Ann. For. Res. 65(1): 608-629, 2022
DOI: 10.5281/zenodo.7222108

ANNALS OF FOREST RESEARCH
https://www.e-afr.org/

COST ANALYSIS OF A GHANAIAN CASE: ASSESSING THE CONSUMER RESPONSE TO FUEL ECONOMY IN THE FACE OF GLOBAL FUEL CRISES

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Abstract

A significant key factor influencing the total cost of national fuel efficiency requirements is how consumers weigh trade transactions between the purchase price of higher fuel economy and the expected fuel savings. Vehicle selection modeling can be used to assess differences in consumer vehicle buying trends, as well as how these variations affect consumer surplus and compliance costs. The study uses a specific selection test with comparative test conditions to explore how it can affect the visual value of fuel economy data. The following fuel economy data are presented differently under each of the six factors: the average amount of money saved/spent over four years compared to a class vehicle, miles per gallon, six years of fuel cost, annual fuel costs, full government-mandated fuel economy stamp and lifetime fuel cost. The national representative sample of 950 prospective car buyers in Ghana was roughly assigned to one situation (in Ghana). The study found that the data provided had a causal effect on how consumers evaluate fuel economy. In comparison to criteria merely presenting the yearly cost of fuel, five-year cost of fuel, and spend/save compared, the study considerably greater willingness-to-pay the values for participation in the scenario with the whole fuel economy labeling. Value changed according to participant statistics: Older participants and those who expected to pay a slightly lower amount for their future car placed a higher value on fuel economy. Despite little information to determine the comparative significance of these myriad theories, this research explores possible explanations for why there may be discrepancies between what consumers are willing to pay for fuel economy and what automakers offer.

Keywords: *Fuel Economy, Consumer response, Purchase price, Participant statistics*

1. Introduction

The global energy consumption of the transport sector is growing at a median rate of 1.1% per annum. The transport sector accounted for the greatest share (63%) of the overall increase in global consumption of petroleum and other liquefied fuels between 2009 and 2035. From 4 quadrillion Btu in 2009 to 5 quadrillion Btu in 2035, Africa's transport energy demand will increase by 0.9 percent annually. Most policymakers are beginning to understand the idea of sustainability, and many who are involved in formulating policies see this as the answer to achieving economic growth in any established or developing country. Transport-related energy use includes the amount used to move people and goods by pipeline, road, air, water, and rail. In an increasingly globalized world, transport infrastructure is essential to enhance trade, economic competitiveness, and quality of life. The most important factors influencing the need for cargo handling are trade and economic activities. The need for passenger transport is affected by a much more complex set of problems such as travel patterns, land use patterns, and urbanization, as well as macroeconomic and fuel market effects [1]. Regulations to lower greenhouse gas (GHG) vehicle emissions and tighten Corporate Average Fuel Economy norms were released by the U.S. Environmental Protection Agency and the Transportation Department on April 1, 2010. The importance of fuel economy in consumer vehicle purchases was a major analytical issue that was included in the assessment of the criteria. When choosing what to buy, do consumers take into account the fuel savings of vehicles with higher fuel efficiency? Will high fuel efficiency demand improve or worsen the well-being of consumers and manufacturers? This issue will be of great interest to them as other countries consider establishing or strengthening their own fuel economy and/or GHG tailpipe regulations. For example, the International Council for Clean Transport (ICCT) says that some countries are thinking about putting in place stricter GHG rules for cars. Coal, oil, petroleum and natural gas products are all examples of fossil fuels. An essential step in reducing emissions of CO2 is the abolition of the subsidy for fossil fuels. Figure 1 depicts the various types of fuel and its example. Different countries have different fuel subsidies. They are designed to increase welfare, reduce consumer petrol prices, and strengthen relationships between the citizens and its government. Although easy to install, they can be very expensive, often failing to help the most vulnerable and challenging to maintain or remove. With a population of 30.8 million, Ghana is a sub-Saharan African country that relies greatly on fossil fuels for its energy requirements. Petroleum has been a major contributor to Ghana's energy composition since 2000, accounting for 80% of the country's entire energy consumption without biomass. Ghana is a slight gas and oil producer in West Africa that distributes its crude oil to foreign markets. The country's domestic power plants are fueled by natural gas produced there. Ghana's energy mix, which relies on biomass and wood fuels, has seen a steady decline in the rate of biofuels due to increasing fossil fuel use. Fossil fuel energy usage grew from 18.8 percent of entire energy consumption in 1995 to 52.5 percent in 2014 at an average yearly rate of 5.83 percent. By 2020, it will rise to almost 87.5 percent. The percentage of biomass use reduced from 49% of the entire primary energy supply in 2010 to 40% in 2018, as reported by the national energy statistics [2]. It causes at least 9 million deaths a year worldwide, of which 85% occur in underdeveloped countries [3]. The fastest growing global form of carbon dioxide emissions from fossil fuels is the transport of 24% of CO2's direct emissions from fuel combustion [4].

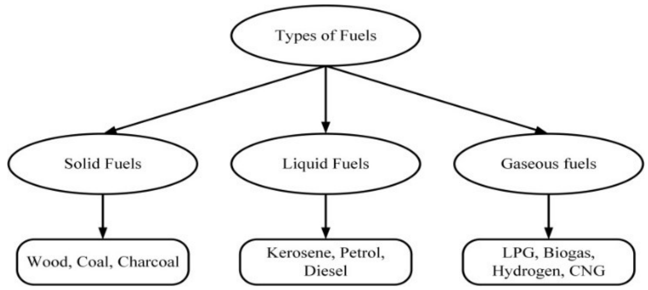

Figure 1: **Various types of fuel**

The economic activity of any country is highly dependent on energy. Similarly, transportation that facilitates both passenger and freight movement is important for the expansion of every economy. Crude oil is one of the most widely used energy sources[5]. Once crude oil is extracted from the ground, the refinery converts it into usable materials, often into non-renewable fuels for transportation. According to Ghana's Strategy National Energy Policy (SNEP), the transportation sector uses 99.7 percent of the country's petrol and 85 percent of its diesel. Approximately 2.5 million road transport vehicles are in use in Ghana, most of the passenger vehicles. As the main source of combustion in Ghana, PMS or petrol is the mainstay of vehicle use. Between 1999 and 2012 about 11 billion and 15 billion liters of PMS and petrol were used. With the use of numerous economic measurements to analyze the demand for automobile gasoline, the investigation into automotive fuel consumption has gained much interest over the past 40 years. The biggest concern is analyzing the consequences of fuel use as a result of the risks to fuel energy conservation [6]. Figure 2 represents the various reason for increasing the fuel price.

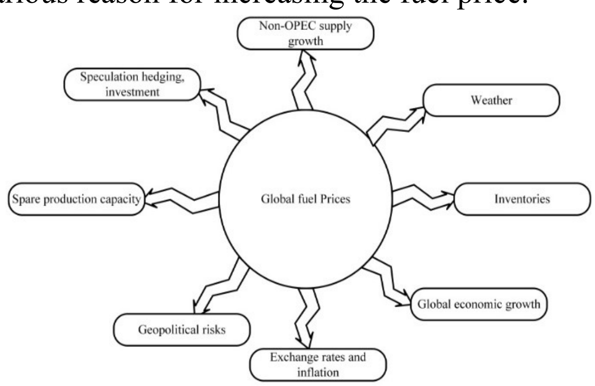

Figure 2: **Various reasons for fuel price increased continuously**

Privately owned automobiles have expanded in Ghana over the past few decades, where the gasoline demand is increasing almost daily. Ghana and the rest of the world have focused on factors that affect how much petrol is used for transportation-related activities. In recent years, the demand for petroleum energy around the world has grown significantly, and its solution is urgently needed [7]. Although the dependence level varies depending on the mode, there is a clear correlation between transport and energy. Quick and energy-intensive methods can send passengers and more valuable cargo [8]. In addition, the transport sector was hit hard by fuel shortages and a lack of foreign exchange to buy crude oil (oil and gas), resulting in disruptions to business routes for drivers and homes standing in regular queues. The movement of goods and services inside and outside Ghana was also hampered due to high transportation costs which lead to high food costs. Despite the country's oil production, fuel costs continue to rise, which is bad for the average Canaanite. While Ghana produces oil, the price of gasoline rose by 7% in 2014. For decades, there have been numerous reports of adverse reactions to the rising prices of petroleum products. According to a 2011 report by the Ghana News Agency, almost a month after the current petrol price hike, passengers and drivers are still arguing about fares in the metropolitan area of Kumasi [9].

According to the United Nations Environment Program, 40 percent of older light cars are imported from Africa and 70 percent from developing countries [10]. In addition, most countries that import or build these vehicles in Africa do not have emission rules governing the type of emission equipment to be placed on these vehicles. In addition, emissions analysis is not required by the annual vehicle inspection system. Therefore, proper maintenance of vehicles to guarantee the effective operation of emission-related technology is not a major concern even when they are available. The primary objective of every government is to develop the economy of the country to improve the living standards of its people. The economic and social development of a country is greatly affected by mass transportation. The transportation sector in Ghana uses a significant amount of fuel. The average annual demand for crude oil, according to currently available data, is 5 to 7 percent, and this demand is likely to increase as the number of cars on the road continues to expand across the country. The country is thus concerned about efforts to reduce traffic congestion and fuel consumption rates. Ghana spent $ 276 million on petrol subsidies in 2011, or about 450 million Ghana cedis. This is 45 million Ghana cedis every month. Figure 3 represents the analytical study of fuel prices in Ghana.

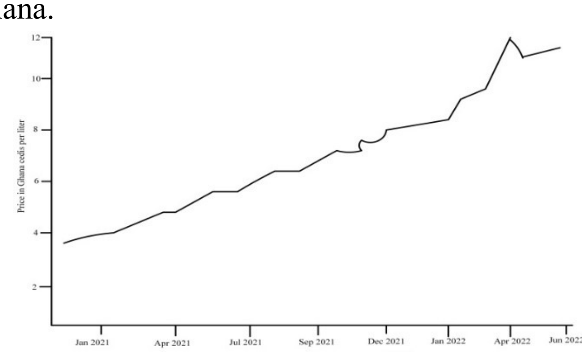

Figure 3: **Analyzing the fuel price in Ghana**

Along with transport, energy is an important economical aspect of a country's growth. All facets of national growth depend on it, but the transport, infrastructural, agricultural, and industrial sectors are extremely significant. It must be utilized sustainably because it is limited and non-renewable. Even though the degree of the association varies on the form of transportation and the demand for the sector, there is a clear correlation between transportation and energy in national growth [11]. Much of the total energy consumed worldwide by human activities is now calculated by transport. In developed countries, transportation accounts for 20 to 25 percent of total energy. Economic analysis of Ghana's energy sector as per the states, the transport sector contributes 23.9% to Ghana's overall energy consumption [12]. The primary sources of energy for Ghana's transportation industry are fossil fuels, especially petroleum products. Depending on the mode of transport, the energy consumption will vary. In developing countries, passenger transport is 60-70% of the average land use of 85%, and private vehicles are the most common means of transporting passengers. The best way to reduce traffic congestion and high fuel consumption rates is to increase the use of public transport [13]. The use of mass transportation in Ghana, especially in urban areas, as a means of improving energy efficiency, on the other hand, is underestimated. This, along with the continued increase in automobile ownership, has helped to increase crude oil consumption and expose the nation to rising import costs for crude oil. Such huge import expenditure on oil pressures the annual budgets and causes massive trade deficits. Vehicles with a manual transmission have approximately 10% more fuel economy than their automatic counterparts, and they have more control over challenging driving conditions. In addition, manual transmission automobiles are less expensive, require less repair and maintenance, and have higher fuel efficiency for city driving than automatic transmission vehicles, although this depends on driving. Drivers have better control and less distraction when operating a manual transmission vehicle [14].

Assessing the number of vehicles, fleet structure, vehicle features, vehicle performance, fuel quality and type, transportation, driving habits, road conditions, maintenance and inspection, and deterioration all affect naval fuel efficiency is challenging [15]. The importance of evaluating naval fuel efficiency in use has been highlighted in previous research, particularly for cars with an overall mileage of over 500,000 km [16]. Although engines now withstand more than 800,000 km before their first repair is required, the US and European environmental systems still take into account the decay rates for cars with lower mileage [17]. The cost of research and the scarcity of resources makes it even more difficult to determine the fuel economy in use. These very high mileages are typical for automotive fleets in Africa. Where this information is provided, it can be used to calculate current greenhouse gas emissions, set base emissions, and explore future emissions conditions for changing vehicle fleets. Since there are currently no emissions reduction policies in place in Africa, an understanding of existing emissions is essential for their creation and maintenance [18].

The micro and macro economies of each country are affected by the commercialization of fuel, and Ghana is no different. Fuel price adjustment is the simple term for a regular increase or decrease in the price of fuel-related products caused by fluctuations in fuel prices in the global market. Changes in the cost of fuel continue to have an impact on the pricing of other commodities around the world and on the prices of many companies in terms of production, revenue and profit. Small and medium enterprises are particularly affected by the frequent changes in petrol prices.

This is partly because small and medium enterprises are an essential safety net in the fight against poverty [19]. The study explores this issue by measuring how consumers evaluate fuel efficiency using a variety of indicators and how this assessment relates to consumer characteristics. As a specific selection experiment with participants randomly assigned to different situations, the study is solitary in that it uses a test, behavioral science method. The selection test permits participants to weigh business transactions among fuel economy and other vehicle characteristics. Though the study recommends that variations in fuel efficiency data delivery may have an impact on consumer assessment, this is the only study that clearly uses this approach to test this effect.

2. Related Work

The information from GLSS 7, the Quadratic Almost Ideal Demand System (QUAIDS) prototype and the Multivariate Profit Framework were used to explore residential energy consumption patterns and energy cost responses for household energy in Ghana. Research focuses on the following fuels: electricity, kerosene, LPG, firewood, coal, and others (FCO). The findings show that price, income, and social demographic characteristics have a significant impact on Ghana's request for all domestic energy fuels. Although FCO and kerosene fuels are non-performing, household requests for LPG fuels and electricity are resilient with values greater than 1. Although all energy fuels are negative and volatile, their own price reveals resilient contemporary fuels (LPG). and electricity) are highly responsive to price increases. When meeting the cross-price flexibility of all fuels, the cultural, socio-economic, and specific uses of each fuel must be considered. The study found that even though the requirement for all energy fuels was negative and prices were flexible, the own price flexibility (LGP and ECG) for contemporary fossil fuels decreased somewhat after correcting for the resulting effect of zero energy expenditure. The study has implications for both policies to ensure widespread availability of efficient and clean domestic energy fuels for consumption and policies to reduce the cost of residential energy fuels. [20].
There are limited studies on factors affecting household energy use in Africa, especially in Ghana. This study differentiates "clean" fuel from "dirty" fuel to determine the factors that affect households' domestic fuel consumption. Samples were taken from the population and health survey data used to survey 11,835 homes across Ghana. To determine whether a family uses "clean fuel" or "dirty fuel", binary type approaches (binary logistics and binary profit) evaluated with socioeconomic factors and spatial variation (regional location) were used. The findings show that socioeconomic factors influence households' energy use and that it is more difficult for rural households to accept clean fuel than for urban households. In addition, men-led households use cleaner fuels than women. As the wealth of the family increases, more and more households are opting for cleaner fuels than for cooking. Also, most households continue to use solid fuels such as charcoal and firewood as their primary energy sources for cooking. Due to internal pollution, the use of these polluting fuels can adversely affect household health. The report suggests that policies should be developed to provide better and cleaner energy sources for homes [21].

Ghana's efforts to reach a middle-income level coincide with increasing demand for electricity and other types of energy. As a result of studies relying on fossil fuels, a rise in energy or electricity consumption could lead to emissions of greenhouse gas. Affected areas of Ghana's socio-economic systems, including agriculture and forestry, and energy production, are currently showing signs of the effects of climate change. Therefore, it is necessary to progress and implement a low-carbon; long-term, sustainable energy production plan that meets the electricity needs of the planned main economic objectives. In analyzing the effects of fuel conversion on the energy production system and the ecosystem, this study used the energy source approach and their generalized environmental effects analysis tool using a quantitative modeling and simulation technique. The key to reducing CO2 emissions in Ghana's energy sector is to incorporate low carbon emissions conversion technologies, including nuclear and renewable energy. To achieve sustainable, reliable, and clean power generation, climate-friendly energy sources must be included in the power sector. Reliance on fossil fuels for power generation is essential for Ghana to fulfill its international climate change obligations, so the country should consider incorporating zero-emission sources in its energy mix [22].

West African countries face significant environmental risks that reduce their quality of life. Emissions-related diseases are estimated to kill seven million people a year in the region. Reducing emissions pollution can save lives and help decrease the rate of worldwide climate alteration, as various climate-damaged emissions also affect human health. The study explored various environmental factors that could have a positive effect on quality of life in West African Anglophone countries. Using the group size regression, the duration of the study was from 1990 to 2018. The results revealed CO2 emissions from gaseous fuels, liquid fuels, residential buildings, businesses and public utilities, as well as CO2 emissions from solid fuel consumption. And transport, which could have an impact on the excellence of life in the Anglophone countries in West Africa. Health cost, mortality rate and fertility rate are additional control factors that have an impact on quality of life. Therefore, policymakers should take steps to reduce emissions (such as energy conservation measures) from the use of liquid and gaseous fuels, residential structures, commercial and public services, solid fuel use and transportation. In addition, the health sector must be properly supported by increased health care costs, which will improve health outcomes and national quality of life [23].

In underdeveloped countries, fuels such as coal and wood are the main sources of energy. In Ghana, savannah and forests are mainly used for collecting charcoal and firewood. Population growth puts more stress on forests and woodlands, which promotes overuse and destruction. The study used a mixed method to explore how household biomass is used in deforestation in the eastern municipality of Sissala, Ghana. Desk assessments, home surveys, focus groups and interviews with key informants were used to gather information from the cross-section of the community in the six rural and urban districts. According to research, firewood collected mostly from farms, forests and open savannah wood lands continues to be the dominant source of energy for most of the houses in the study area. The study also found that the use of firewood has a negative impact on the environment and the health of the population, especially women. This is because women are more likely than men to inhale the smoke of cooking activities. The study also shows that LPG is the most popular alternative energy source for homes, but its high cost is a major barrier to access. According to the study, continuous firewood collection poses a significant threat to environmental sustainability. Among other things, the research suggested that the Forestry Commission of the Ministry of Agriculture should implement educational and awareness campaigns to inform families about sustainable harvesting of fuel trees. In addition, the government has introduced subsidy schemes for households, especially those in rural areas, to purchase better fuel stoves as a way to reduce their reliance on wood fuel [24].

One of the fundamental forces behind economic growth in developing countries is energy, which is a basic factor in education, industrial production and health sector. One of the major problems facing policymakers in emerging countries including Ghana is increasing access to energy in rural areas. As a result, power outages, energy availability, access to finance and market access are hydro-head problems facing medium and small enterprises (SMEs) in developing countries. In other contexts, while energy effectiveness seems to be rising nationally, the situation is different in rural areas because they have less access than urban areas because they rely heavily on biological and other genetic energy sources. Three phases form the framework of this study. The first stage uses the product generation dematerialization approach to assess how efficiently electricity and fossil fuels are used. The practices of medium and small enterprises related to energy efficiency will be explored in the next step. The connection among productivity, energy efficiency, and carbon emissions is explored in the third stage using a common unrestricted structure (GUM). The main results of the study reveal that energy use is not effective and that energy consumption among SMEs is declining, with the exception of blackouts, not effectiveness, and productivity is a key factor in energy efficiency. In a summary, the domestic research demonstrates that decreased energy use is not the result of increased productivity brought about by more energy-efficient technology. Instead, it turns out that blackouts cause accidental energy cutbacks, according to a review of the rural energy scenario. Furthermore, it has been shown that rural SMEs use almost no energy-efficient procedures. It suggests increasing public awareness of energy efficiency and switching to new appliances rather than old ones in order to conserve energy [25].

Food security depends on the price of sustainable and reasonable food items. Higher food costs make a family less likely to spend on other necessities of life, including education and health. The world saw an unexpected increase in the cost of fuel (petroleum products) and food in 2007-2008, which attracted the attention of scholars and international leaders. Ghana and its food / agriculture policies have branches as a result of the impact of rising fuel prices on maize pricing. There is a price transfer system in the country's major maize markets, which further affects this impact. This study examines the dynamics, scope and reactions of fuel price changes in several Ghanaian markets for maize. To do this, MOFA data was collected on monthly maize prices from January 2000 to December 2015. In addition, ACEP provided monthly information on gas costs over the same period. Approaches used include trend analysis, integration, threshold autorrection (TAR) and impulse response function analysis. In general, over the years and months, the price of corn in all four markets of the study progressed in the same direction as the price of gasoline. Prices were integrated in all markets and they responded with key limitations. In addition, the price of corn in all markets increased immediately and sharply during the years under review when petrol prices increased. The study found that this impact continues and does not cause a nominal decline in maize prices. Therefore, it is advisable to take into account how the rules governing petrol prices may affect the price of maize. To reduce the impact of fuel costs on maize prices, MOFA and all other organizations in the farming region must offer transport infrastructure [26].

3. Methodology

3.1 Establishing a survey

In order to better understand the research questions, the study conducted a poll with 950 participants intending to buy or lease the vehicle over the next twelve years. Three sections of the 20-minute online survey were conducted by participants. Participants filled out a set of basic questionnaires, including their population, current car (product, model, yearly driving space and usage patterns) and next expected vehicle (intended product and model, acquisition deadline, expected purchase price, or want to lease or buy a used or new vehicle, extraction and expected use). Participants were assigned approximately one of six test parameters after completing a selection test designed to determine their preferences for vehicles. Participants select up to six of the 20 possible vehicle characteristics (from the list provided by Consumer Reporting Experts) and rank the six characteristics, indicating their preferences for their vehicles and what they value in the car in the open. In addition to their understanding of the selection test, it also evaluates participants' attempts to find the most up-to-date fuel efficiency data for lease or purchase.

3.2 Selection research

In the said selection test, participants were shown six sets of vehicle options, each consisting of three unnamed vehicle selections with systematically different characteristics. These packages are designed according to every participant's expected buying cost and vehicle class for their next vehicle (little SUV, medium SUV, big SUV, little car, medium car, big car, utility vehicle or microbus). Participants picked a car that they could buy or lease from each pair. In each of the eight vehicle classes, five additional vehicle characteristics in additionally to fuel economy were incorporated in the selection test.

- Every participator's self-reported anticipated buying cost served as the basis for one of four levels representing the purchase cost.
- The midway of the accelerators for each class is the center of the accelerated (0–60 mi) presentation, which is one of three stages, and is customized for every participator's expected vehicle class for an upcoming lease or buying. The selected range is defined as the information provided by the expert in consumer reports, according to which the highest and lowest numbers are 30 percent higher and lower than the midpoint.

For each of the eight vehicle types, fuel economy is described as one of four stages, represented in Table 1. Every level is centered on the average fuel economy that is next to the participants' self-reporting vehicle class. For buying or lease, the lowest and highest scores in the range are 30 percent higher and lower, respectively, from the middle of that class. Based on the randomness of each participant's test, the data to be provided about fuel economy changed between six possible scenarios. Fuel economy rating is obtained by assumption that the vehicle travels 16,000 miles annually and spends 60% of its time in cities and 40% of its time on highways, depending on the EPA's estimates of vehicle fuel economy on the required label. Importantly, MPG figures are derived from window sticker figures, which are 28% lower than CAFE figures.

Table 1: **Feature values for six different ways to convey fuel efficiency data in a sample survey**

Characteristics and stages		Little vehicle	Medium vehicle	Big vehicle	Little SUV	Medium SUV	Big SUV	Microbus	Utility vehicle
State 1: Fuel efficiency of town/highway (MPG)		30	30	25	25	30	22	32	28
		36	32	30	30	32	28	35	32
		45	40	35	35	43	35	38	39
		50	45	45	42	47	38	42	49
State 2: Yearly price of gasoline ($)		1550	1870	2000	1880	2250	2500	2470	3500
		1180	1350	1780	1670	2040	2175	1800	3110
		1100	1110	1480	1420	1870	1860	1690	2150
		980	985	1210	1195	1480	1690	1550	1950
State 3: Six years of fuel price ($)		7110	8115	10105	9850	11200	12500	11180	13200
		6825	7840	9570	8955	10130	11689	10986	12400
		5190	6550	8715	8120	9876	1042	10100	11200
		4950	5570	7500	7950	8955	975	940	10655
State 4: Spending and saving vehicle	Save	750	700	980	820	1040	1120	990	1250
		1300	1450	1800	1865	1998	2650	2100	2750
	Spent	1600	1850	1950	2050	2500	2950	2710	2840
		300	420	550	410	570	550	670	800

average over 6 years ($)								
State 5: Annual gasoline prices ($)	18250	20500	25750	22780	28950	30580	28740	30750
	15625	18750	20950	18765	25750	28750	25985	26795
	13350	15680	18600	17658	24500	25980	22744	24985
	10200	12700	15790	14780	20788	22750	20500	22355
State 6: Entire fuel economy (MPG)	35	32	32	25	25	22	25	20
	28	30	28	28	20	18	15	25
	50	28	24	32	35	15	32	27
	45	34	30	39	38	28	30	35

Participants were informed that 60 percent of the fuel costs and fuel economy numbers reported depended on the city, 40 percent on the highway driving rate, and that fuel prices depended on a traveling distance of 16,000 miles per year at a fixed gasoline price of $3.5 per gallon. These specific figures are based on the annual mileage of the period designed for automobiles in the 2020 model years and EPA gas prices. Although participants are allowed to take into account their current and predicted upcoming travel plans when choosing in the investigation, the research seeks to clarify that the petrol prices mentioned in the selection test depend on this assumption. The participant allocated to the lifetime fuel price state expressed that fuel prices were calculated at a fixed gasoline price of $4.00 per gallon based on 160,200 miles over a 30-year period. This increased gas price depends on the long-term rise in the EIA's forecast gas prices.
Interviews with automotive experts on consumer reports led to the development of vehicle characteristics and conditions. Each participant agreed to understand the challenge. The whole factor of the possible combinations of these characteristics and levels was distributed between the optional packages using the performance design; the D-effectiveness was 94 percent, which was greater than the conventional recommendation of 85 percent and suggests a "better" design symmetrical and orthogonal. The highest acceleration level cannot be combined with the greatest fuel economy level, and the two and three levels of exceptional features and trims cannot be combined with the cheapest price level. These controls were used as part of the design process to avoid incorporating unrealistic attribute combinations. Each of the final 50 exam packages generated eight blocks with six choices, and participants were roughly allocated to finishing one block out of six options. In a pilot release with 230 people from the target audience, the study checked the reliability and realism of all the possible combinations of features.

3.3 Random assessment for conditions related to fuel economy

Every participant in the expressed choice experiment was randomized to the following conditions that differ in how the fuel economy data is processed. The only difference between the situations is how the fuel economy data is shown. The experiment setups are as follows:
State 1: MPG (city/highway combination), such as "25 MPG";
State 2: Annual fuel cost (excluding annual mileage 16, 000)
State 3: Six-year fuel cost such as "$ 9,150" (not calculated, five-year mileage assumed to be 80,000);
State 4: How much did you save or spend in six years compared to a regular new car in the class that each participant wanted, for example, "Save $ 500 on petrol costs in six years";
State 5: Lifetime fuel costs (unaccounted for, 160,150 miles per vehicle over 30 years for all eight classes, taken from the NHTSA's Car Miles Travel Plan for Passenger Vehicles, and Energy Information Management expects higher gas prices to be $ 4 per gallon, for example, "$ 20.80);
State 6: The full EPA fuel economy labeling, which includes MPG (combination city/highway), annual fuel cost, participants' target class, fuel economy, and GHG estimates of the expanse saving/spending over six years comparing to a regular new vehicle, And Smoke rating. Except for the smoke rating, it was 5/10 for all cars.
These six study settings were chosen precisely to evaluate whether the type of fuel efficiency presentation causes participants to value fuel economy the most. Recall that states 1, 2, and 4 were chosen to describe distinct elements of the whole EPA fuel economy labeling (excluding greenhouse gas and smog rating), and the study investigates whether any of these elements of the label appear to be more significant than others. State 3 and State 5 are included in the research because the study believes that greater fuel price numbers (as opposed to fuel utilization numbers) may be more persuasive in influencing people to make fuel-effectiveness decisions than the elements on the entire fuel economy label. Because participants may utilize the data that was most pertinent to them or was most recognizable to them, State 6 was chosen to examine if the entire EPA fuel economy labeling (incorporating States 1, 2, and 4) could result in a higher fuel economy assessment.

3.4 Evaluation of Data

This study examines the vehicle replacement selection of test participants at each test stage to analyze the first research objective (evaluating how the fuel economy consumer assessment is affected by the data used to illustrate the fuel economy). Excellent results for median fuel efficiency quality demonstrate more frequently selected automobiles with higher fuel efficiency throughout the test. The study established a parameter to provide the average ranking of each participant in the selected vehicles in six selection packages that represent the lowest, central, and most effective vehicles from "1," "2," and "3." The Kruskhal Wallis H test detects potentially significant changes in vehicle performance at each test level. This lets us determine fuel efficiency data to see if participants' preferences for fuel-efficient cars changed. The study uses the Kruskal-Wallis (non-parameter) H-test since the ranking factors are better with this form of significant test. The study uses STATA 16.1 to analyze three multinomial logit (MNL) models. In each test scenario, models evaluate fuel efficiency overall and by vehicle and population characteristics. These models can calculate participants' vehicle quality preferences by calculating utility coefficients for each aspect. The alternative is the model-dependent variable, which calculates preferences for each aspect while preserving other characteristics and independent factors. Because alternatives are unlabeled and vary, the probe eliminates alternative-specific constants. The study determines WTP values for greater fuel efficiency, showing how participants value an extra unit of increased fuel efficiency in proportion to car cost. The Delta approach is used to determine WTP standard errors.

The study defines fuel efficiency in all MNL models as fuel cost per year to compare situations. This study analyzed fuel-efficiency models using MPG and gallon/1020 miles, as well as nonlinear increases in fuel cost, MPG, and gallons/1020 miles each year. Except for the lifetime fuel price scenario, the study used $4/gallon, MPG, yearly car kilometers driven, and $3.78/gallon gasoline. The study compared different computation methods.

As a flaw of the reported selection procedure, the study notes that participants may have interpreted the instructions differently. In the trial, 50% of participants drove between states at the same rate as the average individual in this car ($3.78 per gallon). The research meant for this remark to emphasize that predicted yearly kilometers, gasoline cost, and city/highway driving proportion were used to determine fuel cost calculations in the choice experiment (for matching circumstances). This argument may also show that people make assumptions about their past, present, and future driving patterns (as well as fuel price estimates).

The study chose to include participants' claimed mileage when calculating fuel costs per year because it's likely they acted as anticipated. The study investigated the impacts of the assumption by computing fuel cost annually using 16,000 car miles driven, but this alternate computation did not affect model conclusions in terms of relevance, sign, or size of variables. To represent rising gas prices over the vehicle's lifetime, the fuel economy criterion was set at $4.00 per gallon. The study uses this figure to calculate the annual gasoline cost based on participant input. The study considered utilizing a gasoline cost of $3.85/gallon (rather than $4.00/gallon) to determine the fuel cost per year for the lifelong fuel cost criterion, but this alternative requirement did not affect the findings.

4. Results and Discussion

4.1 Information Gathering

Using persons (age 20 or above) with a validating driver's license who intend to lease/buy a used or new car in the upcoming twelve years as the target demographic, the study employed a market research firm to assemble a cross-national sampling of Ghana car purchasers. Sixty-five percent of participants said they intended to lease or buy a car within the next two years, with all participants planning to do so within the next 12 years. The final database contains a sample of 950 vehicle buyers or tenants, except those who failed three quality assurance queries (n = 250) based on the age, gender, education, race, income, and geographical area of the Ghanaian citizens. To complete the research in less than half of the average finishing time (n = 195). Due to the lack of demographic information on the target audience, the research is unable to properly determine whether this representative sample of targeted vehicle buyers or lessees. According to prior studies, those who are planning to buy a new vehicle, in particular, tend to be a little older and have greater education levels and family revenue than the average person

4.2 Data and analytics' effects on vehicle choices

Utilizing factor of ranking car selection, the research first examines whether the six fuel economy data performance types have a distinct effect on purchaser car selections. The total significant variation between the condition averages was found using the Kruskal-Wallis H test, $\chi 2(5) = 70.25$, $p < .001$. In particular, persons who were shown MPG data chose vehicles that were considerably most fuel-efficient (M = 3.35) than those that were shown yearly cost of fuel (M = 3.40, average rating = 910.10), five-year cost of fuel (M = 3.30, average rating = 950.85), and spend/save comparability (M = 3.26, average rating = 952.35). Related to this, people who participated chose meaningfully more fuel-efficient cars when the entire fuel economy labeling was displayed (M = 3.57), as opposed to when the yearly cost of fuel, five-year cost of fuel, or spend/save evaluation were displayed (M = 3.21), five-year cost of fuel, or M = 3.13, respectively.

4.3 Using a specified option test, evaluate fuel economy

Utilizing participation choices experimental values from the six test conditions, the study calculate three MNL methods to give a more thorough examination of the effects of the interventions. Recall that the vehicle selection in every option set serves as the model' predictor variables. Overall car feature coefficients in the three models are important (at a confidence level of 98%) and have the predicted direction. Participants specifically chose automobiles with cheaper initial expenses, lower operating costs (or greater fuel efficiency), and quicker accelerating. Respondents also favored cars with greater levels of safety, dependability, and luxury amenities and finish. The considerable, maximum levels for fuel economy (expressed as fuel price annually) show that participator place a high emphasis on increased fuel efficiency.

The following section will go over each factor included in modeling 1, 2, and 3 and how it interacts with the annual gasoline price. The non-interacted cost of fuel annually coefficient and the interacted coefficients are understood as "summarizing" the interacting variables, as a participant should be aware of. In Model 1, the analysis takes into account the annual cost of gasoline for every situation. Considering that this is the typical way that fuel economy data is provided to customers, the non-interacted fuel price annually coefficient serves as the "basis" for comparability and reflects state 6 (complete EPA fuel efficiency label). Model 1 shows that participants place a high priority on savings of fuel. Individuals in Tests 2 to 5 considerably underestimate the fuel savings condition comparing to the 6 participants (baseline). The value under state 1 and state 6 does not differ significantly from each other. The biggest value of fuel economy is that those in state 6 will spend \$ 20.52 to saving \$ 1 / year on fuel prices. Those in state 1 can reduce their petrol costs by \$ 1 a year to a comparable, rarely changed WTP value of \$ 18.52.

A lower fuel efficiency rating was found among individuals in state 4 (fuel economy should be spent for more than five years or saved for more than six years compared to the median car in their chosen vehicle class), but they were still ready to pay \$ 6.5. Decrease fuel prices by \$ 1 per annually. Instead of integers, the study finds more interest in comparative variations of WTP values across study contexts. In state 6 the participant expresses a much better fuel economy estimate than in state 2, 3, 4 and 5, according to the strong critical coefficient for the condition relating to the price of petrol per year (except state 1). The WTP rates from Model 1 are compared in Figure 4, which also illustrates an auxiliary approach for estimating significant differences in scenarios. Ninety-five percent non-aligned trust gaps represent significant differences in WTP rates. When standard errors from multiple coefficients are combined, the effects are slightly different from Model 1 and are obtained using standard errors of WTP values obtained utilizing the delta approach. As for the significant differences between the different modes, Figure 4 provides a very moderate perspective. According to Figure 4, participants in state 6 place more emphasis on fuel economy than those in state 2, 3 and 4. In addition, those in state 1 place a higher priority on fuel efficiency than those in state 4. Thus, in some cases, the study may conclude that the way fuel economy data is presented has a major impact on how participants perceive fuel economy.

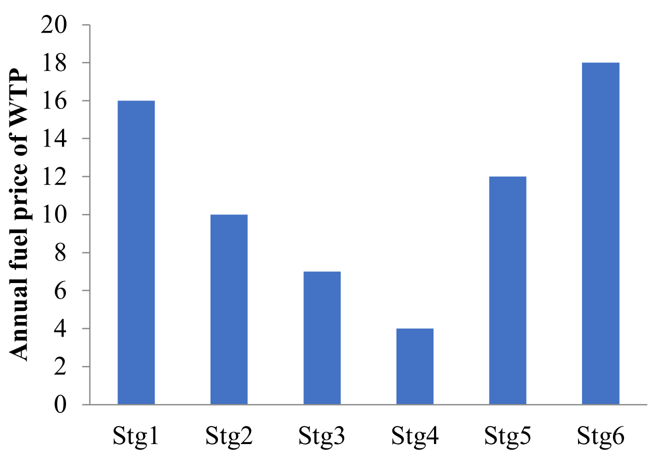

Figure 4: **Various state fuel price estimation**

In Model 2, the study combines participants' population and preferred vehicle characteristics with fuel economy. The findings show that the fuel economy rating is related to the age of the respondents and the expected purchase price of their next vehicle, but not any other features. The core WTP value on this model is \$ 10.25, which saves \$ 1 / year on fuel costs. Each additional year is associated with a \$ 0.20 improvement to saving \$ 1 / annual in fuel prices, demonstrating a strong, effective relationship between age and fuel economy value. As a result, a 60-year-old participant would be willing to spend $ 18.95 to avoid paying $ 1 a year for petrol. For each $ 1500 rise in planned purchasing cost, participators are ready to spend $ 0.30 fewer to save $ 1 / annual on fuel prices. In contrast, the expected purchasing cost of participation 'is strongly and negatively related to the fuel economy rating of the next car. Therefore, a participant who plans to invest $ 40,000 in his or her next car will be ready to pay $ 3.98 to save $ 1 / annual on fuel price.

The study relates to participant statistics, desired vehicle characteristics, and the condition in Model 3. In addition to the age of the participants' next car and the planned purchase price, the Model 3 demonstrates a substantial estimate of fuel economy between the state 2–6. For an average 60-year-old participant expecting a car price of $ 30,000, Table 2 shows the WTP values for each situation and the expected vehicle purchase price effects. Figures 5 and 6 show how WTP ratings change with age and the projected cost of a new vehicle under each scenario. For making these graphs as legible as feasible, the study doesn't include confidence intervals since, when computed by mixing standard error values obtained by the Delta approach, several confidence intervals would overlap. Whenever participants ages and predicted future car purchase costs are taken into consideration, this model indicates that there are considerable disparities across circumstances. Figure 5 and 6 shows the difference in WTP by aging and the estimated purchase price of the next vehicle, as well as an approximate estimate based on the condition. The WTP values of older participants (80 years) range from $ 12.97 (state 4) to $ 25.35 (state 6), while the WTP values of younger individuals (18 years) range from $ 6.75 (state 4) for $ 18.95 (state 6). Participants who intend to spend the least money ($0) on their future car are ready to pay anything between $3.55 (state 4) and $15.91 to save $1/year on gasoline. The individuals in state 6 (the foundation for comparability to other circumstances), senior individuals, and individuals who intend to buy less expensive automobiles exhibit the greatest WTP rates to saving $1/annual in gasoline expenditures, whose values follow the similar patterns as those shown in Models 1 and 2. Once more, the study pays more attention to the relative valuation that WTP values reflect than to their actual values.

Table 2: **Information from the Ghanaian Census and the research sample's (n = 950) characteristics**

Various Aspects		Test Samples (%)	Ghana Census (2020) (%)
Gender	Female	45	52
	Male	60	55
Age	20-30	10	12
	31-40	18	15

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DOI: 10.5281/zenodo.7222108

	41-50	18	16
	51-60	18.5	16.2
	61-70	20	17.5
	>71	25	21.5
Learning stage	School or less	70	69
	Graduation	22	19
	Any degree	15	14
Salary	< 30,000	22	18
	30k to 50k	32	20
	50k to 80k	25	18.5
	80k to 100k	13.5	12.8
	100k to 160k	12	14.5
	160k and more	6.5	15.5
Area	West	20.8	18.5
	South	25.6	22.2
	East	42.5	40.2
	North	22.8	24.3

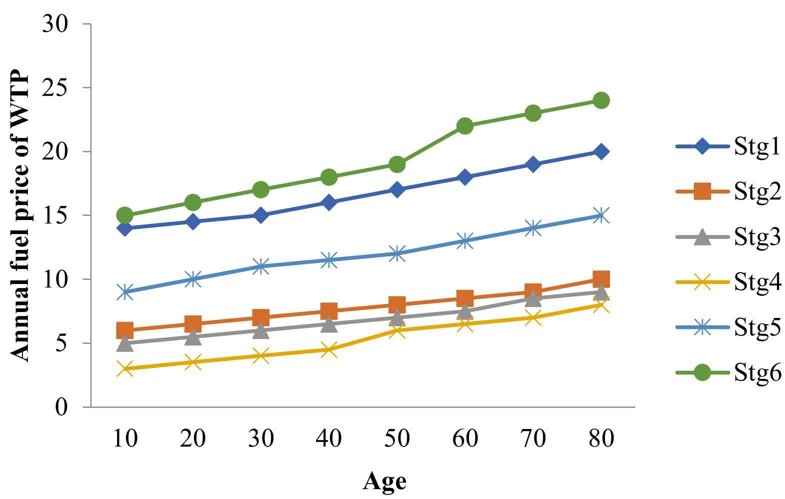

Figure 5: **Annual fuel price of WTP based on participant age**

Ann. For. Res. 65(1): 608-629, 2022
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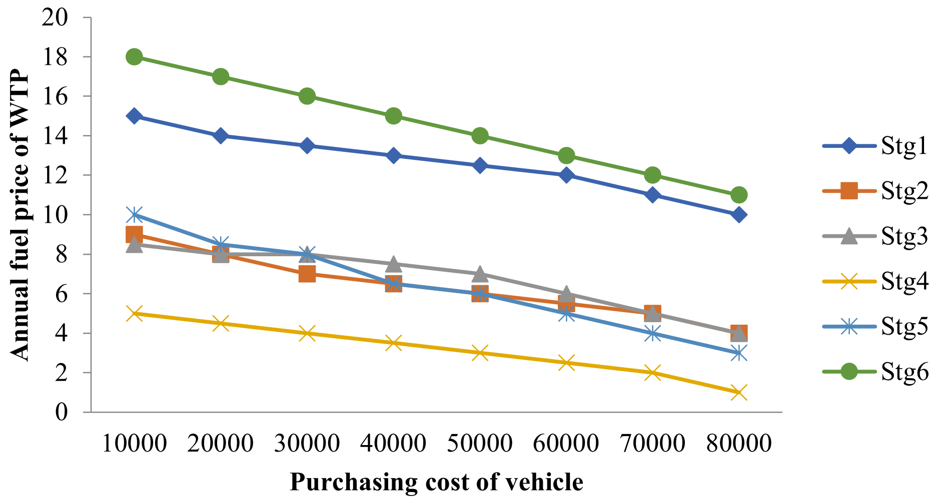

Figure 6: **Annual fuel cost based on purchasing a new vehicle**

This study contributes to the expansion of research into how buyers value the fuel economy. The research uses the approach of a specific selection experiment combined with random, comparable situations to answer the question of how the display of fuel economy data affects the estimation of fuel economy. The main goal of this study is to determine how data presentation affects how consumers value fuel economy. Depending on the outcomes of this study (in which participants were randomly assigned to treated group), the study realize that the various conceptualizations of fuel economy can normally influence participator selection of fuel-efficient cars as well as how much they are ready to pay for yearly fuel price savings.

Indirect WTPs of participants are shown in four categories: annual cost of fuel ($ 10.52), five years of fuel price ($ 9.00), and total saved/spend over six years on fuel compared to the total vehicle. Then that class ($ 7.30) was much better than the implicit WTP for fuel economy under the entire EPA-mandated fuel economy label ($ 20.52 to saving $ 1 / annual on fuel price). Compared to those who observed the fuel economy expressed as MPG ($ 20.45), the absolute EPA labeling WTP figures did not differ significantly. The fuel economy labeling display may have created the largest WTP because it provided so many activities that could resonate with different participants. A broad-spectrum label currently used by EPA helps readers focus on the most important qualities. For example, those interested in environmental sustainability can view data on CO2 emissions, and those interested in finance can view annual or six-year fuel price data.

Another, related hypothesis is that individuals are more persuaded by several forms of data than they are by a single metric alone. The results indicate that value of fuel economy might be greater with a higher availability of data supplied, which builds on prior research that helped notify the revamp of the required fuel economy label and that has analyzed the effect of certain components from the EPA fuel economy labeling on purchase decision. The values of WTP for those who have seen the total fuel economy labeling are considerably greater than two of the three mechanisms of the fuel economy labeling, especially the total fuel price and the quantity saved/spent on fuel over six years indicates that for an average vehicle in that class, there may be some ratings added to the values. WTP, whose value and ownership were claimed only under the MPG scenario, however, did not differ significantly from absolute fuel economy labeling, which is an intriguing finding. As the most common fuel economy indicator in Ghana, MPG can be analyzed very easily so many customers may choose to evaluate or focus on it. Potential financial and savings intentions are the most frequently cited details for customers to engage in effective car purchasing. Of all the data on the complete EPA labeling, MPG appears to result in the largest estimated fuel savings.

Another argument for why individuals who had seen the EPA fuel economy label gave the data about fuel economy the best ratings is that this method of presenting is the most reliable or well-known. Additionally, it's conceivable that individuals in this scenario were more attentive to the data since it was provided in the form of a real label as opposed to the other circumstances, which merely displayed the fuel economy statistics (such as "25 MPG") with the other qualities. In other words, although the data on fuel efficiency appeared to be identical under other conditions, the indicated test seemed different in comparison with other features. As a result, participants may have been more interested in the fuel efficiency aspect of the situation where the full EPA label is visible.

Taking into account consumer statistics and the following vehicle features, the study found that the value of fuel efficiency is strongly and positively related to age (to save $ 1 per year on fuel costs, WTP is $ 0.20 older each year). According to a study of Ghana car sales data, the elderly are positively associated with fuel economy value. Notably, the study found a significant negative correlation between the participant's next car and the expected purchase price of fuel economy (WTP - $ 0.30 to $ 1500 price increase to save $ 1 / year on fuel costs).

This study points out that the results demonstrate a variation in fuel economy evaluation, with certain WTP values pointing to an overvaluation and others to an underestimation. The "rational actor" will consider a $1/year reduction in fuel expenses to be worth $15.96 in current value at a baseline discount factor of 7% and a 30-year vehicle lifespan. With suggested discount rates of between 3 percent and 4 percent, the WTP calculations from participator in the entire EPA labeling ($19.55) and MPG ($17.45) circumstances point to overvaluation. Participants in the lifetime fuel cost scenario, on the other hand, have a WTP value of $12.52, which indicates practically entire evaluation and an estimated discounted rate of about 8%. Importantly, the WTP calculation for a person with median age (60), predicted vehicle cost ($30,000), and near-full value of fuel efficiency, with an inferred discounting rate of roughly 6%–7%, shows near full evaluation of fuel economy. The estimated discounting rates for the other circumstances' WTP values range from around 15 percent to 18 percent, that suggests that fuel economy savings are undervalued.

5. Implication of Polices

Designing an effective fuel efficiency policy requires understanding how customers value fuel efficiency. Understanding how buyers prioritize car qualities like speed and fuel economy can help predict fuel efficiency rules' effects on the auto market and, by extension, the standards' economic effects. In the same way, it's important to know how to present information about fuel economy to

get buyers to act on their interest in this feature since consumers' stated preferences don't always match up with their actual buying behavior.
To reduce transportation emissions with fuel-efficient vehicles, policymakers must encourage consumers to buy them. These data suggest that the mandated fuel economy label may be the most persuasive source of information for promoting the purchase of fuel-efficient cars and creating the most accurate fuel economy appraisal. Significant information gaps exist about whether and how real-world buyers use the fuel efficiency label. A plan for fuel economy could encourage (or even require) providers to highlight information about fuel efficiency when customers are making decisions.
Spending more may not be as important as spending "just the right amount" for fuel economy, even though fuel economy labeling encourages buyers to pay the most for fuel economy. The study showed near-complete evaluation for some scenarios but overestimated WTP rates. Improving the perceived quality of fuel economy is important for reducing emissions (possibly to encourage most fuel efficiency choices), but policymakers may need to examine delivery strategies to encourage most "rational" purchasing decisions. The data that teaches customers to estimate fuel economy is similar to net profit.
The differences in WTP for gasoline price decreases, when presented in different data, disprove the study that customers behave logically. This understanding highlights the need for legislation to drive markets toward desirable objectives, as consumer preferences alone may not be enough. This irrational discovery may explain why customers want large, fuel-inefficient cars. Automakers can boost demand by appealing to consumers' symbolic associations with their vehicles. Even though most SUV drivers stay on the sidewalks and don't go off-roading, SUV ads show outdoor activities and places where you can do whatever you want.

Conclusion

Finally, this study shows that how fuel economy data is given has a direct effect on consumer valuing of fuel economy, with a broader range of measures appearing to provide the greatest WTP. These results confirm the hypothesis that the substantial range in WTP for fuel efficiency may be partially due to variations in measuring system between researches, which helps to explain the identified discrepancies in consumer assessment of fuel economy. The results of the national delegates reveal a wide range of fuel economy estimates and the provision of fuel economy data to consumers has a significant impact on their vehicle selection. Together, these results show that consumers are concerned about fuel economy, but not all indicators are equal; a wide range of measurements can lead to a higher evaluation of fuel efficiency. Future studies should examine how much fuel efficiency information is best received by customers. Further study may examine the threshold at which evaluation falls because of excess metrics, label clutter, or burdensome customer cognitive effort.

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