping criteria among U.S. consumers. In particular, we examined the role of the environmental attribute within the broader set of vehicle attributes that influence the purchase criteria used to select passenger vehicles and pickup trucks. Following factor analysis, cross tabulation, and application of AHP, we identified several relationships of interest between consumer purchase criteria, vehicle consideration sets, and eventual vehicle choice. We note that, outside of income, general demographics do not appear to be strongly associated with differences in vehicle purchase criteria rankings; on the other hand, respondents' eventual vehicle choices align with differences in criteria rankings.

Cross-tabulations revealed the consistency of body style and fuel type within consideration sets, at least among survey respondents who list alternative vehicles considered. AHP revealed insights into the relative vehicle criteria weights and heterogeneity of vehicle criteria weights across gender, income, fuel type, and body style. AHP also showed directionally consistent criteria weights for fuel economy and environmental performance across environmental frames (i.e. social responsibility, willingness to pay, and salience of environmental concerns) but notably more sensitivity to frame for the environmental vehicle criterion.

Balancing criteria in the vehicle purchase decision

We found a notable compensatory relationship between the importance of environment and performance, value and durability. For example, respondents who stated that environmental friendliness was "not at all important" to their vehicle purchase decision gave the highest relative weights to the criteria of performance, value, and durability. Among those who stated the environmental friendliness was "important" or "extremely important," we observed significantly lower weights for durability, and to a lesser degree, performance and value. We note that this relationship between environmental friendliness and durability, performance, and value is in the context of consumers' preferences for vehicle attributes; whether or not they actually have to balance these criteria when selecting a vehicle will in part depend how vehicle features are packaged.

In contrast, the choice of body style and fuel type appear to be non-compensatory. Aligning with the finding of Higgins et al., we found substantial stability in body style across consumer vehicle consideration sets, providing evidence that the choice of body style is non-compensatory for many consumers. We found a notable, but somewhat lesser, degree of stability in fuel type across consideration sets, suggesting that for some consumers,

particularly those with high valuation of environmental friendliness in the case of BEV and PHEV, selecting a particular fuel type also bears characteristics of a non-compensatory decision rule.

Consistency in stated and revealed preferences for environment and fuel economy

For the environmental impact-related criteria (overall environmental friendliness, fuel economy), we found substantial consistency between respondents' stated and revealed preferences, as expressed through the fuel types and fuel economy metrics of the elements of their consideration set, and particularly their newly purchased vehicle. Respondents who purchased BEVs, PHEVs, or HEVs weighted both environmental friendliness and fuel economy higher than the NVES sample in general, and higher than respondents who purchased gas-fueled vehicles. Diesel-fueled vehicle purchasers weighted fuel economy higher than those who purchased gas-fuel vehicles and at a similar relative weight as those who purchased BEVs, PHEVs, or HEVs. For overall environmental friendliness, diesel purchasers had relative weights much lower than BEV, PHEV, and HEV purchasers.

We also saw consistency between environmental and fuel economy criteria, environmental attitudes, and vehicle purchased. Respondents who most strongly agreed with the statement that purchasing an environmentally friendly vehicle is a "social responsibility," and particularly for those who strongly agreed that they would be willing to pay more for an environmentally friendly vehicle, we saw substantially higher weightings of the environmental friendliness and fuel economy criteria, as compared to the respondent sample in general and to those who disagree with those statements. We also found that respondents with high criteria weights for fuel economy and environment considered and purchased more fuel efficient vehicles. In summary, we found evidence that consumers' criteria weights for environmental attributes were consistent with environmental attitudes across framings and were reflected in the vehicles they considered and purchased.

Vehicle purchase criteria by demographics and vehicle types

Our analysis revealed significant and substantial criteria differences across purchasers of different vehicles types, with fewer findings of note across demographic groups. Looking at criteria weights across demographic groups, we observed statistically significant, but generally small differences between men and women.

One demographic trend of note is a stronger desire for environment and fuel economy among lower income purchasers. In other words, higher income groups (i.e., those most likely to be able to afford to pay extra for a more environmentally friendly vehicle) placed significantly lower relative weight on environment and fuel economy compared to groups with lower income. For the most affluent group, those with annual household income over $150k, this observation is the most dramatic, with environment and fuel economy by far ranking last and second to last out of the ten attribute-related criteria that we examined. For fuel economy, this finding likely encompasses the dual nature of the attribute, which has both environmental and financial ("value") implications. This observed de-emphasis of the environmental attribute among the highest income group gains salience in the context of the ongoing discussion surrounding the influence of affluent

consumers on markets for consumer goods and services. Nielsen et al. recently argued that “positional consumption [behavior] of the super-affluent… drives consumption norms across the population” including behaviors related to resource consumption and pollution [26,27]. Since the distribution of new vehicle buyers tends toward higher income brackets as compared to the general U.S. population, the preferences of the affluent may shape the options offered in vehicle markets. In addition, the substantial differences in environmental criteria between low- and high-income consumers in the new vehicle market also suggest a possible lack of alignment between the attributes of the bulk of new vehicle purchases and the presumable shopping criteria of consumers in the used car market.

Finally, our AHP analysis suggests that there are consumers with a strong desire for fuel economy across purchasers of most vehicle body styles. In the time elapsed since the data we analyzed were collected, the U.S. light duty vehicle fleet has evolved to include more options. More electrified and advanced technology vehicles are expected to become increasingly available across a larger selection of body styles. Given that body style is largely non-compensatory, taken together, the expansion of green vehicle offerings and our findings suggest that additional types of vehicle models could emerge to better suit certain respondents’ purchase criteria.

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Data Availability:

EPA measured fuel economy, in terms of miles per gallon (MPG) or miles per gallon equivalent (MPGe), were obtained from fueleconomy.gov for vehicle model years 2013, 2014, 2016, and 2017. These data were matched to survey data at the make-model level of specificity. The Strategic Vision New Vehicle Experience Survey data for calendar years 2014, 2015, and 2016 are proprietary. EPA cannot release confidential business information (CBI), or data protect by copyright, patent, or otherwise subject to trade secret protections. Request for CBI data may be directed to the database owner by an authorized person or by contacting the party listed below:

Edwards Associates Inc.

Attention: DBA Strategic Vision

10725 Tierrasanta Blvd.

San Diego, CA 92124

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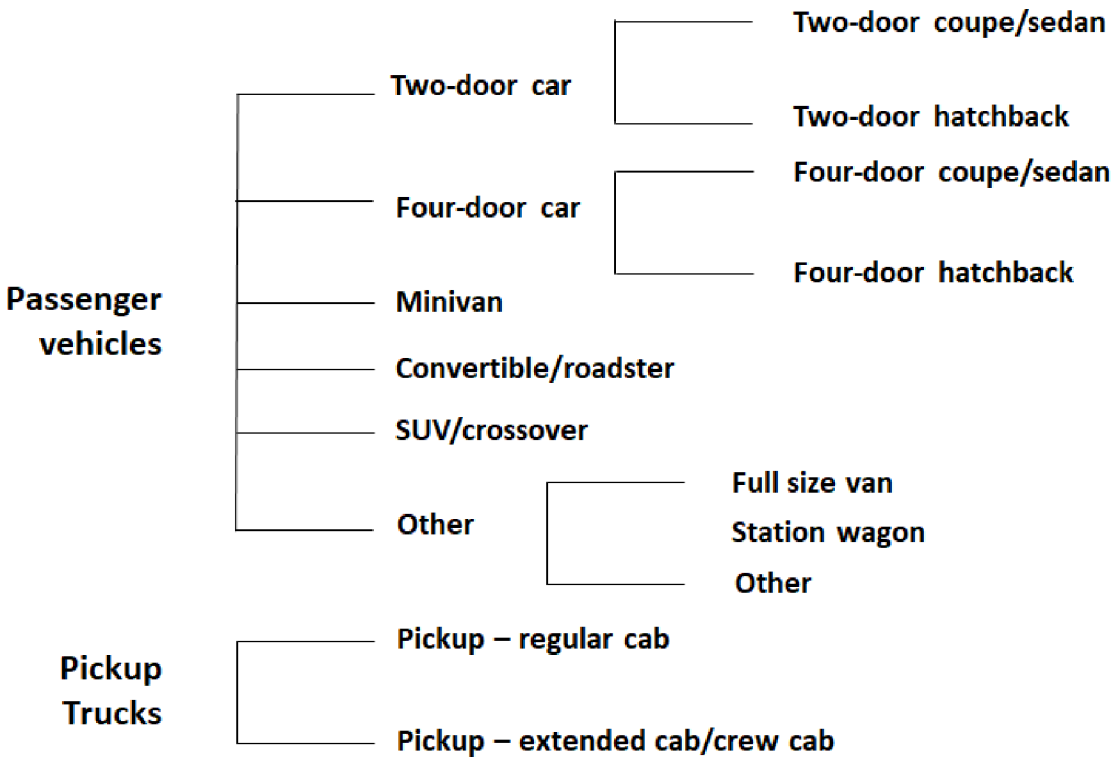

Figure 1. Hierarchy of vehicle body styles

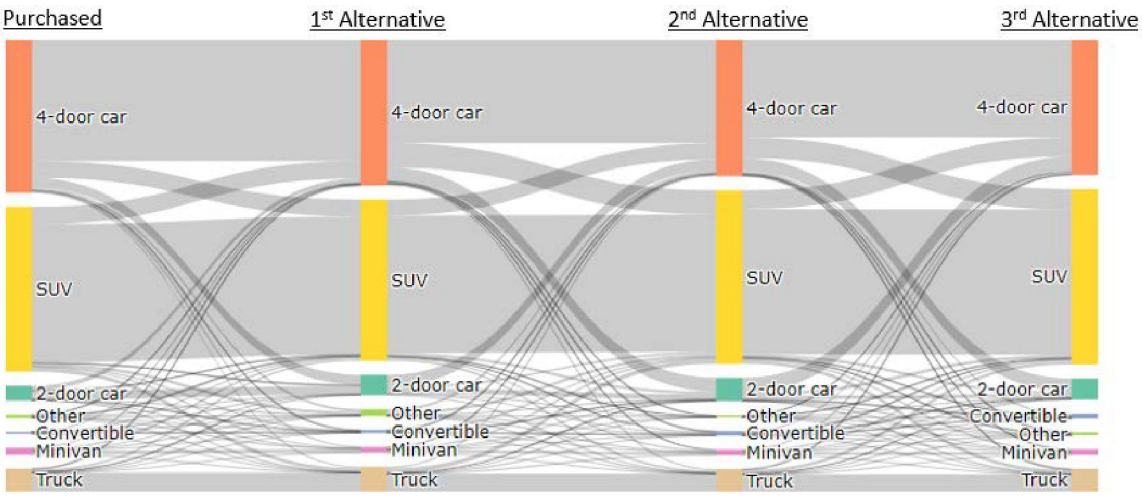

Figure 2. Sankey diagram of purchased and considered vehicle body styles

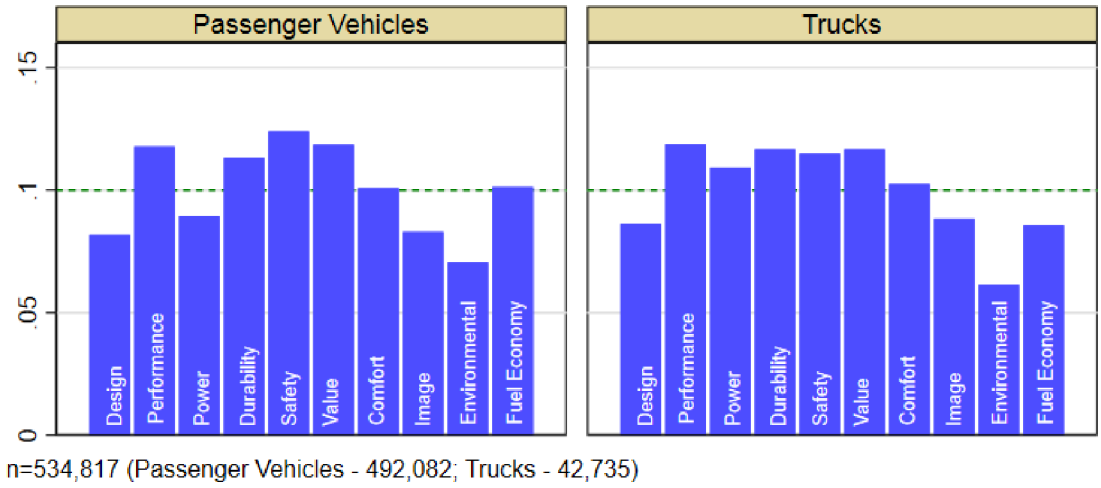

Figure 3. Relative criteria weights across the NVES sample for passenger vehicles and pickup trucks

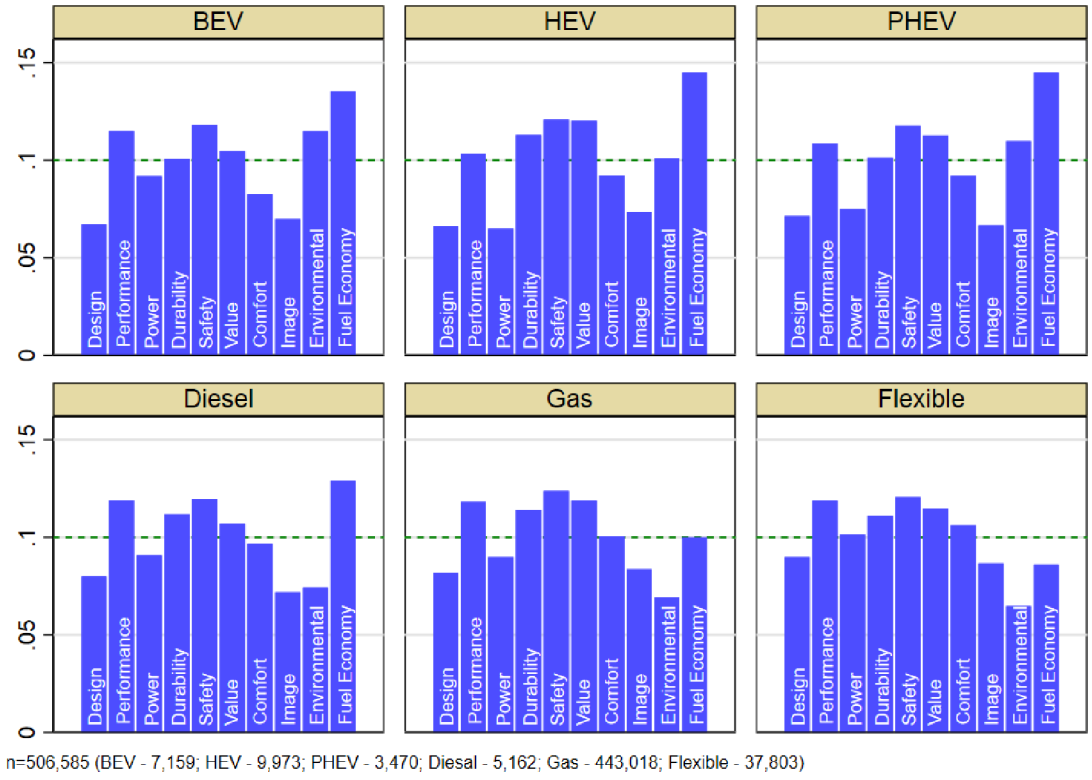

Figure 4. Relative criteria weights - respondents grouped by fuel type of purchased vehicle

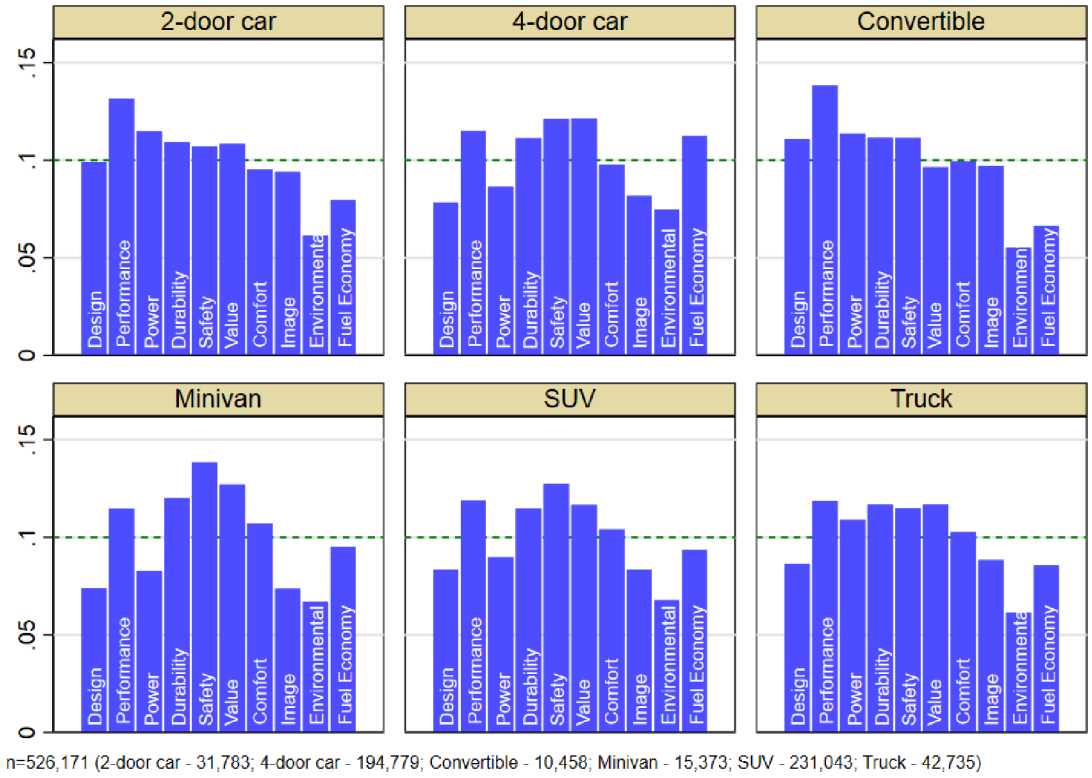

Figure 5. Relative criteria weights - respondents grouped by body style of purchased vehicle

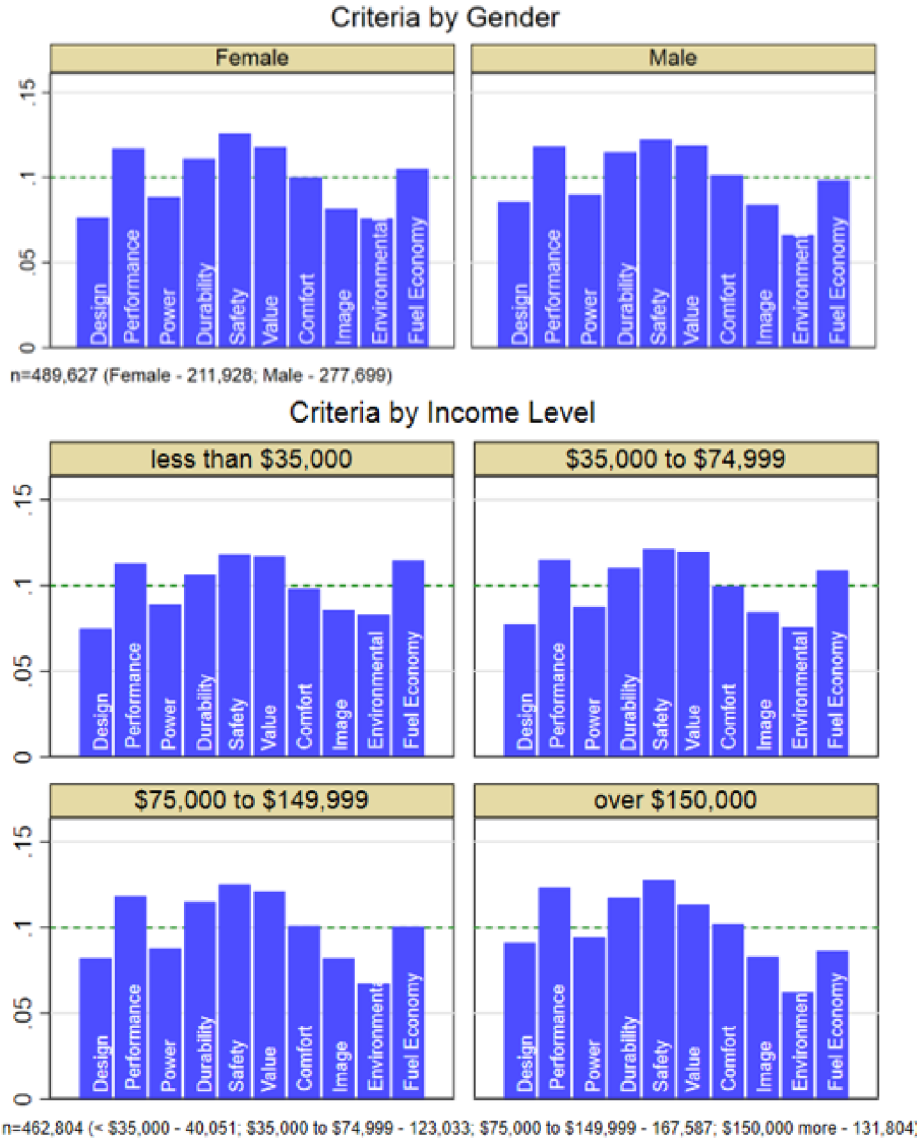

Figure 6. Relative criteria weights across the NVES passenger vehicle buyer sample by gender and income group

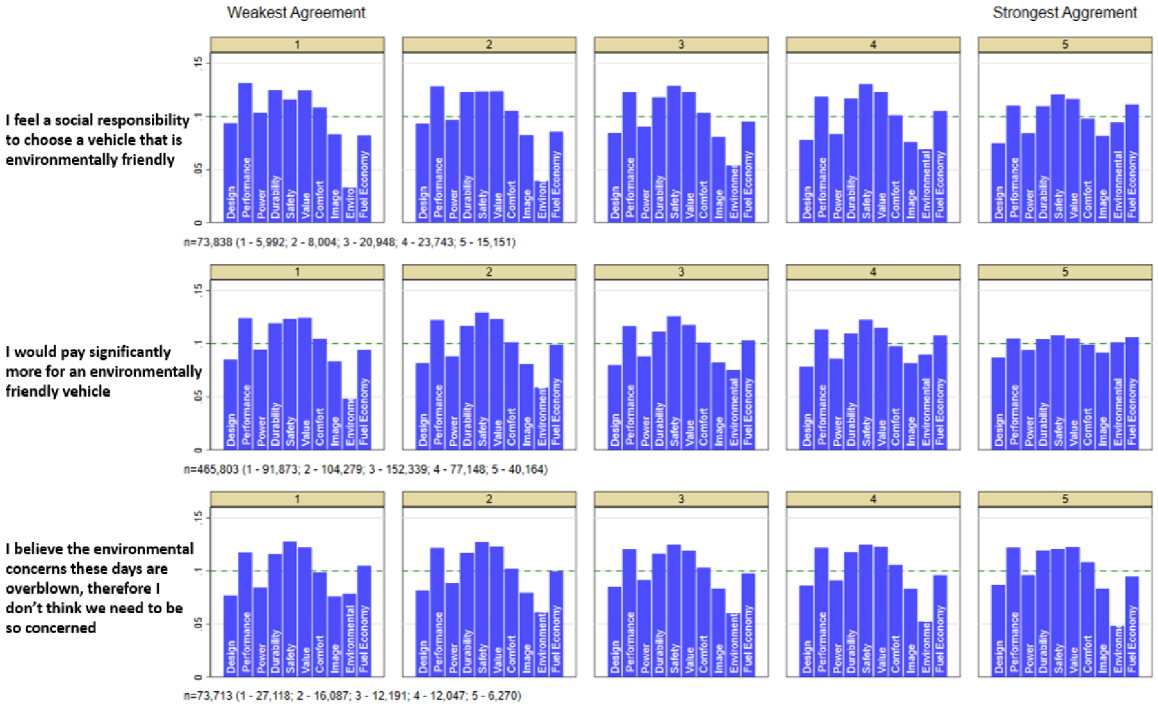

Figure 7. Relative criteria weights – passenger vehicle purchasers grouped by strength of agreement with statements about their environmental preferences

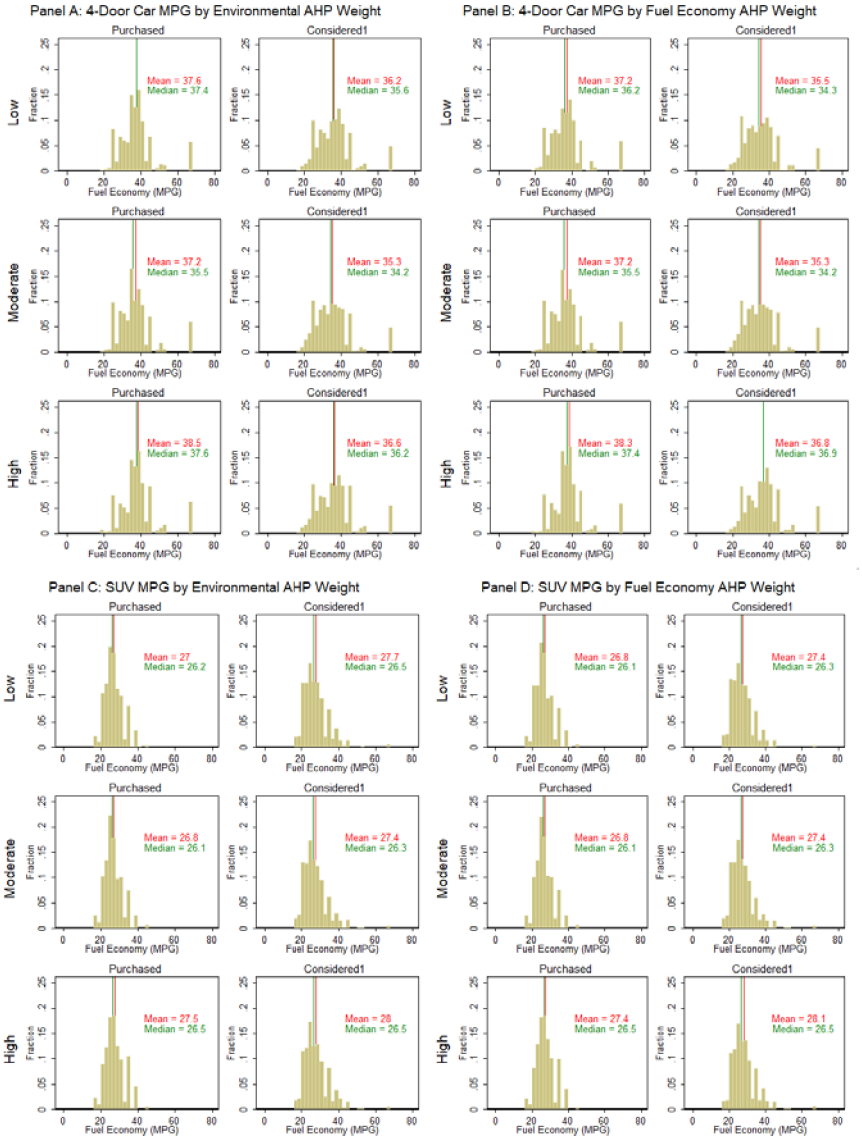

Figure 8. Fuel economy distributions of purchased and considered 4-door cars and SUVs by low, moderate, and high AHP weights of Environment and Fuel Economy

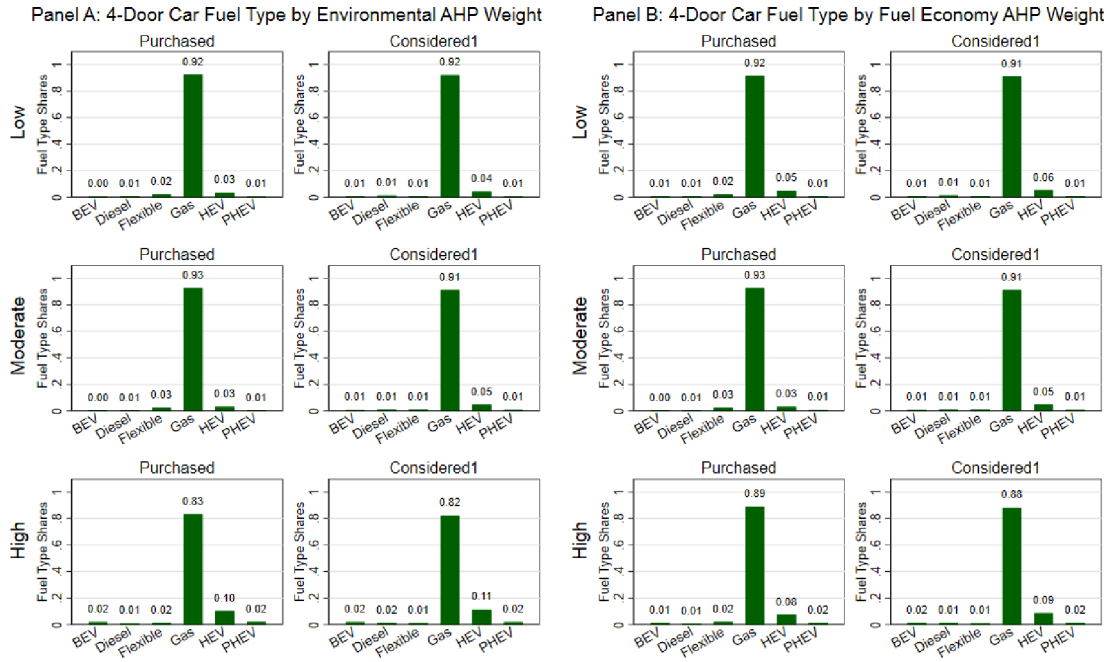

Figure 9. Fuel type distributions of purchased and considered 4-door cars by low, moderate, and high AHP weights of Environment and Fuel Economy

Table 1:

"Overall" attributes in NVES

Attribute	Questionnaire item description	Mean score (s.d.)*	Number of responses with non-missing values
Comfort	Overall seat comfort	4.33 (0.780)	566,838
Versatility	Overall interior versatility	4.06 (0.887)	566,014
Durability	Overall impression of durability/reliability	4.47 (0.711)	672,387
Value	Overall value for the money	4.51 (0.704)	659,891
Power	Overall power and pickup	4.19 (0.854)	692,485
Service Department	Overall experience with the service department	4.07 (1.089)	596,002
Environment	Overall environmental friendliness	3.77 (1.10)	658,008
Vehicle Image	Overall vehicle image	4.16 (0.91)	556,107
Exterior Styling	Overall exterior styling	4.14 (0.881)	695,161
Exterior Workmanship	Overall exterior workmanship	4.23 (0.856)	692,618
Performance	Overall driving performance	4.50 (0.704)	693,389
Interior Styling	Overall interior styling	4.14 (0.843)	691,736
Interior Workmanship	Overall interior workmanship	4.23 (0.817)	691,458
Interior Design	Overall interior design	4.17 (0.824)	691,226
Sound System	Overall performance of sound system	3.96 (0.853)	683,941
Quietness	Overall quietness	4.14 (0.881)	683,160
Safety	Overall safety of the vehicle	4.54 (0.704)	673,920
Engineering	Overall thoughtful engineering	4.27 (0.816)	659,154
Brand Image	Overall brand image	4.07 (0.970)	658,004
Selling Dealership	Overall experience with the selling dealership	4.18 (0.975)	657,423

Notes: The shaded rows are attributes that we focus on in our later analyses of vehicle purchase criteria. In some cases, we combine closely associated items in Table 1 based on exploratory factor analysis; in some cases, we further study the items individually.

* The surveys provided a "combined weight" for each response, which is meant to make the vehicle purchases from the survey sample representative of national vehicle registrations. Here we account for these weights in the mean scores and standard deviation (s.d.) calculation. Scores are on a 1–5 scale, with 5 representing high importance.

Table 2.

Comparison of body styles and fuel types of purchased and alternatively considered vehicles

Vehicle Body style						
	Most Considered Vehicle					
Purchased Vehicle	**2-door car**	**4-door car**	**Convert.**	**Minivan**	**SUV**	**Pickup Truck**
2-door car (n= 18,107)	**56.3%**	30.7%	4.2%	0.1%	6.2%	2.5%
4-door car (n = 130,181)	7.2%	**78.7%**	0.6%	0.4%	11.5%	1.6%
Convertible (n = 5,555)	16.5%	11.0%	**67.1%**	0.1%	4.9%	0.5%
Minivan (n = 9,521)	0.4%	5.0%	0.1%	**67.8%**	25.0%	1.7%
SUV (n = 155,020)	1.3%	14.4%	0.2%	1.1%	**80.1%**	2.9%
Pickup Truck (n = 26,178)	1.0%	2.5%	0.2%	0.1%	5.3%%	**90.1%**
Vehicle Fuel Type						
	Most Considered Vehicle					
Purchased Vehicle	**BEV**	**HEV**	**PHEV**	**Diesel**	**Gas**	**Flexible**
BEV (n = 4,251)	**44.0%**	10.7%	15.3%	3.0%	26.8%	0.3%
HEV (n = 6,629)	2.3%	**46.8%**	3.6%	2.5%	44.0%	0.7%
PHEV (n = 2,276)	15.9%	20.4%	**37.0%**	2.1%	23.9%	0.7%
Diesel (n = 3,797)	1.1%	8.6%	1.5%	34.2%	**54.1%**	0.6%
Gas (n = 291,225)	0.3%	2.9%	0.3%	1.2%	**94.3%**	0.9%
Flexible (n = 24,787)	0.1%	0.9%	0.1%	4.9%	**90.0%**	4.1%

Table 3.

Exploratory Factor Analysis for “Overall” Importance Scores

Buyers of Passenger Vehicles (n = 426,511)					**Buyers of Pickup Trucks (n= 37,551)**				
Attribute-based Criteria	**Design**	**Pragmatic**	**Dealer Experience**	**Image**	**Attribute-based Criteria**	**Design**	**Pragmatic**	**Dealer Experience**	**Image**
Interior design	**0.757**	0.266	0.171	0.176	Interior design	**0.744**	0.290	0.196	0.196
Interior styling	**0.754**	0.208	0.160	0.208	Interior styling	**0.742**	0.238	0.168	0.237
Interior workmanship	**0.747**	0.320	0.180	0.118	Interior workmanship	**0.724**	0.370	0.190	0.149
Exterior workmanship	**0.694**	0.281	0.167	0.188	Exterior workmanship	**0.601**	0.426	0.181	0.222
Exterior styling	**0.688**	0.145	0.138	0.302	Exterior styling	**0.624**	0.253	0.152	0.340
Performance	0.468	0.447	0.164	0.099	Performance	0.409	**0.567**	0.196	0.101
Power	0.460	0.281	0.197	0.168	Power	0.367	0.486	0.172	0.156
Sound system	0.446	0.216	0.223	0.233	Sound system	0.452	0.233	0.229	0.234
Durability	0.318	**0.631**	0.177	0.186	Durability	0.304	**0.641**	0.182	0.244
Safety	0.225	**0.623**	0.198	0.107	Safety	0.240	**0.560**	0.214	0.170
Value	0.141	**0.545**	0.206	0.182	Value	0.172	**0.540**	0.240	0.176
Engineering	0.367	**0.523**	0.223	0.236	Engineering	0.336	**0.570**	0.238	0.264
Seat comfort	0.388	0.432	0.273	0.137	Seat comfort	0.407	0.446	0.256	0.144
Service department	0.177	0.226	**0.686**	0.156	Service department	0.159	0.210	**0.679**	0.154
Dealership	0.195	0.259	**0.680**	0.180	Dealership	0.193	0.252	**0.672**	0.184
Vehicle image	0.403	0.225	0.212	**0.593**	Vehicle image	0.358	0.274	0.225	**0.615**
Brand image	0.274	0.265	0.240	**0.592**	Brand image	0.256	0.263	0.248	**0.616**
Quietness	0.388	0.365	0.225	0.143	Quietness	0.409	0.349	0.222	0.160
Interior versatility	0.413	0.328	0.274	0.267	Interior versatility	0.455	0.350	0.272	0.261
Environment	0.110	0.325	0.284	0.291	Environment	0.173	0.186	0.306	0.296

Notes: Bolded values indicate high factor loadings, with 0.5 cutoff following standard convention. The higher the factor loading, the more correlated the attribute is with the factor.

Table 4.

Attribute-based vehicle selection criteria

Criteria	Survey Item(s) (“Importance of Overall…”)	Relation to Literature
Design	Interior design; Interior styling; Interior workmanship; Exterior workmanship; Exterior styling	Similar to “image” in Hafner et al. [15], “aesthetics view” in Raut et al. [11]
Performance	Driving performance	See, e.g., Byun [12], Vrkljan and Anaby [9], Van Rijnsoever et al. [16]
Power	Power and Pickup	Bundled with other attributes like performance in, e.g., Byun [12]
Durability	Impression of durability/reliability	Comparable to “reliability” in Vrkljan and Anaby [9], Koppel et al. [10]
Safety	Safety of the vehicle	See, e.g., Byun [12], Koppel et al. [10], Raut et al. [11]
Value	Value for the money	Analogous to, e.g., “purchase price” and “maintenance cost” in Higgins et al. [14], “economical aspects” in Raut et al. [11]
Comfort	Seat comfort	See, e.g., Vrkljan and Anaby [9], Raut et al [11]
Image	Vehicle image; Brand image	Encompasses aspects of “style” and “manufacturer” in Raut et al. [11]
Environment	Environmental friendliness	See, e.g., Hafner et al. [15], Higgins et al. [14], Van Rijnsoever et al. [16]
Fuel Economy	Fuel economy/mileage	See, e.g., Higgins et al. [14], Vrkljan and Anaby [9]