# DETERMINANTS OF USED CAR RESALE VALUE

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# Abstract

Hybrid vehicles have recently emerged as a growing market segment in the automobile industry. The value these vehicles hold over time has important implications for consumers. Vehicles that maintain their value better over time are likely to be in higher demand, and thus auto-makers are keen on producing more and more of these vehicles in the next few years. Using a multiple variable regression analysis, this thesis analyzes the major determinants of resale value in used cars. Current market values of used cars compared with their original prices are used as data. This study predicts that hybrid vehicles maintain their value better than traditional vehicles due to environmental perceptions as well as fuel efficiency ratings.

KEYWORDS: (Hybrids, Resale Value, Used Cars)

# ON MY HONOR, I HAVE NEITHER GIVEN NOR RECEIVED UNAUTHORIZED AID ON THIS THESIS

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MICHAEL S. RICHARDSON

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# CHAPTER I

### INTRODUCTION

This thesis will assess the determinants of resale value in the used car market with an emphasis on depreciation rate variations between cars with hybrid engines and those with traditional engines. With today's regularly fluctuating gas prices as well as other sources of demand, new and used cars gain or lose value at an alarming rate, in part due to miles per gallon (MPG) ratings. The advent of hybrid technology in car engines brings not only greater fuel efficiency but also positive environmental externalities that are attractive to many consumers. This combination may allow car owners to maintain higher resale values of their cars. When trying to determine the economic importance of this issue, it is important to realize the scope of the used-car market. "With 1999 sales of \$361 billion, used-vehicle markets represented approximately 12.5 percent of total U.S. retail sales. In terms of unit volume, the 40.9 million used-vehicle transactions surpassed the number of new-vehicle transactions by an almost three-to-one margin."<sup>1</sup> With the difficult economic times facing the country, it is likely that the percentage of used car sales as compared to all car sales will likely increase, making this issue more and more important.

<sup>&</sup>lt;sup>1</sup>Urban, David J., George E. Hoffer, and Michael D. Pratt. "Perceptions of Advertising in the Market for Used Vehicles." *Journal of Advertising Research* 41, no. 1 (2001): 66-77.

Technically, depreciation can be defined as "the decline in the value of a capital asset. Depreciation represents a cost of ownership and the consumption of an asset's useful life."<sup>2</sup> To further focus the definition towards the automotive industry, the following definition is also helpful: "The decrease in the market value of a vehicle over time. The amount of yearly depreciation is affected by variables including car condition, resale market supply and demand, and reputation of the manufacturer and/or model."<sup>3</sup> This is the definition that should be considered when interpreting the vocabulary in this paper.

To be sure, the future value of a valuable asset, such as a car, is an important consideration to have in mind when making the initial purchase. For those who choose not to buy the vehicle outright and instead opt for a lease contract, resale value holds equally considerable importance. According to LeaseGuide.com, "A lease is a formal contract with a leasing provider that allows you to drive the provider's car and only pay for the portion of the vehicle's value that you use up during the time you're driving it."<sup>4</sup> Therefore, the value that remains in the car when a lessee's contract terms have expired is the resale value. Cars that maintain their value better or longer will have lower lease payments. Whatever path is chosen, a purchase or a lease, the ability of a car to hold its value at a higher level will be an important consideration.

<sup>&</sup>lt;sup>2</sup>"Competitive Sourcing Glossary of Terms." in U.S. Department of State. Available from <u>http://209.85.173.132/search?q=cache:RqD5FTnYVHUJ:cspo.state.gov/content/documents/CS%2520Glos</u> <u>sary%25200f%2520Terms.doc+depreciation+cspo&hl=en&ct=clnk&cd=3&gl=us</u> Accessed on 12/8/2008.

<sup>&</sup>lt;sup>3</sup> "Auto Loan Glossary." in Wachovia Dealer Services. Accessed on 12/8/2008. Available from www.wachoviadealer.com/Consumers/CustomerService/AutoLoanGlossary/default.asp

<sup>&</sup>lt;sup>4</sup> "The Basics of Leasing." in Lease Guide.com. Accessed on 12/8/2008. Available online at http://www.leaseguide.com/carlease.htm

The U.S. automotive industry is currently undergoing a significant change as automakers struggle to stay afloat. No aspect of the situation speaks more clearly than the statistics. A quick glimpse at sales numbers provide much of what one needs to know. February sales, compared to last year's revenues, are lagging. New auto sales in the U.S. fell 41%, to 688,000 vehicles, when compared with last year's numbers. General Motors reported a 53% drop, Ford reported a 48% drop, Toyota a 40% drop, and Honda reported a 38% drop. February is the fifth straight month that U.S. auto sales fell 35% or more as compared to the same month a year ago.<sup>5</sup> Further, many auto makers are worried that the market has yet to see a bottom. As these companies move forward in these tough times, the products they choose to produce and sell will have a great impact on their ultimate success. This means offering vehicles that consumers are interested in buying.

With the telling statistics cited above, it is certain that hybrids are on their way to gaining more market share and thus more of a presence on the road. More and more hybrids on the road lead to more hybrids for sale in the used car market. Car owners are certainly interested in knowing how the value of their car will survive over time. Further, a car that retains its value notwithstanding higher gas prices would give owners peace of mind. Manufacturers are taking note as well. To stop the sales declines that many are experiencing, changes in business plans and strategies will occur, and in some cases, have already occurred. Ford, for example, has made changes and will begin adjusting its

<sup>&</sup>lt;sup>5</sup> Kellog, Alex P., and Matthew Dolan. "U.S. Auto Sales Plunged 41% in February." *The Wall Street Journal.* 4 Mar. 2009. Newspaper on-line. Available from http://online.wsj.com/article/SB123608748443918465.html. Internet. Accessed 8 Mar. 2009.

assembly line to produce small cars based on six models it currently sells in Europe.<sup>6</sup> More of Ford's plans have been recently revealed as the company considered asking for bailout funds. According to *The Wall Street Journal*, "Ford will explain to Congress it is rushing to launch new hybrids and electric vehicles by 2011, including a battery-powered commercial van and compact sedan."<sup>7</sup>

The remainder of this introduction will outline the different avenues I intend to explore regarding resale value. The variables under consideration are covered first, followed by a description of the mathematical methods that will be used to produce a regression equation. Finally, data collection is described and the expected outcomes of this study are outlined.

### Factors Influencing Resale Value

As any car buyer or seller knows, there are many factors that influence the sales price of a car. Factors such as purchase price, the make and age of the car, and how many miles it has been driven all affect resale value. Other factors include quality ratings, fuel efficiency, market conditions, safety ratings, and now, hybrid technology. For the most part, these variables have an intuitive effect on the resale value of an automobile. The make of a car correlates to the reputation of the manufacturer. A car made by a Japanese manufacturer, for example, will receive higher perceptions of dependability due to customer experiences and thus have an increased resale value. A

<sup>&</sup>lt;sup>6</sup> Muller, Joann. "Whipsaw." *Forbes* 182, no. 4: 38-40. Database on-line. Available from *Business Source Premier*, EBSCO*host*. Accessed 14 September 2008.

<sup>&</sup>lt;sup>7</sup> Langley, Monica, and John D. Stoll. "Ford Will Speed Green-Car Launches." *The Wall Street Journal.* 3 December 2008. Newspaper online. Available from <u>http://online.wsj.com/article/SB122817144031770385.html</u>. Internet. Accessed 12 December 2008.

2008 study on dependability administered by J.D. Power and Associates reveals that of the 10 manufacturers listed with at least four out of five stars in the "Overall Dependability" category, 5 of them were Japanese companies.<sup>8</sup>

Age and mileage are negative contributors to the resale value in that the older a car, or the more miles it has been driven will expend some of the vehicle's useful life and will lead to lower resale value. Quality ratings tie-in with reputations of the manufacturer and thus good quality ratings will add long-term value and bad ratings will, conversely, decrease long-term value. Fuel efficiency and its effect on resale value will fluctuate with gas prices as gas price go up, fuel efficiency becomes more important to resale value. Further, an MPG rating can add value or subtract value depending on the rating. A car receiving a good MPG rating will be more appealing in times of high gas prices and thus increase demand and value for the car. The opposite goes for vehicles with poor MPG ratings.

Hybrid technology, which is the focus of this study, will most likely add positive value for a variety of reasons. The fuel efficiency of hybrid vehicles will no doubt create good MPG value. Further emphasis and appeal may result from the environmental externalities associated with the very low emissions that hybrids give off. The manner in which hybrids are perceived will very much affect demand. A surge in environmentalism and the hope for more green technologies and products casts positive light on hybrid engine technologies.

<sup>&</sup>lt;sup>8</sup> "2008 Vehicle Depedability Study." Available from

http://www.jdpower.com/autos/ratings/dependability-ratings-by-brand. Accessed 17 December 2008.

### <u>Method</u>

A thesis topic such as this can be assessed with mathematical models derived from quantitative data. A multiple variable regression can analyze the data by assessing the role each independent variable plays in determining the dependent variable (in this case, resale value). Significance can also be assessed by observing the p-values for each variable. The use of a statistical model will aide in making a claim on this thesis, and to identify some of the major contributors to resale value in automobiles.

### **Data Collection**

The data used for this regression will be quantitative in nature. The sources of data are what someone would expect for used car information. Four sources that are used include Kelly Blue Book, Edmunds, a government fuel economy resource, and Car and Driver. Kelly Blue Book and Edmunds will both serve as data sources, with each source providing different aspects of the independent variables used. With the cooperation of these sources, data regarding price of a car-including new and used-with the respective age, mileage, make, condition, miles per gallon, safety ratings, and hybrid technology information will be obtained. These variables will allow for a regression to be run and an equation to be estimated.

#### Expected Outcomes

Before I can make predictions regarding the influence each variable will have on resale value, a review of prior research and literature is appropriate. This will allow me to make a more confident prediction as well as confirm which variables are needed to produce a strong equation that explains much of the variations in vehicle depreciation. An expected equation could look like this:

Dummy variables are put in place for make of the car and hybrid technology. The two possible variables for make will be whether or not the car is made by a Japanese manufacturer. An additional dummy variable assessing European manufacturers could be easily included. The two possible outcomes for hybrid technology will be whether or not the vehicle has hybrid technology in the engine. All of the other variables will be quantitative in nature and will be associated with positive or negative coefficients, as discussed earlier.

The next section of this thesis will cover prior studies conducted on the variables to be included in this study.

### CHAPTER II

### LITERATURE REVIEW

The relatively recent emergence of hybrid technology vehicles brings a new determinant of resale value for used automobiles. Both consumer attitudes as well as hard-hitting statistics portray a shift in what buyers are looking for in new and used cars. Much of the literature in this review will help me understand how the selected variables will influence, positively or negatively, the resale value of used cars. The worth of tradein vehicles as well as pre-owned retail vehicles is frequently the determining factor in whether a car owner buys a new car. This literature review should bolster my understanding of these issues.

The review of relevant literature in the following pages is arranged according to which of the independent variables is addressed. Traditional explanations for resale value are discussed first. These traditional variables include age, mileage, make, condition, miles per gallon, and safety ratings. The final portion of the review will discuss the most recent addition available to vehicles today--hybrid technology. The review of this literature will provide support for the outcomes I expect to see once the mathematical regression has been run.

### Age and Mileage

Intuitively, one can predict the influence that both age and mileage will have on the amount of depreciation a vehicle will undergo. Newer cars are more valuable than older cars. The same goes for mileage. The more a car has been driven, the more of the vehicle's useful life has been expended and the vehicle is thus worth less. A review of the literature on these variables will confirm my expectations and allow for more confidence to be employed when making a predicted regression equation.

An article entitled "The Determinants of Used Rental Car Prices" reports predictably that both car age and mileage contribute negatively to resale value.<sup>1</sup> The article further mentions car make and quality and the impact these variables have on used car prices. These findings support the predicted signs of the coefficients in a regression model equation. Both age and mileage are mentioned as negatively contributing variables to resale price of used rental cars. Further, there is mention of seasonal differences in resale prices, something that I had not considered to be a major variable in the process.<sup>2</sup>

<sup>&</sup>lt;sup>1</sup> Cho, Sung Jin. "The Determinants of Used Rental Car Prices." *Journal of Economic Research* 10, no. 2 (2005): 277-304.

### Make of Automobile

The "make" of a vehicle refers to the manufacturing company of that vehicle. As all drivers know, America's roads are not solely filled with cars made by American manufacturers, but rather by a mixture of many different manufacturer nationalities. Through consumer experience as well as quality/reliability ratings, drivers come to conceptualize, almost stereotype, the nationalities of the different manufacturers. The following review of literature addresses how manufacturers of foreign nations, specifically Japan, are perceived in the marketplace. This perception will influence demand and thus allow me to make a prediction as to how the make of a vehicle will affect resale value.

A study found in a 2003 issue of *McKinsey Quarterly* briefly covers car quality and its impact on consumers. The authors address product appeal, and thus demand, and how incentives can identify the appeal. The article states that "U.S. companies in 2002 have increased their incentives to a staggering 14 percent of sale prices—twice as high as those offered by foreign competitors, on average. Even so, the U.S. market share of the Big Three has slipped over this period, by a combined 1.5 percent a year."<sup>3</sup> One way to view the role of the incentives in this case is that they serve to even out demand. A car company that offers more incentives in the form of discounts and rebates is likely doing so to make its products more appealing to purchase. Therefore, a company offering more incentives than another is likely receiving a lower level of demand. It can be inferred, then, that US companies face a smaller and even declining demand against foreign producers and need to offer the incentives to equalize demand. While a recent article in

<sup>&</sup>lt;sup>3</sup> Ganguli, Niladri, T. V. Kumaresh, and Aurobind Satpathy. "Detroit's new quality gap." *McKinsey Quarterly*, no. 1 (2003): 148-151.

*The Wall Street Journal* cites an increase in Toyota's discounts and cash-backs for November, Toyota is likely responding to the falling overall demand and not to an increase in the competition from its American counterparts. Indeed, Toyota still claims a wide margin from its Detroit rivals in the incentives category.<sup>4</sup> Lower demand will most likely be grouped with faster rates of depreciation.

This article goes on to address Japanese producers and the higher quality standards associated with them. The authors infer that "Japanese automakers are particularly effective at testing for the attributes that excite their target customers."<sup>5</sup> This assumption allows me to predict that the make of a car, or the nationality of the company, will influence how well a used car retains its value. This article supports the prediction that cars produced by Japanese manufacturers will have higher perceived quality along with slower depreciation rates and thus higher resale values.

Another article from *McKinsey Quarterly* addresses both the influence of perceived quality as well as hybrid technology, and its importance to car manufacturers. "Given competitor's increased capability, the accelerating pace of change, and customers' sophistication, a car maker grows in a world of flat demand only by taking a holistic approach to improving the perceived value of a vehicle at the time of sale, and by increasing the total revenues generated throughout its lifetime."<sup>6</sup> If one increases the perceived value of a car, sales will increase in both the initial sale of the car as well as the

<sup>&</sup>lt;sup>4</sup> Barris, Mike. "Auto Makers Report Continued Sharp U.S. Sales Declines." *The Wall Street Journal.* 3 Dec. 2008. Newspaper on-line. Available from http://online.wsj.com/article/SB122823927738572881.html. Internet. Accessed 8 December 2008.

<sup>&</sup>lt;sup>5</sup> Ganguli, Niladri, T. V. Kumaresh, and Aurobind Satpathy. "Detroit's new quality gap." *McKinsey Quarterly*, no. 1 (2003): 148-151.

<sup>&</sup>lt;sup>6</sup> Ealey, Lance, and Luis Troyano-Bermüdez. "Are automobiles the next commodity?" *McKinsey Quarterly*, no. 4 (1996): 62-75.

resale value of the used car, thus making the car a better investment. The article goes on to say that "perceived value is improved by optimizing performance, quality, and price."<sup>7</sup>

Based on the studies discussed above, I can confirm my prediction that Japanese manufacturers will be perceived more positively and thus increase demand. This increase in demand will result in higher prices, allowing for these vehicles to retain their value for a longer period of time.

### **Title History and Condition**

Beyond how old a car is, how many miles it has been driven, and its make, a record of how well the car has been treated will carry considerable importance when consumers look to purchase the car. Kelly Blue Book offers market values for a given vehicle at up to four different condition levels. A review of studies conducted in the past will help provide confidence as to how title history and the condition of a vehicle will influence how well a car maintains its value.

A relevant study that was found addresses three variables that influence the resale value a used car is sold for in internet auctions: title history, seller reputation, and time of the end of the auction. Because internet auctions are not a main concern in this study, I will not focus on the seller reputation and time of the end of the auction. Important judgments can be made, however, regarding the title history of the vehicle and its effect on resale value. In this study, the authors conducted different regressions assessing whether their targeted variables have a strong influence on resale value. The results of

<sup>&</sup>lt;sup>7</sup> Ealey, Lance, and Luis Troyano-Bermüdez. "Are automobiles the next commodity?" *McKinsey Quarterly*, no. 4 (1996): 62-75.

one such regression show that "higher bids were generated by cars with clear title."<sup>8</sup> Further, cars with clear title history were valued higher by an amount of \$1,147 than cars without clear titles.<sup>9</sup>

This study assists in predicting how the title history and condition of a used vehicle will affect the resale value of that vehicle. As stated in the study, a car with a clear title history will sell or be valued at a higher price than cars without clear histories. A dummy variable will be used to address this concept in the statistical model, with three different levels of history and condition assessing the vehicle. As found in this study, I predict that a used car with clear title history will retain a higher resale value than a used car with a history of accident or misuse as reflected in the title history of the vehicle.

### Miles Per Gallon

The ability of a car to efficiently burn fuel and still provide a certain amount of engine power is certainly an important vehicle characteristic. As consumers watch gas prices fluctuate, they know how often they must pay to fill up their tanks. The review of that studies that follow in this section will aid in identifying the effect a vehicle's fuel efficiency will have on resale value, or how well a car maintains its value.

Theory regarding depreciation of durable goods as well as consumer behavior when making a trade-in speaks to some of the predicted outcomes that were discussed above in the introduction. Fuel efficiency, a major concern currently, is discussed in an

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<sup>&</sup>lt;sup>8</sup> Andrews, Thomas, and Cynthia Benzing. "The Determinants of Price in Internet Auctions of Used Cars." *Atlantic Economic Journal* 35, no. 1 (2007): 43-57.

article from *Contemporary Economic Policy*.<sup>10</sup> The ability of the consumer to accurately value fuel cost savings suggests that the value of a car with good fuel efficiency will increase when placed on sale, directly addressing MPG rating and the expectation of a positive coefficient in the regression equation.<sup>11</sup>

An article entitled "Can Trade-Ins Hurt You?" addresses the mentality of a consumer. The authors reason that "when consumers engage in a transaction involving a trade-in, they place more importance on getting a good value for the used product than on getting a good price for the new product."<sup>12</sup> The result of a mentality such as this will be observed in the prices that sellers list for their vehicles with high fuel efficiency. Consumers are very aware of market conditions and realize that gas prices are a major concern to potential buyers.

Espey and Nair found in their study concerning automobile pricing that a positive and significant value for fuel economy existed. This result "suggests that consumers are likely to accurately value fuel cost savings."<sup>13</sup> Putting environmental externalities aside, the study described in this article predicts that consumers will rationally have miles per gallon and fuel efficiency as a major concern. This notion supports the intuition that higher fuel economy will allow vehicles to be valued at a higher price throughout their useful life than their low-mileage counterparts. There is also support here to increase the

<sup>&</sup>lt;sup>10</sup> Espey, Molly, and Santosh Nair. "Automobile Fuel Economy: What Is It Worth?" *Contemporary Economic Policy 23*, no. 3 (2005): 317-323.

<sup>&</sup>lt;sup>11</sup> Ibid.

<sup>&</sup>lt;sup>12</sup> Zhu, Rui (Juliet), Xinlei (Jack) Chen, and Srabana Dasgupta. "Can Trade-Ins Hurt You? Exploring the Effect of a Trade-In on Consumers' Willingness to Pay for a New Product." *Journal of Marketing Research (JMR)* 45, no. 2 (2008): 159-170.

<sup>&</sup>lt;sup>13</sup> Espey, Molly, and Santosh Nair. "Automobile Fuel Economy: What Is It Worth?" *Contemporary Economic Policy 23*, no. 3 (2005): 317-323.

positive coefficient expected with fuel economy. In other words, I expect resale value to increase as fuel economy increases.

#### Safety Ratings

Another variable that consumers consider when purchasing a vehicle, be it new or used, is safety. The nature of driving has some intrinsic dangers that drivers are appropriately concerned with. Crash test results provide drivers with ratings on how well drivers and passengers are protected in case of an accident. It is reasonable, then, to infer that the crash test ratings that automobiles receive affect consumer demand and thus market value.

Indeed, vehicle safety is emerging as an important factor in the purchase process: "In the past decade, there has been a significant increase in the amount of consumer interest in the safety performance of privately owned vehicles."<sup>14</sup> But, historically, vehicle safety has been shown to take a back seat to other factors such as price, appearance, and dependability/reliability.<sup>15</sup> Perhaps this trend is changing as the results of the study cited show that "participants in the study were most likely to list safety as the most important factor considered in the new vehicle purchase process."<sup>16</sup> Whether vehicle safety is at the top or in the middle of the list of consumer concerns is not a major variant. A vehicle's safety as an item on the list allows me to make a prediction as to its effect on market value.

<sup>&</sup>lt;sup>14</sup> Koppel, Sjaanie, Judith Charlton, Brian Fildes, and Michael Fitzharris. "How important is vehicle safety in the new vehicle purchase process?." *Accident Analysis & Prevention* 40, no. 3 (2008): 994-1004.

<sup>15</sup> Ibid.

<sup>&</sup>lt;sup>16</sup> Ibid.

Because research has shown that safer cars are more desirable, I can assign a positive coefficient to the safety variable in our predicted regression equation.

### Hybrid Technology

As consumers in the United States are more and more directed toward "green" advertisements (those that highlight the planet's need for energy efficiency and energy with a minimal carbon footprint), the resulting products available to consumers will have another criterion to be judged by: the product's green factor. The same factor applies to the purchase of a new or used car. An article, "The Hybrid Phenomenon," highlights the growing emergence of hybrid sales with figures from Toyota. With more than 500,000 hybrid sales to date, the company is targeting one million hybrid sales as of 2010.<sup>17</sup> The article goes on to discuss some of the environmental externalities associated with hybrids that may affect consumer demand and thus resale prices. The article states: "Hybrids have saved more than an estimated one million barrels of crude oil, three million pounds of smog-forming gases, one million metric tons of carbon dioxide and an estimated 125 million gallons of gasoline."<sup>18</sup> Statistics such as these speak to the increased demand that hybrids are experiencing and tie-in with fuel economy. If consumers are aware that they can help the environment as well as their wallets by purchasing a hybrid, the demand will maintain higher resale values. The article goes on to discuss some historical points about the hybrid engine and differing types of hybrids as well.

<sup>&</sup>lt;sup>17</sup> Carr-Ruffino, Norma, and John Acheson. "The Hybrid Phenomenon." *Futurist* 41, no. 4: 16-22, 2007. Available from *Business Source Premier*, EBSCO*host*. Accessed 14 September 2008.

Giving attention to how demand is affected by analyzing the environmental externalities will be useful in forming a hypothesis predicting which factor will play a large role in resale value of used cars. The articles mentioned above lend support to the expectation that the presence of hybrid technology will allow vehicles to maintain higher value in the used car market.

There is further literature on consumer attitudes towards buying a hybrid vehicle. J.D. Power & Associates states in its article "The Economics of Buying a Hybrid" that 72% of consumers say they are definitely/probably interested in having hybrid/electric technology in their next vehicle.<sup>19</sup> The article then goes on to discuss whether it is financially lucrative to go through buying a car with better fuel efficiency or hybrid technology and whether fuel cost savings will cover the added expense from the technology, because it is apparent that products with cutting edge technologies will induce a price premium. The article gives more credence to the demand side argument that consumers are looking for better fuel efficiency.<sup>20</sup>

Another article from *The Futurist* focuses on the behavior of auto manufacturers, and emphasizes that auto manufacturers will have to expand hybrid technology to a wider range of vehicles to get an edge on market share. While many if not all producers have directed hybrid technology toward a particular type of car, few have expanded the technology to a wider range of models so that the technology becomes standard or available in all models.<sup>21</sup>

<sup>&</sup>lt;sup>19</sup> Murray, Charles J. "The Economics of Buying a Hybrid." *Design News*, August 2008. Available from *Academic Search Premier*, EBSCO*host.* Accessed 14 September 2008.

<sup>&</sup>lt;sup>20</sup> Ibid.

<sup>&</sup>lt;sup>21</sup> Nathanson, Scott. "Not All Hybrids Are Created Equal." *Futurist* 41, no. 4: 24-25, 2008. Available from *Academic Search Premier*, EBSCO*host*. Accessed 14 September 2008.

An article written in 2005, before the recent spike in oil prices, points to the costbenefit analysis of buying a hybrid versus buying a traditional car. The article states that "It'll take 25 years or more to recoup the hybrid premium." Obviously with today's higher gas prices, the number of years will be cut significantly. Interestingly, pricé premiums will spread themselves over much of the useful life of the vehicle, maintaining higher resale values thus enabling the purchaser of a hybrid vehicle to recoup an additional amount of the price premium in the subsequent sale of the use hybrid vehicle. While the source, in this case, for higher resale values is different than other articles regarding hybrids, the same outcome for its coefficient in the regression equation is expected. Both demand conditions as well as price premiums imply or suggest a positive influence on the resale value. Nevertheless, this article points out a common sentiment across the literature regarding the price premium of buying a hybrid.<sup>22</sup>

Some very interesting and useful research found in the *Journal of Marketing Research* points to the mentality associated with trade-ins: "Drawing on research on mental accounting, the authors reason that when consumers engage in a transaction involving a trade-in, they place more importance on getting a good value for the used product than on getting a good price for the new product."<sup>23</sup> A study such as this highlights how resale prices will be determined by private party sellers as well as preowned dealerships. This article could provide some input when it comes to the "mental accounting" aspect, which describes how a person values a new car purchase over time

<sup>&</sup>lt;sup>22</sup> Berman, Bradley. "Driving Change--One Hybrid At A Time." *Business Perspectives* 17, no. 1: 30-33, 2008. *Business Source Premier*, EBSCO*host*. Accessed 14 September 2008.

<sup>&</sup>lt;sup>23</sup> Zhu, Rui (Juliet), Xinlei (Jack) Chen, and Srabana Dasgupta. "Can Trade-Ins Hurt You? Exploring the Effect of a Trade-In on Consumers' Willingness to Pay for a New Product." *Journal of Marketing Research (JMR)* 45, no. 2 (2008): 159-170.

with its use, and its value when the car is sold to a secondary market. It hints at the fact that people may increase the price of the used car in order to maintain the vehicle as a good investment. "Because many other factors, such as benefits associated with the new product and the future resale price of the product, will still affect the overall performance of the new account, the opening amount is not weighted as much as the closing amount."<sup>24</sup>

This "mental accounting" theory incorporates price premiums mentioned earlier and their effect in a secondary market. With evidence of high gas prices all over the news, sellers as well as buyers are aware of where value lies in their cars. An increased demand for hybrid/fuel efficient cars because of environmental implications as well as higher value placed on such cars by the sellers should will create higher resale values. This article can give more credence to the hypothesis that fuel efficiency and hybrid technology play a major role in maintaining a higher resale value.

A very useful and informative article addressed specifically the residual value of hybrid vehicles. While hints that there is not enough data substantiate such claims were noted in the article, the article did shed light on some other factors that could influence the resale value of these vehicles down the road. The potential for other fuel-efficient vehicles to enter the market other than hybrid ones cast uncertainty to the future of hybrid cars. Fuel cell and ethanol-type cars are mentioned as possible replacements.<sup>25</sup>

<sup>&</sup>lt;sup>24</sup> Zhu, Rui (Juliet), Xinlei (Jack) Chen, and Srabana Dasgupta. "Can Trade-Ins Hurt You? Exploring the Effect of a Trade-In on Consumers' Willingness to Pay for a New Product." *Journal of Marketing Research (JMR)* 45, no. 2 (2008): 159-170.

<sup>&</sup>lt;sup>25</sup> Awyers, Arlena. "Predicting used hybrid's residuals residuals can be tricky." *Automotive News* 81, no. 6259: 28F-28F, 2008. Available from *Business Source Premier*, EBSCO*host*. Accessed 15 September 2008.

An article entitled "The Lowdown on Hybrids" lists pros and cons associated with the purchase of a hybrid vehicle and briefly mentions their effect on resale value. The pros include fuel savings, lessened environmental impacts, higher resale value, and temporary tax incentives, all of which increase demand.<sup>26</sup> The cons include higher cost per vehicle, higher insurance costs, limited availability and uncertainty in maintenance problems.<sup>27</sup> The cons, in this case, seem to take a back seat as the sales statistics show an increasing demand.

An article discussing vehicle quality also mentions the effect of a new feature in cars: hybrid technology. There is also some light shed on product differentiation and its importance in establishing price premiums. This can be translated into differentiation in the form of hybrid technology. "Product features, performance, quality, styling, and efficiency have been the traditional attributes used to distinguish motor vehicles since the industry began."<sup>28</sup> The ability of a vehicle to be distinguished based on its features should translate into its ability to maintain higher value throughout its lifetime. These assertions, therefore, help in allowing me to predict that hybrid technology, strictly from a feature standpoint, will cause vehicles with the technology to retain higher resale values than cars without the technology.

<sup>&</sup>lt;sup>26</sup> Deierlein, Bob. "The Lowdown on Hybrids." *Beverage World* 126, no. 6: 114-114, 2008. Available from *Business Source Premier*, EBSCO*host.* Accessed 15 September 2008.

<sup>&</sup>lt;sup>27</sup> Ibid.

<sup>&</sup>lt;sup>28</sup> Ealey, Lance, and Luis Troyano-Bermüdez. "Are automobiles the next commodity?" *McKinsey Quarterly*, no. 4 (1996): 62-75.

### Summary and Research Model

The topics discussed above will each serve as the independent variables used to explain the amount of depreciation a vehicle will undergo over a time period. Based on the results of studies already conducted, I can formulate which variables will help maintain a vehicles value and which will decrease value. Below is a table summarizing much of the literature on the independent variables and the subsequent coefficient I can predict will turn up when a multiple variable regression analysis is run.

# TABLE 2.1

Variable	Study	Findings	Predicted Coefficient
Age/Mileage	Cho (2005)	Negative contributors to resale value	Negative (-)
Make	Ganguli (2003) Ealey (1996)	Japanese perceived as better quality	Positive (+)
Title History & Condition	Andrews (2007)	Clear history (better condition) creates more value	Positive (+)
Miles Per Gallon Rating	Miles Per Gallon Rating Zhu (2008)		Positive (+)
Safety	Koppel (2008)	Better safety is more desirable	Positive (+)
Hybrid	Carr-Ruffino (2007) Murray (2008)	Positive externalities, increased demand	Positive (+)

### SUMMARY OF EXISTING LITERATURE

With the prior literature that has been reviewed, I can formulate an expected regression equation:

Resale Value (DV) = f [A - b1(Age) - b2(Mileage) + b3(Make) + b4(Title/Condition) + b5(MPG) + b6(Safety) + b7(Hybrid)]

The following section of this thesis will cover the methods I will use to collect data in the best way that will allow me to run a proper regression analysis.

#### CHAPTER III

#### METHODOLOGY

As mentioned throughout the introduction and literature review, this study will incorporate a multiple variable regression analysis to measure the amount of influence each independent variable has on a car's resale value. A quantitative rather than a qualitative approach is preferred in this case because the variables involved can be observed mathematically. Other qualitative variables, such as manufacturer nationality and market segment, can be measured using dummy variables. The independent variables selected (i.e. age, mileage, make, title history/condition, miles per gallon, safety ratings, and market segment) will be measured according to the amount of influence they have over the dependent variable, which will be some variation on resale value. These variations include the percentage of the original retail price that was maintained as well as the percentage of the original price per year that the vehicle loses over time. Added together, I hope that the independent variables will provide a significant amount of explanation as to why resale value changes with different vehicles, as well as show significance in the hybrid market segment.

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#### Sample, Variables, and Data Sources

Because of the vast amount of vehicles on the market today, a systematic approach is needed for the selection of vehicles used in the data set. Today's auto market is broken down into segments. Car and Driver.com, an online auto market resource, provides a segmented list of the auto market. Of the eleven segments provided, 6 were chosen (segments such as Most Researched, Performance, and Sports/GT were omitted for purposes of simplicity as well as exclusivity). The segments selected for examination were: Best-Sellers, Crossovers, Diesel, Economy, Hybrid, and Luxury. From each segment, a handful of cars were chosen to encompass a broad range of manufacturers as well as vehicle-type. Of all the segments included, the Best-Sellers provided the most vehicles included in this study. This allows me to make a better claim on the cars that are more popular among consumers. In all, 82 car models were selected from the six different segments. A breakdown of the cars selected with their respective segments is provided in Table 3.1. In addition, Table 3.2 shows a breakdown of the manufacturers

#### TABLE 3.1

					# of	
Year	Segment	# of Cars	Year	Segment	Cars	Total
2003	Best-Sellers	16	2005	Best-Sellers	14	30
2003	Crossover	8	2005	Crossover	9	17
2003	Diesel	1	2005	Diesel	1	2
2003	Economy	5	2005	Economy	7	12
2003	Hybrid	3	2005	Hybrid	6	9
2003	Luxury	6	2005	Luxury	6	12
Total		39			43	82

#### VEHICLE SELECTION SEGMENTATION

# TABLE 3.2

		Year 2003		
	# of		# of	
Manufacturer	Cars	Manufacturer	Cars	Total
Honda	7	Subaru	1	
Toyota	5	Mitsubishi	1	
Chevy	4	Volkswagon	1	
Ford	2	Jeep	1	
Chrysler	2	Nissan	1	
		Mercedes-		
Kia	2	Benz	1	
BMW	2	Saab	1	
Lexus	2	Volvo	1	
Hyundai	2	Acura	1	
Dodge	1	Mazda	1	
Total	29		10	39

# MANUFACTURER BREAKDOWN

		Year 2005		
	# of		# of	
Manufacturer	Cars	Manufacturer	Cars	Total
Honda	7	Subaru	1	
Chevy	6	Mitsubishi	1	
Toyota	4	Volkswagon	1	
Ford	4	Jeep	1	
Chrysler	2	Nissan	1	
		Mercedes-		
Kia	2	Benz	1	
BMW	2	Saab	1	
Lexus	2	Volvo	1	
Hyundai	2	Acura	1	
Dodge	1	Mazda	1	
GMC	1			
Total	33		10	43

Once the list of vehicles by manufacturer and segments had been created, then the data collection process could begin. In order to better illustrate the data collection process, I will show the data for one model year and vehicle and explain how each data point was acquired. Table 3.3 shows 9 observations used in the data set, all for the first car that data was collected for: a 2003 Toyota Camry.

As seen in the sample data set, one vehicle allowed for nine observations. This method allowed for mileage interval and vehicle condition variation, with both having three levels of difference. To obtain what the vehicle cost as a new car in 2003, Edmunds.com was able to send me links to archived versions of their website for multiple years in the past.<sup>1</sup> Once all 2003 Toyota models were found, the Camry was then selected. The resulting page offered many different available models to choose from. The model specifications (Camry LE-4 door, 2.4 liter engine, 4 cylinders, automatic transmission) were held, as closely as possible, to base or entry level engines and body styles. Without maintaining entry level models, the variation among different body styles, engines, and features would be independent variables themselves, and significance could be masked by these factors. Automatic transmissions were chosen, when possible, over manual transmissions as the majority of the vehicles selected had entry level automatic transmissions. If, however, a manual transmission was selected for the original MSRP specifications, then a manual transmission was also selected when acquiring the current market value of the car under Kelly Blue Book pricing. Once these concerns were taken care of, the "True Market Value" price was recorded in the data set

<sup>&</sup>lt;sup>1</sup> Archived MSRP's. Available from <u>http://web.archive.org/web/\*/http://www.edmunds.com</u>. Accessed February 2009.

# TABLE 3.3

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# SAMPLE DATA COLLECTION

						Current		% Lost per		_			Driver	Passenger	<u>Best-</u>	Cross-	_	[	
Year	Make	Model	<u>MSRP</u>	Age	Mileage	Price	% Maintained	<u>Year</u>	Japanese	European	Condition	MPG	<u>Safety</u>	Safety	Sellers	over	Econ	Luxury	Hybrid
2003	Toyota	Camry LE (4dr, 2.4L, 4cyl, Auto)	\$22,105	5	37500	\$9,605	43.45%	11.31%	1	o	3	24	5	4	1	0	о	o	o
2003	Toyota	Camry LE (4dr, 2.4L, 4cyl, Auto)	\$22,105	5	37500	\$9,005	40.74%	11.85%	1	0	2	24	5	4	1	0	0	0	0
2003	Toyota	Camry LE (4dr, 2.4L, 4cyl, Auto)	\$22,105	5	37500	\$8,230	37.23%	12.55%	1	0	1	24	5	4	1	o	0	0	o
2003	Toyota	Camry LE (4dr, 2.4L, 4cyl, Auto)	\$22,105	5	75000	\$8,230	37.23%	12.55%	1	0	3	24	5	4	1	0	0	0	0
2003	Toyota	Camry LE (4dr, 2.4L, 4cyl, Auto)	\$22,105	5	75000	\$7,630	34.52%	13.10%	1	o	2	24	5	4	1	o	0	0	0
2003	Toyota	Camry LE (4dr, 2.4L, 4cyl, Auto)	\$22,105	5	75000	\$6,855	31.01%	13.80%	1	o	1	24	5	4	1	o	0	0	0
2003	Toyota	Camry LE (4dr, 2.4L, 4cyl, Auto)	\$22,105	5	112500	\$6,705	30.33%	13.93%	1	o	3	24	5	4	1	0	0	0	0
2003	Toyota	Camry LE (4dr, 2.4L, 4cyl, Auto)	\$22,105	5	112500	\$6,105	27.62%	14.48%	1	0	2	24	5	4	1	0	0	o	0
2003	Toyota	Camry LE (4dr, 2.4L, 4cyl, Auto)	\$22,105	5	112500	\$5,330	24.11%	15.18%	1	0	1	24	5	4	1	0	0	0	o

The column labeled "Age" was calculated simply by measuring how many years had passed since the vehicle had been offered as new. For purposes of simplicity, a car that was listed as new in 2003 was regarded as five years old. Likewise, a car that was new in 2005 was listed as three years old. A sample with vehicles chosen from two different time periods allows for age to be influential as a variable.

The column labeled "Mileage" offers three levels of mileage for the nine Camry observations. Multiple sources (Kelly Blue Book, Edmunds, CarFax) observe the average annual miles driven for a driver in America to be 15,000 miles. Therefore, this study listed the middle interval for mileage to be one based on 15,000 miles driven per year. The other two intervals, a high and low category, were calculated using multiples of the average. To get the low mileage interval, the average mileage (15,000) was multiplied by .5 (or divided in half). This produced 7,500 miles driven per year for the low mileage interval. To find the high mileage interval, the average mileage was multiplied by 1.5 (15,000 x 1.5). This produced 22,500 miles driven per year for the high mileage interval. For a given year, each of these intervals was multiplied by the age of the vehicle to get how many miles would have been accumulated. So, for a 2003 vehicle, the mileages for each interval were as follows: Low—37,500, Middle—75,000, High—112,500, as seen in the sample data set.

With the year, make, model specifications, age, and mileage all having been assigned values or titles, a current market value could be obtained using Kelly Blue Book online.<sup>1</sup> Under the "Used Cars" section listed on the homepage, I could search for a car by year, make, and model. After a 2003 Toyota Camry was selected, there were three

<sup>&</sup>lt;sup>2</sup> <u>http://www.kbb.com/</u>

different value options to select from. The three options were: Trade-In Value, Private Party Value, and Suggested Retail Value. Because I was not interested in the trade-in value, this option was eliminated from contention. Further, the Suggested Retail Value provided the following explanation for the category: "the Kelley Blue Book Suggested Retail Value is representative of dealers' asking prices and is the starting point for negotiation between a consumer and a dealer."<sup>2</sup> As negotiation circumstances and techniques could vary with each buyer or seller, this option was also eliminated, leaving Private Party Value as the choice for pricing. The Private Party Value is described as the value that "a buyer can expect to pay when buying a used car from a private party."<sup>3</sup> Once this option was selected, the model specifications and mileage interval were entered. All vehicle features were kept standard and at baseline specifications, as discussed earlier. The website was now ready to provide market values for three levels of vehicle condition: excellent, good, and fair. To maintain numerical value, each of these conditions was assigned a number. A "3" was for excellent, a "2" for good, and a "1" for fair. This allowed for condition variation to take place, an independent variable used in this study. The three values were recorded according to the relative vehicle condition. To get the other six observations for each vehicle, only the mileage interval was changed and the three respective values were recorded for each level of mileage.

The "Percent (%) Maintained" column was calculated by dividing the current market value by the original MSRP. This provided me with a proportion of the original price that had been maintained in spite of age and mileage variables. This column was one of the dependent variables available for use as it shows how well a vehicle can

<sup>&</sup>lt;sup>3</sup> <u>http://www.kbb.com/KBB/UsedCars/2003\_Toyota\_Camry.aspx</u>

<sup>&</sup>lt;sup>4</sup> Ibid.

maintain its value, which is the major focus of this study. The other dependent variable available for use, Percent (%) Per Year, was also calculated at this point. To clarify, this column measured the percentage of the original MSRP that had depreciated per year over the life of the vehicle. To get this, I would need to subtract the Percent Maintained value from 1. This would provide the Percent Depreciated. For the first 2003 Toyota Camry entry, the value is: 1 - .434517 = .565483, or 56.5483%. This percentage was then divided by the age of the vehicle, providing the percent depreciated per year. This dependent variables measure how quickly a car will lose its value, which is also the focus of this study. Both of these dependent variables, percent maintained and percent depreciated per year, could be used separately to estimate a regression equation.

The next two columns are independent variables indicating the nationality of the manufacturer. Because nationality is a qualitative observation, dummy variables were put to use for this category. The 2003 Toyota Camry provided in the sample data set received a "1" for the Japanese category as Toyota is a Japanese company. The European dummy variable behaves the same except it indicates whether a vehicle was manufactured by a European automaker, and thus the 2003 Toyota Camry received a "0" for this variable. A car made by an American manufacturer, such as Ford, would receive a "0" for both variables as it is neither Japanese nor European.

The following column, labeled "Condition", measured the condition the vehicle was in. Kelly Blue Book offers explanations for the three condition levels listed for the market values. The three conditions levels and explanations are listed in Table 3.4, shown below. For each mileage interval, the three vehicle condition classifications were recorded as separate observations, providing for nine observations for each vehicle.

### TABLE 3.4

### CONDITION LEVEL DESCRIPTIONS

Condition	Description
Excellent (3)	*Looks new, is in excellent mechanical condition and needs no reconditioning *Never had any paint or body work and is free of rust *Clean title history and will pass a smog and safety inspection *Engine compartment is Clean, with no fluid leaks and is free of any wear or visible defects *Complete and verifiable service records
Good (2)	<ul> <li>*Free of any major defects</li> <li>*Clean title history, the paints, body, and interior have only minor (if any) blemishes, and there are no major mechanical problems</li> <li>*Little or no rust on this vehicle</li> <li>*Tires match and have substantial tread wear left</li> <li>*A "good" vehicle will need some reconditioning to be sold at retail</li> </ul>
Fair (1)	*Some mechanical or cosmetic defects and needs servicing but is still in reasonable running condition *Clean title history, the paint, body and/or interior need work performed by a professional *Tires may need to be replaced *There may be some repairable rust damage

http://www.kbb.com/KBB/Selection/Condition.aspx?VehicleClass=UsedCar&ManufacturerId=49&Vehicl eId=3160&ModelId=286&PriceType=Private+Party&YearId=2003&Mileage=75000&SelectionHistory=3 160|30124|80903|100|10|

The column labeled "MPG" reports the miles per gallon rating, or fuel efficiency, of a vehicle. Fueleconomy.gov, a government-based internet source, provides city and highway fuel efficiency numbers for any car on the road.<sup>4</sup> To promote simplicity, the combined value for fuel economy issued by the Environmental Protection Agency was used for each vehicle, providing only one number for each observation. Engine specifications and body styles were kept standard, as with prior variables, when collecting the miles per gallon rating.

<sup>&</sup>lt;sup>5</sup> <u>http://www.fueleconomy.gov/</u>

Crash test ratings, to account for the safety variable, were also found using Kelly Blue Book. Once the page with three market values for a vehicle was presented, crash test results could be found under the "Specifications" link on the left side of the webpage. The tab labeled "safety" was then accessed and driver and passenger front-end crash ratings were recorded for each vehicle. There were 6 vehicles whose ratings could not be found using Kelly Blue Book, and thus another source was used. CarFax.com provided the ratings that were missing from Kelly Blue Book.<sup>5</sup> To ensure CarFax ratings were consistent with Kelly Blue Book ratings, checks of random vehicles were conducted, comparing Kelly Blue Book and CarFax ratings. In all cases, the ratings were the same.

The five remaining data columns listed in the sample data set are concerned with the automobile market segment that each vehicle falls under. This method allowed me to use hybrid technology as a dummy variable, while simultaneously collecting data on the other market segments as well. For the market segment variables, a "1" was assigned to a vehicle if it fell under that market segment. The segment that was omitted was diesel cars, as this was the segment with the least amount of vehicles included in this study. Thus, a diesel car received a "0" in all segment categories.

The method for collecting data described in the above sections was the same for all of the vehicles included in this study. 82 vehicles were included, providing for 738 lines of data (observations). With all of the data collected in quantitative form, running statistical models was the next step involved, as described in the next chapter.

<sup>6</sup> http://www.carfax.com/car\_safety/ratings/SRR.cfm

### CHAPTER IV

#### RESULTS

Correlations of all of the variables, including both dependent variables, are shown in Table 4.1. In general, the individual correlations between the dependent and independent variables are in the hypothesized directions formulated in the literature review. Age and mileage are negatively correlated with the ability of a vehicle to maintain value. Japanese and European cars are positively correlated, although a Japanese distinction shows a much higher correlation. Vehicle condition, fuel efficiency, and safety ratings are also positively correlated with value maintenance. The use of vehicle segments provides interesting correlations. A vehicle falling under the best-seller category, for example, has a negative correlation to value maintenance. Luxury vehicles also have a negative correlation. The crossover, economy, and hybrid segments carry positive correlations, with the hybrid segment having the highest correlation.

The correlation matrix also shows any high correlations (when r > .40) among the independent variables. High correlation between variables signifies an overlap in the information that these variables contain about the behavior of the dependent variable.<sup>1</sup> Because of this overlap, it is difficult to determine where significance lies in our regression results.

<sup>&</sup>lt;sup>1</sup> Kahane, Leo H. Regression Basics. Thousand Oaks, California: Sage Publications, Inc., 2001.

As seen in Table 4.1, there are four such independent variables that are highly correlated. Specifically, the age variable is highly correlated (r = .515) with the mileage variable, the European variable is high correlated (r = .609) with the luxury segment variable, the miles per gallon (MPG) variable is highly correlated (r = .661) with the hybrid segment variable, and the driver safety variable is highly correlated (r = .665) with the passenger safety variable.

# CORRELATION MATRIX

	% Maintained	% per Year	Age	Mileage	Japanese	European	Condition	MPG	Driver	Passenger	Best- Sellers	Crossover	Economy	Luxury	Hvbrid
% Maintained	1.000									Ŭ			2	J	<b>,</b>
% per Year	-0.471	1.000													
Age	-0.486	-0.522	1.000												
Mileage	-0.500	-0.056	0.515	1.000											
Japanese	0.417	-0.458	0.069	0.035	1.000										
European	0.031	-0.051	0.020	0.010	-0.375	1.000									
Condition	0.190	-0.181	0.000	0.000	0.000	0.000	1.000								
MPG	0.493	-0.455	0.006	-0.003	0.365	-0.012	0.000	1.000							
Driver	0.332	-0.225	0.091	-0.047	0.322	0.061	0.000	0.100	1.000						
Passenger	0.247	-0.209	0.009	-0.004	0.338	0.240	0.000	0.102	0.665	1.000					
Best-Sellers	-0.299	0.217	0.088	0.045	-0.027	-0.314	0.000	0.285	0.155	0.012	1.000				
Crossover	0.022	-0.010	0.005	-0.003	0.141	-0.042	0.000	0.229	-0.003	0.066	-0.388	1.000			
Economy	0.018	0.009	0.049	-0.025	-0.098	-0.171	0.000	0.079	-0.117	-0.094	-0.314	-0.212	1.000		
Luxury	-0.088	0.052	0.020	0.010	-0.098	0.610	0.000	0.103	-0.058	0.129	-0.314	-0.212	-0.171	1.000	
Hybrid	0.385	-0.274	0.100	-0.051	0.152	-0.145	0.000	0.661	-0.116	-0.221	-0.267	-0.180	-0.145	-0.145	$1.000$ $\frac{3}{6}$

To ensure that significance is not masked or improperly assigned to a variable, regression analyses are run with only one of the highly correlated variables. Take the high correlation between age and mileage, for example. When a regression is run, either age or mileage is included as an independent variable, but not both at the same time. The same goes for the other independent variables with high levels of correlation. This systematic approach can be seen when looking at the regression results tables.

The following four pages show the results of many different regressions that were run. The first two pages of regressions, Tables 4.2 and 4.3, use Percent Maintained as the dependent variable. Therefore, the results in the estimated equations speak to how the independent variables influence a vehicle's ability to maintain value. The last two pages of regression, Tables 4.4 and 4.5, use Percent Depreciated Per Year as the dependent variable. The results of these respective regressions speak to how the independent variables influence a vehicle's tendency to lose value, or depreciate.

.

# **REGRESSION RESULTS**

(Dependent variable in 3 models shown is Percent Maintained; t-statistics reported in parentheses.)

	Model #1		Model #2		Model #3	
Intercept	0.40996	***	0.26477	***	0.59669	***
	(22.40612)		(8.23015)		(15.93591)	
Age	-0.07387 (-22.31710)	***	-0.07152 (-22.31710)	***	-0.06469 (-22.09217)	***
Mileage						
Japanese	0.11503	***	0.0986 (12.24486)	***	0.11212	***
	(15.11797)	<u></u>			(17.22038)	
European	0.07929	***	0.06729	***		
	(7.97332)		(6.72839)			
Condition	0.03337	***	0.03337	***	0.03337	***
	(8.46720)		(8.63089)		(9.51851)	
MPG	0.00653	***	0.00667 (14.73861)	***		
	(14.17515)					
Driver Crash			0.03211	***	0.04508	***
			(5.43843)		(8.11934)	<u> </u>
Passenger Crash						
Best-Sellers					-0.30961 (-15.91439)	***
Crossover					-0.26727 (-13.18313)	***
Economy					-0.23808 (-11.58503)	***
Luxury					-0.26777 (-13.11788)	***
Hybrid					-0.13423 (-6.21576)	***
Adjusted R-	0.400		0.740		0.707	
squarea	0.628		0.642		0.705	
F Statistic	249.580	***	221.032	***	197.120	***
		# p<0.1	* p<.05	** p<.01	*** p<.001	

# **REGRESSION RESULTS**

(Dependent variable in 3 models shown is Percent Maintained; t-statistics reported in parentheses.)

	Model #1		Model #2		Model #3	
Intercept	0.26755	***	0.0923	**	0.43172	***
	(18.33294)		(3.22490)		(13.15800)	
Age						
Milegge	-2 535-06	***	-7.48E.06	***	-2 255 06	***
wincuye	(-22.88701)		(-23.0872)		(-25.1187)	
lapanese	0.10726	***	0.0869	***	0.10271	***
	(14.15639)		(11.02200)		(16.80440)	
European	0.07318	***	0.0584	***		
	(7.37569)		(5.93300)			
Condition	0.03337	***	0.03337	***	0.03337	***
	(8.47654)		(8.75279)		(10.06220)	
MPG	0.00674	***	0.00691	***		
	(14.66019)		(15.49050)			
Driver Crash			0.04068	***	0.05432	***
			(7.03490)		(10.44990)	
Passenger Crash						
Best-Sellers		·····			-0.30319	***
					(-16.4813)	
Crossover					-0.25455	***
·····					(-13.29188)	<u></u>
conomy					-0.22306 (-11.4966)	
uxury					-0.25847	***
					(-13.3956)	
lybrid					-0.11086 (-5.4505)	***
Adjusted R- quared	0.629		0.652		0.736	
Statistic	250 452	***	220 796	***	220.785	***

# p<0.1 \* p<.05 \*\* p<.01 \*\*\* p<.001

(Depende	ent variable in 3 mod	els shown is l	%Depreciated Per Yea	r; t-statistics	reported in parenthe	ses.)
	Model #1		Model #2		Model #3	
Intercept	0.31545	***	0.35586	***	0.27395	***
	(58.54950)		(37.48560)	······	(24.79228)	
Age	-0.02058	***	-0.02123	***	-0.02322	***
	(-21.5896)		(-22.45223)		(-26.7530)	
Mileage						
lapanese	-0.03132	***	-0.02675	***	-0.02989	***
	(-13.9788)		(-11.2558)		(-15.56031)	
European	-0.02179	***	-0.01846	***		
	(-7.44383)		(-6.25404)			
Condition	-0.00923	***	-0.00923	***	-0.00923	***
	(-7.95066)		(-8.08699)	······	(-8.9181)	
MPG	-0.00176	***	0.00181	***		
	(-13.02873)		-13.52578			
Driver Creat			(0.00002)	***	0.01220	***
Driver Crash			(0.00893)		-0.01328	
Passenger Crash		·····	(3.13017)		( 8.10055)	
Best-Sellers					0.08157	***
					(14.20802)	
Crossover					0.06899	***
					(11.53264)	
Economy					0.05845	***
					(9.64354)	
Luxury					0.06773	***
					(11.24253)	
Hybrid			<u> </u>		0.03084	***
					(4.83859)	
Adjusted R-						
squared	0.617		0.629		0.695	
F Statistic	238.033	***	209.608	***	187.825	***
		#n<Ω1	* n< 05	** n<.01	*** n< 001	

(Dependent v	ariable in 3 models sho	own is %Dep	preciated Per Year; t-sta	tistics repor	ted in parentheses.)	
	Model #1		Model #2		Model #3	
Intercept	0.2372	***	0.25386	***	0.15211	***
······	(43.14990)		(22.82396)	- <u></u>	(10.58472)	
Age						
Mileage	-5.60E-08		-6.91E-08		-8.63E-08	*
	(-1.34414)		(-1.46237)		(-2.1043)	
Japanese	-0.03559	***	-0.03365	***	-0.03685	***
	(-12.47030)		(-10.9866)		(-13.76617)	
European	-0.02513	***	-0.02374	***		
	(-6.72989)		(-6.21369)			
Condition	-0.00923	***	-0.00923	* * *	-0.00923	***
<u> </u>	(-6.22222)		(-6.23058)		(-6.3521)	
MPG	-0.00165	***	-0.00167	***		
	(-9.53117)		(-9.62206)			
Driver Crash			-0.00386	***	-0.00645	**
			(-1.72284)		(-2.83443)	
Passenger Crash						
Best-Sellers					0.08631	***
					(10.71189)	
Crossover					0.07839	***
					(9.34638)	
conomy					0.06957	***
					(8.18759)	
uxury					0.07459	***
					(8.82662)	
Hybrid					0.04809	***
					(5.39801)	
Adjusted R-						
quared	0.374		0.376		0.399	
<sup>c</sup> Statistic	89.053	***	74.905	***	55.435	***
		# p<0.1	* p<.05	** p<.01	*** p<.001	

The regressions shown above were run systematically with more independent variables included with each model. Because of the high correlations that were found in the correlation matrix, however, some variables were substituted for others. Table 4.2 will be used as an example of the progression used to run these regressions.

The first regression in Table 4.2 (labeled Model #1) incorporates 5 independent variables, producing an estimated equation. The independent variables used are age, make (both Japanese and European), condition, and miles per gallon. The adjusted rsquare statistic (0.628) shows a strong goodness of fit. In other words, the independent variables included in the regression explain approximately 63 percent of the variation seen in the dependent variable. The second regression shown (Model #2) adds driver safety ratings as an independent variable. This addition increases our adjusted r-square value to 0.642, providing more explanation in the variation seen in the ability of a vehicle to maintain its value. The third regression shown in Table 4.2 (Model #3) adds the market segment variables, while also removing the European and miles per gallon independent variables. Those variables were removed because of the high correlation that exists between European cars and the luxury vehicle market segment, as well as the high correlation between hybrid vehicles and miles per gallon. As shown, this regression model produces an r-square of 0.705, providing the high proportion of explanation of the variation exhibited by the dependent variable. This process of adding and subtracting independent variables was also used in the three other pages of regression results. Table 4.3 uses mileage instead of age for every regression. Tables 4.4 and 4.5 use percent

depreciated per year as the dependent variable, but use the same progression of independent variables.

The regression analyses provide substantial support for most of the predicted relationships noted in this study. As shown by the negative coefficients listed in the results, age and mileage are negatively associated with the ability of a vehicle to maintain value. In other words, both age and mileage take away from a car's resale value. Vehicles made by Japanese or European manufacturers are shown to hold value better than those that aren't, with Japanese vehicles holding higher value based on maintenance than European models. The condition variable also shows a positive and significant relationship, as the better the condition of a vehicle, the higher the resale value. Miles Per Gallon is also shown to increase the resale value of a vehicle. The positive and significant coefficient shows that the higher the M.P.G. rating, the better the ability of a car to maintain value. Driver safety is also shown to increase value as the crash test rating increases.

The third regression shown on each results table (Model #3) shows interesting results regarding the market segment variables. The resulting coefficients for all segment variables are negative, which is not the exact relationship predicted in the hypothesized equations. Possible explanations for these negative coefficients include the nature of the omitted dummy variable category: diesel engine vehicles. Vehicles with diesel engines exhibit very high fuel efficiency rates, and the M.P.G. variable was removed when the segment variables were added. Therefore, a diesel-engine vehicle may have shown a strong ability to maintain value compared to the other segments, causing them to hold

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negative coefficients in the estimated equations. In any case, interesting observations can still be made regarding which market segment a vehicle is listed under.

While the hybrid market segment variable lists a negative coefficient, the coefficient is shown to be the smallest of all of the segment variables. This means that the hybrid classification results in the lowest percentage reduction in resale value. In other words, a hybrid vehicle will hold value better than any of the other segments used as independent variables in this study. This confirms my hypothesized relationship between resale value and hybrid technology.

The third and fourth pages of regressions, labeled Table 4.4 and 4.5, use percent of value depreciated per year as the dependent variable. The same progression was used for adding and substituting independent variables as was used for the first two pages of regressions. In general, the adjusted r-square values were lower for this dependent variable. Initially, the coefficients for the independent variables are all negative. The reason for the change in sign is because what the dependent variable is measuring. The first two pages of regressions deal with how well a vehicle can maintain value, while the last two pages show how a vehicle can lose value. Nevertheless, significance was found for nearly all the independent variables incorporated. Further, the hybrid segment proved to slow depreciation more than any other segment. In other words, the hybrid segment added the least amount of depreciation per year for a given vehicle in comparison with the other auto segments. The final pages of regression results, Table 4.5, reported the smallest r-square values (the value went from approximately .65 to .37). This drastic change occurred as the mileage variable was substituted for age. This makes me think that the age of a vehicle plays a more important role in determining the amount of depreciation per year than mileage.

### CHAPTER V

#### DISCUSSION AND CONCLUSIONS

Because of the scope of the used car market, this study has its limitations. First, the hybrid market segment has not been around for very long, and thus historical data were limited to a very recent time frame. For this same reason, there is not nearly the same amount of hybrid models available for purchase as traditional-engine vehicles. A sample with an equal proportion of hybrid vehicles and traditional vehicles would perhaps show even more accurate results.

Further, green technology seems to be one of the front-runners in terms of consumer demand. This trend may cause the market values of hybrid vehicles to be higher than normal. Market conditions can change very quickly, as seen with the recent spike in gasoline prices and subsequent almost as drastic collapse in the prices. While energy efficiency and sustainability will undoubtedly serve as a major concern for producers and consumers for some time to come, perhaps the appeal of hybrid vehicles will ebb as the novelty of the technology will wear off, and market conditions are not heavily weighted towards specific variables. Alternatively, if gas prices remain low and

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hybrid technology continues to maintain its value better than its comparable non-hybrid competitors, then the conclusion may be that green technology is in high demand.

More accurate results could be achieved by measuring vehicles of ages other than five or three years old. As seen in the regression results, age plays a very important role in the decline of value in a car, and a study including vehicles of any age would be more accurate. Further, the zip code used for finding historical MSRP's and current market values could have an effect on demand, and thus value. A vehicle with four-wheel drive capabilities may be valued higher in Colorado than in Georgia.

# What Factors Are Associated with Resale Value Determination?

Upon the completion of this study, what did I learn about the nature of value maintenance in used cars? Nearly all of the independent variables used in all the regressions were found to be significant. Age, mileage, make, condition, fuel efficiency, safety ratings, and market segment all play important roles in determining how a vehicle will maintain value. The presence of hybrid technology in a car proved to slow depreciation and helped in value maintenance of that vehicle, as predicted in the literature review. This effect of decreased depreciation was isolated to the perception of hybrid vehicles and their effect on the environment (separate from greater fuel efficiency). Another important observation I can make is in regards to the market segment the vehicle falls under. The mere labeling of a vehicle seems to add or subtract value at surprising rates. The vehicles in the best-sellers category, for example, were shown to depreciate more quickly than cars in any other segment.

### Implications for Further Research

Avenues for continued research are abundant on this topic. First and foremost, the sample used to run a regression could always be changed. Different considerations could be employed for vehicle selection. A detailed report of vehicles sold in the U.S. during the course of a year could provide a template for finding the right proportion of makes and models to be included in a sample. A study similar to this one conducted in the next few years could report more important findings as more and more hybrid models are coming off the assembly line.

Measuring the change in the amount of influence hybrid technology has on resale value over a longer period of time would be a very interesting variation on this study. The extended time period could capture fluctuations in gas prices and the resulting changes in consumer demand, which affects market value. The results of such a study would show how well hybrids, and other market segments as well, fare in changing market conditions, and identify which vehicles have the strongest overall demand.

This study is based on the vehicles and market values available in the United States. A very intriguing variation on this study would include samples taken from Europe. The demand conditions are likely to be different in these places as the price of gas is consistently higher and the makeup of vehicles is significantly different. With the results of a similar study conducted in a European country, one could compare and contrast the different drivers of resale value determination as well as the influence hybrid vehicles hold.

### Implications for the Consumer

The results produced in this study indicate that hybrid vehicles will retain their value better than vehicles without hybrid engines. This translates into a decrease in the cost of ownership for a hybrid car owner as depreciation occurs more slowly. This tendency is naturally attractive to consumers. Greater fuel efficiency, positive environmental externalities, and a decreased cost of ownership will undoubtedly continue the trend of high demand among consumers.

Other than the presence of hybrid technology, more implications can be drawn from the results produced in this study. Indeed, all of the variables found to be significant are important for a consumer to be aware of when purchasing a vehicle with the intention of re-selling it in the future. The age, miles driven, manufacturer nationality, condition, fuel efficiency rating, safety ratings, and market segment of a vehicle all play important roles in determining the pace at which a car loses value. Intuitively, younger cars that have been driven less will be valued higher than older, high mileage vehicles. Japanese and European cars are shown to add value to resale price. Cars with clean title histories that have been kept in good condition will sell for higher prices than those without. Higher M.P.G.'s add to resale value, along with higher crash test ratings. Consumers have the ability to inform themselves of these factors and make a purchase decision with them in mind.

#### Hybrids in Recent News

Kelly Blue Book, the used car appraiser used in this study, recently released its 2009 Best Resale Value Awards. Many interesting comparisons can be drawn between the results of this study and the awards that were issued. In the "Overall Top 10" category, eight of the ten vehicles receiving awards were made by Japanese manufacturers. Further, two of the eight Japanese vehicles receiving awards were hybrid vehicles. The results shown in this study provide support for this award as Japanese cars tended to maintain value better than non-Japanese cars, and hybrid cars showed high value maintenance. The "Best Brand" award was given to Honda, a Japanese manufacturer; its second such classification in the last four years. The website cites the importance of quality (dependability and reliability) and fuel efficiency in determining the recipient of the award.<sup>1</sup> Both quality, from a manufacturer standpoint, and fuel efficiency were found to be significant factors in resale value in this study.

### Implications for Auto-Makers

Auto manufacturers are well aware of the importance hybrid vehicles have today, and more importantly, the importance they will hold in the future. Hybridcars.com, an internet website "dedicated to hybrid gas-electric vehicles and the full range of consumer information and tools about cars, energy, and the environment," reports that many, if not all, automakers are moving towards the production of greener vehicles: "Toyota has committed to 10 new hybrids globally by 2012. GM is planning to introduce 26 new

<sup>&</sup>lt;sup>1</sup> <u>http://www.kbb.com/kbb/NewsAndReviews/BestResaleValueAwards.aspx</u>

hybrids by 2014.<sup>2</sup> While the price of oil may have dropped in recent months, automakers are forecasting a return to high gas prices in the near future.

As shown in the results of this study, hybrid vehicles maintain their value better over time, and not solely because of their high M.P.G. ratings. The positive environmental externalities associated with hybrid vehicles add to the long-run value of the car. Therefore, it is important to auto-makers to keep pace with emerging alternative fuel-types and technologies. While consumers will always be concerned with fuel efficiency, any vehicle that is perceived as more environmentally friendly than a traditional vehicle will most likely have an increased demand as well.

#### Conclusion

To be sure, the automobile industry is currently undergoing some significant reconstruction and the landscape and makeup of the industry will change. To remain solvent, auto-makers must keep consumer demands as a top priority. This study reveals that in addition to historical quality, fuel efficiency, and safety, consumers are interested in vehicles that are perceived as environmentally friendly. Vehicles with hybrid engine technology incorporate a new determinant for resale value, and this determinant has been found to slow the depreciation process in used cars.

<sup>&</sup>lt;sup>2</sup> "Signs of a Future Hybrid Car Rebound." Available from <u>http://www.hybridcars.com/news/signs-future-hybrid-car-rebound-25624.html</u>.

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