Factors Influencing Consumer Likelihood of Purchasing a Flexible-Fuel or Hybrid Automobile

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BACKGROUND

The emission of greenhouse gases (GHG) from the consumption of fossil fuels is a concern because of the threat of global climate change. Since automobiles are responsible for one-sixth of the world's carbon and nitrogen oxide emissions (Potoglou and Kanaroglou, 2007), developing fuels and vehicles that reduce the use of fossil fuels has become a priority. One alternative is the production of flexible-fuel vehicles (FFVs) that can run on ethanol/gasoline blends of up to 85% ethanol (E85). Another alternative is the production of hybrid electric vehicles that increases fuel efficiency by supplementing an internal combustion engine with an electric motor.

While the production of both flexible-fuel and hybrid vehicles is increasing, there is still a great deal of uncertainty about how consumers will respond to these products. For example:

- As the percentage of ethanol in fuel increases, both GHG emissions and fuel efficiency decrease; thus, people who drive FFVs and consume E85 have to refuel their vehicles more often than those who drive vehicles using lower ethanol blend fuels. As a result, extra time spent on refueling will be another "cost" of E85 and FFVs.
- Some consumers might be attracted to FFVs and hybrids because of the potential to reduce the accumulation of GHGs, or because of the associated reduction in fuel imports.
- On the other hand, some consumers might be concerned that increased production of ethanol will lead to an increase in land use intensity and/or an increase in food prices from increased competition for land and other agricultural resources.

CONCEPTUAL FRAMEWORK

Household transportation decisions typically involve the allocation of both time and money, and the choice of FFVs and hybrids (particularly with the advent of "plug-in hybrids") is no exception. Thus, we adapt a household production model (Komei 1988) that considers travel behavior as a function of both time and monetary inputs. We extend the model by incorporating the negative externalities associated with travel into the household utility function.

In this model, households generate utility through participation in location-specific activities (X). These activities are produced using inputs of goods and services (represented in the model by a composite good Z), time ($\overline{H}$), and travel (T), which itself is a function of time (H) and money (C). Travel is assumed to generate externalities (E) that vary depending upon choice of location (r) and travel mode (m). Thus, maximizing utility involves allocating time and money to different activities and the goods, services and travel needed to produce these activities, subject to a single combined (time and money) budget constraint, or:

$$\underset{Z_r,\overline{H}_r,C_{rm},H_{rm}}{Max} \quad U = U\left[X_r\left(Z_r,\overline{H}_r,T_{rm}(C_{rm},H_{rm})\right),E\left(\sum_r\sum_m T_{rm}(C_{rm},H_{rm})\right)\right]$$

$$s.t. \quad \sum_r P_r Z_r + \sum_r\sum_m C_{rm} + w\left(\sum_r \overline{H}_r + \sum_r\sum_m H_{rm}\right) = w\Pi$$

where P_r is the price level of the composite goods and services at the r^{th} location, w is household wage rate, H_L is hours spent working, and π is the total time available.

DATA AND METHODS

Data was collected through an online survey of automobile owners conducted in January and February of 2009. The survey sample was drawn from an online research panel designed to be representative of the U.S. population. Individuals are recruited for the panel by telephone using random-digit dialing and address-based sampling methods. If needed, panel members are provided with free access to the Internet and a computer in exchange for agreeing to serve on the panel. This survey was fielded to 2,851 members of the panel and 1,727 useable responses were received before the survey was closed.

The survey provided respondents with some basic information on ethanol blends and feedstocks on a series of "information screens." The information screens were interspersed with questions on vehicle ownership, driving patterns, familiarity and experience with ethanol and FFVs, plans regarding next automobile purchase, respondent attitudes on a variety of topics, and sources of information. Responses to the survey questions were supplemented with demographic information from each panel member's profile.

Respondents were specifically asked how likely they would be to choose an FFV as their next vehicle (response options were "Not at all likely", "Somewhat likely" and "Very likely") and to indicate the extent to which they agreed (on a five point Likert scale ranging from "Strongly Disagree" to "Strongly Agree") with the statement: "The next automobile I purchase or lease is likely to be a Gasoline/Electric Hybrid." A bivariate probit model (Greene 2000) was used to jointly analyze responses to these questions, necessitating the transformation of the original ordinal responses to binary variables where 1 = somewhat or very likely for the FFV question and somewhat or strongly agree for the hybrid question.

Bivariate Probit Regression (n = 1,516)	FFV		Hybrid	
Variables	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
Demographics				
Age/10	-0.152	0.132	-0.140	0.127
Age squared/1000	0.136	0.131	0.127	0.128
Education (Less than high school = 1, High school = 2, Some college = 3, Bachelor's degree or higher =4)	0.130**	0.046	0.013	0.045
Household income (categorical midpoint / number of members of household) log form	-0.100*	0.058	0.054	0.057
Race (1 if white, 0 otherwise)	0.126	0.104	-0.079	0.098
Gender(1 if male, 0 otherwise)	-0.046	0.082	-0.130*	0.078
Republican (1 if Republican, 0 otherwise)	0.034	0.091	-0.267***	0.086
Independent (1 if Independent, 0 otherwise)	-0.221	0.196	-0.014	0.201
Child (1 if at least one child under 18 in household, 0 otherwise)	0.122	0.118	-0.127	0.114
Geographic				
Rural residence (1 if reside in rural area, 0 otherwise)	0.144	0.097	-0.137	0.096
Non-attainment county (1 if reside in Clean Air Act non-attainment county, 0 otherwise)	0.211**	0.089	0.011	0.084
County-level corn production (1 if corn production at or above national county average, 0 otherwise)	0.184	0.122	0.025	0.114
Northeast (1 if reside in Northeast, 0 otherwise)	0.060	0.138	-0.035	0.130
South (1 if reside in South, 0 otherwise)	0.223*	0.124	-0.036	0.117
West (1 if reside in West, 0 otherwise)	0.108	0.136	-0.013	0.128
Current Transportation Choices				
Age of current automobile (years)	-0.019**	0.008	-0.003	0.008
Hybrid (1 if current automobile is hybrid , 0 otherwise)	-0.567*	0.303	1.024***	0.304
FFV (1 if current automobile is FFV, 0 otherwise)	0.993***	0.358	-0.103	0.253
Leased (1 if current automobile is leased, 0 otherwise)	-0.408**	0.208	-0.347	0.227
Used (1 if current automobile was used when purchased or leased, 0 otherwise)	-0.132	0.088	-0.112	0.082
Fuel efficiency of current automobile (MPG, categorical midpoints)	0.004	0.008	-0.007	0.008
Car (1 if current automobile is compact car, sports car or sedan, 0 otherwise)	-0.105	0.089	0.032	0.085
Domestic (1 if domestic manufacturer of current automobile, 0 otherwise)	-0.049	0.090	-0.020	0.084
Public (1 if used public transportation in last year, 0 otherwise)	0.187	0.116	0.213**	0.100
Carpool (1 if carpooled in last year, 0 otherwise)	0.149	0.101	-0.038	0.089
Estimated number of miles driven on typical day (categorical midpoints)	0.0002	0.002	-0.001	0.002
How often go out of way to buy cheaper gasoline (1=Never, 2=Rarely, 3=Frequently, 4=Always)	0.114*	0.045	0.118**	0.044
How long before purchase or lease next automobile (categorical midpoints)	0.090***	0.033	0.057*	0.033
Knowledge and Attitudes				
Familiarity with ethanol (1=Not at all, 2=Somewhat, 3=Very)	-0.061	0.078	-0.062	0.075
Familiarity with FFVs (1=Not at all, 2=Somewhat, 3=Very)	-0.027	0.078	0.083	0.073
Farmland should be used for food not fuel (1=Strongly Disagree, . . .5=Strongly Agree)	-0.153***	0.039	0.046	0.035
Reducing dependence on oil imports important for national security (1=Strongly Disagree, . . .5=Strongly Agree)	0.194***	0.044	0.135***	0.044
More land in U.S. should be opened up for oil drilling (1=Strongly Disagree, . . .5=Strongly Agree)	-0.023	0.038	-0.010	0.035
FFVs cost significantly more than other vehicles (1=Strongly Disagree, . . .5=Strongly Agree)	-0.099**	0.045	0.031	0.042
E85 is not likely to be readily available in area in near future (1=Strongly Disagree, . . .5=Strongly Agree)	-0.076*	0.039	0.024	0.037
Score on Global Climate Change/Environmental Concern Index	0.249***	0.065	0.251***	0.065
Score on perceived consumer effectiveness index	0.060	0.092	0.159*	0.086
Sources of Information				
Print (1 if generally get environmental information from newspapers or magazines , 0 otherwise)	0.217**	0.085	0.105	0.083
Radio (1 if generally get environmental information from radio, 0 otherwise)	-0.081	0.090	-0.019	0.085
Internet (1 if generally get environmental information from internet, 0 otherwise)	0.095	0.086	0.122	0.081
Friends & Family (1 if generally get environmental information from friends or family, 0 otherwise)	0.137	0.108	-0.073	0.098
Child*Friends & Family (1 if Child = 1 and Friends & Family = 1, 0 otherwise)	-0.134	0.197	0.271	0.181
Member (1 if member of environmental organization, 0 otherwise)	-0.248	0.192	0.053	0.169
Intercept	1.702**	0.759	-1.837**	0.757
ρ	0.184	0.053	0.078*	0.286
Log likelihood = -1538.7018				
Likelihood-ratio test of ρ=0: chi²(1) = 11.5522, Prob > chi² = 0.0007				
*One, two and three stars indicate significance at 10%, 5% and 1%.				

CONCLUSIONS

The regression results suggest that there are some similarities and differences in the factors influencing the likelihood of purchasing an FFV or hybrid. Respondents, who are fuel price conscious, concerned with global climate change/environment, believe that dependence on imported oil raises national security concerns, and who are not planning to purchase or lease a car in the near future, consider it more likely that their next vehicle will be either a FFV or a hybrid. Respondents who currently have either an FFV or hybrid are more likely to choose that type of automobile in the future. However, hybrid owners consider themselves less likely to choose an FFV.

Respondents who consider themselves more likely to choose an FFV for their next vehicle tend to be more educated, have lower household incomes, reside in a non-attainment (air quality) county, live in the South instead of the Midwest, have a newer automobile, own instead of lease this automobile, and believe that farmland can be used for fuel as well as food production, FFVs do not cost significantly more than other vehicles, and E85 is likely to be readily available in their area in the near future.

On the other hand, females, Democrats, users of public transportation, and those who believe that their individual actions as consumers can have an effect on the ambient environment tend to consider themselves more likely to choose a hybrid for their next vehicle.

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