2) CHOOSE THE ONE VEHICLE YOU WOULD MOST LIKELY PURCHASE (Vehicle A, B, or C)

Vehicle Features	A	B	C
Vehicle Style:	Pick-up truck	Pick-up truck	Car
Fuel Type:	Gas	Hybrid electric	Diesel
Vehicle Size:	Mid-size/large	Mid-size/large	Mid-size/large
Maintenance Cost Per Year:	$300	$450	$600
Acceleration (0-60 mph):	9 seconds	12 seconds	15 seconds
Incentive:	Not Applicable	No sales tax on purchase	No sales tax on purchase
Gradability:	Not Applicable	60 mph	Not Applicable
Purchase Price:	$45,500	$40,950	$50,050
Fuel Cost Per Year:	$2,115	$1,080	$840
***Check One Vehicle*:**	☐	☐	☐

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Incentives for Alternate Fuel Vehicles: A Large-Scale Stated Preference Experiment

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Abstract

This paper reports on a stated preference (SP) study that was conducted as part of the 2002 California Vehicle Survey of households and businesses. The objective of the SP study was to explore conditions and incentives that might encourage California residents to buy or lease alternate fuel vehicles and to statistically estimate a set of vehicle choice models for use in the California CALCARS vehicle fleet forecasting models. SP data were collected from 2,200 households recruited in in the household portion of the Vehicle Survey. The choice alternatives in the SP experiments included conventional gasoline vehicles, hybrid electric vehicles and diesel vehicles of different size and body style classes. The attributes that were tested included purchase, fuel and maintenance costs, acceleration, gradability and alternative-fuel incentives. Initial estimations assumed a multinomial logit form and focused on the specification of utility functions. Main and interaction effects among the variables were tested and the effects of socio-economic variables on utility values were explored. Once a reasonable set of utility specifications was established, nested logit models of vehicle choice were developed. The model coefficients indicate that fuel cost savings, reductions in vehicle purchase taxes and allowing free parking for alternative-fueled vehicles provide significant purchase incentives for those vehicles. However, the ability of the vehicles to sustain speeds on grades ("gradability") is also a significant factor in purchasers' evaluations of hybrid electric vehicles. The resulting models have been implemented in the CALCARS vehicle fleet forecasting model and are being used by the California Energy Commission (CEC) to analyse strategies for reducing petroleum dependency in the state.

Keywords

Stated preference model, forecasting models for vehicle choice, incentives for alternative fuel vehicles, hybrid electric vehicles, CALCARS, nested logit model, diesel vehicles, vehicle type choices.

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1. Introduction

The California Energy Commission (CEC) is required by state law to analyse strategies for reducing petroleum dependency in the state. To comply with this mandate, the CEC monitors the composition of the current vehicle fleet and developed the California (light duty) Conventional and Alternative Fuel Response Simulator (CALCARS) model (Kavalec, 1996) to predict the composition of future fleets. CALCARS is a forecasting model that estimates the California vehicle fleet composition for future years. Patterned after the Personal Vehicle Model (PVM), developed in 1983 by Kenneth Train for the CEC (Train, 1983), CALCARS uses a set of nested multinomial logit models for vehicle ownership and choice. Unlike the PVM and other vehicle choice models however, CALCARS combines stated and revealed preference data in order to forecast the penetration and use of both conventional and alternative fuel vehicles. Stated preference (SP) methods were first used for the vehicle choice modeling after a successful pilot study that was conducted for the CEC (Bunch, et al, 1993). A 1995 update of the CALCARS model included vehicle choice models estimated from SP surveys. Those models had a multinomial logit structure across alternative vehicle fuel types (gasoline, electric, compressed natural gas, and methanol), body styles and size classes similar to models estimated at the University of California Institute of Transportation Studies (Golob, et al, 1995).

Data for the CALCARS model are collected periodically in statewide surveys, the most recent of which was conducted in 2002. As part of the 2002 update, the CEC wished to explore current conditions and incentives for encouraging use of alternate fuel (AF) vehicles among California residents. Hybrid electric and diesel vehicles have just begun penetrating the U.S. market and there was an active policy interest in determining the factors that would impact the rate of penetration of those vehicles. Among the AF vehicle incentives that have been considered and, in some locations, implemented, are vehicle registration tax reductions, free parking and eligibility for use of high occupancy vehicle lanes. In addition, in California as in the rest of the U.S., there have been significant shifts in vehicle type choices toward sport utility vehicles (SUVs), light duty trucks and vans which have higher gasoline consumption rates. The CEC was especially interested in developing a model that was sensitive to the differential competition that exists in vehicle replacement among different vehicle types, recognizing that their existing multinomial logit vehicle choice model likely did not completely represent the structure of choices in this market.

To address these issues, the CEC requested a large-scale SP study to be conducted and used to statistically estimate a set of vehicle choice models, sensitive to AF incentives and reflecting a more general choice structure for use in the CALCARS forecasting system. The authors of this paper were involved in the design and conduct of the 2002 California Vehicle Survey, including the large-scale SP study and the development of the vehicle choice models.

This paper reports on the design and conduct of the SP experiment and the development of the household vehicle choice models in the 2002 California Vehicle Survey. The following section of this paper describes the structure of vehicle choice models selected for this study. The third section describes the methods used in the recruitment of subjects for the SP experiments, the design of the SP experiment, the retrieval of the completed SP instruments, and the description of the final sample. The fourth section presents the results of the model estimation. The last section contains a summary and conclusions.

2. The Vehicle Choice Model

The CALCARS model segments the residential population by the number of vehicles owned and forecasts the vehicle fleet for various scenarios by simulating each household's vehicle ownership, based on probabilities of vehicle choice from vehicle choice models. Thus, vehicle choice models compatible with CALCARS must yield probabilities of choices of various car ownership alternatives. Furthermore, they should be specified and estimated for households by the number of vehicles owned.

In selecting the model structure for the vehicle choice model, it was assumed that households maximize their own utility with regard to their choices of vehicles. The multinomial logit model (Ben-Akiva and Lerman, 1985) which is used for a wide range of choice contexts and was part of the existing CALCARS system, was considered to be unlikely to accurately represent choice behaviour in this case because it requires that the choice alternatives be relatively undifferentiated perfect substitutes. In the case of vehicle choice, it is very likely that this condition does not hold for many households. For example, a subcompact car may not serve a household the same way as a pickup truck if that household needs a vehicle for transporting objects. Therefore, the nested logit model structure (Ben-Akiva and Lerman, 1985) was considered for this study. It is a model of discrete choice based on the assumption of utility maximization and the nested model structure allows the consideration of alternatives that are not totally independent from each other.

The model assumes that a household's utility for a given vehicle can be defined in general terms as:

$$U_{fbs}=f(X_{fbs}, SE)$$

Where X_{fbs} is a vector of attributes that vary across the choice dimensions, such as fuel type (f), body style (b) , and size class (s))[1] and SE is a vector of socio-economic variable describing the household.[2]

The probability of a given alternative being chosen is defined by the nested logit model tree, in which the nests at lower levels of the tree are treated as conditional choices to those above. Determining the structure of this tree is an empirical exercise guided by consistency conditions and statistical fit. The most appropriate structure of the nested logit model can be determined using an empirical approach. A tree structure is specified, consisting of hierarchical nests. The coefficients of inclusive prices variables (the log of the sum of the exponentiated utilities within each nest) for this tree structure can be statistically estimated using a full information maximum likelihood (FIML) procedure . To be consistent with the utility maximizing principle, these inclusive price coefficients should

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[1] Some attributes may vary across only one or two of these dimensions.

[2] These attributes can be specified only as alternative-specific variables which take on a value of zero for at least one of the alternatives. As with the vehicle attributes, they may be specified in a way such that they vary across any one or more of the choice dimensions.

generally be between 0 and 1.0. If they are not, alternative forms of the nesting structure should be tested.

As an example, it might turn out that the choice of body style is at the top level of the tree, followed by the size class, and then by fuel type. The corresponding structure is shown below in Figure 1.

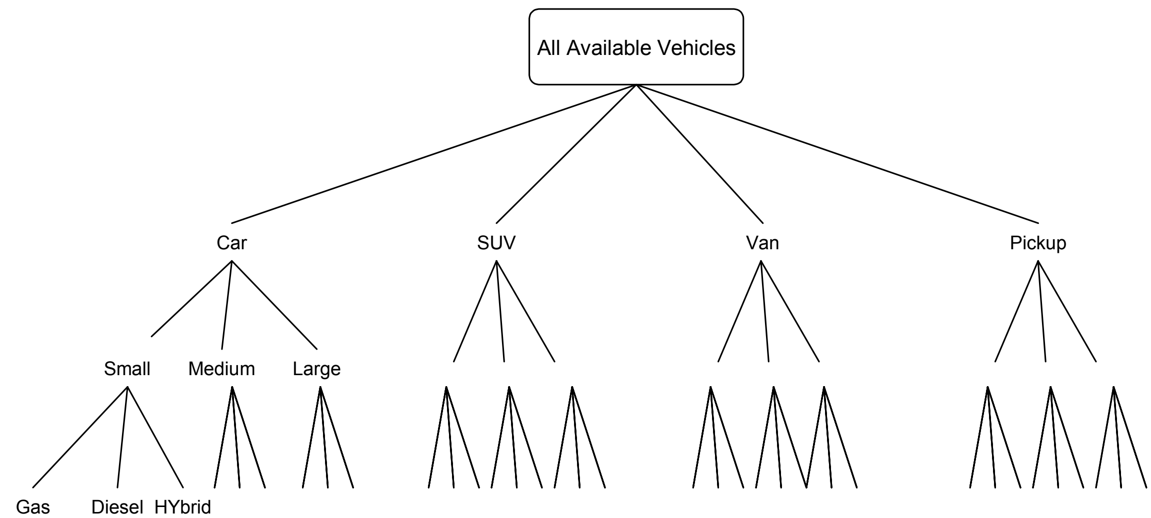

Figure 1: Example of nest hierarchy in vehicle choice

For the tree structure shown in Figure 1, the choice would be modeled as:

$$p(fbs)=p(b)*p(s|b)*p(f|bs)$$

The conditional probability of a particular fuel type being chosen given a specified body style and size class is a multinomial choice among the available fuel types. The conditional probability of size class choice has an inclusive price term from the fuel type nest and the marginal probability of body style has the inclusive price from the size class choice nest. The mathematical form of this model form is well-documented in the literature (Ben-Akiva and Lerman, 1985).

3. The SP Experiments

3.1 Recruit Survey

A set of SP experiments was designed to provide data for the development of the vehicle choice models. A fully representative sample of 4,178 California households was recruited through random-digit-dial (RDD) telephone interviewing. In this initial recruit interview, information was obtained regarding household characteristics including make, model, and vintage of all vehicles owned or leased by the household for general transportation purposes. Eligible household respondents had at least co-decision making responsibilities for the selection and purchase of household vehicles. Respondents were informed of the objectives of the follow-up SP survey and were requested to participate if they planned to add or replace a household vehicle within the next six years. The characteristics of recruited household respondents were compared with 2000 U.S. Census data by region, household size, number of vehicles, age, educational status, gender and income, and were found to be fully representative.

Eight percent of recruited households were unwilling to participate in the follow-up survey and 12.2% of recruited households (largely elderly households) stated that they would not be adding or replacing a vehicle within the next six years. Thus, 3333 eligible households were recruited to participate in the SP survey.

3.2 SP Survey Instrument

The vehicle choice alternatives for the SF experiment study were labeled by the following categories of vehicle fuel type, body style, and vehicle size:

1. Fuel type - gasoline-powered, hybrid-electric, diesel powered
2. Body style - car, van, SUV, pick-up truck
3. Vehicle size - subcompact, compact, mid/large-size, and full-size.

The attributes of the choice alternatives were:

1. Purchase price - cost of vehicle
2. Fuel cost per year
3. Maintenance cost - include fees for oil changes and regular maintenance
4. Acceleration - time in seconds to travel from 0 to 60 mph
5. Alternate fuel incentive - benefit to consumer from buying AF vehicle
6. Gradability - speed which hybrid vehicle could maintain while climbing a 20-mile mountainous grade with full load

Each respondent completed a set of eight choice exercises, each involving a choice from among three alternatives. The choices presented to each respondent were constructed specifically for that respondent. Each choice exercise had a base alternative, specified by the most likely characteristics of the next purchase (as elicited from the respondent in the Recruit Survey). Those characteristics were augmented by environmental variables to define the base conditions for each scenario. Two AF vehicles were constructed for each scenario and the respondent was asked to select his/her preferred alternative from among the two AF vehicles and the base vehicle. Attribute values for the two AF alternatives were selected from the following levels of attributes:

1. Purchase price
   - base price (specified by respondent in the recruit survey)
   - 10% higher than base price
   - 10% lower than base price
   - 20% lower than base price

2. Fuel Cost
   - $ 0.12/mile,
   - $ 0.09/mile
   - $ 0.06/mile
   - $ 0.03/mile

3. Annual Maintenance Cost
   - $ 600
   - $ 450
   - $ 300
   - $ 150

4. Acceleration (0-60 mph)
   - 15 sec
   - 12 sec
   - 9 sec
   - 6 sec

5. AF Incentive
   - None
   - Free public and meter parking
   - Use of HOV lanes
   - No vehicle sales tax on purchase

6. Gradability
   - 30 mph
   - 45 mph
   - 60 mph
   - 75 mph

3.3 Experimental Design

The levels of attributes assigned to the AF vehicles in the respondent's eight choice exercises came from a design matrix developed for the study. The design followed the general approach for SP surveys that are used to develop discrete choice models (Louviere, Hensher and Swait, 2000). The matrix had a total of 128 scenarios. The first 64 scenarios were generated from 411-8 main effects design and the remaining 64 scenarios were generated from two 211-6 endpoint main effects and interaction designs to measure 2-way within alternative attribute interactions. Of the eight scenarios assigned to each respondent, four were sampled without replacement (in blocks of 16 respondents) from the first 64 (main effects) and four were sampled without replacement (in blocks of 16 respondents) from the second 64 (endpoint main effects and interactions). This design provided sufficient data for estimating both utility function coefficients and nest parameters of a nested vehicle class choice model.

3.4 SP Experiment Data Retrieval

Each recruited household was mailed a package containing the SP survey instrument, instructions, and vehicle definitions (see Appendix A). The package was addressed to the person who participated in the recruitment survey, although it was requested that the person most responsible for the vehicle ownership decisions of the household complete the SF choice exercises. Respondents were given the opportunity to respond to the SP survey by mail, Internet, or phone. A stamped mail-back envelope was provided for those respondents who indicated that they would mail back the completed questionnaire. Reminder calls were made to households not initially completing the survey, and respondents were allowed to switch their mode of responding. Overall, 66.8% of recruited, eligible households completed the SP portion of the residential California Vehicle Survey. At the conclusion of the survey, 65.0% of household respondents had chosen to answer by mail, 24.8% by Internet, and 10.2% by phone. The SP exercises took an average of 10 minutes to complete by Internet and an average of 13 minutes to complete by phone.

Once a respondent's survey was received, a thank you letter with a check for US$15 was sent.

Table 1 compares the characteristics of the respondents who completed the SP exercises against the eligible sample recruited for the SP experiment by totals and by method of responding. Overall, the completed SP survey was fully representative of the recruited, eligible sample for every characteristic sub-category. The only exception was the group of respondents, age 25-34who comprised 20.6% of the recruited sample and 17.6% of those completing the SP survey.However, by mode of responding, differences in response rates by subcategories were more pronounced. Had only the mail method of return been used for the SP survey, males, those age 18 to 34, those with a college degree, and, those with household incomes between $75,000 and less than $100,000 as well as households with incomes over $150,000 would have been significantly underrepresented.

The mail mode of return for the SP survey was highest among females, those age 55 and older, those with only a high school diploma or less education, and those with household incomes under $20,000. Conversely, the Internet mode of return increased the overall representativeness of the completed SP survey by producing significantly higher response rates among those age 35 to 44, those with at least a college degree, and those with household incomes of $75,000 or more. The Internet mode produced significantly lower response rates among those age 65 or older, those with less than a college degree, and those with household incomes below $20,000,

The phone method of response increased the representativeness of the overall SP response by producing significantly higher response rates among females and those with household incomes of $20,000 to less than $50,000. Conversely, the phone mode produced significantly lower response rates among males and households with incomes between $75,000 to less than $100,000. These results are generally consistent with previous split samples studies which have shown that providing an Internet response option can increase both the representativeness of a sample and the response rate (Adler, Rimmer and Carpenter, 2002).

Table 1: Representativeness of Completed Stated Preference Sample by Total and Method of Data Collection Compared to Total Recruited Eligible Sample

Summary	Sub-Category	Total Recruited Eligible Sample		Completed Stated Preference Sample		Mail		Internet		Phone	
Household/Respondent Characteristics											
Total Number of Household Respondents			3333		2227		1448		552		227
Gender	Male		45.3%		43.3%	▼	42.2%		48.9%	▼	37.0%
	Female		54.7%		56.7%	▲	57.8%		51.1%	▲	63.0%
Age	18-24 years		7.8%		6.5%	▼	5.5%		7.8%		10.1%
	25-34 years		20.6%	▼	17.6%	▼	15.7%		20.5%		22.5%
	35-44 years		24.4%		24.4%		22.9%	▲	30.4%		18.9%
	45-54 years		21.5%		22.8%		22.9%		22.5%		22.5%
	55-64 years		13.6%		14.9%	▲	15.8%		12.1%		15.4%
	65 or older		10.7%		12.3%	▲	15.5%	▼	5.6%		7.9%
	DK/Refused		1.4%		1.5%		1.7%		1.1%		2.7%
Education	High school or less		22.00%		22.0%	▲	24.6%	▼	13.2%		27.3%
	Some college		34.1%		33.3%		35.1%	▼	26.3%		38.8%
	College degree		26.2%		25.7%	▼	23.0%	▲	34.8%		21.1%
	Post graduate/degree		17.6%		18.8%		17.3%	▲	25.4%		12.8%
	DK/Refused		0.1%		0.2%		0.0%		0.3%		0.0%
Number of Vehicles in Household	1		29.3%		30.9%		30.0%		31.5%		35.0%
	2		43.9%		44.0%		45.2%		41.3%		42.7%
	3		17.9%		17.4%		17.0%		19.7%		14.1%
	4 or more		8.9%		7.7%		7.8%		7.5%		8.2%
Household Income	Less than $20,000		7.7%		8.5%	▲	9.9%	▼	4.1%		10.4%
	$20,000 to <$50,000		30.5%		30.8%		31.8%		25.0%	▲	38.3%
	$50,000 to <$75,000		22.5%		23.2%		23.8%		21.3%		23.9%
	$75,000 to <$100,000		16.8%		15.3%	▼	14.4%	▲	20.4%	▼	9.0%
	$100,000 to <$150,000		13.0%		13.4%		12.2%	▲	17.4%		11.3%
	More than $150,000		6.1%		5.4%	▼	4.3%	▲	8.7%		4.1%
	DK/Refused		3.4%		3.4%		3.6%		3.1%		3.0%

▼ Significantly lower than total recruited,eligible sample
▲ Significantly higher than total recruited eligible sample

3.5 Model Development

The vehicle choice dataset included 2,200 households with approximately 17,500 choice observations, each containing a single SP response along with household data from the recruit survey. Table 2 shows the distribution of the number of households and choice observations by household car ownership.

Table 2: Distribution of the Sample

Number of Vehicles	Number of Households	Number of Observations
1	673	5,384
2	960	7,680
3+	549	4,392
All	2,182	17,456

This provided sufficient data for identifying the structural parameters of a nested logit model and for estimating the main effects of key variables, interaction effects for selected attributes, and differential class structure cross-elasticities. Separate models were developed for one-car, two-car and three plus-car households.

The initial estimations assumed a multinomial logit form and focused on the specification of utility functions. Main and interaction effects among vehicle attributes were tested and the effects of socio-economic variables on utility values were explored. A combination of statistical tests and reasonability checks was used to determine the most appropriate utility function specifications. The models were segmented according to household characteristics as appropriate. Main and interaction effects among vehicle attributes were tested and the effects of socio-economic variables on utility values were explored. A combination of statistical tests and reasonability checks were used to determine the most appropriate utility function specifications. The models include the effects of each of the variables that were included in the stated preference experiments. The effects of purchase cost, maintenance costs, fuel costs, and acceleration rate are included variables for all vehicle types. The effects of incentives for hybrid vehicles including free parking, use of high occupancy vehicle lanes, and tax reductions and the effect of limitations on hybrid vehicles' grade-climbing ability are measured using alternative-specific coefficients. The influences of demographic characteristics such as geographic location, age, income, household size and gender were also identified.

Once a set of reasonable specifications was established, nested logit models were tested. The ALOGIT statistical package was used to estimate coefficients of nested logit models. Since ALOGIT assumes a tree structure that is not necessarily consistent with utility maximization ("non-normalized" form), a dummy node structure was used as necessary to ensure that the resulting model was in a normalized form. The nesting dimensions that were tested included fuel type, vehicle body type and vehicle size. A full information maximum likelihood estimation procedure was used to estimate the coefficients and structural parameters of the nested logit models. Over 200 nesting structures were tested, involving different combinations of three fuel types (gasoline, diesel and hybrid), three size classes (subcompact, compact, mid/large) and four body types (car, truck, SUV, van).

3.6 Estimation Results

Almost without exception, coefficients of the SP attributes had the expected signs and were statistically different from zero. Purchase price, maintenance and fuel costs were found as expected to have negative signs, meaning that, all else equal, consumers prefer lower prices. The values of the coefficients varied by segment and also varied across the specifications that were tested. In general, the coefficient values imply that customers will spend an additional $2,000 to $10,000 in purchase price to save $1,000 in annual fuel costs.

The two vehicle performance characteristics that were included as SP attributes, gradability and acceleration rate have opposite signs due to the way in which they were specified. Gradability was defined as the maximum sustainable speed on an upgrade and thus its coefficient has a positive sign, meaning a higher speed is more desirable. Acceleration rate was defined as the number of seconds required to reach 60 mph so its coefficient has a negative sign. Again, the values of these coefficients vary across segments but generally fall in a range such that vehicle buyers are willing to spend $200 to $1,000 for each 10 mph increase in gradability.[3] For comparison, the coefficients indicate that consumers are willing to pay between $100 and $300 extra for each one-second decrease in the amount of time required for the vehicle to reach 60 mph.

The gradability and acceleration factors as specified in these models are both linear, meaning that the effects are constant across the range that was tested (6 to 15 seconds for acceleration from 0 to 60 mph and sustained speeds of 30 to 75 mph). Several sets of specification tests were conducted to determine whether acceleration and gradability effects are in fact linear within those ranges and whether there are significant demographic variations in preference. For gradability, the greatest effect, as might be expected, is in going from 45 mph to 60 mph sustained speed. The differences between 30 mph and 45 mph and between 60 mph and 75 mph are somewhat lower. However, these differentials are not all statistically significant in the models and so the linear specification was retained.

[3] Or, conversely, they will be willing to pay this much less for a vehicle with lower gradability. Note that this attribute applies only to hybrid vehicles; conventional gasoline and diesel vehicles were assumed, for all practical purposes, to be unaffected by sustained grades.

The specification tests for acceleration included a quadratic specification in which the second-power term was statistically significant, indicating a greater difference in preference in going from 15 seconds to 12 seconds than from 12 to 9 or 9 to 6. However, the range of acceleration values tested spans the stationary point determined by the coefficient values, resulting in the expected monotonicity condition to be violated within this range of acceleration rates.4 Although it is possible that some buyers might, under some conditions, prefer lower acceleration rates, the linear specification was retained to reflect the monotonic relationship that is more likely to hold across the full population of vehicle purchasers.

Several types of variations were identified in the strength of preference that buyers have for acceleration. In general, as might be expected, males placed a higher weight on acceleration than did females and younger buyers placed higher weights than older buyers. However, these effects were not included in the final forecasting models for CALCARS as the forecasting inputs to those models do not include age and gender.

Three incentives were included in the SP experiments for diesel and hybrid vehicles and all were found to have the expected positive coefficients indicating that they were posi-

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[4] The coefficients and statistics for the acceleration variables (in seconds) are shown below.

	accelRate	accelRatesq
Estimate	.8351	-.4258E-01
"T" Ratio	18.2	-19.5

The quadratic term is statistically significant but improves the log likelihood by only 2%. The table below shows the resulting utility values from these terms:

Accel (sec.)	Utility (from acceleration terms)
6	3.5
7	3.8
8	4.0
9	4.1
10	4.1
11	4.0
12	3.9
13	3.7
14	3.3
15	2.9

tively valued. The values attributed to forgiving the purchase tax and providing free parking at municipal lots and spaces each range between $200 and $900. Providing access to diamond (high occupancy vehicle) lanes is generally a much lower-valued incentive, likely because only a fraction of California vehicle owners travel in corridors where they can take advantage of these lanes.

A number of specification tests were conducted to determine how various household characteristics affect vehicle choice. Consistent effects were identified for three such characteristics: household size, household income and residence location. Household size was found to affect vehicle type and size choices: larger households generally prefer larger vehicles. Buyers' sensitivity to purchase price and maintenance costs were found to be inversely affected by income: the sharpest break occurs at incomes of approximately $50,000. Residence location was found to affect the value attributed to diamond lanes , reflecting the fact that diamond lanes are not available in many areas in California. San Francisco residents were found to be more receptive to hybrid vehicles even after accounting for obvious demographic and travel characteristics. The specification tests also included an analysis of two-way interaction effects among the SP attributes, but none were found to significantly improve the models statistically.

Once a set of reasonable specifications was established, nested logit models were tested. The nesting dimensions that were tested included fuel type, vehicle body type and vehicle size. In total, 30 vehicle types were defined as described in Table 3.

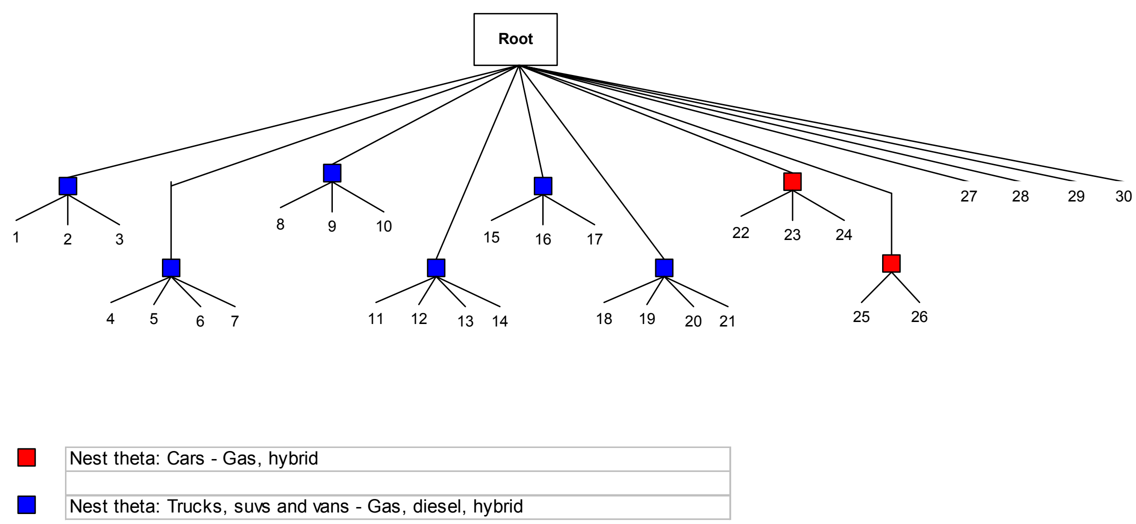
Table 3: Vehicle Types

1	Truck, Mid-size/large, Gas	16	Van, Mid-size/large, Hybrid
2	SUV, Mid-size/large, Gas	17	SUV, Mid-size/large, Hybrid
3	Van, Mid-size/large, Gas	18	Truck, Compact, Hybrid
4	Truck, Compact, Gas	19	SUV, Subcompact, Hybrid
5	Van, Compact, Gas	20	Van, Compact, Hybrid
6	SUV, Subcompact, Gas	21	SUV, Compact, Hybrid
7	SUV, Compact, Gas	22	Car, Subcompact, Hybrid
8	Truck, Mid-size/large, Diesel	23	Car, Mid-size/large, Hybrid
9	SUV, Mid-size/large, Diesel	24	Car, Compact, Hybrid
10	Van, Mid-size/large, Diesel	25	Car, Subcompact, Gas
11	SUV, Subcompact, Diesel	26	Car, Mid-size/large, Gas

12	Van, Compact, Diesel	27	Car, Compact, Diesel
13	SUV, Compact, Diesel	28	Car, Mid-size/large, Diesel
14	Truck, Compact, Diesel	29	Car, Subcompact, Diesel
15	Truck, Mid-size/large, Hybrid	30	Car, Compact, Gas

In general, the nesting structures that worked best5 have a single nesting layer with nests distinguishing trucks, SUVs, vans and cars by fuel type. The tables and figures below show the coefficients and nesting structures of the final estimated models for use in the CALCARS regional applications.6 Figures 2 to 4 below show the nesting structures. Models shown are for three levels of vehicle ownership levels (1, 2 and 3+) and for CALCARS regional applications.

Figure 2: Nesting Structure for 1-Vehicle Segment



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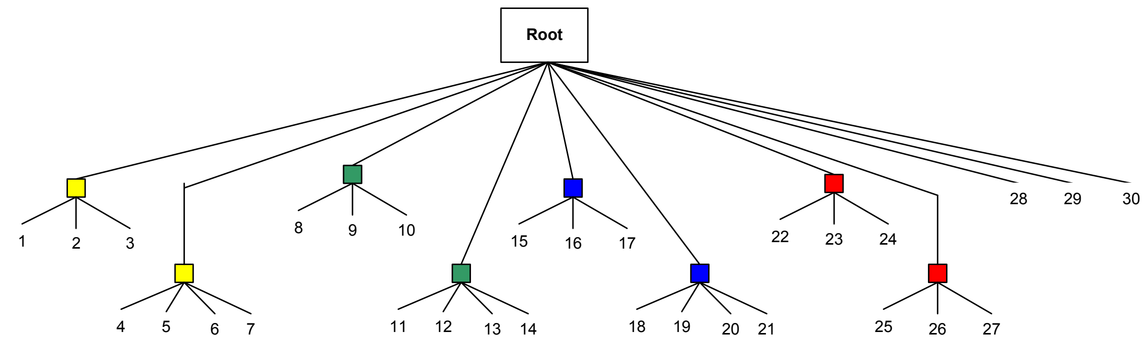
[5] "Best" is defined here as having nest parameters in the range of 0 to 1 and maximizing the log likelihood.

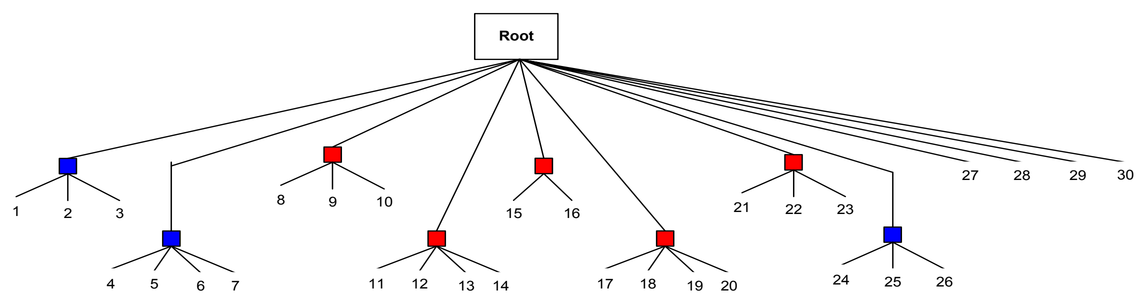
[6] A separate set of models was developed for statewide applications, removing regional locational variables.

Figure 3: Nesting Structure for 2 Vehicle Segment



- Nest theta: Cars - Gas, hybrid
- Nest theta: Trucks, suvs and vans - Hybrid
- Nest theta: Trucks, suvs and vans - Diesel
- Nest theta: Trucks, suvs and vans - Gas

Figure 4: Nesting Structure for 3+ Vehicle Segment



- Nest theta: Trucks, suvs, cars and vans - Gas
- Nest theta: Trucks, suvs, cars and vans -Diesel, hybrid

The tables below show the estimated nested coefficients for each vehicle ownership segment. Following each table of coefficients is a second table indicating which coefficients apply to each type of vehicle.

Table 4a: Regional Model for 1 Vehicle Segment

	Nested Coefficient	T-Stat
Purchase cost for HH income <$50K ($/10,000)	-0.535	-4.5
Purchase cost for HH income >$50K ($/10,000)	-0.172	-1.8
Maintenance cost for HH income < $50 K ($/100)	-0.179	-8.8
Maintenance cost for HH income > $50 K ($/100)	-0.127	-5.3
Fuel cost ($/10,000)	-2.542	-5.8
Gradability (mph)	0.014	7
Acceleration rate (sec. for 0-60 mph)	-0.054	-7.3
Incentive: Free parking	0.103	1
Incentive: Diamond lanes	0.159	1.6
Incentive: No tax	0.216	3.1
Subcompact constant	0.000	0
Compact constant	0.491	5.7
Mid-size/large constant	0.343	3.2
Car constant	0.000	0
SUV constant	-0.966	-4.4
Pickup constant	-1.591	-6.5
Van constant	-2.097	-7.3
Gas constant	0.000	0
Hybrid constant	-1.692	-12
Diesel Constant	-1.657	-21.3
San Francisco hybrid constant	0.354	3.9
San Diego hybrid constant	-0.406	-2.5
Household size for group 1* vehicles (# people)	0.152	2.8
Household size for group 2* vehicles (# people)	0.379	5.2
Inertia for current vehicle type and size	0.632	8.6
Nest theta: Cars - Gas, hybrid	0.870	24.7
Nest theta: Trucks, SUVs and vans - Gas, diesel, hybrid	0.739	18.4

Group 1: Subcompact SUVs, compact SUVs, mid-size/large cars
Group 2: Mid-size/large Trucks, compact vans, mid-size/large vans, mid-size/large SUV
Base: Subcompact cars, compact cars, compact trucks

Table4b: Coefficients for Vehicle Type, 1 Vehicle Regional Model

	Gas	Hybrid	Diesel
Purchase cost for HH income <$50K ($/10,000)	x	x	x
Purchase cost for HH income >$50K ($/10,000)	x	x	x
Maintenance cost for HH income < $50 K ($/100)	x	x	x
Maintenance cost for HH income > $50 K ($/100)	x	x	x
Fuel cost ($/10,000)	x	x	x
Gradability (mph)		x	
Acceleration rate (sec. for 0-60 mph)	x	x	x
Incentive: Free parking		x	x
Incentive: Diamond lanes		x	x
Incentive: No tax		x	x
Subcompact constant	x	x	x
Compact constant	x	x	x
Mid-size/large constant	x	x	x
Car constant	x	x	x
SUV constant	x	x	x
Pickup constant	x	x	x
Van constant	x	x	x
Gas constant	x		
Hybrid constant		x	
Diesel Constant			x
San Francisco hybrid constant		x	
San Diego hybrid constant		x	
Household size for group 1* vehicles (# people)	x	x	x
Household size for group 2* vehicles (# people)	x	x	x
Inertia for current vehicle type and size	x	x	x

Table5a: Regional Model for 2 Vehicle Segment

	Nested Coefficient	T-Stat
Purchase cost for HH income <$50K ($/10,000)	-0.642	-4.4
Purchase cost for HH income >$50K ($/10,000)	-0.460	-5.9
Maintenance cost for HH inc. < $50K ($/100)	-0.207	-7.6
Maintenance cost for HH inc. > $50K ($/100)	-0.148	-7.9
Fuel cost ($/10,000)	-3.441	-6.6
Gradability (mph)	0.015	7.2
Acceleration rate (sec. for 0-60 mph)	-0.077	-9.7
Incentive: Free Parking	0.175	1.9
Incentive: Diamond Lanes in San Francisco	0.177	1
Incentive: Diamond Lanes in Los Angeles	0.073	0.6
Incentive: No Tax	0.237	3.7
Subcompact constant	0.000	0
Compact constant	0.477	5.3
Mid-size/large constant	0.835	9
Car constant	0.000	0
SUV constant	-1.499	-4.2
Pickup constant	-1.900	-5.1
Van constant	-2.765	-5.8
Gas constant	0.000	0
Hybrid constant	-1.637	-9.9
Diesel Constant	-1.552	-12.7
San Francisco hybrid constant	0.544	5.6
Household size for group 1* vehicles	0.184	3.1
Household size for group 2* vehicles	0.259	4.6
Household size for group 3* vehicles	0.418	5.2
Inertia for current vehicle type and size	0.725	9.4
Nest theta: Cars - Gas, hybrid	0.835	14.9
Nest theta: Trucks, SUVs and vans - Hybrid	0.699	10.4
Nest theta: Trucks, SUVs and vans - Diesel	0.654	15.1
Nest theta: Trucks, SUVs and vans - Gas	0.508	9.2

Group 1: Compact trucks, compact SUVs
Group 2: Subcompact SUVs, mid-size/large SUVs, mid-size/large trucks
Group 3: Mid-size/large vans, compact vans
Base: Subcompact cars, compact cars, mid-size/large cars

Table5b: Coefficients for 'Vehicle Type, 2+ Vehicle Regional Model

	Gas	Hybrid	Diesel
Purchase cost for HH income <$50K ($/10,000)	x	x	x
Purchase cost for HH income >$50K ($/10,000)	x	x	x
Maintenance cost for HH income < $50K ($/100)	x	x	x
Maintenance cost for HH income > $50K ($/100)	x	x	x
Fuel cost ($/10,000)	x	x	x
Gradability (mph)		x	
Acceleration rate (sec. for 0-60 mph)	x	x	x
Incentive: Free Parking		x	x
Incentive: Diamond Lanes in San Francisco		x	x
Incentive: Diamond Lanes in Los Angeles		x	x
Incentive: No Tax		x	x
Subcompact constant	x	x	x
Compact constant	x	x	x
Mid-size/large constant	x	x	x
Car constant	x	x	x
SUV constant	x	x	x
Pickup constant	x	x	x
Van constant	x	x	x
Gas constant	x		
Hybrid constant		x	
Diesel Constant			x
San Francisco hybrid constant		x	
Household size for group 1* vehicles	x	x	x
Household size for group 2* vehicles	x	x	x
Household size for group 3* vehicles	x	x	x
Inertia for current vehicle type and size	x	x	x

Table6a: Regional Model for 3+ Vehicle Segment

	Nested Coef-ficient	T-Stat
Purchase cost ($/10,000)	-0.452	-5.7
Maintenance cost for HH income < $50K ($/100)	-0.103	-3.3
Maintenance cost for HH income > $50K ($/100)	-0.097	-5.4
Fuel cost ($/10,000)	-1.021	-2
Gradability (mph)	0.005	2.6
Acceleration rate (sec. for 0-60 mph)	-0.072	-9
Incentive: Free parking in San Francisco	0.440	2.1
Incentive: Free parking in other regions	0.245	1.1
Incentive: Diamond Lanes in San Francisco	0.001	0
Incentive: Diamond Lanes in San Diego	0.367	1.2
Incentive: Diamond lanes in Sacramento	0.265	0.8
Incentive: No tax	0.097	1.4
Subcompact constant	0.000	0
Compact constant	0.060	0.6
Mid-size/large constant	0.641	6.3
Car constant	0.000	0
SUV constant	0.140	1.6
Pickup constant	0.458	2.2
Van constant	-1.272	-4.4
Gas constant	0.000	0
Hybrid constant	-1.118	-6.8
Diesel constant	-1.007	-8.7
San Francisco hybrid constant	0.455	3.4
Los Angeles hybrid constant	0.305	2.8
Sacramento hybrid constant	0.410	2.2
Household size for group 1* vehicles	0.139	2.5
Household size for group 2* vehicles	0.325	4
Inertia for current vehicle type and size	0.406	4.6
Nest theta: Trucks, SUVs, cars and vans - Gas	0.646	11
Nest theta: Trucks, SUVs, cars and vans -Diesel, hybrid	0.788	23.1

Group 1: Compact cars, mid-size/large cars, subcompact cars, compact SUVs, subcompact SUVs, mid-size/large SUVs.
Group 2 Mid-size/large vans, compact vans.
Base: Compact trucks and mid-size/large trucks.

Table6b: Coefficients for Vehicle Types: 3+ Vehicle Regional Model

	Gas	Hybrid	Diesel
Purchase cost ($/10,000)	x	x	x
Maintenance cost for HH income < $50K ($/100)	x	x	x
Maintenance cost for HH income > $50K ($/100)	x	x	x
Fuel cost ($/10,000)	x	x	x
Gradability (mph)		x	
Acceleration rate (sec. for 0-60 mph)	x	x	x
Incentive: Free parking in San Francisco		x	x
Incentive: Free parking in other regions		x	x
Incentive: Diamond Lanes in San Francisco		x	x
Incentive: Diamond Lanes in San Diego		x	x
Incentive: Diamond lanes in Sacramento		x	x
Incentive: No tax		x	x
Subcompact constant	x	x	x
Compact constant	x	x	x
Mid-size/large constant	x	x	x
Car constant	x	x	x
SUV constant	x	x	x
Pickup constant	x	x	x
Van constant	x	x	x
Gas constant	x		
Hybrid constant		x	
Diesel constant			x
San Francisco hybrid constant		x	
Los Angeles hybrid constant		x	
Sacramento hybrid constant		x	
Household size for group 1* vehicles	x	x	x
Household size for group 2* vehicles	x	x	x
Inertia for current vehicle type and size	x	x	x

4. Summary and Conclusions

Vehicle choice models that included alternative fuel vehicles and incentives for alternative fuels were developed for the California CALCARS vehicle fleet forecasting system. Data were obtained from an SP choice survey of a representative sample of Californians, who intended to change or add a vehicle in the next six years. The SP experiment was designed to provide the data needed for developing and estimating vehicle choice models.

The completed SP instruments were retrieved from the respondents by three different modes: telephone, mail-back, and Internet. Given the apparent propensity of different segments of the population to respond to SP surveys such as the California Vehicle Survey via different response modes, the multi-method data collection approach was more successful at providing an overall representative response sample than any one mode would likely have been on its own.

Nested logit models were estimated for choice among vehicles with different fuel types, body styles and sizes. The model coefficients indicate that fuel cost savings, reductions in vehicle purchase taxes and allowing free parking for alternative-fueled vehicles provide significant purchase incentives for those vehicles. However, the ability of the vehicles to sustain speeds on grades ("gradability") is also a significant factor in purchasers' evaluations of hybrid electric vehicles. The resulting models have been implemented in the CALCARS vehicle fleet forecasting model and are being used by the California Energy Commission (CEC) to analyze strategies for reducing petroleum dependency in the state.

5. References

Adler, T. J., Rimmer, L. and D. Carpenter (2002). Use of an Internet-based Household Travel Diary Survey Instrument, *Transportation Research Record* **1804**, Transportation Research Board, Washington D. C.

Ben-Akiva, M.E. and Lerman, S.R. (1985). *Discrete Choice Analysis*, MIT Press.

Bunch, D.S., M. Bradley, T.F. Golob, R. Kitamura, and G.P. Occhiuzzo (1993). Demand for Clean Fueled Vehicles in California: A Discrete Choice, Stated Preference Survey, Transportation Research A, 27A, 237-253.

Golob, T., Brownstone, D., Bunch, D. and R Kitamura (1995). Forecasting Electric Vehicle Ownership and Use in the California South Coast Air Basin, Report to the Southern California Edison Company.

Kavalec, C. (1996). CALCARS: The California conventional and Alternative Fuel Response Simulator, A Nested Multinomial Vehicle Choice and Demand Model, Sacramento, CA: California Energy Commission.

Louviere, J., Hensher D. and J. Swait (2000). *Stated Choice Methods: Analysis and Application*, Cambridge University Press, Cambridge.

Train, K. (1983). California Personal Vehicle Energy Demand Model, Sacramento: California Energy Commission.

Appendix A : The SP instrument

The California Vehicle Follow-Up Survey

Instructions for Completing The California Vehicle Follow-Up Survey:

Starting with the first exercise below:

1) **Please read and review each hypothetical vehicle's features for Vehicle A, B, and C.**
2) **After careful examination, please choose the ONE hypothetical vehicle that you would be most likely to purchase as your next replacement vehicle.**
3) **Indicate your choice by checking the box corresponding to your chosen vehicle (either Vehicle A, B, or C).**
4) **Continue to exercise 2 and repeat steps 1-3.**
5) **Repeat steps 1-3 for all 8 exercises.**

If needed, please refer to the Vehicle Features Reference Guide on the back page for vehicle feature definitions

1) CHOOSE THE ONE VEHICLE YOU WOULD MOST LIKELY PURCHASE (Vehicle A, B, or C)

Vehicle Features	A	B	C
Vehicle Style:	Pick-up truck	Pick-up truck	Pick-up truck
Fuel Type:	Gas	Hybrid electric	Diesel
Vehicle Size:	Mid-size/large	Mid-size/large	Mid-size/large
Maintenance Cost Per Year:	$300	$450	$150
Acceleration (0-60 mph):	9 seconds	9 seconds	6 seconds
Incentive:	Not Applicable	None	Use of diamond/carpool lane
Gradability:	Not Applicable	60 mph	Not Applicable
Purchase Price:	$45,500	$50,050	$50,050
Fuel Cost Per Year:	$1,410	$1,080	$1,080
Check One Vehicle:	☐	☐	☐

Example

2) CHOOSE THE ONE VEHICLE YOU WOULD MOST LIKELY PURCHASE (Vehicle A, B, or C)

Vehicle Features	A	B	C
Vehicle Style:	Pick-up truck	Pick-up truck	Car
Fuel Type:	Gas	Hybrid electric	Diesel
Vehicle Size:	Mid-size/large	Mid-size/large	Mid-size/large
Maintenance Cost Per Year:	$300	$450	$600
Acceleration (0-60 mph):	9 seconds	12 seconds	15 seconds
Incentive:	Not Applicable	No sales tax on purchase	No sales tax on purchase
Gradability:	Not Applicable	60 mph	Not Applicable
Purchase Price:	$45,500	$40,950	$50,050
Fuel Cost Per Year:	$2,115	$1,080	$840
Check One Vehicle:	☐	☐	☐

3) CHOOSE THE ONE VEHICLE YOU WOULD MOST LIKELY PURCHASE (Vehicle A, B, or C)

Vehicle Features	A	B	C
Vehicle Style:	Pick-up truck	Pick-up truck	SUV
Fuel Type:	Gas	Hybrid electric	Diesel
Vehicle Size:	Mid-size/large	Mid-size/large	Mid-size/large
Maintenance Cost Per Year:	$300	$300	$300
Acceleration (0-60 mph):	9 seconds	9 seconds	15 seconds
Incentive:	Not Applicable	No sales tax on purchase	No sales tax on purchase
Gradability:	Not Applicable	45 mph	Not Applicable
Purchase Price:	$45,500	$40,950	$50,050
Fuel Cost Per Year:	$1,410	$1,080	$1,080
***Check One Vehicle*:**	☐	☐	☐

4) CHOOSE THE ONE VEHICLE YOU WOULD MOST LIKELY PURCHASE (Vehicle A, B, or C)

Vehicle Features	A	B	C
Vehicle Style:	Pick-up truck	Pick-up truck	SUV
Fuel Type:	Gas	Hybrid electric	Diesel
Vehicle Size:	Mid-size/large	Mid-size/large	Compact
Maintenance Cost Per Year:	$300	$600	$450
Acceleration (0-60 mph):	9 seconds	15 seconds	6 seconds
Incentive:	Not Applicable	No sales tax on purchase	No sales tax on purchase
Gradability:	Not Applicable	30 mph	Not Applicable
Purchase Price:	$45,500	$36,400	$36,400
Fuel Cost Per Year:	$2,115	$360	$600
***Check One Vehicle*:**	☐	☐	☐

Example

5) CHOOSE THE ONE VEHICLE YOU WOULD MOST LIKELY PURCHASE (Vehicle A, B, or C)

Vehicle Features	A	B	C
Vehicle Style:	Pick-up truck	Pick-up truck	Pick-up truck
Fuel Type:	Gas	Hybrid electric	Diesel
Vehicle Size:	Mid-size/large	Mid-size/large	Mid-size/large
Maintenance Cost Per Year:	$300	$150	$150
Acceleration (0-60 mph):	9 seconds	15 seconds	6 seconds
Incentive:	Not Applicable	None	None
Gradability:	Not Applicable	75 mph	Not Applicable
Purchase Price:	$45,500	$36,400	$50,050
Fuel Cost Per Year:	$1,410	$1,080	$360
***Check One Vehicle*:**	☐	☐	☐

CONTINUE TO NEXT PAGE

6) **CHOOSE THE ONE VEHICLE YOU WOULD MOST LIKELY PURCHASE (Vehicle A, B, or C)**

Vehicle Features	A	B	C
Vehicle Style:	Pick-up truck	Car	Pick-up truck
Fuel Type:	Gas	Hybrid electric	Diesel
Vehicle Size:	Mid-size/large	Compact	Compact
Maintenance Cost Per Year:	$300	$600	$600
Acceleration (0-60 mph):	9 seconds	15 seconds	6 seconds
Incentive:	Not Applicable	None	None
Gradability:	Not Applicable	75 mph	Not Applicable
Purchase Price:	$45,500	$50,050	$50,050
Fuel Cost Per Year:	$2,115	$360	$1,080
***Check One Vehicle*:**	☐	☐	☐

7) **CHOOSE THE ONE VEHICLE YOU WOULD MOST LIKELY PURCHASE (Vehicle A, B, or C)**

Vehicle Features	A	B	C
Vehicle Style:	Pick-up truck	Van	SUV
Fuel Type:	Gas	Hybrid electric	Diesel
Vehicle Size:	Mid-size/large	Compact	Subcompact
Maintenance Cost Per Year:	$300	$150	$600
Acceleration (0-60 mph):	9 seconds	6 seconds	15 seconds
Incentive:	Not Applicable	No sales tax on purchase	None
Gradability:	Not Applicable	30 mph	Not Applicable
Purchase Price:	$45,500	$50,050	$36,400
Fuel Cost Per Year:	$1,410	$360	$1,080
***Check One Vehicle*:**	☐	☐	☐

Example

8) **CHOOSE THE ONE VEHICLE YOU WOULD MOST LIKELY PURCHASE (Vehicle A, B, or C)**

Vehicle Features	A	B	C
Vehicle Style:	Pick-up truck	Van	Car
Fuel Type:	Gas	Hybrid electric	Diesel
Vehicle Size:	Mid-size/large	Mid-size/large	Subcompact
Maintenance Cost Per Year:	$300	$600	$150
Acceleration (0-60 mph):	9 seconds	15 seconds	15 seconds
Incentive:	Not Applicable	None	None
Gradability:	Not Applicable	30 mph	Not Applicable
Purchase Price:	$45,500	$50,050	$36,400
Fuel Cost Per Year:	$2,115	$360	$360
***Check One Vehicle*:**	☐	☐	☐

CONTINUE TO NEXT PAGE

Vehicle Features Reference Guide

Vehicle Style: The body style of the vehicle (car, SUV, pick-up truck, or van).

Vehicle Size: The size of the vehicle (subcompact, compact, mid-size/large).
Subcompact cars *include subcompact sedans, coupes, station wagons, and sports cars, ex: Metro, Focus, Escort, Neon,* ***Compact cars*** *include compact sedans, coupes, station wagons, and sports cars, ex: Grand Prix, Cavalier, Corolla, Stratus,* ***Mid/large cars*** *include mid/large sedans, coupes, station wagons, and sports cars, ex: Taurus, Intrepid, Concorde, Regal, Cadillac, Lincoln,* ***Subcompact SUV's*** *ex: Rav4, Escape, Tracker,* ***Compact SUV's*** *ex: Explorer, Cherokee, Blazer,* ***Mid/large SUV's*** *ex: Excursion, Yukon, Expedition,* ***Compact pick-up trucks*** *ex: Chevy S-10, Ford Ranger,* ***Mid/large pick-up trucks*** *ex: Dodge Dakota, Ford F-150,* ***Compact vans*** *include all minivans,* ***Mid/large vans*** *include all standard, conversion, and large sized vans; does not include U-Hauls or RV's*

Fuel Type: The type of fuel the vehicle will use (gasoline, hybrid electric, or diesel).

Purchase Price: The price of the vehicle if you were to buy it outright (i.e. purchase not lease).

Fuel Cost Per Year: The estimated annual cost of fuel the vehicle would require, based on the estimated number of miles the vehicle would be driven per year (obtained from the telephone survey based on your replacement vehicle).

Maintenance Cost Per Year: The cost of maintaining the vehicle per year. This cost would include fees for oil changes and regular vehicle maintenance.

Acceleration (0-60 mph): The amount of time (in seconds) the vehicle would take to travel from 0 mph to 60 mph.

Incentive: The benefit to the consumer gained from buying an alternative fuel vehicle (i.e. hybrid electric or diesel).

Gradability: The speed (30 mph, 45 mph, 60 mph, or 75 mph) a hybrid electric vehicle could maintain while climbing a 20-mile mountainous grade with a full load.

Alternative Fuel Definitions

Diesel-Fueled Vehicles:
- Today's diesel vehicles are comparable to today's gasoline vehicles in terms of acceleration, noise, and pollution
- Compared to similar gasoline vehicles, diesel vehicles provide as much as 40% higher fuel economy
- Diesel vehicles have more durable engines than gasoline vehicles, providing advantages for stop and go driving and towing
- Currently, around one-quarter of all refueling stations dispense diesel fuel

Hybrid Electric Vehicles (HEVs):
- Powered by both gasoline engines and electric motors
- Compared to similar gasoline vehicles, hybrid electric vehicles provide as much as 40% higher fuel economy, and have lower tail pipe emissions
- Offer range and refueling time comparable to gasoline vehicles
- Are gasoline fueled, so battery recharging is not needed at any time
- Body style and size are similar to gasoline vehicles

Example

Thank you!

Your information on this topic is very important to this research. Once we have processed your survey, we will send you a check for $15 as a token of our appreciation. If you would like to return your survey by mail, please check ONE box for each of the 8 exercises and return your survey to us in the postage-paid envelope provided **within the next few days**.

Return completed surveys to:
MORPACE International, Inc.
c/o The California Vehicle Survey
31700 Middlebelt Road, Suite 200
Farmington Hills, MI 48334

If you have any questions, please contact Caitlin at MORPACE International at 1-800-206-5938 or SurveyHelp at the email address: M010497help@morpace.com.