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Consumer Valuation of Improvements in Fuel Economy and Reductions in Emissions of Vehicles in Turkey

Ali Kuru
Clemson University

CONSUMER VALUATION OF IMPROVEMENTS IN FUEL ECONOMY AND REDUCTIONS IN EMISSIONS OF VEHICLES IN TURKEY

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Ali Kuru
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Accepted by:
Dr. Scott R. Templeton, Committee Chair
Dr. Molly Espey
Dr. Matthew S. Lewis
Dr. Robert Fleck

ABSTRACT

In this study, I estimate consumer valuation of reducing the adverse impact on the environment of car's operation and saving on fuel expenses from improved fuel economy. To estimate these valuations, I use a hedonic model of new passenger cars sold in Turkey from June to December 2015. The estimated implicit value of improved fuel economy is then compared to the present discounted value of the associated fuel-cost savings expected throughout the vehicle's economic life. The results indicate that the consumer valuation of improved fuel economy is less than the present discounted value of associated fuel-cost savings, implying that imposing standards on fuel economy in the country may be more effective for addressing the concerns about the environmental consequences of fuel use by leading people to buy more fuel-efficient cars.

Given that an improvement in fuel economy might be correlated with reductions in tailpipe emissions, I collect information on various attributes that might indicate a reduction in an adverse environmental impact of a car's operation in order to disentangle the consumer valuation of improved fuel economy from the consumer valuation of reducing the adverse environmental impacts of their cars. Results indicate that the model which additionally accounts for the attributes that might indicate reductions in adverse environmental impacts of car's operation fits the data statistically significantly better. In addition, the estimated consumer valuation of improved fuel economy significantly declined in absolute value after including those attributes in the model. This suggests that not accounting for the consumer valuation of reducing the adverse environmental impact of their vehicles in the empirical model might upward bias the estimation of the consumer

valuation of improved fuel economy. Results also indicate that consumers might significantly value reducing adverse environmental impacts of tailpipe emissions except NO_x from their vehicles. Given that relatively more information is provided about CO_2 emissions than NO_x, this result might suggest that policymakers need to provide more information about NO_x emissions to car buyers.

In addition, the results also indicate that consumers respond significantly differently to a change in fuel prices from how they respond to a change in fuel consumptiveness—the reciprocal of fuel economy—of a vehicle for a given change in the fuel cost of driving a certain distance. A preliminary analysis about how changes in fuel prices and characteristics of production facilities shift the consumer's bid function and producer's offer function is also briefly discussed. Tracing such shifts might be used in the second-stage of the hedonic model to determine the demand and supply functions of fuel economy in the future research.

DEDICATION

For the Most Gracious, the Most Merciful

For my mother and father

For my beloved wife Kezban and our sons Ibrahim and Ahmet

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CHAPTER ONE

INTRODUCTION

Concerns about the environmental consequences of fuel use have increased since global warming has become an issue. According to the European Environment Agency's report, the transportation sector was responsible for approximately 20.4 percent of the total CO_2 emissions in European Union countries in 2015 and a similar percentage of 15.6 percent in Turkey for the same year ("Greenhouse," 2016). In addition, the passenger cars were responsible for approximately 44.5 percent of the transportation related emissions ("Greenhouse," 2017).

Under certain conditions, one way to reduce emissions from passenger cars is to improve their fuel economy. Depending on consumer response, an improvement in fuel economy means either a longer distance traveled for a given fuel consumption or more money saved from driving a given distance. It is possible that consumers may choose to drive more when it becomes cheaper, a situation known as the rebound effect of improved fuel economy, and, therefore, the total amount of money saved and emissions reduced may not be as much as expected. However, evidence from the U.S. vehicle market suggests that the long-run rebound effect is estimated to offset only 10.7 percent of the fuel savings from improved fuel economy (Small and Van Dender, 2007). Therefore, both fuel expenses and emissions in total are expected to decline on average as the fuel economy improves.

Given these benefits consumers gain from improved fuel economy, how much value consumers place on such improvement has been of great interest in previous research.

Even though such valuation has been extensively investigated for car buyers in various countries, especially in the U.S., it has not been investigated for car buyers in Turkey. Some found that consumer valuation of improved fuel economy was statistically insignificant (Train and Winston, 2007; Berry et al., 1995), but the majority of the previous research found that such valuation was significant (Espey and Nair, 2005; Vance and Mehlin, 2009; Chugh et al., 2011; Alberini et al., 2016) and that consumers substitute more fuel-efficient cars especially during times of high fuel prices (Li et al., 2009; Burke and Nishitateno, 2013; Busse et al., 2013). Given that Turkey had the 5th highest fuel prices in the world in 2014 ("Pump Price," n.d.), investigating the consumer valuation of improved fuel economy in a country with such high fuel prices may at least fill the gap in the literature for the country if not bring a new perspective. Therefore, I start my research by asking first:

> RQ-1A: To what extent, if any, do car buyers in Turkey value an improvement in fuel economy while holding all else constant?

Recent evidence from simulations, based on the real-world data from the U.S. auto market, suggests that not accounting for heterogeneity among consumers in terms of their willingness to pay for reduced fuel-costs might significantly affect the estimated consumer valuation of future fuel-cost savings (Bento et al., 2012). Some studies investigated the consumer valuation of fuel economy for separate nests usually based on the size of the vehicles (e.g. Gramlich, 2010); some, on the other hand, did it based on fuel types (e.g. Grigolon et al. 2017). However, types of heterogeneity are not limited to these categories. For example, buyers of different vehicular body types may have unmeasured characteristics—such as their expectations about the distance travelled for a given period or/and throughout the vehicle life—that may influence their willingness to pay for an

improvement in fuel economy and vary by body type. Chugh et al. (2011) accounted for this type of heterogeneity in their estimation of the consumer valuation of fuel economy. Even though they found significant results for each segment—diesel sedan, diesel hatchback, petrol sedan and petrol hatchback—they did not, however, investigate if the degree of consumer valuation of improved fuel economy depends on vehicular body type. Therefore, I explore my first question further:

> RQ-1B: Does the degree of the consumer valuation of improved fuel economy depend on vehicular body type?

Given that the fuel costs of driving a given distance is a function of both the price of fuel and the fuel consumptiveness—the reciprocal of fuel economy—of a vehicle, a decrease in such fuel costs can be driven by a decrease in fuel prices as well as a decrease in fuel consumptiveness of a vehicle, or by a decrease in both. Even though consumers save the same amount in fuel costs of driving a given distance no matter where such saving is originated from, the value they place on the anticipated savings in fuel costs may differ in terms of the origin of the savings. This is because a decrease in fuel prices may be seen as a relatively shorter-term gain in comparison to a decrease in fuel consumptiveness of a vehicle. For this reason, I ask, as another subsidiary question to my first question:

> RQ-1C: Do consumers value the improvements in fuel prices and fuel consumptiveness equally provided that both improvements generate the same saving in the fuel cost of driving a given distance?

Under certain conditions, economic theory predicts that the implicit value consumers place on improved fuel economy should equal the present discounted value (PDV) of the associated explicit future fuel-cost savings (Alberini et al., 2014). If consumers place implicitly lower value on improved fuel economy than the PDV of what

they would explicitly save on their future fuel costs, then they might buy vehicles with lower fuel economy and, therefore, emit more. In other words, they would have bought vehicles with better fuel economy and, therefore, emitted less if they had correctly anticipated how much they would save on their future fuel costs based on improved fuel economy, i.e. if they were not myopic about their future fuel-cost savings. For this reason, it is often asserted that imposing standards on the fuel economy of vehicles may help both increase the consumer welfare and address the concerns related to the adverse environmental impacts of vehicles by leading people to buy more fuel-efficient cars if they are myopic about the associated future fuel-cost savings (Anderson et al., 2011; Busse et al., 2013; Allcott and Wozny, 2014). On the other hand, due to their ability to affect consumer decisions on both how much to drive and which car to buy, some researchers argue that market-based instruments, such as fuel taxes, may be more effective as long as the benefits of improved fuel economy are not poorly perceived (Busse et al., 2013). Given that CO_2 emissions in the transportation sector in Turkey were approximately equal to 8.4 percent of total CO_2 emissions in the same sector in 28 European Union countries in 2015 ("Greenhouse," 2016), it is important to understand how car buyers in Turkey perceive the benefits of improved fuel economy to address the concerns about the environmental consequences of fuel use effectively (Anderson et al., 2011). Therefore, I ask:

> RQ-2: Is the value consumers in Turkey implicitly place on an improvement in fuel economy equal as the present discounted value of the associated explicit fuel-cost savings?

Even though previous studies have extensively investigated this question for the U.S. auto market, limited research has been conducted on auto-markets in other countries

such as Turkey. Some of those studies conclude that consumer valuation of improved fuel economy is lower than the present discounted value (PDV) of the associated future fuel-cost savings (Berry et al., 1995; Busse et al., 2013; Greene et al., 2013; Alcott and Wozny, 2014). However, these results are not conclusive. Some studies found that the consumer valuation of improved fuel economy is about the same as the PDV of future fuel-cost savings (Goldberg, 1995; Espey and Nair, 2005; Chugh et al., 2011; Sallee et al., 2016; Grigolon et al., 2017), while others have concluded that the former is higher than the latter (Brownstone et al., 2000; Econometrics C., 2008; Gramlich, 2010).

To address the concerns about the environmental consequences of fuel use more effectively, obtaining a more accurate, or less biased, estimate of consumer valuation of improved fuel economy is crucial. Given that certain characteristics of a vehicle such as power and weight can impact its fuel economy, it is important to disentangle the marginal willingness to pay (MWTP) for those characteristics from the MWTP for fuel economy *per se*. For example, the MWTP for fuel economy may also reflect the MWTP for associated lower emissions (Espey, 2013). Thus, if an improvement in fuel economy also means a reduction in emissions, then the estimated WTP for improved fuel economy would be expected to reflect at least two factors: the WTP for saving money on fuel expenses and the MWTP for reducing the adverse environmental impact of fuel use. In this case, ignoring the latter could result in an upward biased estimation of the WTP for saving money on fuel expenses. To investigate if such bias exists, I ask:

> RQ-3A: Does disentangling the consumer valuation of reducing the adverse environmental impacts of their cars from the consumer valuation of saving on fuel expenses based on improved fuel economy significantly change the estimation of the latter while holding all else constant?

If disentangling these valuations makes a statistically significantly change in the estimation of the latter, then doing so could help correct such potential bias in the estimations and obtain more accurate estimates of both valuations. If purchasing a vehicle with better fuel economy helps car buyers reduce both money spent on fuel expenses and their adverse impacts on the environment, then saving money by purchasing more fuel-efficient car could also be an additional motivation for them. Thus, by disentangling the consumer valuation of reducing adverse environmental impacts of their cars from the valuation of saving on fuel expenses, I would also explore whether the car buyers in Turkey significantly value a reduction in the adverse impacts of their cars on the environment beyond the savings they receive on fuel expenses from buying a vehicle with lower adverse impact on the environment. Hence, I ask:

> RQ-3B: To what extent, if any, do car buyers significantly value reducing the adverse environmental impacts of their cars while holding fuel economy and all else constant?

Even though numerous studies found that consumers are willing to pay more for environmentally friendly goods to reduce their adverse impacts on the environment (Roe et al., 2001; Kotchen and Moore, 2007; Saphores et al., 2007; Jacobsen et al., 2012; Houde, 2012), the consumer valuation of reducing the adverse environmental impact of their vehicles has received limited attention. Evidence from the choice experiment conducted among potential car buyers in Germany suggests that CO_2 emissions of the car impact the vehicle purchase decision in general, but the estimated willingness to pay (WTP) for a reduction in CO_2 emissions varies across samples in the population in terms of demographic features (Achtnicht, 2012). Evidence from estimating consumer valuation of

fuel economy labels in the Swiss car market suggests that car buyers are willing to pay more for the vehicle in the lowest emission category (Alberini et al., 2016). However, the authors concluded that their results indicate the WTP for both lower emissions and the fuel economy label itself given that such labels help reduce the uncertainty, and, therefore, the search efforts needed to find out about the fuel economy of the vehicles.

To address the first and third research questions, I constructed an extensively detailed dataset of new passenger cars sold in Turkey from June to December 2015. In addition to the season fixed effects and maker fixed effects, more than 45 predictors were used to explain the variations in the natural log of manufacturer-suggested retail prices for a total of 6314 unique sub-models. The effects of fuel economy and characteristics that indicate reductions in the adverse environmental impacts of cars on the vehicle price are estimated through hedonic analysis and interpreted as the implicit value of an improvement in a particular characteristic independent of all others, consistent with the theory behind it. To investigate the second research question, I additionally constructed a second dataset by extracting the relevant information from Turkey's largest online used-cars market to calculate the present discounted value of future fuel-cost savings based on an improvement in the fuel cost of driving a given distance. Subsequently, I compared the calculated explicit value of those savings with the estimated implicit value consumers place on improved fuel economy.

The Application of Hedonic Model and Use of Functional Form in Previous Literature

Automobiles are valued by car buyers for their utility-bearing characteristics (Rosen, 1974). Most of the vehicle characteristics, including fuel economy and the ones that

indicate reductions in the adverse environmental impacts of the vehicle are not individually marketable. To uncover the consumer preferences for such non-separable characteristics, the existing literature has usually applied two approaches: the hedonic valuation method and the stated preference method via surveys (Moon et al., 2002). However, the willingness to pay estimations from surveys are often criticized because of a bias from answering the questions according to society's expectations (Paulos, 1998). The hedonic approach may be less prone to such bias since it infers the implicit price of each non-marketable characteristic based on the variations in the price of a good.

However, the hedonic approach has also been criticized for its inability to address the omitted variable bias (Atkinson and Halvorsen, 1984). This study should not be substantially affected by such bias since I am considering various aspects of a vehicle using more than 70 variables including maker fixed effects and four environmental characteristics that may be related with fuel economy but not accounted for in previous studies. The fixed effects of each maker, or each manufacturer, are accepted in the literature as an effective method to pick up most of the effects of unobservable or difficult to measure characteristics such as safety. In addition, I also included season fixed effects in the estimation to minimize a potential bias from omitting any time-invariant variables that may be correlated with fuel economy.

The functional form used to create the model is an important consideration in hedonic analyses. Constructing a linear relationship between the price of a vehicle and its attributes may not be plausible because doing so implies that each additional unit of a characteristic gives the same marginal utility as the first (Goodman, 1983). Instead,

modeling a log-linear specification when variables are omitted or replaced by proxies is suggested (Cropper et al., 1988). Using a log transformation of the price as the dependent variable might also help reduce the effects of the outliers with substantially high prices (Alberini et al., 2016). Since the dataset constructed for this study also contains such outliers and since proxies for unobserved characteristics are also used in the estimation, estimations in this research would be better modeled with log-linear specification.

The Measurement for Vehicle Price and Fuel Economy in Previous Literature

Some of the previous studies used actual transaction prices, but most of them used the manufacturer-suggested retail price (MSRP) of the vehicle or their transformations as the dependent variable. Since I do not have access to the actual transaction prices, I used the natural log of the MSRP as the dependent variable in this research. Consistent with Alberini et al.'s (2016) argument, I also argue that the estimated effects of both fuel economy and environmental characteristics of vehicles on the natural log of MSRP should not be significantly different from their effects on the natural log of the actual transaction prices. To check the robustness of this argument, I propose applying the properties of stochastic frontier price model which is briefly introduced and discussed in Chapter Seven.

Various measures for fuel economy are proposed in the previous studies. Some of them used the fuel-cost of driving a given distance while some others used either fuel economy or fuel consumption (Greene, 2010). It is argued that vehicle price is better modeled as a function of fuel consumption for a given distance rather than as a function of fuel economy (Espey and Nair, 2005) because expressing the fuel efficiency of a car as the latter might lead to a confusion about the fuel efficiency of a car (Larrick and Soll, 2008).

In addition, the auto-markets in European countries as well as Turkey have a different structure than the market in the U.S. as they are not heavily dominated by one fuel type. To incorporate the differences in fuel consumptions and fuel prices between diesel and petrol powered cars, studies conducted for auto-markets in European countries used the fuel cost of driving 100 KM, which is the fuel consumption multiplied by fuel price. Examples include EFTEC (2008) for the U.K. auto market, Vance and Mehlin (2009) and Achtnicht (2012) for the German car market, and Alberini et al. (2016) for the Swiss car market. Thus, the fuel cost of driving 100 KM is used in this study as well since the fuel consumptions and fuel prices between diesel and petrol powered cars also substantially differ in the Turkish auto market.[1]

[1] The sales-weighted fuel consumptions of a diesel- and a petrol-powered car were 4.28 and 5.84 liters during the study period, and the sales-weighted prices of diesel and petrol per liter were 3.76 and 4.52 Turkish Liras during the same period.

CHAPTER TWO

DATASETS

Two unique datasets were constructed, one for the estimation of the implicit marginal values of vehicle characteristics and the second for the estimation of explicit future fuel-cost savings from an improvement in fuel economy. Four sources were used to construct the first dataset that contains information about sub-models sold during at least one month in Turkey from June to December 2015. The primary source of the information for the prices and characteristics of each sub-model was the electronic brochures of the manufacturers on their official websites.

A sub-model is defined by a maker, model, trim level, body type, number of doors, engine displacement, transmission and fuel type. For example, one sub-model in the dataset is a Ford Focus Trend X sedan diesel 1.5 liters 120 PS power-shift automatic four-door. The maker is Ford and the model is Focus. Each sub-model that was sold at least once in a particular month during the seven-month period represents one observation in a monthly dataset. The number of unique makers that were included in the dataset is 28, unique models is 199 and unique sub-models is 1098.

Among the other three sources for the first dataset, the Automotive Distributors' Association (ADA) in Turkey provided information about the number of each sub-model sold in Turkey in each month during the study period. The least number of a sub-model sold was one and the most was 14,674 in total during the seven-month period. The Energy Market Regulatory Authority (EMRA) in Turkey was the source of information for the monthly weighted means of fuel prices. EMRA calculates these averages based on the daily

sales volumes at all gas stations of the eight largest retail fuel companies throughout the country. The Central Bank of Republic of Turkey was the source for information on the monthly Euro/Turkish Lira exchange rates and the consumer price indices.

A particular sub-model was dropped from my first dataset if its price was more than 800,000 Turkish Lira (approximately 300,000 US Dollars in 2015 terms) or if at most six were sold during the seven-month period. In addition, Bentley, Ferrari, Lamborghini, Maserati and Porsche were also excluded because no official price list was posted for them on their websites. Also, some sub-models were excluded because I was unable to collect full information on all of their characteristics. Finally, electric cars were also excluded because there was only 1 sub-model, BMW i8. Further details about cleaning this dataset are provided in Appendix A. The number of unique sub-models in total excluded for any reason was approximately 200 of the 1300 possible. However, they correspond to only 2.4 percent of the market in terms of the total number of cars sold because of the infrequency they were sold over the seven-month period. The final dataset contains approximately 900 observations each month or 6314 observations in total. Since some sub-models were not sold in every month, our panel data are unbalanced. The number of observations, vehicles sold in the market and the percentages of the number of cars sold included in the final dataset for each month are listed in Table 6.

Two sources were used to construct the second dataset, which was used to calculate the present discounted value of the fuel-cost savings. The primary source of these data was an online automobile market for used cars in Turkey, www.sahibinden.com. It was built in 2000, and people use it not only for used cars but also for other used goods. Alexa, an

Amazon LLC company, which reports the most visited websites globally indicates that sahibinden.com is among the ten most visited websites in Turkey, saying it "has more than 30 million unique visitors and 3.5 billion page views in a month" ("Sahibinden.com," n.d.). The Central Bank of Republic of Turkey was the second source for the second dataset for the information needed to estimate the rate at which vehicle owners discount future savings in fuel costs.

The annual kilometers driven for each body type of a vehicle were calculated from the data extracted from sahibinden.com in November 2016 that includes information on the total kilometers on the odometer, the age, the date listed, and the sub-model name of each car listed. I have restricted the dataset to include only sub-models sold between June and December 2015. Therefore, only the information about 2015 model-year cars was used in calculating the average of annual kilometers driven for each vehicular body type. Further details about creating and cleaning this dataset are provided in Appendix B.

VARIABLES

Dependent Variable

Because of the lack of access to the actual transaction price of each vehicles sold, the manufacturer-suggested retail prices (MSRPs) were obtained. All prices are in Turkish Lira (TL) even though some models have Euro-based prices. For the latter, I calculated average monthly MSRPs in TL by multiplying their Euro-based prices with the monthly average of the Euro/TL exchange rate (Figure 1) unless the manufacturer stabilized the exchange rate for a given month. If the manufacturer suggested a stabilized exchange rate

for a given month, then I multiplied their Euro-based prices by the given exchange rate to calculate their MSRPs in TL.

The MSRPs were adjusted by inflation based on the monthly consumer price indices and, therefore, measured in June 2015 prices (Table 1). The consumer price indices exhibited an increasing trend until December 2015 (Figure 1). The natural logarithm of the inflation-adjusted MSRPs was used as the dependent variable. The MSRPs are given in the brochure either with or without further details about their components. The general formula manufacturers use to calculate the MSRPs, both Euro- and TL-based prices, from their components is the following:

$$MSRP = (NP + SCT) * (1 + VAT) + OTHCOSTS \quad (2.1)$$

where NP is the net price of a car before any taxes or fees; SCT is the special consumption tax imposed on the net price and is 45, 90, or 145 percent of the net price if the engine size is less than 1.6 liters, at least 1.6 liters but not more than 2 liters, or more than two liters; VAT is the value-added tax and equals 18 percent of the sum of the net price and the special consumption tax; OTHCOSTS represents the other costs such as registration and plate costs. Additional information about these components is provided in the Appendix C.

Explanatory Variables

The vehicular body types used in this research are sedan (SEDAN), station wagon (SWAGON), hatchback (HBACK), sports utility vehicle (SUV), and sports cars (SPORTS).[2] SEDAN's share in the market for the seven-month period was 49.8 percent

[2] Multi-purpose vans (MPVs) were merged with HBACKs since they look similar from the outside.

while it was 32.6 and 15.2 percent for HBACK and SUV (Table 3). Car buyers paid on average the most for sports cars and the least for hatchbacks during this period (Table 1).

The fuel costs of driving a given distance is the FCOST100KM variable, which is the total Turkish Lira spent on fuel to drive 100 kilometers. The general formula I used to calculate the FCOST100KM is the following;

$$FCOST100KM = (Fuel\ Consumption) * (Real\ Price\ of\ Fuel) \qquad (2.2)$$

where the fuel consumption is the amount of fuel in liters a car consumes to be driven 100 kilometers and the real price of fuel is the total Turkish Lira spent to buy one liter of fuel adjusted by the monthly consumer price indices measured in June 2015 prices. The average fuel consumption in Turkey as well as in Europe is calculated by taking the arithmetic average of 4/11 of the city consumption and 7/11 of the highway consumption based on the directives amended by the Economic Commission for Europe ("The fuel consumption," n.d.). The fuel consumption of the same sub-model did not change across months; however, both the nominal and the real prices of fuel exhibited a decreasing trend during the seven-month period (Figure 1).

To address the research questions, I multiplied the FCOST100KM with dummies for each body type: FCOST100KM*SEDAN is abbreviated to FCOST100KMSEDAN, FCOST100KM*SWAGON is FCOST100KMSWAGON, FCOST100KM*HBACK is FCOST100KMHBACK, FCOST100KM*SUV is FCOST100KMSUV, and FCOST100KM*SPORTS is FCOST100KMSPORTS. Whenever the FCOST100KM itself is used in an estimated model, it represents the real fuel cost of driving a sedan 100 kilometers (km) since sedan had the largest market share and, therefore, is taken as the base

group. The real fuel cost of driving 100 km is, on average, the highest for sports cars and the lowest for station wagons. In addition, the real fuel costs of driving 100 km fell, on average, over time for each body type (Table 2).

Operation of a vehicle can create adverse impacts on the indoor and outdoor environment. Four variables represent whether a vehicle has features or characteristics that might reduce these. The first of the environmentally-related features is whether a vehicle has start/stop technology (STARTSTOP), a feature that puts the engine in a sleep mode instead of idling it at a temporary stop, such as at traffic lights or at drive-throughs. Related literature shows that idling the engine has a major impact on fuel use (Rahman et al., 2013) and, therefore, increases CO_2 emissions from fuel use because idling the car more than 10 seconds consumes more fuel and emits more CO_2 than restarting it (Gaines et al., 2012). Given that idling the engine negatively impacts its life ("Why Engine," 2013), the start/stop technology may also help reduce the wear and tear on the engine from idling. Furthermore, this technology also helps reduce the noise from a running engine so that people inside and outside of the car are subjected to less noise (Edmunds, 2014).

STARTSTOP=1 only if this feature is offered in the standard package of the vehicle. The feature is turned on by default when the driver starts the car for the first time, but it can manually be deactivated later while the car is running. Therefore, the driver does not need to activate it every time she reaches a stopping point because the engine automatically puts itself into a sleep mode during a temporary stop and is restarted once the driver releases the brake. For cars with manual transmission, the driver needs to

manually activate this system by moving the gear lever to neutral, and it is automatically deactivated once the driver steps on the gas pedal.

The driving cycles for city (ECE-15) and urban (EUDC) used to calculate the fuel consumptiveness of a vehicle accounts for standing time during the cycle which is taken as the 20.90 percent of the time of the total trip (Barlow et al., 2009). Therefore, the effect of the having start/stop technology on fuel consumptiveness of the car should be reflected in estimated fuel consumption values in the manufacturers' brochures. Of the 1098 unique sub-models in the seven-month period, 629 (approximately 57.3 percent) had this technology while their market share was equal to approximately 43 percent (Table 2).

In addition to start/stop technology, there might be other characteristics that help reduce the adverse environmental impacts of the cars. I may not observe all of such characteristics, but I instead observe whether cars are explicitly advertised as an environmentally friendly car (ADVGREEN) in the official brochures. ADVGREEN=1 if a sub-model was advertised as emitting relatively lower CO_2 or other detrimental gasses in comparison to either its previous model or its competing rivals. ADVGREEN=0 for others, including those that were not advertised as lower emitters in the brochure even if they were in reality. One may argue the effectiveness of those advertisements because car buyers need to read the brochure to see. However, sales agents of the manufacturers are expected to explain important details about the car to the prospective car buyers and, therefore, to emphasize its contribution in reducing emissions. Of the 1098 unique sub-models in the seven-month period, 551 (approximately 50.2 percent) were ADVGREEN cars, representing approximately 56.5 percent market share (Table 2).

Vehicles that manufacturers advertise as the most fuel-efficient and the least emitters among all cars they sell are denoted as green cars (GREENCAR=1), a subset of ADVGREEN. These sub-models were equipped with technological enhancements and/or have unique designs such that they emit the least amount among all the manufacturer sells. Manufacturers emphasize them using larger letters or devoting one or two pages in the brochure to them. Manufacturers also give them unique names so that consumers can easily distinguish them. For example, BMW calls its most fuel-efficient and least-emitting vehicles Efficient Dynamic (ED) models, such as BMW 320i ED sedan automatic.[3] See Table 7 for the manufacturers and respective unique names they give to cars in GREENCAR category. Of the 1098 unique sub-models in the seven-month period, 174 (approximately 15.6 percent of all sub-models, or 31.6 percent of ADVGREENs) were GREENCARs, representing approximately 23.8 percent market share (Table 2). In addition, cars that use liquefied petroleum gas and cars that have hybrid engines are also advertised as the least emitters and, therefore, included in both ADVGREEN and GREENCAR categories.

The authorities in Turkey announced in 2014 that all cars must comply with Euro-6 Emission Standards by January 1, 2016 ("Turkiye'de Euro6'ya", 2014). Some manufacturers began to produce new models complying with these standards before 2015. These standards limit the average NO_x emission level to 0.08 g/km from its previous level of 0.18 g/km for diesel cars (ICCT, 2016). In this study, the EU6DIESEL=1 if a diesel car complies with these standards. Of the 551 unique sub-models that are DIESEL, 275

[3] It would have been very interesting for research purposes if those sub-models had twins in the market, but there is no such twins.

(approximately 49.9 percent) were EU6DIESEL in the seven-month period, representing 38.6 percent of the diesel cars (Table 2).

HYBRID denotes hybrid vehicles, which use both fuel and electric motors to power the engine. All HYBRID cars in this dataset use petroleum (Table 3), and no plug-in hybrids were sold during the study period. All hybrid vehicles are also in GREENCAR and ADVGREEN categories and have STARTSTOP technology. Of the 1098 unique sub-models, only 2 were hybrid in the seven-month period. The total number of hybrids sold was 599, or approximately 0.13 percent of the total number of cars sold in the same period.

Vehicles have other attributes that consumers might value, including fuel types, power and performance, size, safety, suspension types, transmission types, wheel-drive types, luxuriousness and comfort, country of production, and makers (or manufacturers). These attributes are not necessarily mutually exclusive; for example, the size of a vehicle might be related to its performance, handling or, safety.

The fuel types included in this research are diesel (DIESEL), petroleum (PETROL), and liquefied petroleum gas (LPG). Their respective market shares are 62.4 percent of DIESEL, 37.5 percent of PETROL and 0.01 percent of LPG for the study period (Table 3). Car owners paid more on average for diesel cars, 85.8 thousand Turkish Liras, than for petrol cars, 74.5 thousand Turkish Liras on average.

Three variables characterize the power and performance of a vehicle. HORSEPOWER is the amount of horsepower the engine generates divided by 100, where one horsepower is equal to 745.7 watts. The ones here with kilowatt and *pferdestarke*--the German word for horsepower--are converted into horsepower using appropriate conversion

rates; one kilowatt is approximately equal to 1.34 horsepower, and one *pferdestarke* is approximately equal to 0.986 horsepower. ACCELRTION measures how many seconds it takes for the car to reach a speed of 100 kilometers per hour. ENGINESIZE is the volume in liters swept by the pistons inside the cylinders of the engine. However, since the tax authority in Turkey levies an escalating special consumption tax depending on the engine displacement, I categorized the ENGINESIZE as follows: ENGSIZELESS1600, ENGSIZEBETW and ENGSIZEMORE2000 (Table 3). Vehicles with an engine volume of less than 1600 cubic centimeters (cc), or 1.6 liters, (ENGSIZELESS1600) are taxed at 45 percent of the car's net price. This category has the largest market share, 96.7 percent, in the study period. Vehicles with engines with more than or equal to 2 liters of volume (ENGSIZEMORE2000) are taxed at 145 percent, and the remainder with engine volumes between 1.6 and 2 liters (ENGSIZEBETW) are taxed at 90 percent.

Three variables are related to car size. First, FLOORSPACE is the floor-space of a sub-model. FLOORSPACE (square meters) equals the length of a sub-model multiplied by its width (without mirrors). Second, the curb weight (WEIGHT) of vehicle is the total weight (tons) of a vehicle with the driver (68kg), the luggage (7kg), and all of its necessary operating consumables such as coolant, motor oil, and a gas tank that is 90 percent full. HEIGHT is the height of the car from the ground to its roof in meters. Three other variables represent the factors that affect the inner-space: LUGGAGE is the capacity (100 liters) of the trunk; FUELTANK is the volume (liters) of the fuel tank; THIRDROW indicates whether a sub-model has three rows and, thus, room for six or seven passengers (Table 3).

The safety of a vehicle depends on the number of airbags. The number of airbags in the front seats are categorized into six separate dummy variables from 1 to 7 airbags. There is no sub-model with three airbags in the front. The number of airbags provided in the front seats is added after AIR; for example, AIR2 means that there are two airbags in the front (Table 3). In addition to the number of airbags in the front seats, the availability of a rear camera (REARCAM) is another safety feature of a vehicle.

The suspension system in a car helps to ensure a smooth ride. The independent suspension system (INDEPSUSP) allows each tire to move independently while the adaptive suspension system (ADAPSUSP) is a technologically more advanced version of the independent system. A semi-dependent system (SEMISUSP) allows each tire to move independently but the behavior of one affects the other. Since almost all passenger cars in Turkey are currently using independent suspensions in the front, for this research cars are categorized by these three suspension systems based on their rear wheels (Table 4).

Four transmission types are included: manual (MANUTRANS), semi-automatic (SEMITRANS), automatic (AUTOTRANS), and continuously variable transmission (CVARTRANS), which allows the transmission system to change gears continuously rather than at fixed ratios. In addition, there are three wheel-drive systems considered in this research: front-wheel drive (FRONTWD), rear-wheel drive (REARWD), and the combination of all-wheel and four-wheel drive types (ALL4WD) (Table 4).

Even though the variables defined thus far may partially represent the comfort and luxury of the cars, I have also included several additional features. Cruise control (CRUISECON) allows driver to set the vehicle speed constant, allowing them to relax their

legs for a while. The availability of automatic air conditioning (AUTOAIRCON), leather seats (LEATHERSEAT), alloy wheels on tires (ALLOYWHEEL), sunroofs (SUNROOF), and all glass top surfaces of the cars (GLASSTOP)[4] can also be considered comfort- and luxury-related variables (Table 4).

In addition to these six features, there are other characteristics also affecting the comfort and luxury of a car. Even though I initially intended to collect information on 18 more vehicle characteristics[5] in addition to what I currently have in the final dataset, the information about those characteristics was missing for some observations. For this reason, I preferred dropping those characteristics from the model instead of losing observations completely. In addition to these characteristics, there are also some unmeasured characteristics that are difficult to observe, such as advance technological enhancements to make the car more comfortable and easy-to-handle overall.

Nevertheless, I included a couple of dummy variables that are expected to pick up the effects of those characteristics. The Automotive Distributors' Association in Turkey has categorized passenger vehicles according to the European vehicle segment standards in which passenger vehicles are divided into six categories based on their size and luxuriousness (EU-Commission, 2000). Among those segments, Segment E represents executive cars and F represents luxury cars. Therefore, in this study LUXURY=1 if a sub-model is in Segment E, and UPPERLUXURY=1 if it is in segment F (Table 4). These

[4] Another difference between the GLASSTOP and SUNROOF is that the former is not openable while the latter is.
[5] Some of those characteristics are whether car has fog lambs, active headrest, xenon headlights, navigation, automatic heating system in the mirrors, immobilizer, drive-mode selector, and metallic paint.

dummies are expected to represent otherwise unmeasured characteristics, including those 18 characteristics, that make a car more luxurious and comfortable.

Cars are also grouped based on whether they were produced or assembled in Turkey (DOMESTIC). Of the 1098 unique sub-models, only 96 of them, or approximately 25.9 percent of the total number of cars sold during the seven-month period, were produced or assembled, in Turkey. Furthermore, there are 28 dummies for each manufacturer (for example, Audi and Ford) in the dataset. The base category is Renault, the manufacturer with the largest market share, 15.1 percent, for the seven-month period. Volkswagen follows Renault with a 14.8 percent market share, and the third largest one is Hyundai with a 6.9% market share. The market is dominated by European brands; overall their share in the market for the seven-month period is 71.5 percent. Specifically, German brands are the leader among Europeans brands with a 32 percent market share among all cars sold during the seven-month period. See Table 5 for a list of each manufacturer and its market share each month.

CHAPTER THREE

THE CONCEPTUAL FRAMEWORK AND THE THEORETICAL MODEL

The hedonic technique has been widely used in the literature to infer the value implicitly attached to non-marketable characteristics of goods based on the observed price of a bundle of those characteristics (Kolstad, 2011). According to this theory, goods can be considered as the combination of different characteristics, and the demand for that good is based on the demand for its characteristics. Sellers ask a price based on the cost of supplying an additional number of a characteristic that they supply and buyers offer a bid based on their preferences until an equilibrium price is reached. How and where they meet at this equilibrium are theoretically explained in a seminal article by Rosen (1974).

The conceptual framework of the theory is straightforward. Consumers care about vehicle characteristics and have a limited income available to purchase them in a bundle. They maximize their well-being from the consumption of individual characteristics, which are eventually bundled in a specific model, subject to their limited income and the prices they face. They attain additional utility from an increase in any good or from a decrease in any bad while holding all else constant. For instance, an improvement in fuel economy, i.e. a decrease in fuel consumptiveness, of a car should increase its utility. Similarly, any characteristics of the car that reduces the adverse environmental impact of the car's operation should also produce a greater utility provided that those characteristics are not simultaneously correlated with some bad.

Rosen (1974) represented the price of an automobile as $P=P(A_1, A_2, \ldots, A_I)$, where P is the price and A_i is the i^{th} characteristic of a car in the competitive market. The implicit

marginal price of each characteristic, at the hedonic equilibrium, can then be derived from the partial derivatives of the car price with respect to that characteristic (Rosen, 1974):

$$\frac{\partial P(A_i)}{\partial A_i} = P_i(A_i), and \;\; i = 1,2, \dots, I \tag{3.1}$$

Rosen (1974) has pictured the hedonic equilibrium as the point where the graph of a buyer's bid function and the graph of a seller's offer function "kiss" each other. The envelope of those tangencies is described as the implicit price function, or hedonic price function, of a characteristic at the competitive equilibrium (Rosen, 1974). This function reflects both the consumer's willingness to pay for and the producer's willingness to accept to provide a particular number of a characteristic at the competitive equilibrium.

However, the automobile market in Turkey, like automobile markets elsewhere, may be monopolistically competitive rather than perfectly competitive due to the facts that 49.9 percent of the cars sold during the study period were produced by only five manufacturers[6] and that they compete with one another primarily by differentiating their products in various ways. If sellers of automobiles are monopolistic competitors and have price-setting power, the equilibrium price of a vehicle is not the seller's marginal willingness-to-accept-compensation. On the other hand, one consumer alone has no power to affect the market price; thus, we can argue that the market can be considered as perfectly competitive from a consumer's point of view. For this reason, I focus only on the consumer side in this study, interpreting the results as the consumer's marginal willingness-to-pay-

[6] They are Renault, Volkswagen, Hyundai, Opel, and Toyota.

price at the equilibrium. Focusing only on the consumer side should not pose any theoretical or econometric issue since individuals have no market power (Palmquist, 1991).

ECONOMETRIC MODELS

Model 1: Partially Specified Seven Monthly Models

To estimate the implicit marginal price of each characteristic, I constructed a partially specified model for each month of the study period in a log-linear specification (Equation 3.2). In these models, the environmental characteristics of the vehicle are not included.

$$logMSRP_i = c + \beta * FCOST100KM_i + \sum_{b=1}^{4} \beta_b * FCOST100KM_i * \zeta_b + \zeta_{sed} + \sum_{b=1}^{4} \zeta_b + \boldsymbol{X_i} * \boldsymbol{\phi} + \sum_{m=1}^{28} \varphi_{im} + \varepsilon_i \quad (3.2)$$

where $logMSRP_i$ is the natural log of the manufacturer-suggested retail price for observation *i*, $FCOST100KM_i$ is the fuel-cost of driving sub-model *i* for 100 kilometers, ζ_{sed} is the dummy variable representing sedans, ζ_b is the set of dummy variables for each body type *b* other than sedan, $\boldsymbol{X_i}$ is the vector of other variables except environmental characteristics, φ_{im} is the fixed effects for each maker *m*, and ε_i is the error term. In addition, $\beta + \beta_b$ is the added effect of $FCOST100KM_i$ on $logMSRP_i$ for each body type *b* and $\boldsymbol{\phi}$ is the set of the effect of each variable of $\boldsymbol{X_i}$ on $logMSRP_i$.

After estimating Equation 3.2 via weighted least squares estimation method where the error terms are weighted by the number of vehicles sold for each observation, I conducted various tests on estimated coefficients for each month regarding to the research

questions. First, I tested that whether the effect of the fuel cost of driving 100 kilometers (FCOST100KM) for each body type on $logMSRP_i$ are significantly different from one another for each month. Then, I constructed a system of seemingly unrelated regressions (SUR), which enabled me to combine the results from seven monthly regressions through the correlation among their error terms. Subsequently, I tested whether the effect of FCOST100KM for each body type on $logMSRP_i$ significantly differs across months.

Model 2: Fully Specified Seven Monthly Models

I now extend the partially specified model by adding the environmental characteristics of the car that may be correlated with fuel economy to obtain more accurate estimation of consumer valuation of improved fuel cost of driving 100 km, as shown in Equation 3.3.

$$logMSRP_i = c + \beta * FCOST100KM_i + \sum_{b=1}^{4} \beta_b * FCOST100KM_i * \zeta_b + \zeta_{sed} + \sum_{b=1}^{4} \zeta_b + \boldsymbol{Z_i} * \boldsymbol{\theta} + \boldsymbol{X_i} * \boldsymbol{\phi} + \sum_{m=1}^{28} \varphi_{im} + \varepsilon_i \tag{3.3}$$

where $\boldsymbol{Z_i}$ and $\boldsymbol{\theta}$ are the vectors of environmental characteristics and their estimated effects on $logMSRP_i$.

The estimation was done via the sales-weighted least squares method. To test whether the partially specified monthly models fit the data discernibly better than the fully specified monthly models, the likelihood ratio tests for each month are conducted. In addition, the adjusted R-square values are also compared between those two models. After the estimation, I tested that whether the effect of the fuel cost of driving 100 kilometers (FCOST100KM) for each body type on $logMSRP_i$ are significantly different from one

another for each month. In addition, I again constructed a system of seemingly unrelated regressions (SUR) using Equation 3.3 and combined the results from seven monthly regressions. Then, I tested whether the effects of FCOST100KM for each body type and whether the effects of each environmental characteristic on $logMSRP_i$ significantly differ across months. Furthermore, I tested whether the estimated effect of FCOST100KM for each body type on $logMSRP_i$ significantly changes for each month before and after including the environmental characteristics of the car in the model. Finally, I tested whether the joint effects of all vehicle characteristics and whether the effect of each of those characteristics on $logMSRP_i$ differ across months.

Model 3: The Fully Specified Pooled Model

Based on the anticipated results from these tests, the vehicle characteristics that have significantly different effects across seasons were allowed to have separate effects across seasons while those that do not differ across seasons[7] are constrained to have the same effect for the entire period (Equation 3.4). This methodology is referred to, in the literature, as the constrained-least-squares approach, a strategy similar to the one followed by Goodman (1983) in his study. He suggested comparing the estimations from separate hedonic price functions for each year and pooling the observations if the equality of the estimated coefficients from different years is not rejected.

[7] The reason for constraining some of the estimated coefficients across seasons but not across months is because the anticipated results suggest that the estimated models are jointly different only across seasons.

$$logMSRP_{it} = c + \beta * FCOST100KM_{it} + \sum_{b=1}^{4} \beta_b * FCOST100KM_{it} * \zeta_b + \zeta_{sed} + \sum_{b=1}^{4} \zeta_b + \boldsymbol{Z_i} * \boldsymbol{\theta} + \boldsymbol{X_{ri}} * \boldsymbol{\phi} + \boldsymbol{X_{ui}} * \boldsymbol{\psi} * \boldsymbol{S_{is}} + \sum_{m=1}^{28} \varphi_{imr} + \sum_{m=1}^{28} \sum_{s=1}^{3} \varphi_{imus} * S_{is} + \boldsymbol{S_{is}} + \varepsilon_{is} \quad (3.4)$$

where *t* represents months and *s* seasons, *r* those restricted, or constrained, to have the same effect for all seasons, *u* those which are allowed to have separate effects, or unconstrained, for each season, and $\boldsymbol{S_{is}}$ the vector of season dummies.

In addition to weighting the error terms by sales volumes, they are also clustered based on unique identification number for each sub-model because the least squares methodology does not take into account that a sub-model is purchased in one month is not independent of whether the same sub-model purchased in another. However, this approach does not account for any possible correlation among errors over time.

After estimating the fully specified pooled model, I again conducted several tests. First, I tested whether the effects of the fuel cost of driving 100 kilometers (FCOST100KM) for each body type on $logMSRP_i$ are significantly different from one another. Then, using the seemingly unrelated regressions system again, I combined the estimation results obtained before and after including the environmental characteristics of the car in this model described in Equation 3.4. Then, I tested whether the estimated effect of FCOST100KM for each body type on $logP_i$ significantly changes before and after including those characteristics of the car in the model.

Model 4: The Within-Between Random Effects Model

Given that fuel cost of driving 100 km is the price of fuel multiplied by the fuel consumptiveness of vehicle and that the fuel consumptiveness of a sub-model does not change across months while the price of fuel does, addressing the question of whether consumers value the improvements in fuel prices and fuel consumptiveness equally when both generate the same fuel-cost savings requires estimating the consumer valuation of reduced fuel consumptiveness and fuel prices separately. The within-between random effects model (Mundlak, 1978), also known as the hybrid model (Allison, 2009), provides the estimated effects of both time-varying and time-invariant variables separately. The estimated effect of time-variation in a time-varying variable on the dependent variable across time for the same observation is referred to as the within-effect, and the estimated effect of a variable on the dependent variable across observations for the same time-period is referred to as the between-effect. In this study, the within-effect represents the estimated effect of the price of fuel while the between-effect represents the estimated effect of fuel consumptiveness of vehicle on the natural log of the MSRP (Equation 3.5).

In the model described in Equation 3.5 below, the time-varying variables are transformed into deviations from their time-averages whereas the dependent variable is not, and a random effects model is estimated to let standard errors reflect the dependency among observations for each sub-model (Allison, 2009). A log-linear specification for seven-month data with sales-weighted and clustered error terms is expressed as follows:

$$
\begin{aligned}
logMSRP_{it} = c + \beta * \overline{FCOST100KM_i} + \gamma \\
* (FCOST100KM_{it} - \overline{FCOST100KM_i}) \\
+ \sum_{b=1}^{4} \beta_b * \overline{FCOST100KM_i} * \zeta_b \\
+ \sum_{b=1}^{4} \gamma_b * (FCOST100KM_{it} - \overline{FCOST100KM_i}) * \zeta_b + \zeta_{sed} \\
+ \sum_{b=1}^{4} \zeta_b + \boldsymbol{Z_i} * \boldsymbol{\theta} + \boldsymbol{X_i} * \boldsymbol{\phi} + \sum_{m=1}^{28} \varphi_{im} + \sum_{s=1}^{3} S_{is} + \varepsilon_{it}
\end{aligned}
\tag{3.5}
$$

where $FCOST100KM_{it}$ is the observed value of the fuel cost of driving 100 kilometers for sub-model *i* in month *t*, and $\overline{FCOST100KM_i}$ represents the time-average of the fuel cost of driving 100 kilometers for sub-model i. In this specification, estimates of β and ($\beta + \beta_b$) give the between-effects for sedan and other body types while γ and $(\gamma + \gamma_b)$ are the within-effect estimates for sedan and other body types.

Pooled OLS estimation would be biased if time-constant unobserved factors that affect the vehicle price and time-varying predictors are correlated (Wooldridge, 2015). In fact, one of the advantages of taking away the time averages in the within-between random effects model is its ability to allow for the correlation among unobserved effects and explanatory variables to be different from zero, making it less affected by such bias (Wooldridge, 2015). There is only one time-varying predictor in this study: the price of fuel. In this case, the estimates of the effect of the price of fuel on vehicle price based on the within-between random effects model is expected to be less affected by such bias. However, it is not certain whether the estimated effects of time-invariant variables are less

affected by such omitted variable bias in the within-between random effects estimation than in the pooled OLS estimation. Nonetheless, I may at least argue that the estimated between-effect—the effect of fuel consumptiveness of vehicle—based on the within-between random effects model is expected to be less affected by a bias that could arise from not separating the effect of the price of fuel on vehicle price from the effect of fuel consumptiveness of vehicle.

After estimating the model described in Equation 3.5, I tested whether the between-effects for each body type significantly differ from one another. I also tested whether the between-effect of fuel cost of driving each body type is equal to its within-effect. However, I was unable to construct the seemingly unrelated regressions system with the within-between random effects estimations because it was not computationally applicable for the program I used. Therefore, I showed only the estimated within-between effect of FCOST100KM for each body type before and after including the environmental characteristics of the car in the model.

Inclusion of CO_2 emissions into the regressions:

I now introduce the CO_2 emission amounts of each sub-model into the last two models, the fully specified pooled model and the within-between random effects model, and compare the estimated effects of the environmental characteristics between those two models to determine whether the effects of the environmental characteristics of the car is independent of the CO_2 level of the car. However, computational difficulties in the program I used prevented me from testing if the estimated effects significantly changed before and after including the CO_2 in the within-between random effects model. Therefore, I compared

only the coefficients, looking for the estimates of any environmental characteristics that changed from significant to insignificant after the inclusion of CO_2 emissions.

CHAPTER FOUR

THE RESULTS

There are two points to mention at this stage. First, stating a (statistically) significant effect always refers, throughout this study, to the significance of the effect at a 5 percent significance level unless otherwise explicitly posted. Second, the estimated coefficient multiplied by 100 in the log-linear specification represents an approximate percentage change in the dependent variable from a unit change in an explanatory variable. However, the exact percentage change can be found using the formula 100*(e^b-1) where b is the estimated coefficient. For instance, the exact effect of a one Turkish Lira reduction in fuel costs of driving a sedan 100 km on the manufacturer-suggested retail price (MSRP) in July is estimated to be 100*($e^{0.0176}$-1) percent, which is 1.78 percent.

Partially Specified Monthly Models

The results from the partially specified monthly regressions suggest that the fuel cost of driving a sedan 100 kilometers (FCOST100KM) has on average a statistically significant and negative effect on the natural log of the manufacturer-suggested retail price (logMSRP) for all months, holding all else constant (Table 8). The estimated effect of it in absolute value on logMSRP is on average the highest for July and the lowest for October, approximately 1.76 percent and 1.14 percent, holding all else constant.

Results from testing the equality of the effects of fuel cost variables on the logMSRP suggest that the effect of the fuel cost of driving a sports utility vehicle 100 km (FCOST100KMSUV) is statistically significantly different from the FCOST100KM for

each month except for October. In addition, the effect of the fuel cost of driving a hatchback 100 km (FCOST100KMHBACK) is significantly different from the effect of FCOST100KM for both August and December, and on the margin of being significantly different for July, with a p-value of 0.05. However, the effect of the fuel cost of driving a station wagon 100 km (FCOST100KMSWAGON) is significantly different from the effect of FCOST100KM only for September and the fuel cost of driving a sports vehicle 100 km (FCOST100KMSPORTS) only for June (Table 8). In addition, the effects of fuel cost of driving body types other than sedan for 100 km on the logMSRP do not differ from one another for each month except that FCOST100KMSUV has a significantly different effect from both FCOST100KMHBACK and FCOST100KMSWAGON for July (Table 9).

The results from testing the equality of the effects of fuel cost of driving 100 km for each body type across months on the logMSRP show that each has the same effect for June, November and December. The effect of FCOST100KMSEDAN for October is different from both July and August while the effect of FCOST100KMHBACK for October is different from July and the effect of FCOST100KMSWAGON for July is different from both October and September. The effects of FCOST100KMSUV and FCOST100KMSPORTS do not significantly differ across months. (Table 10).[8]

Fully Specified Monthly Models

Likelihood ratio tests between partially and fully specified models for each month suggest that I reject the null hypothesis, for all months except for December, that the

[8] The way to read the Table 10 and similar tables is to match the row with column and compare the corresponding number with 5 percent significance level. For example, the number at the left-top corner in Table 10 is 0.246. This number is the prob>chi2 value from testing the equality of the coefficients of FCOST100KMSEDAN between June and July. Since 0.246 is bigger than 0.05, I fail to reject the null.

partially specified model fits the data better than the fully specified model (Table 11). In addition, the results for the adjusted R^2 values illustrate a slight improvement as well from the partially specified model, approximately around 98.3 percent, to the fully specified model, approximately around 98.4 percent, meaning that 98.4 percent of the variation on the natural log of the manufacturer-suggested retail price (logMSRP) is explained by the explanatory variables included in the fully specified model.

The results from the fully specified seven monthly regressions indicate that the effect of fuel cost of driving a sedan 100 km (FCOST100KM) on the logMSRP is significant and negative for all months, holding all else constant (Table 12). The estimated effect of FCOST100KM in absolute value on the MSRP, on average, is the highest for July and the lowest for October, approximately 1.5 percent and 0.9 percent. The estimated effects of fuel cost for all body types in absolute values are the highest in July and the lowest in October (Table 12).

The results from running the same monthly regressions with FCOST100KM interacted with each body type show[9] that the effects of fuel cost of driving a sedan 100 km (FCOST100KMSEDAN), a hatchback (FCOST100KMHBACK) and a sports utility vehicle (FCOST100KMSUV) are all significant and negative for each month. However, the effect of fuel cost of driving a station wagon 100 km (FCOST100KMSWAGON) is significant and negative for all months except October, and the effect of fuel cost of driving a sports vehicle 100 km (FCOST100KMSPORTS) significant and negative for June, July, September and December, but not significant although negative for the remaining months.

[9] I have not posted those results here to save space and to avoid repetition, but they are readily available at hand.

The results from testing the equality of the effects of fuel cost variables on the logMSRP indicate that the effect of FCOST100KMSUV is statistically significantly different from the effect of FCOST100KM for all months except October while the effect of FCOST100KMHBACK is significantly different for all months except for October and November. On the other hand, the effect of FCOST100KMSWAGON is significantly different from the effect of FCOST100KM for both August and September whereas the effect of FCOST100KMSPORTS is different for only June (Table 12). The results from testing the equality of the effects of FCOST100KMSWAGON, FCOST100KMHBACK, FCOST100KMSUV, and FCOST100KMSPORTS on the natural log of the MSRP for each month show that their estimated effects are not significantly different from one another for every month, holding all else constant (Table 13).

The results from testing the equality of the effects of fuel cost of driving each body type 100 km across months indicate that all estimated effect of fuel cost of each body type do not statistically significantly differ from one month to another, holding all else constant (Table 14). The conclusion based on this test is that the effect of fuel cost for each body type can be constrained to be the same for all months.

Among the environmental characteristics of the vehicle, the effect of the start/stop technology (STARTSTOP) on logMSRP is significant and positive for every month except for November and December, holding all else constant (Table 12). It has, on average, the highest effect for June and the lowest for December, approximately 3.1 percent and 0.5 percent. The vehicles advertised as lower emitters (ADVGREEN) have on average significant and positive effects on logMSRP for June, July and October while the vehicles

advertised as the least emitters (GREENCAR) have on average significant and negative effects on natural log of MSRP for June, July, September and October. The estimated effect of ADVGREEN on the MSRP is on average the highest for June and the lowest for November, approximately 3.2 percent and 1.0 percent. The estimated effect of GREENCAR on the MSRP is on average the highest for June and the lowest for August, approximately -4.1 and -1.9 percent. The effect of EU6DIESEL on logMSRP is not significant for any month. Finally, the hybrid vehicles (HYBRID) has significant and positive effects for every month except August, with the highest absolute effect on the MSRP being, on average, in November and the lowest in August, approximately 13.6 percent and 6.3 percent.

However, care must be taken when considering the effect of GREENCAR since it is a subset of ADVGREEN, i.e. ADVGREEN=1 whenever GREENCAR=1. The estimated coefficient of GREENCAR represents an additional effect on the logMSRP in addition to the effect of ADVGREEN on the logMSRP. To determine the overall effect of GREENCAR on the logMSRP requires summing the estimated effects of GREENCAR and ADVGREEN. The same analysis holds for diesel vehicles that comply with Euro-6 Standards (EU6DIESEL) as well since it is a subset of diesel cars (DIESEL). While EU6DIESEL has no significant effects for any month, it is actually the effect of EU6DIESEL in addition to the effect of DIESEL on the logMSRP.

The results from testing the equality of the effects of each environmental characteristic across months indicate that all do not have significantly different effects across months, holding all else constant (Table 15). The conclusion based on this test is

that the effect of each environmental characteristic can be constrained to be the same for all months.

The estimated effects of fuel cost of driving 100 km for each body type between partially and fully specified models, i.e. before and after including the environmental characteristics in the model, are found to be significantly different for June, July and August but not for November and December while results for September and October are mixed (Table 16). Specifically, the effect of fuel cost of driving a sport utility vehicle 100 km on the logMSRP are significantly different in the fully specified model from the partially specified model for all months except November and December; the effects of fuel cost of driving a sedan 100 km, a hatchback and a sports car are significantly different between those models for June, July, August and October whereas the effect of fuel cost of driving a station wagon 100 km changed for only June, July and August (Table 16).

Results from testing whether the joint effects of all variables significantly changed across months suggest that they are the same within seasons but different across seasons (Table 17). However, the joint effects are the same between November and December even though they are not the same between September and December nor between October and December. In addition, the equality of the coefficients of all variables other than fuel costs of body types and environmental characteristics across months is tested. The ones that have significantly different effects across months are posted in Table 18.

The Fully Specified Pooled Model

Results from the fully specified pooled model estimation suggest that the effect of the fuel cost of driving a sedan 100 km (FCOST100KM) on the natural log of the

manufacturer-suggested retail price (logMSRP) is significant and negative while holding all else constant (Table 19). The results from running the same regression with separate fuel cost variables for each body type indicate that the effects of fuel cost of driving 100 km for all body types except sports cars on the logMSRP are significant, holding all else constant. In addition, the estimated effect in absolute value of the fuel cost of driving a sedan 100 km (FCOST100KMSEDAN) on the MSRP is approximately 1.1 percent on average, while the effect of the fuel cost of driving a station wagon 100 km (FCOST100KMSWAGON) is approximately 0.9 percent, the effect of the fuel cost of driving a hatchback 100 km (FCOST100KMHBACK) is approximately 0.8 percent, the effect of the fuel cost of driving a sports utility vehicle 100 km (FCOST100KMSUV) is approximately 0.7 percent, and the effect of the fuel cost of driving a sports car 100 km (FCOST100KMSPORTS) is approximately 0.5 percent.

Except for FCOST100KMSWAGON, the fuel costs of driving the other three body types have different effects, on average, from the effect of FCOST100KM on the logMSRP, holding all else constant (Table 19). In addition, results also indicate that the effects of FCOST100KMSWAGON, FCOST100KMHBACK, FCOST100KMSUV, and FCOST100KMSPORTS on the logMSRP are not significantly different from one another (Table 20).

Among the environmental characteristics of the vehicle, both the start/stop system (STARTSTOP) and the vehicle advertised as lower emitter (ADVGREEN) have significant and positive effects on the MSRP, approximately 2.4 percent and 2.1 percent on average, holding all else constant. The effect of the vehicle advertised as the least emitter

(GREENCAR) in addition to the effect of ADVGREEN on the MSRP is significant and negative, approximately -2.8 percent on average, holding all else constant. Similarly, the effect of diesel vehicles that comply with Euro-6 Standards (EU6DIESEL) in addition to the effect of DIESEL on the logMSRP is positive but not significant. Finally, the hybrid vehicles (HYBRID) have a significant and positive effect, approximately 12.2 percent on average, on the MSRP (Table 19).

The estimated effects of fuel cost of driving each body type 100 km are significantly different between the partially and the fully specified models, i.e. before and after controlling for the effect of environmental characteristics in the model (Table 21). In other words, disentangling the consumer valuation of reducing the adverse environmental impacts of a vehicle from the valuation of saving money on fuel expenses resulted in a significant change on the estimated consumer valuation of the latter.

The Within-Between Random Effects Regression (The Hybrid Model)

The results from the hybrid model for the estimated within- and between-effects of fuel cost of driving each body type 100 km and the environmental characteristics are listed in Table 22, and the results for all other variables can be found in Appendix D (Table 22D). Given that the fuel cost of driving a sedan 100 km (FCOST100KM) is equal to the fuel price multiplied by fuel consumption, the within-estimates of FCOST100KM and its variations across body types represent the effect of fuel price for each body type on the natural log of the manufacturer-suggested retail price (logMSRP) as fuel consumption of any sub-model did not change across months throughout the study period. The estimated within-effects suggest that the effect of a change in fuel prices on the logMSRP are positive

for the owners of sedan, sports utility vehicle and sports vehicle while it is negative for the owners of hatchback and station wagon. The within-effects are significant for the owners of station wagon and sports cars, but not for the remaining three. In addition, the effects of fuel prices on vehicle price for owners of station wagon and sports cars are significantly different from the effect of fuel prices for owners of sedan while the effects for owners of remaining three body types do not significantly differ from one another.

On the other hand, the estimated between-effects of the fuel cost of driving 100 km multiplied by the time-average of the fuel price represent on average the consumer valuation of the fuel consumptiveness, the reciprocal of fuel economy, of a vehicle while holding all else constant. The estimated between-effects are all significant for each body type except for station wagon and sports cars. The estimated between-effects are all negative for each body type except for sports cars, holding all else constant. The estimated between-effects of fuel cost of driving a sedan 100 km on the MSRP in absolute value is on average estimated to be the highest, approximately 0.8 percent of the mean price of sedans times the time-average of fuel prices, while the between-effects of fuel cost of driving a hatchback and a sports utility vehicle 100 km on the MSRP in absolute value are approximately 0.6 and 0.5 percent of the mean prices of each body type times the time-average of fuel prices respectively.

In addition, the estimated between-effects of fuel cost of driving hatchbacks and sports utility vehicles 100 km on the logMSRP significantly differ from the estimated between-effects of fuel cost of driving sedans 100 km whereas the estimated between-effects of fuel cost of driving the remaining two body types 100 km do not (Table 22).

Results from testing the equality of the estimated between-effect of fuel cost of driving each body type other than sedan indicate that the between-effects of fuel cost of driving hatchbacks, sports utility vehicles and station wagons 100 km are statistically the same whereas the estimated between-effects of fuel cost of driving sports cars 100 km differs from those three (Table 23). Moreover, results from testing the equality of the between-effect of fuel cost of driving a vehicle 100 km versus its within-effect indicate that I reject the null for sedans, hatchbacks and SUVs but failed to reject it for sports and station wagons. This implies that fuel costs of driving sedans, hatchbacks and SUVs have statistically significantly different between-effects from their within-effects whereas those effects are not significantly different from each other for station wagon and sports cars (Table 25).

The estimated effects of environmental characteristics on the natural log of the manufacturer-suggested retail prices (logMSRP) are all significant except for the effect of diesel vehicles that comply with Euro-6 Standards (EU6DIESEL), holding all else constant (Table 22). The estimated effect of the start/stop system on the MSRP is approximately 2.4 percent; cars advertised as lower emitter is 2.1 percent; and the hybrid cars is 7.8 percent, holding all else constant. The estimated effect of cars advertised as the least emitter in addition to the effect of cars advertised as a lower emitter is approximately -2.3 percent on the MSRP.

The within-effects, the effect of the fuel price on the logMSRP for each body type, are the same before and after including the environmental characteristics in the within-between random effects model because all environmental characteristics are time-

invariant. However, testing the equality of the estimated between-effect of fuel cost of driving 100 km across body types before and after including the environmental characteristics in the within-between random effects model is not computationally applicable in the program I used. Therefore, I listed only the coefficients before and after including the environmental characteristics in the model (Table 24). Comparing the results shows a decrease in the estimated between-effect of fuel cost of driving 100 km for all body types except sports cars on the logMSRP by approximately 0.002-0.003 in absolute terms along with an improvement in the adjusted R-square from 0.9798 to 0.9804.

Inclusion of CO_2 Emissions of the Car in the Regressions

The inclusion of gram values of CO_2 emissions in the fully specified pooled model results in an insignificant effect of fuel cost of driving all body types except sedans, but does not result in any insignificant effect of the environmental characteristics. Only the estimated effect of ADVGREEN has a t-value equal to 1.95 after the inclusion of CO_2 in the model, a value at the margin of being insignificant at a 5 percent level. In general, the estimated coefficients of fuel cost variables decrease by more than a half in magnitude after the inclusion. The estimated effect of CO_2 on the logMSRP is negative and significant, implying that car owners are willing to pay approximately 0.13 percent less, on average, for a one-gram increase in the CO_2 emission of their vehicle per kilometer (Table 26).

In the within-between random effects model, the estimated between-effects of the fuel cost of driving of sedans and hatchbacks 100 km remain significant while the estimated between-effects of the fuel cost of driving the other three body types 100 km become insignificant after the inclusion of CO_2. The effects have slightly increased in absolute

value after the inclusion. In addition, there is a slight decrease in the estimated effects of the environmental characteristics after the inclusion of CO_2, and the estimated effect of CO_2 itself is positive and insignificant in this model (Table 26).

CHAPTER FIVE

ESTIMATING THE IMPLICIT VALUES AND THE EXPLICIT FUEL-COST SAVINGS FROM IMPROVED FUEL ECONOMY

Estimating the Implicit Marginal Price of the Improved Fuel Economy

For simplicity, assume that the natural log of manufacturer-suggested retail price (logMSRP) is explained by the fuel cost of driving 100 km (FCOST100KM) and all other variables (OTH) as follows:

$$log\widehat{MSRP}_i = \hat{c} + \hat{\beta} * FCOST100KM_i + \boldsymbol{OTH_i} * \boldsymbol{\phi} + \hat{\varepsilon}_i \tag{5.1}$$

Then, taking the partial derivative of $\widehat{MSRP}_i$ with respect to $FCOST100KM_i$ after taking exponential of both sides in Equation 5.1 gives the implicit marginal value, or implicit marginal price, of FCOST100KM as suggested by hedonic theory (Equation 5.2):

$$\widehat{MSRP}_i = e^{(\hat{c}+\hat{\beta}*FCOST100KM_i+\boldsymbol{OTH_i}*\boldsymbol{\phi}+\hat{\varepsilon}_i)}$$

$$\frac{\partial \widehat{MSRP}_i}{\partial FCOST100KM_i} = \hat{\beta} * \widehat{MSRP}_i \tag{5.2}$$

The right side of Equation 5.1 has two components: The first, $\hat{\beta}$, is the estimated coefficient of FCOST100KM, and the second, $\widehat{MSRP}_i$, is the predicted price for each observation.

Special care must be taken in this step. One could take the mean (or weighted mean) of the MSRPs in the dataset as the predicted MSRPs, but doing so would be misleading because the expected value of the $\widehat{MSRP}_i$ is not necessarily equal to its mean unless the variance of the error term is zero. The conditional expectation of $\widehat{MSRP}_i$ in an exponential function can be found using the following equation (Duan et al., 1983):

$$E(\widehat{MSRP}_i|FCOST100KM_i, \boldsymbol{OTH_i}) = e^{(\hat{c}+\hat{\beta}*FCOST100KM_i+\boldsymbol{OTH_i}*\boldsymbol{\phi})} * e^{(\hat{\sigma}_\varepsilon^2/2)}$$

where $\hat{\sigma}_\varepsilon^2$ is the variance of the error terms from the estimations. In this case, different models may result in slightly different conditional expectations of the MSRPs. Applying this change to the Equation 5.2 results in:

$$\frac{\partial E(\widehat{MSRP}_i|FCOST100KM_i, \boldsymbol{OTH_i})}{\partial FCOST100KM_i} = \hat{\beta} * e^{(\hat{c}+\hat{\beta}*FCOST100KM_i+\boldsymbol{OTH_i}*\boldsymbol{\phi}+\hat{\sigma}_\varepsilon^2/2)} \tag{5.3}$$

Economic theory predicts that any increase in fuel cost of driving 100 km negatively impacts the MSRPs since consumers are willing to bid less for a car with such an increase while holding all else constant, implying a negative result in Equation 5.3. In addition, the implicit marginal price of an improvement in FCOST100KM would be higher (lower) if the car is more (less) expensive. However, the negative (positive) impact on the vehicle price diminishes (grows), or becomes less negative (more positive), as the fuel cost of driving a given distance becomes higher (lower) (Equation 5.4). This makes economic common sense since both the willingness to pay for an additional improvement in fuel cost of driving and the cost of providing such additional improvement are expected to increase as the fuel cost of driving becomes lower, holding all else constant.

$$\frac{\partial^2 E(\widehat{MSRP}_i|FCOST100KM_i, \boldsymbol{OTH_i})}{(\partial FCOST100KM_i)^2} = \hat{\beta}^2 * e^{(\hat{c}+\hat{\beta}*FCOST100KM_i+\boldsymbol{OTH_i}*\boldsymbol{\phi}+\hat{\sigma}_\varepsilon^2/2)} > 0 \tag{5.4}$$

The implicit values of a marginal improvement, 1 Turkish Lira decrease, in the fuel-cost of driving each body type 100 km are calculated using Equation 5.3 based on both the fully specified pooled model and the within-between random effects model (Table 29). Results suggest that owners of sedans among all body types are willing to pay implicitly

the highest amount on average for a 1 Turkish Lira (TL) decrease in fuel cost of driving 100 kilometers: approximately 943 TL based on the fully specified pooled model and 658 TL based on the within-between random effects model. The estimated implicit value for each body type is lower in the within-between random effects model, and owners of sports cars are estimated to be willing to pay a negative value for such an improvement based on this model, a result contradictory to the predictions based on economic theory.

The Present Discounted Value of Future Fuel-Cost Savings from Improved Fuel Economy

Economic theory predicts that the estimated implicit marginal value of improved fuel economy should be equal to the expected fuel-cost savings from a 1 Turkish Lira reduction in the fuel-cost of driving 100 kilometers based on the present discounted value. To estimate the latter, the following formula was used:

$$FCS_b = \sum_{t=1}^{T} \frac{s_t}{(1+r)^t} * \frac{KM_{bt}}{100} * [FCOST100KM_b - (FCOST100KM_b - 1)]$$

which can be simplified to:

$$FCS_b = \sum_{t=1}^{T} s_t * \frac{1}{(1+r)^t} * \frac{KM_{bt}}{100} \tag{5.4}$$

where FCS_b is the present discounted value of future fuel cost savings from a 1 Turkish Lira decrease in the fuel-cost of driving 100 km for body type *b,* including sedans; *T* is the expected vehicle life on average; s_t is the vehicle's survivability rate in year *t*; *r* is the real discount rate and KM_{bt} is the annual kilometers driven for body type *b* in year *t.* The fuel efficiency of a car is assumed to be constant over time even though it may not be in

reality.[10] It is also assumed that consumers expect fuel prices to follow a random walk, meaning that consumers take today's fuel price as the best reference in calculating their future fuel-cost saving that involve future fuel prices. This is because they cannot predict the changes in fuel prices in the future. The components in Equation 5.4 are calculated as follows.

- *The Real Discount Rate:*

Because the subjective discount rate, the rate at which consumers discount the expected future savings, is not observed, the opportunity cost of money is used as the discount rate. For those who finance their cars with loans, the subjective discount rate is assumed as the annual percentage rate of the loan. For those who buy their cars using savings, the subjective discount rate is assumed as the annual interest rate for savings. According to the survey conducted by OYDER, the Automotive Investors' Association in Turkey, in June 2015 ("OYDER Otomobil," 2016), approximately 52 percent of new passenger car owners used car loans at the time of purchase. Hence, I use this percentage to calculate the weighted average of the annual nominal discount rate. The nominal interest rates for car loans and savings were calculated to be 14.72 percent and 10.27 percent for the study period. Then, the weighted average of the annual nominal discount rate is calculated as 12.58 percent. Since the annual inflation rate for the study period, on average, was 7.65 percent, the weighted average of the annual real discount rate is then calculated to be 4.93 percent (Table 28).

[10] There is no study conducted on this subject in Turkey, or even in Europe (to the best of my knowledge), to measure the depreciation over time in fuel efficiency of a car.

- *Vehicle Life and Vehicle Survivability Rate*

Lu (2006) has estimated the expected life of a vehicle as 13 years in the US, and the same value is also assumed by Espey and Nair (2005); however, Allcott and Wozny (2014) have assumed 25 years of life. Since no research has been conducted on estimating the average vehicle life in Turkey, I assumed it to be 20 years in this research. Assuming 20 years of vehicle life is also consistent with the scrappage law in the country, which provides a substantial discount on the special consumption tax on new car purchases replacing 20-year-old cars with new ones. In addition, there is also no research on estimating the vehicle survivability rating in Turkey. Hence, I used the same estimated survivability rates of cars found in the Lu's (2006) study (Table 28).

- *Annual Kilometers Driven Throughout Vehicle Life*

Using the used-cars market data, I calculated the average annual kilometers driven for both diesel and petrol cars of each body type, and then the annual kilometers driven for each body type was weighted based on the market shares of diesel and petrol cars from the number of cars sold for each fuel type during the seven-month period. For example, the market share of diesel sedans among all sedans was approximately 69.9 percent during the study period; therefore, I calculated the annual kilometers driven for all sedans as 19,968 after weighting the calculated annual kilometers driven for diesel sedans (22,443 kilometers) and petrol sedans (14,228 kilometers) based on the market shares of diesel and petrol cars, 69.9 percent and 30 percent (Table 27). These calculated annual kilometers driven were assumed to be the annual kilometers driven for the first year after the purchase

of brand new car, and I assumed a 4 percent decrease in annual kilometers driven every year thereafter, as Lu's (2006) study suggested (Table 28).

The Comparison of the Implicit Value of Fuel Economy and the Explicit Fuel-Cost Savings

Using the Equation 5.4, the present discounted value of explicit fuel-cost savings throughout the vehicle life from a 1 Turkish Lira (TL) decrease in fuel cost of driving 100 km is calculated to be approximately 1400 TL for owners of sedans and station wagons and approximately 1200 TL for owners of other three body types (Table 29).

The implicit marginal prices of improved fuel cost of driving a given distance for each body type are then compared to the present discounted values of the associated future fuel-cost savings. The former being less than the latter may suggest that car buyers in Turkey are myopic about their expectations for future fuel-cost savings. Results from both the constrained fully specified and the within-between random effects models suggest that owners of all body types are willing to pay less for a 1 TL decrease in fuel cost of driving 100 kilometers than what they would explicitly save from such a decrease based on the present discounted value (Table 29). The difference between the implicit valuation and explicit savings is the highest for hatchback and station wagon owners, and the lowest for sedan owners.

CHAPTER SIX

DISCUSSIONS

Consumer Valuation of Reducing the Adverse Environmental Impacts of Their Cars

The consumer valuation of reducing the adverse impacts on the environment of a car's operation estimated in this study may be driven by three factors: intrinsic, extrinsic and image motivations (Ariely et al., 2009). The intrinsic motivation can be purely altruistic, meaning that people attain positive utility with the well-being of other people by contributing to a public good (Fehr and Schmidt, 2003). Previous studies have discussed altruism and voluntary provision of public goods, finding that individuals are willing to contribute to public goods by spending their time and/or money (Becker, 1974; Meier, 2006; Fehr and Schmidt, 2003).

The extrinsic motivation refers to any reward or benefit associated with the prosocial behavior (Ariely et al., 2009). To the best of my knowledge, there is no tax incentive or a reward in Turkey for vehicles with attributes that indicate reductions in the adverse impact on the environment of car's operation. The image motivation for car buyers in this study is perhaps the desire to be liked by others and to be known as a person who cares about the environment. Evidence from previous studies suggests that buyers of Toyota Prius, a hybrid vehicle with a unique shape that can be distinguished from other hybrid cars, are willing to pay extra for signaling environmental friendliness (Sexton and Sexton, 2014; Delgado et al., 2015). It would be ideal to disentangle these three factors, however; the estimated consumer valuation of characteristics that indicate reductions in the adverse impacts on the environment of the car's operation should be interpreted in this

study as the willingness to pay for at least both the intrinsic and the image motivations if not for the extrinsic motivations.

In addition, the estimated effects of those characteristics based on both the fully specified pooled model and the within-between random effects model were found to be statistically significant and similar before and after controlling for the CO_2 emissions in those models. This result along with the insignificance of the effect of the CO_2 itself might imply that car owners in Turkey judge the environmental characteristics of the car based on whether such characteristics help reduce the adverse environmental impact of the car regardless of how much reduction in CO_2 emissions they provide. This evidence is similar to consumers judging the energy-friendliness of electric goods based on the scaled efficiency labels rather than the absolute value listed on the sticker (Waechter et al., 2015).

Given that the start/stop technology (STARTSTOP) helps reduce fuel consumption, and, therefore, emissions from fuel use, several arguments can be made about the interpretation of the significant and positive willingness to pay for having this feature in a car. First, it may represent the willingness to pay for reducing emissions, primarily CO_2, from fuel use while standing in a temporary stop such as at traffic lights. Existing literature suggests that the start/stop technology helps reduce emissions but does not provide specific information about which emission types are significantly reduced. For example, CO_2 emissions from a four-wheel drive car with start/stop technology in urban traffic is estimated to be more than 20 percent lower than CO_2 emissions from the same car without start/stop technology (Fonseca et al., 2011), but no information is provided if there is a reduction in other emissions. Second, this feature may represent the willingness to pay for

a reduction in the noise from a running engine. Third, it may also represent the willingness to pay for reducing possible wear and tear on the engine.

In addition to these three arguments about the start/stop technology, there is also a possibility that consumers may be willing to pay extra for this feature because they may expect to save even more on their fuel expenses. The declared value of fuel consumptiveness of a vehicle in most, if not all, of manufacturers' brochures are calculated based on the driving cycles implemented by the Economic Commission for Europe. According to those calculations based on the combination of both the driving cycle for city (ECE-15) and the driving cycle for highway (EUDC), a car is driven 11,016.63 meters in 1220 seconds including 255 seconds of standing time, which is approximately 20.90 percent of the time of the total trip (Barlow et al., 2009). Given that the duration of traffic lights in Turkey is up to 120 seconds depending on the city and traffic intensity, the percentage of the time a car owner spends in temporary stops in terms of an entire trip may be more than what was calculated from those driving cycles. If that is the case, then having a car with this technology may help save even more on fuel expenses.

The consumer valuation of vehicles advertised as lower emitters (ADVGREEN), or the least emitters (GREENCAR) based on the estimations in this study should be interpreted as the willingness to pay for the improvement(s) in vehicle attributes that enable the vehicles to emit less and to be advertised as low emitters or the least emitters accordingly while holding all other characteristics constant. Results from this research suggest that car buyers in Turkey are willing to pay extra on average for a car that is advertised as a lower emitter (ADVGREEN) beyond their willingness to pay for the

additional fuel-cost savings those cars provide, holding all else constant. This is consistent with the evidence from a mail survey of Californian households in 2004, suggesting that they were willing to pay up to 5 percent more for greener computers and cell phones than their non-green versions (Saphores et al., 2007).

One of the reason why consumers value cars in the GREENCAR category significantly less than cars in the ADVGREEN category, holding all else constant, might be consumers being cynical and/or confused about the green claims and/or judging those products as if they were materially lower in quality (Crane, 2000). Given that vehicles in the GREENCAR category have unique names such as Efficient Dynamics while vehicles in the ADVGREEN category have not and that the material quality and reliability of vehicles are not controlled in this study, car buyers may be more skeptical about those cars in the GREENCAR category than the ones in the ADVGREEN category.

If the cars in the GREENCAR category have, in reality, lower material quality and reliability than the cars in the ADVGREEN category, then the ones in the GREENCAR category are expected to have relatively lower resale values in the used market, holding all else constant. Since such lower values can also be observed in the used-cars market, car buyers in the new-car market may bid marginally lower for vehicles in the GREENCAR category even if they are not skeptical about the material quality and reliability of those cars. Furthermore, those in the GREENCAR category may have relatively lower resale values than the ones in the ADVGREEN category for reasons other than material quality and reliability concerns.

Another reason why car buyers might be more confused and/or skeptical about cars in GREENCAR category might be related to the combination of their characteristics. Producers may bundle certain characteristics of vehicles in a different way to achieve better fuel economy and lower emissions, but such bundling may lead consumers to question how well the characteristics of vehicle will function in the new bundle. Furthermore, producers may also redesign the aerodynamics of their cars to help lower the consumption of fuel, but consumers may not like the new designs.

The insignificance of the effect of diesel cars complying with Euro-6 Standards (EU6DIESEL) in addition to the effect of diesel cars on vehicle price implies that consumers are indifferent whether their diesel cars comply with such standards. Since those cars differ from other diesel cars only by their NO_x values while holding all else constant, the insignificance of the effect of EU6DIESEL may be interpreted as consumer not willing to pay for reducing NO_x emissions. Given that NO_x emissions in the European countries have decreased by 44 percent from 1990 to 2011 and that 47 percent of this reduction has occurred in road transport ("Nitrogen Oxides," 2014), the insignificance of the additional reductions in NO_x may be the result of experiencing already low levels of NO_x emissions in the sector. In addition, given that car manufacturers provide information of their car's CO_2 emission levels in both their brochures and emission labels but not of NO_x emissions, the insignificance of the effect of EU6DIESEL may also be a result of a lack of information in the market on the NO_x emissions of the cars. It is also possible that some people may not even know the importance of Euro-6 standards for the environment even if they are informed about the NO_x emissions of their cars.

Since I am accounting for the fuel economy of the cars in my estimations, and since GREENCAR=1 and STARTSTOP=1 for all hybrid vehicles, the estimated effect for hybrid cars must represent factors other than these three. One possible interpretation might be that consumers are willing to pay more for a hybrid car as it may signal an environmentally friendly personality. Recent evidence from a study conducted in the U.S. suggests that people are willing to pay 4.5 percent more for Toyota Prius that signals environmental friendliness than other hybrid vehicles (Delgado et al., 2015). However, the estimated effect of hybrids found in this study represents only the marginal effect of hybrids over non-hybrid cars. I was unable to estimate the marginal effect of hybrids that signal environmental friendliness over other hybrids because there are only two hybrid sub-models in my dataset. Therefore, caution must be taken before interpreting the effect of hybrids as signaling environmental friendliness because further research is needed to justify this conclusion.

Consumer Valuation of Saving Money on Fuel Expenses

In partially specified monthly models without the environmental characteristics of the vehicle, the estimated consumer valuation of improved fuel economy is the combination of the valuations of both saving money on fuel expenses and reducing the adverse environmental impact of the car. Given that the results from the likelihood ratio tests suggested that the fully specified monthly models with environmental characteristics of the vehicle fit the data significantly better than the partially specified models for each month except December and that the adjusted R^2 values for each monthly regression also slightly improved in the fully specified models, I tentatively conclude that accounting for

environmental characteristics of the vehicle in the empirical model improves the estimation. In addition, the estimated effects of the fuel cost of driving 100 km on vehicle price became statistically significantly smaller in absolute values in the fully specified monthly models except in late autumn and in early winter. Obtaining such significant changes in those estimated effects implies that there may be a potential upward bias in the estimation of the consumer valuation of improved fuel economy if the consumer valuation of reducing the adverse environmental impact of the car is not controlled nor disentangled in the model.

Finding that new passenger car buyers in Turkey significantly and positively value on average a 1 Turkish Lira reduction in fuel cost of driving 100 km is consistent with some previous studies while it is not supported by some others. Specifically, evidence from model year 2001 new cars sold in the U.S. suggests that new car buyers are willing to pay extra to travel 1 more mile per gallon of fuel consumption (Espey and Nair, 2005). Similarly, evidence from new cars sold in India from 2002 to 2008 also suggests that car buyers are willing to pay extra to travel 1 more kilometers per liter of fuel consumption (Chugh et al., 2011). However, evidence from a random sample of consumers who bought a new 2000 model year vehicle in the U.S. suggests that the effect of fuel consumption of a vehicle on the average utility consumers attain from the vehicle was statistically insignificant (Train and Winston, 2007). Similarly, evidence from all models sold in the U.S. from 1971 to 1990 suggests that the effect of the fuel-efficiency of the car, measured in miles per dollar, on vehicle price was statistically insignificant (Berry et al., 1995).

Buyers of sedans and sports cars are found to value the improvement in fuel cost of driving 100 km significantly differently from each other and from buyers of hatchbacks, SUVs and station wagons while the values placed by buyers of latter three body types are not statistically significantly different from one another. This evidence implies that buyers of sedans and sports cars might have unmeasured characteristics related with fuel economy that differ from buyers of other three body types, and not accounting for different body types might bias the estimation of the consumer valuation of improved fuel economy. The closest study to the one reported here was conducted by Chugh et al. (2011) who investigated vehicles sold between 2002 and 2008 in the Indian auto-market, finding that owners of diesel hatchbacks, petrol hatchbacks and petrol sedans are on average willing to pay approximately 8-9 percent higher for driving one more kilometer per liter of fuel consumption in urban areas while owners of diesel sedans are willing to pay approximately 4.5 percent higher. However, they estimated the consumer valuation of each segment in four separate estimations from separate observations rather than estimating a combined model from all observations and did not test whether the estimated consumer valuation of improved fuel economy for each segment statistically differed from one another.

Among buyers of all body types, the valuation the buyers of station wagons and sports cars implicitly place on improved fuel economy was found to be insignificant for buyers of both although it is negative for buyers of sports cars, holding all else constant. This insignificance suggests that buyers of these two body types might focus more on other attributes of a car than on fuel economy, or it could be a result of the lack of observations for these two body types in this study. The market shares of station wagons and sports cars

were approximately 1.1 and 1.3 percent, and the number of unique sub-models that are station wagon and sports car was only 46 and 48 of the total 1098 sub-models included in the study. In addition, I may have also failed to account for some attributes of sports cars that are different from other body types, characteristics that may blur the estimation of their valuation of improved fuel economy. For example, high-tech features frequently found in sports cars were not individually controlled even though I did control for luxuriousness. Such features may affect the fuel economy of the car negatively, and yet buyers of sports cars might give marginally more value to those cars precisely because of those features.

The Implicit Value of One Turkish Lira Reduction in Fuel Cost of Driving Each Body Type 100 KM Versus the Present Discounted Value of the Associated Future Fuel-Cost Savings

Using log-linear specification implies that owners of more expensive cars are willing to pay more for an improvement in fuel cost of driving 100 kilometers than owners of less expensive cars. Even though a Turkish Lira saving is still a Turkish Lira saving for everyone, it might be observed that car buyers who are planning to drive more might want to have a more comfortable and/or luxurious vehicle so that they buy a more expensive car that provides the comfort and luxuriousness they are looking for.[11] If that is the case, then buyers of more expensive cars might be willing to pay more for an improvement in fuel cost of driving 100 km than the others.

To see if there is a significant positive correlation between car prices and kilometers driven for a given period, I have combined the estimated kilometers driven per year during

[11] I would like to give special thanks to Dr. Templeton and Dr. Fleck for helping me at this point by suggesting this perspective.

at least 6 or at most 18 months of a 2015 model-year vehicle's life from the used-cars dataset with the nominal MSRPs from the new-cars dataset and matched these two data for each sub-model.[12] The correlation between the kilometers driven per year and nominal MSRP for all vehicle body types together was 0.1182 and statistically significant based on the Pearson correlation coefficient critical value for 562 observations. More importantly, it was also positive for owners of Sedans, Hatchbacks, SUVs and Station-wagons but negative for owners of Sports cars.[13] The respective correlation coefficients were 0.0506, 0.1714, 0.1528, 0.2589 and -0.1042 for those body types. However, it was statistically significant for only owners of hatchbacks.

In addition, I found that annual miles driven increases on average as household's income increases (Table 31) based on the 2009 National Household Travel Survey dataset ("U.S. Department," n.d.). I acknowledge that households with different incomes may purchase the same car. Nonetheless, casual empiricism and economic common sense also indicate that people with higher income tend to buy more expensive cars. Evidence from a survey conducted in 1998 among household in San Francisco suggests that people with higher income are more likely to buy luxury cars and SUVs (Choo and Mokhtarian, 2004). Thus, owners of more expensive cars might be traveling more on average and save more on their fuel expenses after an improvement in fuel cost of driving 100 km.

[12] The annual kilometers driven data I gathered was for only those sub-models which are sold during the study period, from June to December 2015. I also restricted the dataset to include only sub-models that were also 2015 models. Then, I calculated the annual kilometers driven according to the kilometers driven between the date a car was purchased until the date it was listed in the online used-cars market. Given that I collected those data on November 2016, a 2015 model-year car might be at least 6 or at most 18 months old. It may have been better to collect data from a broader time-period, like 10 years, but I do not have price information for those sub-models that are sold before 2015.

[13] The negative correlation for owners of sports cars implies that the ones that buy more expensive sports cars drive less the other sports car owners. This might be because the owners of more expensive sports cars may be driving their cars mostly in the city to show off and not drive them much in highways.

Nonetheless, estimating the implicit value of 1 Turkish Lira reduction in fuel cost of driving each body type separately has also enabled me to potentially find that it might not vary much across body types if the prices of body types varies inversely with the effect of fuel cost of driving each body type. For example, even though the mean price of sports cars was higher than other body types (Table 1), the estimated effect of fuel cost of driving a sports car 100 km was smaller than the others such that the implicit value of 1 Turkish Lira reduction in fuel cost of driving a sports car 100 km was about the same as what it was for sedans based on the estimation from fully specified pooled model (Table 29).

Results from both the fully specified pooled model and the within-between random effects model suggest that new passenger car buyers in Turkey are willing to pay less on average for a 1 Turkish Lira reduction in their future fuel-cost savings based on the present discounted value where the discount rate is defined as the opportunity cost of money. This conclusion is consistent with some of the previous studies. Specifically, recent evidence from the used cars registered in the U.S. in monthly cross-sections from January 1999 to December 2008 suggests that consumers are willing to pay 76 cents upfront for a 1 dollar reduction in the present discounted value (PDV) of their future fuel-costs (Allcott and Wozny, 2014). In addition, another study conducted on transactions from approximately 20 percent of new car dealerships in the U.S. from January 1999 to July 2008 suggests little evidence of consumer myopia (Busse et al., 2013), meaning that the upfront payment consumers are willing to pay on average for an improvement in fuel economy is less than the PDV of their expected future fuel-cost savings. Similarly, the results from a multi-client survey of 1000 U.S. household from 2004 to 2013 suggest that consumers systematically

undervalue their future fuel-cost savings from improved fuel economy (Greene et al., 2013).

The conclusion of this research regarding with this issue reported here does not, however, support some of the previous literature. Recent evidence from new passenger cars sold during 1998-2011 in seven European countries suggests that consumers are willing to pay 0.91 Euro upfront for a 1 Euro reduction in the PDV of their future fuel-costs, but this undervaluation is not statistically significant (Grigolon et al., 2017). Evidence from used cars sold in the US from July 1993 to July 2008 suggests that consumers trade off 1 dollar today to save a 1 dollar in their future-fuel costs based on the present discounted value (Sallee et al., 2016). Evidence from the model year 2001 automobiles sold in the U.S. also suggests a one for one tradeoff between the upfront payments for an improvement in fuel economy and the PDV of the future fuel-cost savings (Espey and Nair, 2005). Evidence from a survey data on households who had purchased new or less than one-year-old cars in the U.K. suggests that consumers are willing to pay up to 1.96 pounds extra for 1 pound decrease in fuel cost of driving a hundred kilometers (Econometrics C., 2008).

In general, the gap between the implicit value of an improvement in fuel economy and the associated explicit fuel-cost savings is highest for owners of hatchbacks and station wagons and lowest for owners of sedans. This difference may imply that the owners of hatchbacks and station wagons might have a higher subjective discount rate than owners of other body types, provided that a higher subjective discount rate may embody the difficulties consumers face in the market such as credit constraints, or limited capital availability, and uncertainty about the future fuel prices (Helfand and Wolverton, 2009).

Finding that implicit marginal value of fuel economy is lower than the present discounted value of the explicit future fuel-cost savings leads to the question of why consumers seem to not fully exploit the opportunity of saving money from an improvement in fuel costs of driving a given distance. This slow adoption of the energy-efficient technologies or opportunities that would help save costs in the future has been referred to as the energy efficiency paradox (Jaffe and Stavins, 1994). Previous literature on savings from fuel-efficiency include various arguments about why consumers may fail to exploit the saving opportunities from fuel-efficient cars: high subjective discount rate on future fuel-cost savings; the difficulties and uncertainties about the factors consumers have to deal with calculating the present discounted value of future fuel-cost savings from improved fuel economy; and being more sensitive to the upfront marginal cost of buying a more fuel-efficient car because of its irreversibility than to savings expected to be gained in the future (Helfand and Wolverton, 2009). In addition, consumers may have limited time and resources to consider the costs and benefits of improved fuel economy, and, therefore, face a lack of information, or asymmetrically available information on the future fuel-cost savings they would attain from improved fuel economy (Tietenberg, 2009).

Even though it is possible that new passenger car buyers in Turkey might experience this paradox, it is also possible that the calculated present discounted value (PDV) of the fuel-cost savings from improved fuel economy may not reflect the true value of those savings due to various difficulties in calculating such values for the Turkish automobile market. First, the vehicle survivability rate, the rate of depreciation in annual kilometers driven over time and the average vehicle life are assumed here to be the same

as those used in the study of U.S. drivers and driving conditions because of the lack of information about those parameters in Turkey. Second, data from the two-decade Michigan Survey of Consumers suggest that consumers expect the real price of the fuel in the future to be equal to its current price (Anderson et al., 2013). However, there is no evidence on whether consumers in Turkey expect fuel prices in the future to be the same as the current price. If the car buyers who bought their cars during the study period had expectations of lower (higher) future fuel prices than its actual price in study period, then the PDV of the future fuel-cost savings from a 1 Turkish Lira (TL) decrease in the fuel cost of driving 100 km may be lower (higher) than it was calculated in this study if the substitution effect of changes in fuel prices is not greater than the income effect.

The third difficulty is that the subjective discount rate on future fuel-cost savings might be different from the opportunity cost of money assumed in this study. Previous literature asserts that consumers have higher subjective discount rates than the opportunity cost of money (Hausman, 1979). Specifically, car buyers seem to use a high discount rate in their calculations of fuel-cost savings from an improvement in the fuel economy (Kubik, 2006). For example, the private discount rate is estimated to range from 11 to 17 percent for car buyers in the U.S. (Dreyfus and Viscusi, 1995). If the subjective discount rate is higher than the opportunity cost of money, then the PDV of the future fuel-cost savings from improved fuel economy would be lower than what was found here. Conducting research on estimating the subjective discount rate of car buyers in Turkey about their future fuel-cost savings might be an important contribution to the related literature.

The last difficulty I did not account for is the rebound effect of improved fuel economy in calculating the PDV of the future fuel-cost savings. Car owners are predicted to travel more when they have more fuel-efficient car if their demand for travel is downward-sloping (Small and Van Dender, 2007). The evidence found in the vehicle market in the U.S. suggests that the rebound effect from improved fuel economy is estimated to offset only 10.7 percent of the fuel-cost savings in the long-run for the period from 1997-2001 and 22.2 percent for the period from 1966-2001 (Small and Van Dender, 2007). Evidence from a study on light-duty vehicles from 1966-1989 in the U.S. suggests that miles travelled increased by about 5-15 percent or less in response to a one unit decrease in fuel cost per mile (Greene, 1992). However, there is no study for car owners in Turkey about the size of the rebound effect. If we assume that the rebound effect of improved fuel economy is about the same as what it is estimated for the car owners in the U.S., then the present discounted value of the future fuel-cost savings from 1 TL decrease in fuel-cost of driving 100 km would be about 10 percent lower than it was calculated in this study.

Are Consumers Indifferent to the Sources of Improvement in the Fuel Cost of Driving a Given Distance?

As I have implicitly assumed in this study before estimating the within- and between-effects of the fuel cost of driving a given distance on vehicle price separately, some of the previous studies have also implicitly assumed that consumers respond the same way to an improvement in fuel cost of driving a given distance even if it stems from different sources. For example, Berry et al. (1995) estimated the effect of driving 1 more

mile per dollar on vehicle price by implicitly assuming that car buyers are indifferent whether such an improvement in miles-per-dollar stems from an improvement in miles-per-gallon or from an improvement in gallons-per-dollar or from the combined improvement in both. Given that previous literature has found that a change in fuel economy has a significant effect on vehicle price (e.g. Espey and Nair, 2005) while a change in fuel price does not necessarily have a significant effect up to six-months (Allcott and Wozny, 2014), consumers might respond differently to the source of the change in the fuel cost of driving a given distance.

Results from testing the equality of the effects of fuel consumptiveness and the effect of fuel prices on vehicle price in this study suggest that owners of all body types except station wagons and sports cars might react differently to a change in fuel cost of driving a given distance if the source of the change is the price of the fuel from how they react to a change in it if the source of the change is the fuel consumptiveness of the car. The reason why the between-effect and the within-effect of the fuel cost of driving a station-wagon or a sports car was found to be statistically the same might, again, be related to the lack of observations in the dataset constructed for this study. Using a longer period might help obtain more precise results to check the robustness of these results

Insignificance of the Effect of the Fuel Prices on Vehicle Prices

The insignificance of the within-effects—the effect of deviations from the time-averages of fuel prices—might be a result of both income and substitution effects canceling each other out. An increase in fuel prices makes operating a car more expensive, holding all else constant, implying a negative income effect on all cars. On the other hand, an

increase in fuel price leads to the price of more fuel-efficient cars to be relatively higher than the price of others. Hence, the overall effect of fuel prices on the price of car is unambiguously negative if it is less fuel-efficient, but ambiguous if it is more fuel-efficient. This is consistent with the evidence from a sample of new cars sold in the U.S. from January 1, 1999, to June 30, 2008, suggesting that both the price and the market share of high fuel-efficient cars increased when fuel price increased by 1 dollar while both the price and the market share of low fuel-efficient cars decreased (Busse et al., 2013).

Given that the real fuel prices fell over the seven-month study period (Figure 1), the insignificance of the within-effects might also suggest that both buyers and sellers in the market may not yet be responsive to changes in fuel prices during the study period. This is consistent with the recent evidence from the vehicle market in the U.S. during the period from 1999 to 2008, suggesting that prices in the vehicle market respond to changes in fuel prices with a delay up to six months (Allcott and Wozny, 2014).

From the manufacturers' view point, one of the reasons why the producers might be slow to respond to a change in fuel prices might be the marginal cost of the price adjustments every month, such as costs of reprinting and distributing the brochures. Another reason might be related to their strategy to increase or to keep their shares in the market. For example, the CEO of Borusan Otomotiv, the primary distributor of BMW and MINI in Turkey, commented on why the company did not change its nominal MSRPs in response to fluctuations (Figure 1) in the Euro/TL exchange rate during the last six months of 2015:[14] "Stabilizing the Euro/TL exchange rate below 3.00 cost us approximately 40

[14] His statement was in Turkish, and I translated it into English.

million Euro. However, we would have sold approximately 7,000 fewer cars and lost our leading position in the market if we had not done so" (Ozpeynirci, 2016, para.1). Since some manufacturers, including BMW and MINI, determine their nominal MSRPs based on the exchange rate between Euro and Turkish Lira, those prices do not change if the exchange rate remains constant. During the seven-month study period, I observed that BMW, Mini, Nissan, Seat and Skoda stabilized the exchange rate for their cars and did not change their nominal MSRPs during the last 5 months of 2015, and Mercedes did not change them during the last 4 months of 2015.

Nevertheless, it is also possible that the actual transaction prices might be responsive to changes in fuel prices even if the manufacturer-suggested retail prices (MSRPs) are not. Specifically, a negative relationship between the actual transaction prices and fuel prices might be observed if manufacturers tend to give higher unofficial discounts on their MSRPs when fuel prices are high than when fuel prices are low, provided that the vehicle market in Turkey was not responsive to changes in fuel prices during the seven-month period.

CHAPTER SEVEN

FUTURE RESEARCH

In addition to improving this study by resolving the difficulties encountered throughout the research mentioned in previous chapter, additional future research is needed. First, extending the seven-month data used in this study would help check the robustness of the results from this study. Specifically, it might help check the insignificant effect of changes in fuel prices on vehicle prices, and perhaps explore more fully the length of the delay in market's response to changes in fuel prices. In addition, the marginal willingness to pay for a hybrid car while holding all else constant was estimated to be approximately 8 percent, but this estimation was based on only two unique sub-models that are hybrid in the dataset. Given that manufacturers have introduced new hybrid models into the market in 2016, collecting more data would help check the robustness of the estimated willingness to pay for hybrid cars found in this study. In addition, collecting more data would also help disentangle the intrinsic motivations from the image motivations for reducing the adverse environmental impact of the car. In addition to extending the dataset, preliminary discussions of two specific considerations for exploring the research even further are briefly presented below.

Stochastic Frontier Price Model

It is asserted in previous chapter that if manufacturers tend to give higher disproportionate discounts unofficially on MSRPs when fuel prices are high than when fuel prices are low, then the actual transaction prices might be responsive to changes in fuel

prices whereas the manufacturer-suggested retail prices (MSRPs) might not be. If that is the case, then the argument I previously made in this study would be incorrect: the effects of changes in fuel prices and fuel consumptiveness of vehicles on natural log of MSRP are not expected to be significantly different from their effects on the natural log of the actual transaction prices. Whether this argument holds could be investigated by applying the properties of the stochastic frontier price model, where the MSRPs are treated as the upper boundary for the prices car buyers would at most pay. Since setting up the same econometric model with the sales-weighted within-between random effects model was computationally not applicable for this approach in the software program I used, I constructed a preliminary model like the unweighted within-between random effects models and compared the results (Table 30). The error terms are not weighted nor clustered, but assumed to have a half-normal distribution by default.

The results from this stochastic frontier price model are compared to the results from the unweighted within-between random effects model; however, it was not feasible to test the equality of coefficients between those two models. The estimated effects of the fuel cost of driving each body type and the estimated effects of environmental characteristics except the effect of ADVGREEN between those two models seem close (Table 30). This may suggest that the estimated effects of the fuel price, and fuel consumptiveness of each vehicle body type, on the natural log of the MSRPs might not be significantly different from what they would have been on the natural log of the actual transaction prices. Similarly, the estimated effects of environmental characteristics except the effect of ADVGREEN on the natural log of MSRPs might not be significantly different

from what they would have been on the natural log of the actual transaction prices. However, this is only a preliminary result, and weighting and clustering the error terms might change the results, and further research might be needed to apply the stochastic frontier approach after addressing the difficulties in the estimations.

Shifts in Consumer's Bid Function and Producer's Offer Function, and Second Stage of the Hedonic Price Model

In the first-stage of the hedonic model, all the vehicle characteristics are treated as exogenous because bids and offers change in the same direction when there is an incremental change in characteristics. However, if one of the exogenous variables, such as income and the price of fuel, changes, then this causes shifts in the consumer's bid function. If, for example, the price of fuel increases, then the consumer's bid function shifts, and we can no longer treat all the vehicle characteristics as exogenous. Such shift in the bid function leads to a shift not only in hedonic price function with a new combination of the vehicle price and characteristics but also in the marginal willingness to pay function for a characteristic Therefore, my future work would be to treat the fuel consumptiveness of vehicle as an endogenous variable and to trace the supply function, i.e. willingness to accept function, of the fuel consumptiveness in the second-stage of the hedonic model.

In addition, since I obtained data during this study on whether manufacturers have taken action to reduce emissions, energy use and water use in their production facilities, future research can use this information to trace the demand function of the fuel consumptiveness of vehicles. Those data represent the factors that shift the producer's offer

function. For example, taking action to reduce emissions would be costly to the companies. Therefore, their offer function would shift upward accordingly.

CHAPTER EIGHT

SIGNIFICANCE AND IMPLICATIONS OF THIS RESEARCH

This study primarily focused on estimating and disentangling the consumer valuation of saving money on fuel costs of driving a given distance for owners of five vehicular body types and the consumer valuation of reducing the adverse environmental impact of car's operation. Results have several implications for the field as well as for car manufacturers and policymakers in Turkey. First, the empirical model constructed with environmental characteristics of the vehicle fits the data statistically significantly better than the model without. Given that vehicles with better fuel economy might have a lower adverse impact on the environment of a car's operation, accounting for consumer valuation of reducing such adverse impact also helps disentangle that valuation from the consumer valuation of saving money on fuel expenses. After disentangling these two valuations, the consumer valuation of saving money on fuel expenses based on an improvement in fuel economy becomes significantly lower in absolute value, implying that not disentangling these two valuations might lead potentially to an upward bias in the estimation of the consumer valuation of an improvement in fuel economy.

In addition to obtaining more accurate, or less biased, estimates of consumer valuation of improved fuel economy, eliminating such a potential upward bias might also be crucial for providing the policymakers more accurate information about to what extent consumers value the improvements in fuel economy. If the policymakers adopt strategies based on estimates that are potentially upward biased, then they may implement less

effective strategies in terms of, for example, addressing the concerns related to the environmental consequences of emissions from vehicles.

Second, the consumer valuation of reducing the adverse environmental impacts of their cars might include the willingness to altruistically contribute to reduce emissions except NO_x from their vehicles as well as the willingness to signal environmentally friendly personality and to reduce internal noise. Given the Turkish car buyers' estimated marginal willingness to pay for these motivations, manufacturers in Turkey might find it profitable to adopt technological enhancements for their cars to reduce emissions, or internal noise, if the marginal cost of the adoption of those enhancements to manufacturers is lower than the extra amount consumers are willing to pay for them. In addition, finding that consumers are willing to pay less for the least emitter cars than low emitters might suggest that manufacturers should explore and address the potential concerns, or skepticism, car buyers may have about the material quality, reliability, or design of those sub-models. Doing so might also help promote those sub-models, and subsequently address the concerns related with environmental consequences of emissions from cars.

Third, finding that the estimated implicit value of improved fuel economy is less than the present discounted value of the associated future savings on fuel expenses might have implications about how the buyers of new passenger cars in Turkey value those expected future savings. They may be myopic about their future fuel-cost savings and/or have high subjective discount rates on those future savings. If that is the case, then market-based policy instruments such as gasoline tax or carbon tax would have little effect on consumer's vehicle choice (Busse et al., 2013). However, imposing standards on fuel

economy or on emissions might be an effective tool for improving consumer welfare and addressing the negative externalities, such as the environmental consequences of fuel use, in the presence of such myopia (Alcott and Wozny, 2014; Anderson et al., 2011). Such regulatory standards, however, might lead manufacturers to reduce the amount and quality of other attributes to produce a car with lower emission, and this poor quality material would increase the probability of death in an accident (Espey and Nair, 2005). For instance, evidence from a simulation based on each fatal automobile accident in the U.S. suggests that incrementing the standards on fuel economy by 1 mile-per-gallon is expected to cause 149 more death on accidents per year (Jacobsen, 2013).

They may, on the other hand, lack information about the benefits and costs from improved fuel economy. If that is the case, then providing more information about those costs and benefits in terms of both consumer welfare and emission reduction may give more insight to car owners and increase their awareness of emission-related issues. For instance, given that the evidence in this study suggests a willingness to pay extra to reduce CO_2 emissions but not NO_x and that car manufacturers provide information about only the CO_2 but not the NO_x emissions of their cars in their brochures, providing more detailed information about each emission type, including NO_x, may help.

The estimated consumer valuation of fuel economy found in this research could also serve as supporting evidence in lawsuits if automobile manufacturers are accused of misleading consumers by deliberately advertising inaccurate fuel economy values (Espey, 2013). In those situations, the estimate of consumer valuation of fuel economy can help determine the amount of the fine by calculating the difference between the implicit value

of the fuel economy claimed and the implicit value of the actual fuel economy experienced by the consumer. Similarly, the estimated consumer valuation of reducing adverse environmental impacts of their cars can also be used as supportive evidence in lawsuits for the case where the manufacturers misinform the consumers about these impacts. For example, in September 2015, Volkswagen was caught using a software to cheat on emission tests for its diesel cars and was subsequently fined 2.8 billion dollars (Eisenstein, 2017).

Fourth, finding that car buyers respond significantly differently to a change in fuel prices from a change in fuel consumptiveness of the vehicle might suggest that policymakers should adopt their strategies accordingly in terms of implementing policies through fuel prices or fuel consumptiveness of vehicles. Specifically, if the vehicle market responds to changes in fuel prices with a delay, then the policymakers should take this into account in their potential implementations through fuel prices. However, the results from this study may only provide preliminary evidence for such stickiness of information in the market. Future research is required to check the robustness of this result and to estimate the length of the delay in the market's response to changes in fuel prices.

APPENDICES

APPENDIX A

Additional Information About Preparing and Cleaning the First Dataset

I entered the prices and characteristics of each sub-model manually to the dataset because information about Turkish automobile market was not readily available, and doing so has also helped detect some mistakes/typos in manufacturers' official brochures and correct them by either asking the manufacturers or cross-checking them from multiple sources. Those mistakes were neither trivial nor easily detectable outliers.

If the manufacturer's official brochure had missing information about a sub-model's particular characteristic, which differs in standard packages offered by different countries, then it was not included in the final dataset because providing that information based on the same manufacturer's official brochures from other countries may be misleading. For example, an armrest may be a part of the standard package in another country but not in Turkey. However, if missing information about a characteristic is not country-specific, then it was filled with information based on an official brochure from another country or from other reliable sources after confirming that other attributes of the same sub-models matched the official brochure. For example, wheel drive type and suspension type information were missing for several sub-models, and I obtained that information from the official brochures of the same car prepared for other countries such as Ireland and the U.K. since the suspension type a car is usually world-wide for the same vehicle platform.

There were two small issues about the number of vehicles sold for each sub-model. First, a few sub-models did not provide number of vehicles sold for their 2014 and 2015

models separately. For example, the number of Alfa Romeo Guilietta 1.4 MultiAir 170 HP TCT Distinctives sold was 46 for June 2015, but these data were for both 2014 and 2015 models of that sub-model. I contacted the Automotive Distributors' Association (ADA), the provider of the quantity-sold information for each sub-model, regarding with this issue, but it indicated that it also did not have that information. For this reason, I combined the numbers of sold under one model year, 2015, and put 46 as the number of sold information for the Alfa Romeo Guilietta 1.4 MultiAir 170 HP TCT Distinctive exemplified here. Even though this may not be the ideal solution, it may be acceptable because everything except the model year and the price is the same for both 2014 and 2015 models. Second, some manufacturers provided the numbers sold for only its models, not for each sub-model. For example, the number of Mercedes A 180 Series sold was 81 in July 2015. However, the ADA did not have further information about how many of the A180 Style, the A180 Urban and the A180 AMG were sold individually. For this reason, I divided the numbers sold for each sub-model equally since those sub-models did not differ in their main characteristics, such as horse power, engine size and length, except for luxuriousness-related characteristics such as a sunroof. Combining all numbers sold into one sub-model would have been incorrect here because those sub-models were not identical in terms of luxuriousness. Therefore, I divided the numbers of sold equally, 27 for each the A180 Style, the A180 Urban and the A180 AMG.

APPENDIX B

Additional Information About the Second Dataset

After extracting the data from the website sahibinden.com, I first detected and eliminated the repetitive listings for the same car from the same seller in the same city. In the process of cleaning the dataset, I excluded diesel cars that were driven more than 55,000 and petrol cars that were driven more than 40,000 annual kilometers on average. This is because those cars were most likely either used for commercial purposes such as a taxi-cab/uber or company vehicles because driving more than 55,000 kilometers, which is approximately 34,175 miles, in a year for an individual who lives in a country which has the fifth highest fuel price in the world may be considered an outlier. I also excluded cars with less than 1000 kilometers in a year on average because of the potential for typos made in the listing such as writing 3000 kilometers instead of 30,000 kilometers for a 4-year-old car. Then, I calculated the upper and lower boundaries of the annual kilometers driven for each vehicle type and for each fuel type by moving approximately two standard deviations above and below the average of annual kilometers. All those above or below these boundaries were excluded.

After the cleaning process, I determined the age of each car for each observation. Determining the age was somewhat difficult because there was no information about the exact month in which each car was bought. For example, assuming a 2015 model year car to be a 2 years-old (from 2015 to the end of 2016) would be incorrect because there is no information about when exactly this car was bought. To address this problem, I obtained the total numbers of sold for new passenger cars for each month from January 2015 to

December 2015 using the dataset provided by Automotive Distributors' Association. Then, I calculated the probability of an average car being sold in a particular month throughout its model year. For example, given that total number of new passenger cars sold in January 2015 was 24,498 while it was 725,596 for the entire year, the probability of a 2015 model-year new passenger car being sold in January 2015 is calculated to be approximately 3.4 percent. Then, I used Equation A.1 to determine a predicted age for each observation:

$$Age_i = ListMonth_i + \sum_{m=1}^{12} Pr_m * (13 - m) \qquad \text{(A.1)}$$

where $ListMonth_i$ is the month the listing is created in 2016 for the observation i; m is the month of the year with January being 1 and December being 12; Pr_m is the probability of a particular car being sold in a particular month of the year.

For example, consider a 2015 model year Alfa Romeo Giulietta with 34,000 kilometers on its odometer by the time it was posted on the used-cars market website, October 2016. First term in the equation, $ListMonth_i$ is then equal to 10 since October is 10th month of the year. Since it is 2015 model year, the Equation A.1 is used, and the second term, $\sum_{m=1}^{12} Pr_m * (13 - m)$, is then equal to;

$$\sum_{m=1}^{12} Pr_m * (13 - m)$$

$$= \big[Pr_{Jan} * 12 + Pr_{Feb} * 11 + Pr_{Mar} * 10$$

$$+ Pr_{Apr} * 9 + Pr_{May} * 8 + Pr_{June} * 7 + Pr_{July} * 6 + Pr_{Aug} * 5$$

$$+ Pr_{Sep} * 4 + Pr_{Oct} * 3 + Pr_{Nov} * 2 + Pr_{Dec} * 1\big] = 5.84$$

The predicted age in months is then equal to 10+5.84= 15.84 months, or approximately 1.3 years, and the average annual kilometers driven is then 34,000/1.3=25,764 kilometer.

APPENDIX C

Additional Information About the Components of Manufacturer-Suggested Retail Price

Manufacturer-suggested retail price (MSRP) are categorized into four components: net price, special consumption tax, value added tax and other costs. The special consumption tax (SCT) is a consumption tax based on the luxuriousness of the good and levied only once at one stage of consumption process of the goods ("The Republic," 2016-1). For example, tobacco products, alcoholic beverages, appliances, petroleum products, mobile phones, and cars are all subject to a SCT at different rates. The other costs (OTHCOST) can be categorized into three separate costs:

a. *Registration Costs and Plate Costs:* These are the costs related with registration process of purchased new car. The registration cost was 179.75 Turkish Lira throughout the country for the study period.
b. *Motor Vehicle Tax (MTV):* It is an annual tax on motor vehicles that was divided in two equal installments. The first part, the first half of the total MTV amount, is obtained when the consumer purchase the brand-new car, and the second part, the second half of the total MTV, is obtained in either January or June depending on when the car was bought ("The Republic," 2016-2). This tax is obtained every year and subject to change based on both vehicle's age and engine size. However, only the first payment is included in the MSRPs; all other future payments are the additional costs the car buyer faces after she purchased the car. The total MTV payment for a brand-new car in its first-year is based on only the engine size as

shown in Equation A.3, and the first payment that was included in MSRP is the half of those amounts:

$$\text{MTV}=\begin{cases} 591\text{ TL} & \text{if Engine Size (ENGSIZE)} \leq 1300\text{ cc} \\ 945\text{ TL} & \text{if } 1301 \leq \text{ENGSIZE} \leq 1600\text{ cc} \\ 1667\text{ TL} & \text{if } 1601 \leq \text{ENGSIZE} \leq 1800\text{ cc} \\ 2626\text{ TL} & \text{if } 1801 \leq \text{ENGSIZE} \leq 2000\text{ cc} \\ 3939\text{ TL} & \text{if } 2001 \leq \text{ENGSIZE} \leq 2500\text{ cc} \\ 5491\text{ TL} & \text{if } 2501 \leq \text{ENGSIZE} \leq 3000\text{ cc} \\ 8362\text{ TL} & \text{if } 3001 \leq \text{ENGSIZE} \leq 3500\text{ cc} \\ 13147\text{ TL} & \text{if } 3501 \leq \text{ENGSIZE} \leq 4000\text{ cc} \\ 21516\text{ TL} & \text{if } 4001 \leq \text{ENGSIZE} \leq 25000\text{ cc} \end{cases} \quad \text{(A.3)}$$

c. *Service Fee:* This is a fee that was taken by manufacturers, and it can differentiate across manufacturers.

APPENDIX D

Results and Discussions of the Estimated Effects of Variables Other Than the Ones Included in the Text

The estimated effects of fuel cost variables and environmental characteristics based on the within-between random effects model were listed in Table 22. The results for other variables are listed in Table 22D below, and their implications are discussed briefly.

Table 22D: The Regression Results from the Within-Between Random Effects Model for the Other Variables Not Listed in Table 22.

Variable	*Coefficient*	*Std Error*	*t*	*P>|z|*
PETROL	-0.0962	0.0157	-6.14	0.000
LPG	-0.0174	0.0375	-0.46	0.643
HORSEPOWER	0.1981	0.0234	8.48	0.000
ACCELRTION	-0.0009	0.0029	-0.29	0.770
ENGSIZELESS1600	0.0144	0.0215	0.67	0.503
ENGSIZEBETW	0.1137	0.0201	5.65	0.000
ENGSIZEMORE2000	0.1343	0.0185	7.26	0.000
FLOORSPACE	0.1203	0.0152	7.89	0.000
WEIGHT	0.1208	0.0561	2.15	0.031
HEIGHT	-0.0071	0.0073	-0.98	0.328
FUELTANK	0.0046	0.0007	6.42	0.000
LUGGAGE	-0.0046	0.0044	-1.05	0.295
THIRDROW	0.1048	0.0192	5.45	0.000
AIR1	0.0102	0.0268	0.38	0.704
AIR2	-0.0229	0.0100	-2.29	0.022
AIR4	-0.0147	0.0085	-1.73	0.084
AIR5	0.0352	0.0283	1.24	0.214
AIR7	-0.0062	0.0102	-0.61	0.542

Table 22D: The Regression Results from the Within-Between Random Effects Model for the Other Variables Not Listed in Table 22 (Continued).

Variable	*Coefficient*	*Std Error*	*t*	*P>|z|*
REARCAM	0.0370	0.0073	5.07	0.000
HATCHBACK	-0.0220	0.0213	-1.04	0.300
SUV	0.0304	0.0244	1.25	0.213
SPORTS	-0.1667	0.0449	-3.71	0.000
STATIONWAGON	-0.0570	0.0422	-1.35	0.177
LUXURY	0.0870	0.0166	5.23	0.000
UPPERLUXURY	0.1911	0.0289	6.62	0.000
SEMISUSP	-0.0156	0.0083	-1.88	0.060
ADAPSUSP	0.0967	0.0355	2.73	0.006
SEMITRANS	0.0917	0.0056	16.24	0.000
AUTOTRANS	0.1053	0.0092	11.42	0.000
CVARTRANS	0.0744	0.0113	6.61	0.000
REARWD	0.0588	0.0187	3.14	0.002
ALL4WD	0.0593	0.0121	4.89	0.000
LEATHERSEAT	0.0418	0.0102	4.11	0.000
ALLOYWHEEL	0.0462	0.0072	6.43	0.000
AUTOAIRCON	0.0544	0.0058	9.34	0.000
CRUISECON	0.0238	0.0067	3.57	0.000
SUNROOF	0.0412	0.0083	4.95	0.000
GLASSTOP	0.0667	0.0135	4.94	0.000
DOMESTIC	-0.0349	0.0087	-4.01	0.000
ALFAROMEO	0.0427	0.0371	1.15	0.249
AUDI	0.3279	0.0249	13.17	0.000
BMW	0.2812	0.0221	12.71	0.000
CITROEN	-0.0204	0.0188	-1.09	0.277
DACIA	-0.1919	0.0166	-11.58	0.000

Table 22D: The Regression Results from the Within-Between Random Effects Model for the Other Variables Not Listed in Table 22 (Continued).

Variable	*Coefficient*	*Std Error*	*t*	*P>|z|*
FIAT	-0.0490	0.0167	-2.92	0.003
FORD	0.0417	0.0147	2.83	0.005
HONDA	0.0741	0.0205	3.62	0.000
HYUNDAI	-0.0219	0.0166	-1.33	0.185
INFINITI	0.2710	0.0288	9.42	0.000
JEEP	0.1945	0.0294	6.61	0.000
KIA	-0.1015	0.0194	-5.23	0.000
MAZDA	0.0339	0.0218	1.56	0.119
MERCEDES	0.3658	0.0219	16.67	0.000
MINI	0.3115	0.0234	13.30	0.000
MITSUBISHI	-0.0054	0.0230	-0.23	0.815
NISSAN	0.0457	0.0170	2.70	0.007
OPEL	-0.0244	0.0158	-1.55	0.122
PEUGEOT	-0.0302	0.0155	-1.95	0.052
SEAT	-0.1082	0.0140	-7.74	0.000
SKODA	-0.0192	0.0129	-1.49	0.137
SUBARU	-0.0032	0.0263	-0.12	0.903
SSANYGYONG	0.0414	0.0230	1.80	0.072
SUZUKI	-0.0760	0.0333	-2.29	0.022
TOYOTA	0.0320	0.0195	1.64	0.101
VOLKSWAGEN	0.0702	0.0160	4.39	0.000
VOLVO	0.1240	0.0225	5.50	0.000
SEASON2	-0.0274	0.0019	-14.73	0.000
SEASON3	-0.0176	0.0021	-8.30	0.000
CONSTANT	9.7612	0.1499	65.11	0.000

SEASON2: Summer, SEASON3: Winter

Among the power-related variables, the estimated effect of 100 horsepower, HORSEPOWER, on the manufacturer-suggested retail price (MSRP) is on average approximately 19.8 percent while holding all else constant. More horsepower is a good for consumers for a given fuel economy, weight and size of the vehicle. Among the other power-related variables, the effect of the acceleration rate of the car, ACCELRTION, is estimated to be negative but not significant. Given that a car is expected to accelerate faster if it has a larger horsepower-to-weight ratio than the others, the insignificance of acceleration may be an outcome of having already accounted for the horsepower and the weight of the vehicle in the estimated model.

Among the other power-related variables, the engine size of the car has positive and significant effects if it is more than 2 liters (ENGSIZEMORE2000) or between 1.6 liters and 2 liters (ENGSIZEBETW), but the effect of the engine size of the car is not significant although positive if it is less than 1.6 liters (ENGSIZELESS1600). Given that more pressure on the engine might shorten its life because a lack of efficiency, an incremental increase in engine size while holding horsepower constant would reduce the pressure on the engine, and thus help the engine maintain a longer and more efficient life. However, the effects decrease from ENGSIZEMORE2000 to ENGSIZELESS1600 since the owners of cars with smaller engine sizes are expected to value an incremental change in engine size less than others.

Among the fuel types, the estimated effect of the petroleum cars (PETROL) on the natural log of the MSRP is statistically significantly lower than the estimated effect of the diesel cars (DIESEL). Given that engines in diesel cars are expected to have a longer life

and lower maintenance costs than the engines in petroleum cars, the willingness to pay extra for diesel cars may reflect this difference in engines between these fuel types. The estimated effect of the liquefied petroleum gas cars (LPG) over DIESEL on vehicle price is negative but not significant, holding all else constant. Given that LPG cars have a natural gas tank, people may think that it has a potential danger of explosion that is not present in DIESEL cars. In addition, the insignificance of this effect may be a result of not having enough observations in the dataset. Of the 1098 unique sub-models, only 4 were LPG cars.

Among the size variables, the effect of the floor-space of the car (FLOORSPACE) on the logMSRP is significant and implies that new passenger car owners in Turkey are willing to pay on average approximately 12 percent more for a square-meter increase in size of the car while holding all else constant. Even though parking the car in a given space is more difficult with a larger car, having more space inside the car would make the ride more comfortable. Similarly, the effect of the weight of the car (WEIGHT) on the logMSRP is also significant and implies that the new passenger car owners in Turkey are willing to pay on average approximately 12 percent more for a ton increase in the weight of the car while holding all else constant. Heavier cars are usually thought to be more protective in a deadly crash even though recent technological advancements may claim opposite[15] while holding all else constant. However, a marginal increase in WEIGHT may also be a bad because of resulting a lower power-to-weight ratio while holding the horse power and all else constant. For this reason, I expect the estimated effect of WEIGHT on logMSRP to reflect the combination of these factors. The other size variable, the height of

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[15] There is some cutting-edge work about constructing a lighter car to improve fuel efficiency without sacrificing safety concerns. Building a car with carbon-fiber technology is one of them. However, those ones are rare in the Turkish car market.

the car (HEIGHT), has a negative but insignificant effect on logMSRP while holding all else constant. Even though having a larger inner space is a good for car buyers, the increased effect of the wind on the road from having more height might be a bad for them.

The estimated effect of the volume of the fuel tank of the car (FUELTANK) on the logMSRP is also statistically significant and positive, holding all else constant. The positive willingness to pay for an improvement in FUELTANK may be a result of saving time and money by reducing the number of trips to the gas station over a given time period. The effect of the volume of the trunk of the car (LUGGAGE) on vehicle price is negative but not significant, holding all else constant. Even though more space in the luggage area is a good for car buyers, it also means a less inner space for a given FLOORSPACE and HEIGHT of the car. Thus, the combined effect of these two may be the reason for the insignificance of the effect of the LUGGAGE on the logMSRP. The effect of having a third row in the car (THIRDROW) on the logMSRP is positive and significant, holding all else constant. Having the third row in the car for a given FLOORSPACE and HEIGHT might reflect two opposite effects: less leg room between rows is a negative effect while the need of extra seats, especially for large families, is a positive effect.

Among the safety-related variables, only the effect of 2 airbags in the front on the logMSRP is significantly less than the effect of 6 airbags while the effects of having any other numbers of airbags in the front row are not significantly different from the effect of having 6 airbags. Another safety-related variable, having a back-up camera (REARCAM), has a positive and significant effect on logMSRP, holding all else constant.

Given that the fuel costs for each body type is held constant in the estimation, the set of dummy variables for vehicular body types could reflect the effects of other factors such as the differences in the shape or the aesthetic of vehicles and the way people feel about them while driving. For example, consumers may be willing to pay more for a sports utility car (SUV) car than for others because of its shape. The estimated effects of hatchback (HBACK), sports (SPORTS) and station wagon (SWAGON) cars in addition to the effect of sedan cars (SEDAN) on vehicle price are all negative while the additional effect of SUV is positive, holding all else constant. These estimated effects in addition to the effect of SEDAN are all insignificant except SPORTS, and the results suggest that the owners of new passenger cars in Turkey are willing to pay on average approximately 16.7 percent less for a sports car than a sedan, while holding all else constant. Since I am holding numerous characteristics of the vehicle constant, this negative effect may be a result of another factor. For example, given that most sports cars have two doors, people may find getting into the rear seats difficult in those cars.

Given that the roads in Turkey, especially in urban areas, usually are in poor repair, the suspension type of a car can make a difference in comfort. Among all suspension types, the adaptive (the dependent) suspension system is equipped with the highest (the lowest) technological enhancement, providing the most (the least) comfortable ride. In addition, road handling is easier moving from the dependent system to the adaptive system. However, repairing/maintenance costs become more expensive. Results suggest that new passenger car owners in Turkey value on average the semi-dependent suspension (SEMISUSP) system on the margin of being significantly less than the independent

suspension (INDEPSUSP) system whereas they value the adaptive suspension (ADAPSUSP) system significantly more than the INDEPSUSP system while holding everything else constant.

Cars with automatic transmissions are easier to drive than cars with manual transmissions. Results suggest that new passenger car owners in Turkey value the semi-automatic transmission (SEMITRANS), automatic transmission (AUTOTRANS) and continuously variable transmission (CVARTRANS) significantly more than the manual transmission (MANUTRANS), holding all else constant. However, even though the CVARTRANS is technologically more enhanced and easier to drive than the AUTOTRANS, it is not valued as much as the latter, perhaps because of the higher repair/maintenance costs car owners may potentially face with these transmissions.

Front-wheel drive and rear wheel drive may have noticeable difference in their performance especially when driving uphill. Hence, people who live on hills value a front-wheel drive system less because rear-wheel drive performs better driving uphill. A similar argument can be made for four-wheel drive and all-wheel drive. Both perform better than the front-wheel drive in hilly places. Results suggest that new passenger car owners in Turkey value both the rear-wheel drive (REARWD) and the combination of all-wheel drive and four-wheel drive (ALL4WD) significantly more than the front-wheel drive (FRONTWD) while holding all else constant.

Leather seat (LEATHERSEAT), alloy wheel (ALLOYWHEEL), automatic air-conditioning (AUTOAIRCON), cruise control (CRUISECON), sunroof (SUNROOF) and glass surface (GLASSTOP) are comfort- and luxuriousness-related variables, and the

results suggest that new passenger car owners place a significantly positive value on each. GLASSTOP is valued more than SUNROOF, perhaps because of the GLASSTOP providing a larger sky view, giving the opportunity to see the stars, moon, or sun while traveling. LUXURY and UPPERLUXURY represent other luxury features that are not already accounted for the model. Estimation results suggest that car owners significantly value those unobserved features more on average, holding all else constant.

Results suggest that new passenger car owners value the DOMESTIC cars, which are assembled or produced in Turkey, significantly less than the others on average, holding all else constant, perhaps because of car owners' opinions of domestically produced cars. They may think that those cars are less reliable, or less safe. This result might encourage foreign manufacturers to enter the Turkish automobile market since car owners do not appear to value foreign cars less on average, all else constant. However, it is also possible that this result may be a reflection of the lower input costs on the producer's side. For example, producers might save transportation costs for their cars if they produce them in Turkey, or labor costs, which may be relatively cheaper than in other countries.

Finally, the results also suggest that new passenger car owners in Turkey place the least value on Dacia among all manufacturers while they place the most value on Mercedes, holding all else constant. These maker fixed effects are, again, expected to pick up the effects of unobserved characteristics such as safety, reliability, and the resale value of the cars that may vary by the manufacturers.

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TABLES AND FIGURES

Table 1: Summary Statistics of the Real Manufacturer-Suggested Retail Prices (1000 Turkish Lira) Across Body Types for Each Month

Month	SEDAN			STATION WAGON			HATCHBACK			SUV			SPORTS		
	Mean*	Min	Max	Mean*	Min	Max	Mean*	Min	Max	Mean*	Min	Max	Mean*	Min	Max
June	82.1	39.1	635.7	78.4	40.9	196.9	59.5	36.9	127.9	96.6	47.1	500.6	183.7	78.6	621.7
July	86.0	39.5	646.5	65.0	40.9	200.2	61.0	36.9	193.7	100.0	48.4	500.2	179.6	78.6	565.8
Aug	87.3	38.4	643.9	68.8	39.7	199.4	62.0	35.7	127.3	100.3	48.2	524.3	168.8	78.2	593.2
Sep	89.5	38.4	671.2	78.2	41.6	207.3	63.0	35.4	128.6	104.9	53.8	519.7	171.3	77.6	587.9
Oct	89.1	37.8	674.1	75.4	41.0	208.2	64.9	34.9	126.6	106.5	53.9	511.7	166.1	76.4	578.9
Nov	87.6	37.6	669.6	74.2	40.7	206.9	63.7	34.6	125.8	101.2	52.5	508.4	167.1	75.9	575.1
Dec	84.8	40.1	672.7	68.8	40.6	207.8	63.0	36.8	125.5	100.9	47.2	507.3	159.7	78.2	573.9

*Means are weighted by the number of cars sold for the given month.

Table 2: Weighted Means of Real Fuel Costs of Driving a Vehicle for a Given Distance by Body Types and Market Shares of Vehicles with Environmental Characteristics

Variable	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
FCOST100KMSEDAN (TL/100km)	20.8	20.3	19.8	19.3	18.7	18.3	17.8
FCOST100KMSWAGON (TL/100km)	18.6	16.4	15.6	17.4	16.3	15.4	13.7
FCOST100KMHBACK (TL/100km)	21.3	20.4	20.0	19.5	19.0	18.5	17.6
FCOST100KMSUV (TL/100km)	23.8	22.8	22.1	23.0	21.2	21.1	19.4
FCOST100KMSPORTS (TL/100km)	24.2	23.9	23.2	22.9	22.7	22.4	21.7
STARTSTOP (percent)	0.385	0.420	0.432	0.425	0.467	0.447	0.437
ADVGREEN (percent)	0.534	0.577	0.529	0.575	0.618	0.557	0.575
GREENCAR (percent)	0.225	0.236	0.220	0.237	0.258	0.229	0.251
EU6DIESEL (percent)	0.178	0.219	0.232	0.234	0.271	0.279	0.266
HYBRID (percent)	0.002	0.001	0.002	0.001	0.002	0.002	0.001

FCOST100KMSEDAN: Fuel Cost of Driving a Sedan 100 Kilometers
FCOST100KMHBACK: Fuel Cost of Driving a Hatchback 100 Kilometers
FCOST100KMSUV: Fuel Cost of Driving a Sports Utility Vehicle 100 Kilometers
FCOST100KMSPORTS: Fuel Cost of Driving a Sports Vehicle 100 Kilometers
FCOST100KMSWAGON: Fuel Cost of Driving a Station Wagon 100 Kilometers
STARTSTOP: Cars with the start/stop technology
ADVGREEN: Cars that are advertised as lower emitter
GREENCAR: Cars that are advertised as the lowest emitter
EU6DIESEL: Diesel cars that comply with the Euro-6 Emission Standards
HYBRID: Hybrid cars

Table 3: Weighted Means and Proportions (percent) of Body Type, Fuel Type, Engine Characteristics, Spatial Dimensions, and Safety Features by Month

Variable	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
SEDAN (percent)	0.548	0.507	0.480	0.487	0.505	0.469	0.490
STATIONWAGON (percent)	0.007	0.013	0.011	0.010	0.008	0.009	0.015
HATCHBACK (percent)	0.296	0.326	0.348	0.328	0.324	0.347	0.321
SUV (percent)	0.139	0.141	0.147	0.161	0.150	0.161	0.162
SPORTS (percent)	0.010	0.013	0.013	0.014	0.013	0.013	0.013
DIESEL (percent)	0.634	0.639	0.605	0.637	0.634	0.609	0.618
PETROL (percent)	0.365	0.361	0.394	0.363	0.366	0.381	0.371
LPG (percent)	0.001	0.000	0.001	0.000	0.000	0.010	0.011
HORSEPOWER (100 HP)	1.088	1.099	1.106	1.114	1.126	1.123	1.115
ACCELRTION(sec/100 kmph)	11.72	11.60	11.54	11.60	11.45	11.45	11.51
ENGSIZELESS1600 (liter)	1.458	1.457	1.460	1.459	1.462	1.464	1.457
ENGSIZEBETW (liter)	1.982	1.983	1.979	1.978	1.978	1.978	1.977
ENGSIZEMORE2000 (liter)	2.506	2.627	2.582	2.572	2.645	2.602	2.512
FLOORSPACE (meter^2)	7.881	7.881	7.871	7.890	7.902	7.884	7.895
WEIGHT (ton)	1.340	1.346	1.349	1.356	1.359	1.357	1.349
HEIGHT (meter)	14.99	14.96	14.98	14.99	14.99	14.99	15.01
FUELTANK (liter)	52.44	52.46	52.48	52.49	52.98	52.70	52.45
LUGGAGE (100 liters)	4.337	4.312	4.301	4.325	4.356	4.299	4.320
THIRDROW (percent)	0.013	0.012	0.013	0.014	0.014	0.013	0.011
AIR1 (One front airbags)	0.006	0.003	0.008	0.003	0.001	0.003	0.001
AIR2 (Two front airbags)	0.243	0.219	0.213	0.215	0.220	0.183	0.189
AIR4 (Four front airbags)	0.172	0.193	0.178	0.189	0.166	0.195	0.187
AIR5 (Five front airbags)	0.014	0.015	0.014	0.019	0.010	0.021	0.018
AIR6 (Six front airbags)	0.401	0.397	0.418	0.414	0.428	0.454	0.434
AIR7 (Seven front airbags)	0.163	0.172	0.169	0.160	0.175	0.145	0.170
REARCAM (percent)	0.201	0.201	0.194	0.214	0.242	0.230	0.233

Table 4: Weighted Proportions (percent) of Suspension Type, Transmission Type, Wheel-Drive Type, and Comfort- and Luxuriousness-Related Characteristics by Month

Variable	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
INDEPSUSP (percent)	0.515	0.534	0.545	0.515	0.537	0.512	0.512
SEMISUSP (percent)	0.465	0.440	0.431	0.458	0.441	0.476	0.475
ADAPSUSP (percent)	0.020	0.025	0.024	0.028	0.021	0.012	0.013
MANUTRANS (percent)	0.501	0.474	0.478	0.431	0.439	0.458	0.459
SEMITRANS (percent)	0.292	0.311	0.300	0.356	0.326	0.317	0.308
AUTOTRANS (percent)	0.141	0.149	0.163	0.150	0.165	0.162	0.160
CVARTRANS (percent)	0.066	0.066	0.059	0.063	0.070	0.063	0.074
FRONTWD (percent)	0.909	0.891	0.887	0.886	0.865	0.879	0.898
REARWD (percent)	0.060	0.070	0.072	0.062	0.076	0.065	0.056
ALL4WD (percent)	0.031	0.039	0.042	0.053	0.059	0.055	0.047
LUXURY (percent)	0.033	0.031	0.029	0.023	0.027	0.032	0.032
UPLUXURY (percent)	0.004	0.005	0.004	0.003	0.004	0.004	0.004
LEATHERSEAT (percent)	0.053	0.055	0.066	0.075	0.083	0.089	0.079
CRUISECON (percent)	0.584	0.588	0.608	0.596	0.603	0.626	0.628
ALLOYWHEEL (percent)	0.661	0.679	0.718	0.683	0.716	0.701	0.711
AUTOAIRCON (percent)	0.491	0.511	0.521	0.523	0.544	0.530	0.546
SUNROOF (percent)	0.092	0.089	0.096	0.116	0.096	0.096	0.094
GLASSTOP (percent)	0.035	0.048	0.043	0.038	0.052	0.050	0.049
DOMESTIC (percent)	0.251	0.266	0.222	0.275	0.243	0.239	0.291

Table 5: Weighted Proportions (percent) of Vehicle Makes by Month

Variable	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
ALFAROMEO (percent)	0.001	0.001	0.001	0.001	0.001	0.001	0.001
AUDI (percent)	0.024	0.025	0.026	0.034	0.022	0.029	0.034
BMW (percent)	0.039	0.048	0.047	0.035	0.056	0.053	0.038
CITROEN (percent)	0.027	0.022	0.027	0.020	0.010	0.024	0.020
DACIA (percent)	0.047	0.047	0.053	0.042	0.046	0.046	0.050
FIAT (percent)	0.064	0.064	0.049	0.071	0.057	0.060	0.071
FORD (percent)	0.070	0.063	0.067	0.058	0.053	0.047	0.051
HONDA (percent)	0.019	0.021	0.024	0.031	0.031	0.026	0.026
HYUNDAI (percent)	0.067	0.057	0.068	0.078	0.073	0.072	0.068
INFINITI (percent)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JEEP (percent)	0.005	0.004	0.004	0.003	0.003	0.006	0.005
KIA (percent)	0.018	0.015	0.017	0.023	0.021	0.032	0.021
MAZDA (percent)	0.002	0.002	0.002	0.005	0.004	0.002	0.002
MERCEDES (percent)	0.052	0.051	0.051	0.054	0.045	0.037	0.041
MINI (percent)	0.002	0.003	0.002	0.003	0.003	0.003	0.003
MITSUBISHI (percent)	0.002	0.002	0.002	0.002	0.002	0.002	0.002
NISSAN (percent)	0.035	0.037	0.036	0.040	0.040	0.040	0.041
OPEL (percent)	0.067	0.054	0.067	0.053	0.059	0.081	0.082
PEUGEOT (percent)	0.031	0.031	0.027	0.028	0.022	0.029	0.032
RENAULT (percent)	0.145	0.148	0.135	0.162	0.165	0.147	0.157
SEAT (percent)	0.026	0.027	0.026	0.022	0.021	0.023	0.019
SKODA (percent)	0.031	0.029	0.028	0.026	0.029	0.029	0.031
SUBARU (percent)	0.002	0.002	0.002	0.003	0.003	0.002	0.002
SSANYGYONG (percent)	0.002	0.001	0.001	0.000	0.000	0.000	0.000
SUZUKI (percent)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOYOTA (percent)	0.073	0.070	0.056	0.045	0.071	0.058	0.081
VOLKSWAGEN (percent)	0.135	0.169	0.173	0.153	0.155	0.138	0.110
VOLVO (percent)	0.010	0.007	0.007	0.010	0.008	0.011	0.009

Table 6: The Number of Unique Sub-Models in the Dataset, Total Number of Vehicles Sold, and the Percentage of Their Inclusion in the Dataset over Months

Month / 2015	*Number of Unique Sub-Models in Dataset*	*Included in the Dataset (Approximate percent)*	*Number of Vehicles Sold in Total*	*Included in the Dataset (percent)*
June	864	83	67,766	97.5
July	912	85	64,218	97.7
Aug	916	90	61,753	98.0
Sep	905	89	47,088	97.3
Oct	905	90	47,954	97.2
Nov	901	91	62,397	97.5
Dec	911	88	114,340	97.4
ALL	1098	85	465,516	97.6

Table 7: Unique Names Given to the Vehicles in GREENCAR=1 category by Their Manufacturers

Manufacturer	*Given Unique Name*
AUDI	Ultra
BMW	Efficient Dynamics
CITROEN	PureTech
DACIA	Eco and LPG
FIAT	TwinAir
FORD	EcoBoost
HONDA	LPG
HYUNDAI	Blue
MERCEDES	BlueTec and BlueEfficiency
OPEL	EcoFlex
PEUGEOT	PureTech
RENAULT	Eco
SEAT	EcoTSI
SKODA	GreenTech and GreenLine
TOYOTA	Hybrid
VOLKSWAGEN	Bluemotion

Table 8: The Estimated Coefficients of Fuel Costs of Each Body Type in Each Partially Specified Monthly Model Before Including the Environmental Characteristics of Vehicle

Variable	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
FCOST100KM	-0.0146***	-0.0176***	-0.0175***	-0.0151***	-0.0114***	-0.0135***	-0.0136***
	(-7.76)	(-9.06)	(-7.59)	(-6.46)	(-5.07)	(-5.71)	(-4.90)
FCOST100KM SWAGON	0.00153	0.0000585	0.00549	0.00576*	0.00325	0.00248	0.00189
	(0.4)	(0.02)	(1.64)	(2.36)	(1.12)	(0.86)	(0.61)
FCOST100KM HBACK	0.00205	0.00248	0.00347*	0.00258	0.00215	0.00269	0.00410*
	(1.73)	(1.96)	(2.52)	(1.71)	(1.38)	(1.83)	(2.46)
FCOST100KM SUV	0.00416***	0.00526***	0.00599***	0.00468**	0.00234	0.00375*	0.00583***
	(3.51)	(4.06)	(4.09)	(2.99)	(1.53)	(2.53)	(3.68)
FCOST100KM SPORTS	0.00701*	0.00457	0.00642	0.00159	0.00597	0.0011	-0.000818
	(2.04)	(1.22)	(1.3)	(0.36)	(1.36)	(0.21)	(-0.16)
67 more variables are included except environmental characteristics of the vehicle.							
Observations	864	912	916	905	905	901	911
Adjusted R^2	0.984	0.984	0.984	0.983	0.984	0.983	0.982

*t statistics are in parentheses, * p<0.05, ** p<0.01, *** p<0.001*
FCOST100KM: Fuel Cost of Driving a Sedan 100 km.

Table 9: Results from Testing the Equality of the Estimated Coefficients of Fuel Cost of Each Body Type Other than Sedan in Each Partially Specified Monthly Model Before Including Environmental Characteristics in the Model

Null Hypothesis / p-values	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
$\hat{\beta}_{HBACK}=\hat{\beta}_{SUV}$	0.078	0.034	0.081	0.186	0.893	0.419	0.252
$\hat{\beta}_{HBACK}=\hat{\beta}_{SPO}$	0.161	0.588	0.558	0.826	0.403	0.771	0.357
$\hat{\beta}_{HBACK}=\hat{\beta}_{SWAGON}$	0.890	0.342	0.537	0.188	0.695	0.940	0.473
$\hat{\beta}_{SUV}=\hat{\beta}_{SPO}$	0.415	0.855	0.932	0.494	0.418	0.625	0.209
$\hat{\beta}_{SUV}=\hat{\beta}_{SWAGON}$	0.484	0.038	0.877	0.652	0.742	0.650	0.191
$\hat{\beta}_{SPO}=\hat{\beta}_{SWAGON}$	0.273	0.308	0.873	0.382	0.582	0.811	0.646

Null: Coefficients of fuel cost of each body type are equal within the same month.

Null is rejected when $p<0.05$

$\hat{\beta}_{HBACK}$ = *The estimated coefficient of fuel cost of a hatchback 100 km*
$\hat{\beta}_{SUV}$ = *The estimated coefficient of fuel cost of a sports utility vehicle 100 km*
$\hat{\beta}_{SPO}$ = *The estimated coefficient of fuel cost of a sports car 100 km*
$\hat{\beta}_{SWAGON}$ = *The estimated coefficient of fuel cost of a station wagon 100 km*

Table 10: Results from Testing the Equality of the Estimated Coefficients of Fuel Cost of Each Body Types Across Partially Specified Monthly Models Before Including Environmental Characteristics

Null Hypothesis / Prob > chi2		*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*
$\hat{\beta}^{t}_{SED}=\hat{\beta}^{k}_{SED}$ where $\hat{\beta}^{t}_{SED}$ is the estimated coefficient of FCOST100KM SEDAN in month t.	*July*	0.246					
	Aug	0.297	0.993				
	Sep	0.845	0.403	0.444			
	Oct	0.257	0.030	0.047	0.229		
	Nov	0.718	0.168	0.205	0.614	0.496	
	Dec	0.763	0.221	0.255	0.660	0.519	0.982
$\hat{\beta}^{t}_{SWAGON}=\hat{\beta}^{k}_{SWAGON}$ where $\hat{\beta}^{t}_{SWAGON}$ is the estimated coefficient of FCOST100KM SWAGON in month t.	*July*	0.344					
	Aug	0.848	0.214				
	Sep	0.438	0.037	0.541			
	Oct	0.320	0.023	0.395	0.764		
	Nov	0.686	0.119	0.826	0.687	0.507	
	Dec	0.798	0.193	0.944	0.600	0.444	0.886
$\hat{\beta}^{t}_{HBACK}=\hat{\beta}^{k}_{HBACK}$ where $\hat{\beta}^{t}_{HBACK}$ is the estimated coefficient of FCOST100KM HBACK in month t.	*July*	0.335					
	Aug	0.590	0.731				
	Sep	0.990	0.383	0.625			
	Oct	0.238	0.040	0.114	0.271		
	Nov	0.544	0.135	0.289	0.567	0.588	
	Dec	0.328	0.076	0.171	0.354	0.938	0.679
$\hat{\beta}^{t}_{SUV}=\hat{\beta}^{k}_{SUV}$ where $\hat{\beta}^{t}_{SUV}$ is the estimated coefficient of FCOST100KM SUV in month t.	*July*	0.373					
	Aug	0.614	0.748				
	Sep	0.983	0.436	0.661			
	Oct	0.561	0.174	0.321	0.582		
	Nov	0.789	0.296	0.485	0.792	0.780	
	Dec	0.305	0.085	0.168	0.333	0.647	0.476
$\hat{\beta}^{t}_{SPO}=\hat{\beta}^{k}_{SPO}$ where $\hat{\beta}^{t}_{SPO}$ is the estimated coefficient of FCOST100KM SPORTS in month t.	*July*	0.309					
	Aug	0.571	0.772				
	Sep	0.315	0.930	0.729			
	Oct	0.720	0.216	0.413	0.223		
	Nov	0.465	0.932	0.864	0.878	0.337	
	Dec	0.318	0.840	0.672	0.907	0.229	0.805
Null: Each common coefficient between two months are equal							
Null is rejected when p<0.05							

Table 11: The Results from the Likelihood Ratio Tests for Each Month Between the Partially Specified Seven Monthly Models and the Fully Specified Seven Monthly Models

	June	July	Aug	Sep	Oct	Nov	Dec
Likelihood Ratio Statistics	61.54	51.20	32.51	30.52	43.19	10.94	8.17
Chi2 Value*	9.49	9.49	9.49	9.49	9.49	9.49	9.49

Null: The partially specified model fits the data better than the fully specified model.

Null is rejected if Likelihood Ratio Statistics > Chi2 Value

*for 95 percent with 4 extra degrees of freedom

Table 12: The Estimated Coefficients of Fuel Cost for Each Body Type and Environmental Characteristics in Each Fully Specified Monthly Model

Variables	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
FCOST100KM	-0.0119***	-0.0150***	-0.0146***	-0.0135***	-0.00891***	-0.0130***	-0.0139***
	(-5.68)	(-6.99)	(-6.00)	(-5.19)	(-3.64)	(-5.04)	(-4.48)
FCOST100KM SWAGON	0.00275	0.0018	0.00658*	0.00573*	0.00318	0.00207	0.00164
	(0.86)	(0.74)	(2.18)	(2.4)	(1.17)	(0.7)	(0.51)
FCOST100KM HBACK	0.00227*	0.00255*	0.00374**	0.00286*	0.00236	0.00246	0.00386*
	(2.05)	(2.18)	(2.87)	(1.98)	(1.61)	(1.66)	(2.3)
FCOST100KM SUV	0.00394**	0.00517***	0.00581***	0.00513**	0.00261	0.00395**	0.00595***
	(3.2)	(3.97)	(3.99)	(3.2)	(1.71)	(2.64)	(3.6)
FCOST100KM SPORTS	0.00874**	0.00629	0.00727	0.00254	0.00743	0.00156	-0.000937
	(2.71)	(1.72)	(1.47)	(0.55)	(1.64)	(0.29)	(-0.18)
STARTSTOP	0.0308**	0.0265*	0.0256*	0.0227*	0.0235*	0.0146	0.00527
	(3.18)	(2.48)	(2.52)	(2.23)	(2.33)	(1.48)	(0.52)
ADVGREEN	0.0319**	0.0274*	0.0198	0.0169	0.0281*	0.00998	0.0126
	(3.02)	(2.51)	(1.72)	(1.44)	(2.23)	(0.99)	(0.9)
GREENCAR	-0.0410***	-0.0406***	-0.0189	-0.0291*	-0.0285*	-0.0191	-0.0219
	(-3.51)	(-3.72)	(-1.65)	(-2.41)	(-2.52)	(-1.70)	(-1.77)
EU6DIESEL	-0.00133	-0.000138	0.00311	0.00597	0.00632	-0.00315	-0.00577
	(-0.14)	(-0.01)	(0.32)	(0.59)	(0.62)	(-0.28)	(-0.49)
HYBRID	0.104**	0.0697*	0.0628	0.0983**	0.121***	0.136***	0.127***
	(3.29)	(1.97)	(1.74)	(2.62)	(3.85)	(4.18)	(3.43)
67 more variables are included.			*t statistics in parentheses, * p<0.05, ** p<0.01, *** p<0.001*				
Observations	864	912	916	905	905	901	911
Adjusted R-squ~d	0.985	0.985	0.984	0.984	0.984	0.983	0.982

Table 13: Results from Testing the Equality of the Estimated Coefficients of Fuel Cost of Each Body Type Other than Sedan in Each Fully Specified Monthly Model After Including Environmental Characteristics to the Model

Null Hypothesis / p-values	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
$\hat{\beta}_{HBACK}=\hat{\beta}_{SUV}$	0.189	0.054	0.169	0.167	0.859	0.272	0.178
$\hat{\beta}_{HBACK}=\hat{\beta}_{SPO}$	0.052	0.322	0.484	0.946	0.278	0.867	0.376
$\hat{\beta}_{HBACK}=\hat{\beta}_{SWAGON}$	0.881	0.743	0.334	0.220	0.757	0.891	0.495
$\hat{\beta}_{SUV}=\hat{\beta}_{SPO}$	0.151	0.766	0.775	0.594	0.296	0.657	0.202
$\hat{\beta}_{SUV}=\hat{\beta}_{SWAGON}$	0.712	0.163	0.798	0.805	0.828	0.518	0.182
$\hat{\beta}_{SPO}=\hat{\beta}_{SWAGON}$	0.175	0.288	0.904	0.530	0.391	0.929	0.670

Null: Coefficients of fuel cost of each body type are equal within the same month.

Null is rejected when $p<0.05$

$\hat{\beta}_{HBACK}$ = *The estimated coefficient of fuel cost of a hatchback 100 km*
$\hat{\beta}_{SUV}$ = *The estimated coefficient of fuel cost of a sports Utility Vehicle 100 km*
$\hat{\beta}_{SPO}$ = *The estimated coefficient of fuel cost of a sports car 100 km*
$\hat{\beta}_{SWAGON}$ = *The estimated coefficient of fuel cost of a station wagon 100 km*

Table 14: Results from Testing the Equality of the Estimated Coefficients of Fuel Cost of Each Body Type Across Fully Specified Monthly Models After Including Environmental Characteristics

Null Hypothesis / Prob > chi2		*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*
$\hat{\beta}^t_{SED}=\hat{\beta}^k_{SED}$	*July*	0.282					
	Aug	0.372	0.915				
where $\hat{\beta}^t_{SED}$ *is the*	*Sep*	0.621	0.642	0.733			
estimated coefficient	*Oct*	0.332	0.051	0.083	0.181		
of FCOST100KM	*Nov*	0.729	0.538	0.628	0.891	0.229	
SEDAN in month t.	*Dec*	0.582	0.758	0.837	0.920	0.190	0.822
$\hat{\beta}^t_{SWAGON}=\hat{\beta}^k_{SWAGON}$	*July*	0.375					
	Aug	0.821	0.248				
where $\hat{\beta}^t_{SWAGON}$ *is the*	*Sep*	0.760	0.193	0.944			
estimated coefficient	*Oct*	0.468	0.083	0.613	0.643		
of FCOST100KM SWAGON	*Nov*	0.715	0.614	0.547	0.481	0.263	
in month t.	*Dec*	0.556	0.845	0.417	0.361	0.196	0.801
$\hat{\beta}^t_{HBACK}=\hat{\beta}^k_{HBACK}$	*July*	0.351					
	Aug	0.690	0.643				
where $\hat{\beta}^t_{HBACK}$ *is the*	*Sep*	0.758	0.583	0.934			
estimated coefficient	*Oct*	0.314	0.062	0.192	0.224		
of FCOST100KM HBACK	*Nov*	0.771	0.557	0.915	0.982	0.221	
in month t.	*Dec*	0.913	0.497	0.810	0.871	0.338	0.885
$\hat{\beta}^t_{SUV}=\hat{\beta}^k_{SUV}$	*July*	0.418					
	Aug	0.718	0.694				
where $\hat{\beta}^t_{SUV}$ *is the*	*Sep*	0.876	0.567	0.856			
estimated coefficient	*Oct*	0.513	0.178	0.352	0.461		
of FCOST100KM	*Nov*	0.674	0.775	0.938	0.804	0.339	
SUV in month t.	*Dec*	0.987	0.510	0.758	0.887	0.600	0.717
$\hat{\beta}^t_{SPO}=\hat{\beta}^k_{SPO}$	*July*	0.308					
	Aug	0.513	0.845				
where $\hat{\beta}^t_{SPO}$ *is the*	*Sep*	0.216	0.731	0.631			
estimated coefficient	*Oct*	0.785	0.262	0.421	0.188		
of FCOST100KM	*Nov*	0.216	0.692	0.601	0.948	0.187	
SPORTS in month t.	*Dec*	0.100	0.403	0.359	0.629	0.091	0.686

Null: Each common coefficient between two months are equal

Null is rejected when p<0.05

Table 15: Results from Testing the Equality of the Estimated Coefficients of Environmental Characteristics Across Fully Specified Monthly Models

Null Hypothesis / Prob > chi2		*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*
$\hat{\theta}_{SS}^{t}=\hat{\theta}_{SS}^{k}$	*July*	0.753					
	Aug	0.698	0.951				
where, $\hat{\theta}_{SS}^{t}$ is the	*Sep*	0.548	0.791	0.835			
estimated coefficient	*Oct*	0.587	0.835	0.881	0.952		
of STARTSTOP	*Nov*	0.218	0.391	0.415	0.547	0.505	
in month t.	*Dec*	0.058	0.134	0.141	0.207	0.184	0.494
$\hat{\theta}_{AdvGr}^{t}=\hat{\theta}_{AdvGr}^{k}$	*July*	0.757					
	Aug	0.417	0.615				
where $\hat{\theta}_{AdvGr}^{t}$ is the	*Sep*	0.321	0.493	0.854			
estimated coefficient	*Oct*	0.807	0.967	0.612	0.498		
of ADVGREEN	*Nov*	0.117	0.221	0.503	0.641	0.242	
in month t.	*Dec*	0.247	0.381	0.676	0.804	0.388	0.876
$\hat{\theta}_{Green}^{t}=\hat{\theta}_{Green}^{k}$	*July*	0.980					
	Aug	0.159	0.153				
where $\hat{\theta}_{Green}^{t}$ is the	*Sep*	0.457	0.458	0.525			
estimated coefficient	*Oct*	0.420	0.419	0.536	0.970		
of GREENCAR	*Nov*	0.158	0.151	0.990	0.528	0.539	
in month t.	*Dec*	0.240	0.235	0.854	0.664	0.681	0.862
$\hat{\theta}_{Eu6}^{t}=\hat{\theta}_{Eu6}^{k}$	*July*	0.927					
	Aug	0.738	0.803				
where $\hat{\theta}_{Eu6}^{t}$ is the	*Sep*	0.589	0.646	0.832			
estimated coefficient	*Oct*	0.572	0.628	0.812	0.979		
of EU6DIESEL	*Nov*	0.899	0.830	0.659	0.527	0.513	
in month t.	*Dec*	0.762	0.696	0.542	0.427	0.415	0.865
$\hat{\theta}_{Hyb}^{t}=\hat{\theta}_{Hyb}^{k}$	*July*	0.452					
	Aug	0.372	0.887				
where $\hat{\theta}_{Hyb}^{t}$ is the	*Sep*	0.906	0.563	0.477			
estimated coefficient	*Oct*	0.682	0.256	0.203	0.624		
of HYBRID	*Nov*	0.462	0.152	0.118	0.431	0.739	
in month t.	*Dec*	0.623	0.245	0.197	0.573	0.907	0.849
Null: Each common coefficient between two months are equal							
Null is rejected when $p<0.05$							

Table 16: Results from Testing the Equality of the Estimated Coefficients of Fuel Cost of Each Body Type in Each Month Between the Partially Specified Model and the Fully Specified Model

Null Hypothesis / p-values	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
$\hat{\beta}_{SED}^{PARTIALLY}=\hat{\beta}_{SED}^{FULLY}$	0.014	0.019	0.007	0.130	0.013	0.539	0.771
$\hat{\beta}_{SWAGON}^{PARTIALLY}=\hat{\beta}_{SWAGON}^{FULLY}$	0.012	0.007	0.027	0.268	0.119	0.912	0.615
$\hat{\beta}_{HBACK}^{PARTIALLY}=\hat{\beta}_{HBACK}^{FULLY}$	0.015	0.025	0.007	0.096	0.020	0.749	0.620
$\hat{\beta}_{SUV}^{PARTIALLY}=\hat{\beta}_{SUV}^{FULLY}$	0.004	0.005	0.002	0.024	0.005	0.370	0.863
$\hat{\beta}_{SPO}^{PARTIALLY}=\hat{\beta}_{SPO}^{FULLY}$	0.005	0.010	0.012	0.085	0.013	0.423	0.789

Null: The coefficients of fuel cost variables within the same month are the same before and after accounting for environmentally friendly attributes.

Null is rejected when $p<0.05$

$\hat{\beta}_{HBACK}$ *=The estimated coefficient of the fuel cost of driving a hatchback 100 km*

$\hat{\beta}_{SUV}$ *=The estimated coefficient of the fuel cost of driving a SUV 100 km*

$\hat{\beta}_{SPO}$ *=The estimated coefficient of the fuel cost of driving a sports car 100 km*

$\hat{\beta}_{SWAGON}$ *=The estimated coefficient of the fuel cost of driving a station wagon 100 km*

$\hat{\beta}_{SED}^{PARTIALLY}$ *= The estimated coefficient of the fuel cost of driving a sedan 100 km based on the partially specified seven monthly model.*

$\hat{\beta}_{SED}^{FULLY}$ *= The estimated coefficient of the fuel cost of driving a sedan 100 km based on the fully specified seven monthly model.*

Table 17: Results from Testing the Joint Equality of All Variables across Months Based on the Fully Specified Monthly Models

Month / Prob>chi2	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*
July	0.9963					
Aug	0.2189	0.3537				
Sep	0.0000	0.0000	0.0000			
Oct	0.0000	0.0000	0.0000	0.7810		
Nov	0.0000	0.0002	0.0000	0.5046	0.3077	
Dec	0.0000	0.0000	0.0000	0.0000	0.0001	0.2859

Null: All common coefficients across two months are jointly the same.

Null is rejected when $p<0.05$

Table 18: List of the Variables that Have Significantly Different Estimated Coefficients Across Months Based on the Fully Specified Monthly Models

	Aug	*Sep*	*Oct*	*Nov*	*Dec*
June	WEIGHT LPG	VOLVO SSYONG* ALFA** WEIGHT LPG	VOLVO SSYONG* ALFA** WEIGHT LPG	VOLVO SSYONG*	VOLVO SSYONG* NISSAN HONDA WEIGHT HORSEPOWER
July		VOLVO SSYONG* MERCEDES ALFA**	VOLVO SSYONG* CITROEN ALFA** PETROL	VOLVO SSYONG* SKODA SEAT LPG	VOLVO SSYONG* SEAT NISSAN LPG
Aug		SSYONG*	SSYONG* CITROEN	SSYONG* LPG	SSYONG* NISSAN LPG
Sep				LPG	TOYOTA LPG
Oct				ALFA** LPG	KIA ALFA** LPG

**SSYONG=SSANGYONG, **ALFA=ALFAROMEO*

Table 19: The Results for the Estimated Coefficients of Fuel Cost of Driving a Vehicle 100 km by Body Type and the Environmental Characteristics of the Vehicle Based on the Fully Specified Pooled Model

logMSRP	*Coef.*	*Robust Std. Err.*	*t*	*P>|t|*
FCOST100KM	-0.0110	0.0018	-6.23	0.000
FCOST100KMSWAGON	0.0018	0.0020	0.90	0.371
FCOST100KMHBACK	0.0027	0.0012	2.26	0.024
FCOST100KMSUV	0.0042	0.0012	3.45	0.001
FCOST100KMSPORTS	0.0060	0.0030	2.01	0.045
STARTSTOP	0.0241	0.0089	2.72	0.007
ADVGREEN	0.0213	0.0103	2.06	0.039
GREENCAR	-0.0282	0.0105	-2.69	0.007
EU6DIESEL	0.0005	0.0092	0.05	0.959
HYBRID	0.1217	0.0296	4.11	0.000
97 more variables				
Number of Obs:	6314			
Adj R-Sq:	0.9838			

Table 20: Results from Testing the Equality of the Estimated Coefficients of Fuel Cost of Each Body Type Other than Sedan in the Fully Specified Pooled Model

Null Hypothesis	*p-values*
$\hat{\beta}_{HBACK}=\hat{\beta}_{SUV}$	0.228
$\hat{\beta}_{HBACK}=\hat{\beta}_{SPO}$	0.296
$\hat{\beta}_{HBACK}=\hat{\beta}_{SWAGON}$	0.650
$\hat{\beta}_{SUV}=\hat{\beta}_{SPO}$	0.550
$\hat{\beta}_{SUV}=\hat{\beta}_{SWAGON}$	0.251
$\hat{\beta}_{SPO}=\hat{\beta}_{SWAGON}$	0.226

Null: The effects of fuel cost of each body type is the same.

Null is rejected if $p<0.05$

$\hat{\beta}_{HBACK}$ = *The estimated coefficient of fuel cost of a hatchback 100 km*

$\hat{\beta}_{SUV}$ = *The estimated coefficient of fuel cost of a sports utility vehicle 100 km*

$\hat{\beta}_{SPO}$ = *The estimated coefficient of fuel cost of a sports car 100 km*

$\hat{\beta}_{SWAGON}$ = *The estimated coefficient of fuel cost of a station wagon 100 km*

Table 21: Results from Testing the Equality of the Estimated Coefficients of Fuel Cost of Each Body Type Between the Partially Specified Model and the Fully Specified Model

Null Hypothesis	*p-values*
$\hat{\beta}_{SED}^{PARTIALLY}=\hat{\beta}_{SED}^{FULLY}$	0.0000
$\hat{\beta}_{SWAGON}^{PARTIALLY}=\hat{\beta}_{SWAGON}^{FULLY}$	0.0005
$\hat{\beta}_{HBACK}^{PARTIALLY}=\hat{\beta}_{HBACK}^{FULLY}$	0.0001
$\hat{\beta}_{SUV}^{PARTIALLY}=\hat{\beta}_{SUV}^{FULLY}$	0.0000
$\hat{\beta}_{SPO}^{PARTIALLY}=\hat{\beta}_{SPO}^{FULLY}$	0.0000

Null: The Constrained coefficients of fuel cost variables for all months are the same before and after accounting for environmental characteristics of the vehicle in the model.

Null is rejected if p<0.05

$\hat{\beta}_{SWAGON}$ *= The estimated coefficient of the fuel cost of driving a station wagon 100 km*
$\hat{\beta}_{HBACK}$ *= The estimated coefficient of the fuel cost of driving a hatchback 100 km*
$\hat{\beta}_{SUV}$ *= The estimated coefficient of the fuel cost of driving a SUV 100 km*
$\hat{\beta}_{SPO}$ *= The estimated coefficient of the fuel cost of driving a sports car 100 km*
$\hat{\beta}_{SED}^{PARTIALLY}$ *=The estimated coefficient of the fuel cost of driving a sedan 100 km based on the partially specified pooled model*
$\hat{\beta}_{SED}^{FULLY}$ *= The estimated coefficient of the fuel cost of driving a sedan 100 km based on the fully specified pooled model*

Table 22: The Estimated Within- and Between- Effects of Fuel Costs Across Body Types and the Environmental Characteristics of the Vehicle in the Within-Between Random Effects Model

Variable	*Coefficient*	*Std Error*	*t*	*P>|z|*
BETW_FCOST100KM	-0.0077	0.0014	-5.45	0.000
BETW_FCOST100KMSWAGON	0.0044	0.0023	1.92	0.055
BETW_FCOST100KMHBACK	0.0015	0.0010	1.59	0.112
BETW_FCOST100KMSUV	0.0027	0.0010	2.66	0.008
BETW_FCOST100KMSPORTS	0.0114	0.0019	6.01	0.000
WITH_FCOST100KM	0.0005	0.0011	0.43	0.668
WITH_FCOST100KMSWAGON	-0.0082	0.0027	-3.06	0.002
WITH_FCOST100KMHBACK	-0.0019	0.0015	-1.26	0.208
WITH_FCOST100KMSUV	0.0003	0.0016	0.17	0.861
WITH_FCOST100KMSPORTS	0.0077	0.0024	3.14	0.002
STARTSTOP	0.0243	0.0070	3.46	0.001
ADVGREEN	0.0207	0.0077	2.68	0.007
GREENCAR	-0.0234	0.0084	-2.78	0.005
EU6DIESEL	-0.0010	0.0069	-0.15	0.884
HYBRID	0.0783	0.0283	2.77	0.006
2 Season Dummies and 69 more variables are included.				
Number of Observations	6314			
Number of Groups	1098			
R-sq within	0.3433		*sigma_u*	0.06725854
R-sq between	0.9804		*sigma_e*	0.01592273
R-sq overall	0.9767		*rho*	0.94692897

Table 23: Results from Testing the Equality of the Between-Effects of Fuel Cost of Each Body Type Other than Sedan Based on the Within-Between Random Effects Model

Null Hypothesis	*p-values*
$\hat{\beta}_{BETW\_HBACK}=\hat{\beta}_{BETW\_SUV}$	0.259
$\hat{\beta}_{BETW\_HBACK}=\hat{\beta}_{BETW\_SPO}$	0.000
$\hat{\beta}_{BETW\_HBACK}=\hat{\beta}_{BETW\_SWAGON}$	0.219
$\hat{\beta}_{BETW\_SUV}=\hat{\beta}_{BETW\_SPO}$	0.000
$\hat{\beta}_{BETW\_SUV}=\hat{\beta}_{BETW\_SWAGON}$	0.459
$\hat{\beta}_{BETW\_SPO}=\hat{\beta}_{BETW\_SWAGON}$	0.012
Null: Between Effects of fuel cost of each body type are equal.	
Null is rejected if $p<0.05$	

$\hat{\beta}_{BETW\_SWAGON}$ = *The estimated between-effect of FCOST100KMSWAGON*
$\hat{\beta}_{BETW\_HBACK}$ = *The estimated between-effect of FCOST100KMHBACK*
$\hat{\beta}_{BETW\_SUV}$ = *The estimated between-effect of FCOST100KMSUV*
$\hat{\beta}_{BETW\_SPO}$ = *The estimated between-effect of FCOST100KMSPORTS*

Table 24: The Comparison of the Between-Effects of the Fuel Cost of Each Body Type Between Partially Specified and Fully Specified Models, i.e. Before and After Including the Environmental Characteristics in the Within-Between Random Effects Model*

Variable	*Partially Specified*	*Fully Specified*
BETW_FCOST100KMSEDAN	-0.0103	-0.0077
	(-7.97)	(-5.45)
BETW_FCOST100KMSWAGON	-0.0060	-0.0033
	(-2.40)	(-1.35)
BETW_FCOST100KMHBACK	-0.0085	-0.0062
	(-6.20)	(-4.02)
BETW_FCOST100KMSUV	-0.0072	-0.0050
	(-6.20)	(-3.92)
BETW_FCOST100KMSPORTS	0.0011	0.0037
	(0.51)	(1.71)
2 Season Dummies and 69 more variables are included.		
R-sq within	0.3433	0.3433
R-sq between	0.9798	0.9804
R-sq overall	0.9766	0.9767
t-statistics are in parentheses.		

*Since environmental characteristics of vehicle in this study are time-invariant for a given sub-model, the within-effects for fuel costs are the same before and after inclusion of those characteristics. Thus, I have listed only the between-effects above.

Table 25: Results from Testing the Equality of the Between-Effect of Fuel Cost of Driving a Vehicle 100 km versus its Within-Effect

Null Hypothesis	*p-values*
$\hat{\beta}_{BETW\_SEDAN} = \hat{\gamma}_{WITH\_SEDAN}$	0.0000
$\hat{\beta}_{BETW\_SWAGON} = \hat{\gamma}_{WITH\_SWAGON}$	0.1913
$\hat{\beta}_{BETW\_HBACK} = \hat{\gamma}_{WITH\_HBACK}$	0.0117
$\hat{\beta}_{BETW\_SUV} = \hat{\gamma}_{WITH\_SUV}$	0.0007
$\hat{\beta}_{BETW\_SPORTS} = \hat{\gamma}_{WITH\_SPORTS}$	0.1668

Null: The between-effect of the fuel cost of driving a vehicle 100 km is equal to its within-effect.

Null is rejected if $p<0.05$

$\hat{\beta}_{BETW\_HBACK}$ = *The estimated between-effect of FCOST100KMHBACK*
$\hat{\gamma}_{WITH\_HBACK}$ = *The estimated within-effect of FCOST100KMHBACK*

Table 26: The Comparison of the Estimated Coefficients for the Fuel Cost of Each Body Type and the Environmental Characteristics of the Vehicle Before and After Including the CO2 in the Fully Specified Pooled Model and in the Within-Between Random Effects Model

	The Fully Specified Pooled Model		The Within-Between Random Effects Model*	
logMSRP	*Before CO_2*	*After CO_2*	*Before CO_2*	*After CO_2*
FCOST100KM SEDAN	-0.0110 (-6.23)	-0.0053 (-2.56)	-0.0077 (-5.45)	-0.0083 (-2.63)
FCOST100KM SWAGON	-0.0091 (-3.81)	0.0026 (-1.32)	-0.0033 (-1.35)	-0.0039 (-1.03)
FCOST100KM HBACK	-0.0082 (-4.7)	-0.0023 (-1.05)	-0.0062 (-4.02)	-0.0068 (-2.07)
FCOST100KM SUV	-0.0068 (-4.75)	-0.0011 (-0.54)	-0.0050 (-3.92)	-0.0056 (-1.82)
FCOST100KM SPORTS	-0.0049 (-1.43)	0.0003 (0.09)	0.0037 (1.71)	0.0031 (0.88)
CO2		-0.0013 (-2.47)		0.0001 (0.21)
STARTSTOP	0.0241 (2.72)	0.0210 (2.36)	0.0243 (3.46)	0.0246 (3.45)
ADVGREEN	0.0213 (2.06)	0.0201 (1.95)	0.0207 (2.68)	0.0206 (2.67)
GREENCAR	-0.0282 (-2.69)	-0.0284 (-2.74)	-0.0234 (-2.78)	-0.0233 (-2.76)
EU6DIESEL	0.0005 (0.05)	-0.0018 (-0.2)	-0.0010 (-0.15)	-0.0009 (-0.12)
HYBRID	0.1217 (4.11)	0.1173 (3.88)	0.0783 (2.77)	0.0784 (2.77)
t statistics are in parentheses	*97 more variables.*	*97 more variables.*	*71 more variables*	*71 more variables*
Number of Obs:	6314	6314	6314	6314
Adj R-Sq:	98.38	98.39	98.04	98.04

*Since CO2 values are time-invariant for a given sub-model, the within-effects for fuel costs are the same before and after inclusion of CO2. Thus, those listed above are the between-effects.

Table 27: Weighted Average of Annual Kilometers Driven across Vehicle Types

Vehicular Body Type	Diesel's Share	DIESEL	PETROL	ALL	
		Average Annual KM	*Average Annual KM*	*Number of Obs*	*Weighted Annual KM*
SEDAN	69.9%	22443	14228	9898	19968
SWAGON	85.6%	19897	12924	302	18892
HBACK	49.1%	19550	13173	5893	16302
SUV	67.7%	18539	13183	2561	16807
SPORTS	27.5%	19978	14751	641	16189

Table 28: Vehicle Life, Assumed Percentage Change in Annual Kilometers Driven, Assumed Vehicle Survivability Rates, Real Discount Rate, and the PDV of Explicit Fuel Cost Savings across Body Types throughout the Vehicle Life from an Improvement in Fuel Cost of Driving 100 Kilometers (Turkish Lira).

Age	*Est. Change in Annual Km*	*Veh. Surv. Rate*	*Real Disc. Rate (4.93%)*	*Calculated PDV of Explicit Fuel Cost Savings across Body Types throughout the Vehicle Life from an Improvement in Fuel Cost of Driving a Hundred Kilometers. (Turkish Lira)*				
				SEDAN	*HBACK*	*SUV*	*SPORTS*	*SWAGON*
1	0%	0.990	0.953	188.4	153.8	158.6	152.7	178.2
2	-4%	0.983	0.908	171.2	139.7	144.1	138.8	161.9
3	-4%	0.973	0.866	155.0	126.5	130.5	125.7	146.7
4	-4%	0.959	0.825	139.8	114.1	117.7	113.3	132.3
5	-4%	0.941	0.786	125.5	102.5	105.6	101.7	118.7
6	-4%	0.919	0.749	112.1	91.5	94.3	90.9	106.0
7	-4%	0.892	0.714	99.5	81.3	83.8	80.7	94.2
8	-4%	0.860	0.680	87.8	71.7	73.9	71.2	83.1
9	-4%	0.825	0.648	77.1	62.9	64.9	62.5	72.9
10	-4%	0.787	0.618	67.2	54.9	56.6	54.5	63.6
11	-4%	0.717	0.589	56.1	45.8	47.2	45.5	53.0
12	-4%	0.613	0.561	43.8	35.8	36.9	35.5	41.5
13	-4%	0.509	0.535	33.3	27.2	28.1	27.0	31.5
14	-4%	0.414	0.510	24.8	20.2	20.9	20.1	23.5
15	-4%	0.331	0.486	18.1	14.8	15.3	14.7	17.1
16	-4%	0.260	0.463	13.1	10.7	11.0	10.6	12.3
17	-4%	0.203	0.441	9.3	7.6	7.8	7.5	8.8
18	-4%	0.157	0.421	6.6	5.4	5.5	5.3	6.2
19	-4%	0.120	0.401	4.6	3.8	3.9	3.7	4.4
20	-4%	0.092	0.382	3.2	2.6	2.7	2.6	3.0
TOTAL (Turkish Lira)				1436	1173	1209	1165	1359

Table 29: The Implicit Value Placed on 1 Turkish Lira Decrease in Fuel Cost of Driving 100 Kilometers by Owners of Each Body Type versus The Present Discounted Value of Explicit Fuel Cost Savings (Turkish Lira)

METHODS	*SEDAN*	*HBACK*	*SUV*	*SPORTS*	*SWAGON*
The PDV of the Explicit Fuel-Cost Savings	1436	1173	1209	1165	1359
Fully Specified Pooled Model	943	517	691	834	647
Within-Between Random Effects Model	665	390	511	-633	230

The Annual Real Discount Rate: 4.93%

Table 30: The Preliminary Results of the Estimated Effects of Fuel Cost of Driving Each Body Type and Environmental Characteristics via the Unweighted Within-Between Random Effects Model (UWBREM) and the Unweighted Stochastic Frontier Price Model (USFPM)

	UWBREM	*USFPM*
FCOST100KM	-0.0078	-0.0078
	(-5.49)	(-5.53)
FCOST100KMSWAGON	-0.0035	-0.0036
	(-1.37)	(-1.40)
FCOST100KMHBACK	-0.0064	-0.0062
	(-4.11)	(-4.33)
FCOST100KMSUV	-0.0051	-0.0056
	(-3.96)	(-4.54)
FCOST100KMSPORTS	0.0032	0.0032
	(1.45)	(1.33)
STARTSTOP	0.0249	0.0243
	(3.53)	(3.53)
ADVGREEN	0.0216	0.0170
	(2.76)	(2.16)
GREENCAR	-0.0253	-0.0258
	(-2.97)	(-3.15)
EU6DIESEL	-0.0012	-0.0022
	(-0.18)	(-0.33)
HYBRID	0.0725	0.0725
	(2.47)	(1.41)
97 more variables		
Number of Obs:	6314	6314
Adj R-Sq:	0.9793	NA

t-statistics are in parantheses.

Table 31: The Relationship between Household Income Levels and Annual Miles Driven Based on the 2009 National Household Travel Survey Data

Household Income	*Annual Miles Driven*
Less than $5,000	9367
$5,000 - $9,999	9222
$10,000 - $14,999	8927
$15,000 - $19,999	9226
$20,000 - $24,999	9436
$25,000 - $29,999	9598
$30,000 - $34,999	10,201
$35,000 - $39,999	10,084
$40,000 - $44,999	10,633
$45,000 - $49,999	10,611
$50,000 - $54,999	11,096
$55,000 - $59,999	10,980
$60,000 - $64,999	11,422
$65,000 - $69,999	11,200
$70,000 - $74,999	11,558
$75,000 - $79,999	11,555
$80,000 - $99,999	11,960
More than or Equal to $100,000	12,247

Figure 1: Nominal Prices of Fuel, Monthly Consumer Price Index (CPI) measured in June 2015, and Euro/Turkish Lira (TL) Exchange Rates across Months from June to December 2015