HEDONIC PRICE VALUATION OF VINTAGE FERRARIS

by

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ABSTRACT

PAUL SPADARO. Hedonic Price Valuation of Vintage Ferraris. (Under the direction of DR. CRAIG A. DEPKEN, II)

This paper provides an econometric analysis of vintage Ferrari sales from automobile auctions between July 2002 and January 2016. Although Enzo Ferrari made race cars earlier, the first Ferrari badged car was produced in 1947. The "Enzo" era, was from 1947 to 1974; the cars built during these years were produced in substantially smaller numbers than the models in the years that followed. Enzo-era cars are generally in higher demand and are also considered to be more valuable than the models produced subsequently. The goal of this study is to estimate a standard hedonic model to measure how characteristics of Ferraris are valued.

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To Rose, my wife, who has been by my side throughout it all. To my family, who are always on my mind. And to my brother Mark, who gave me a subscription to Forza in 2002 that I still receive.

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CHAPTER 1: INTRODUCTION

On March 12, 1947, Enzo Ferrari went for a test drive in the very first Ferrari. With a passion for automobile racing, Enzo Ferrari had been working on a race car since 1945 and called it the Ferrari 125 S. The 125 S was the first car completely built by Ferrari and to wear the Ferrari prancing horse logo. As his success on the track continued, Ferrari realized that production road cars could be sold as a means to finance the race car operations.

The first Ferrari road cars were individually handmade to the highest standards, incorporating knowledge and technology that was being used in the race cars being built simultaneously. Early Ferraris were built in small numbers, usually with the chassis built by Ferrari and the body finished by a local "motorcoach" builder. Vignale, Scaglietti, and PininFarina were three of the most prominent motorcoach names from the early days. Each of these coach builders created cars that were unique; handcrafted on an individual level, so that, for many models, no two cars are alike. While this practice continued throughout the 1950's and 1960's, as Ferrari grew as a company and production numbers increased the use of coachbuilders ended. Approximately 12,700 cars were produced during the 27 years known as the "Enzo-era" (Sheehan, 2009).

In 1969, the Italian automobile conglomerate FIAT purchased 50% of Ferrari. The merger gave Ferrari access to additional financial capital while FIAT gained a prestigious manufacturer in it's business lineup. While there was very little impact of the FIAT merger on the performance and design of Ferrari's race cars, there was a notable

change to the road cars. Production numbers increased while focus on design and performance shifted to other areas, such as emissions control and fuel economy. With FIAT's influence and substantial investment capital, 52,000 cars were produced between 1974 and 1995, and increase of 409% from the Enzo-era (Sheehan, 2009).

Enzo Ferrari owned 50% of Ferrari until his death in 1988 at which time FIAT increased it's share of stock in Ferrari to 90% (the remaining 10% was controlled by Enzo Ferrari's son, Piero). In 1991 Luca Cordero di Montezemolo was appointed president and overhauled the production side of the company. In doing so, he turned around the performance of the company, increasing profits and efficiency. Ferrari soon started producing cars that both looked exotic and outperformed most other road cars available. The overall production numbers increased to total approximately 110,000 cars under Montezemolo's influence from 1991 to 2015 (Sheehan, 2009).

Enzo-era models are chosen for this study because of the differences in the number of vehicles produced in each era and also because of the unique characteristics of each car. Recent auction sales have seen prices of Enzo-era Ferraris climb rapidly. Sheehan (2012) details the rise and fall of prices due to various global economic conditions since the early 1970's. Four of the major North American auction companies, RM Sotheby's, Gooding & Company, Barrett Jackson, and Mecum Auctions, provide public databases of their auction results dating back to 2002. This information confirms an increase in the value of vintage Ferraris, as shown in Figure 1.

Awareness of the value of vintage Ferraris has increased in the last decade, in particular due to an ever growing presence on cable television, the internet, and social media. In 2008, Barrett Jackson and the cable television channel SPEED began a

partnership to broadcast multiple auctions throughout the year. This media package increased Barrett Jackson's exposure resulting in an increased number of buyers and additional cars being sold at its auctions.

Twice a year, in Scottsdale, Arizona and in Monterey, California, there are multiple auction companies present in the same city on the same weekend. This creates direct competition for buyers, the cars being sold, and most importantly to the auction companies, for total sales. The companies themselves do as much as possible to drive up the prices of the cars so that they will earn a larger commission, which is typically 10% of the final sales price. Sensational advertising, large crowds, and fast paced bidding creates a party-like atmosphere at certain auctions, while other auction events feature rare cars that might have never been sold before.

Another factor that plays a part in the trend of rising prices is the limited number of Enzo-era cars in existence and the increasing number of buyers who desire to own one; a classic example of supply and demand. And as the wealthiest people in the world continue to increase their net worth, there is more capital available to push prices higher.

Hedonic modeling has been widely used to value the prices of automobiles in academic literature. Chapter 2 contains a brief discussion of these studies, as well as additional Ferrari market research. The variables included in this study are Auction Sales, Brent Oil Price per Barrel, Personal Consumption Expenditures, Year of Auction, Age of Car (auction year minus year of production), Square of the Age of Car, Model, Auction House, Exterior Color, Roof, and Original Currency of Sale. A detailed discussion of each variable follows in Chapter 3.

Chapter 4 discusses the economic model used to measure the variables, while Chapter 5 sums up the results in detail. A hedonic model is used, because it allows the model to include different variables to determine which characteristics have an impact on the overall value of the average Ferrari. The final chapter offers concluding remarks.

CHAPTER 2: LITERATURE REVIEW

There is a small community of experts who track and detail the history of Ferraris. Gerald Roush started the *Ferrari Market Letter* in 1976 from his personal notes. The *Market Letter* grew as people realized it provided a valuable source of information about Ferrari models and their approximate market values. The market values are based on the asking prices of second hand sales of Ferraris, not the actual sales prices (Roush, 2014).

Another expert is Michael Sheehan, who frequently writes the *Ferrari Market Update* for *FORZA: The Magazine about Ferrari*. Sheehan is part of a well established network of secondary dealers who specialize in pre-owned Ferraris. He also maintains a website and writes articles for various car collector publications. In his 2012 article, *Are Ferraris Booming or Busting,* Sheehan notes a cycle of Ferrari values from 1973 that coincide with different economic factors and makes arguments alluding to a correlation between the selling prices of Ferraris and macroeconomics shocks (Sheehan, 2012).

There are additional online resources that catalog the serial numbers of cars in an effort to track them, including barchetta.cc/All.Ferraris, 330gt.com, and f-register.com, among others. These sources do not always provide pricing, though, and instead focus on tracking the condition and modifications to the vehicles. Additionally, Ferrari itself catalogs the history of the company, including brief summaries on each model.

Hedonic regression has been used to study the pricing indices for automobiles since Andrew Court's work for the Automobile Manufacturer's Association in 1939.

Since that paper, a number of other works have been written covering different time periods which Varela-Irimia (2014) mentions to include Griliches (1961), Triplett (1969), and Ohta (1987) in the United States. Authors who have focused on the European markets include Cowling and Cubbin (1972), Murray and Sarantis (1999), Requena-Silvente and Walker (2006), Kroonenberg and Cramer (1974), Dalen and Bode (2004), Reis and Silva (2006), and Tomat (2002). Also Epsey (2000) studied the value of fuel economy on the price of a car.

Griliches (1961) explores the value of "quality changes" to automobiles. Quality change refers to the basic improvements to vehicles year after year, which may be included in the pricing as standard equipment, but are in fact differences that can be quantified. Griliches notes that his study doesn't include enough characteristics about the cars and mentions that they "may not interact in any simple linear fashion." He suggests including additional "qualities" and to weight different cars according to their importance in the market.

Ohta and Griliches (1976) chose thirteen manufacturers that produced cars from 1955 to 1977 in the first study to use performance variables, such as acceleration, top speed, and fuel economy. The study focuses on the difference in prices between manufacturers using used car pricing to find that there is a large difference in pricing between different manufacturers, and a relatively small difference between physical appearances and performance.

Another example of hedonic regression involving automobiles is Andersson (2005) who looks at the willingness of an individual to pay for their personal safety when purchasing a car. He notes that there are problems with using hedonic regression, mainly

from trying to value the perception of an individual's views of safety and risk. Andersson also suggests that if an objective risk is presented, an individual might not completely understand the risk. Other examples of individuals' subjectivity impacting their decision to purchase one car over another will be discussed later in this paper.

Using country-level market information, a measure of vehicle usage, and physical characteristics, Prado (2009) applies a hedonic model to automobiles in four European countries. The measure of usage is of special importance in this study, as Prado is looking at automobile leasing. He notes that each country is significantly different from the others in terms of pricing. Prado's model accounts for unobserved characteristics, such as brand reputation and perception by including a variable differentiating each manufacturer. The other variables include original cost of the car, the price of diesel fuel as an economic indicator, and physical attributes of the car.

Varela-Irimia (2014) uses hedonic regression while looking at the Spanish automobile market during the 1990s. Of special note is the focus on the unobserved effects of time that, when omitted, can present incorrect conclusions. Including a time variable, such as age, corrects the model for these time effects.

This study would not be complete without mentioning Marcel Massini, who is known in the world of Ferrari collectors as the expert who can answer any question about the history of a vehicle. Since the early 1980s, Massini has documented information about every Ferrari produced. When a client is looking for information on a specific model, Massini provides a book of information on the car, documenting its previous owners, repairs, modifications, and other important historical facts (Edgar, 2011). This information is very important for a buyer, especially of a historic model. While not

available for this study, Massini's information might prove beneficial to further studies by adding additional information and specifics to the model.

CHAPTER 3: DATA AND MODEL VARIABLES

3.1 Auction Houses

The data analyzed in this paper were obtained from four major auction houses: RM Sotheby's, Gooding & Company, Barrett Jackson, and Mecum Auctions. These companies have a minimum of three auctions annually, usually in January, March, and August. The auctions themselves have unique characteristics that differentiate themselves and the attending audiences from each other. These distinctive characteristics impact the cars entered in the auction, which in turn impact the sales numbers and sales prices. These differences are further compounded by the timing of the auctions. Twice a year, there are multiple auction events held in the same location on the same date, located only miles from each other. This creates competition for both buyers and sellers, and patterns emerge as auctions continuously sell certain cars.

Barrett Jackson is known for selling large numbers of cars in a wide range of prices and specifically for auctioning American muscle cars. Barrett Jackson typically holds four auctions each year, in Scottsdale, Arizona, Palm Beach, Florida, Montville, Connecticut, and Las Vegas, Nevada. The television and media exposure from the 2008 contract with SPEED thrust Barrett Jackson into the national car enthusiast spotlight and brought attention to car collecting that had not been there previously. As a result, the number of cars at Barrett Jackson auctions has increased, from 744 cars in 2004 to 1,469 2016 at the January Scottsdale auction alone (Monopoli, 2016).

In January, 2009, when General Motors was preparing for bankruptcy, the company brought more than 200 rare cars from storage warehouses to the Barrett Jackson auction in Scottsdale, Arizona (Autoweek, 2009). Knowing this was going to happen, collectors attended the auction with the expectation that they could purchase unique cars that had never before been privately owned. One such a buyer was Rick Hendrick, a multi-millionaire who started a private personal car collection in 2009. Attending the January 2009 Barrett Jackson auction, he purchased more than 20 cars for his budding collection. Hendrick focused on the cars coming from the GM Heritage Collection, knowing they were rare finds that might not be available again in his lifetime. Hendrick also desired these cars because of his preference for Chevrolets. As of 2016, his collection is considered to have the most Chevrolet Corvette's in a private collection in the entire world. More than half of his cars are Corvette's, and Chevrolet Camaro's comprise a large portion of the remainder of the inventory.

Hendrick is not alone in having a preference for owning a car from a single manufacturer. Many auto enthusiasts generally prefer one manufacturer to another. If they are in the position to own multiple cars, more often than not they own multiple cars from the same automaker. This is a common characteristic among "car guys" and loyalty to a manufacturer comes in various forms and for a variety of reasons. While the reasons might differ as much as the badges on the car, the resulting preferences have an impact on the demand for different types of cars and thus certain auction companies cater to specific types of collectors.

Vintage Ferraris selling at Barrett Jackson might command a lower price due to a low number of interested buyers attending. From a seller's viewpoint, it is riskier to

bring a high-end European car to an auction that specializes in relatively lower priced American cars. In the previously mentioned 2009 Barrett Jackson Scottsdale auction, a total of 1,077 cars were sold for an average of $56,542 (Sports Car Digest, 2009). The average sales price of Enzo-era Ferraris was $1,202,942 at the RM Sotheby's and Gooding & Co. events taking place the same weekend in January 2009 in Scottsdale.

Table 1. January 2009 auctions

Auc House	Ave Sales Price, $	Auc Date	Auc Location
RM Sotheby's	626,821	Jan 16, 2009	Scottsdale, AZ
Gooding & Company	1,779,064	Jan 17, 2009	Scottsdale, AZ

From January 2003 to January 2016, 26 vintage Ferraris sold at the Barrett Jackson auctions with an average price of $171,924, well above the average price of all cars sold at the January 2009 auction (see Figure 2).

Mecum Auctions is another auction company that holds its events exclusively in the United States. While Mecum is not a household name in the way that Barrett Jackson is, the cars that cross the block at Mecum's auctions typically sell for a higher price than at Barrett Jackson. In this study, 20 Enzo-era Ferraris sold at Mecum Auctions for an average price of $924,837 from August 2009 to January 2016 (see Figure 3). This average sales price represents a notable difference from the values represented at Barrett Jackson and reflects the pedigree of Ferraris that are sold at Mecum Auctions.

The auction company Gooding & Company annually hosts auction events in Scottsdale, Arizona, Amelia Island, Florida, and Monterey, California. Compared to Mecum Auctions and Barrett Jackson, Gooding & Company "appreciates the privilege of presenting distinguished vehicles from prestigious collections" (Goodingco.com).

The vintage Ferraris sold at Gooding & Co. that are included in this study average $1,859,020 from 232 examples that were sold from August 2004 to January 2016 (see Figure 4). Table 1 shows four cars that sold for over $15,000,000; two 1961 250 GT SWB California's, a 1961 250 GT SWB Berlinetta Speciale, and a 1957 250 Testa Rossa.

Table 2. Gooding & Co. sales over $15,000,000

Model	Sales Price, $	Auc Date	Auc Location
1961 250 GT SWB California	16,952,859	Aug 16, 2015	Monterey, CA
1961 250 GT Bertone Coupé	16,620,450	Aug 16, 2015	Monterey, CA
1961 250 GT SWB California	15,406,182	Aug 17, 2014	Monterey, CA
1957 250 Testa Rossa	17,686,449	Aug 21, 2011	Monterey, CA

After taking these four cars out of the data set, the average price decreases slightly to $1,599,240 (see Figure 5).

After its first auction event in Toronto in 1992, RM Sotheby's expanded its operations throughout the 1990's to include a number of additional locations around the United States, including Monterey, California. The continued expansion saw locations in Europe included during the mid-2000's. Currently, the auction events take place in all over the world, from Monaco and London to Scottsdale, Arizona and Monterey, California. An RM Sotheby's auction generally represents a higher relative number of vintage Ferraris than any of the other previously mentioned auction companies. From 822 total observations, the data set in this study contains 544 sales from RM Sotheby's, averaging $1,612,933 (see Figure 6). RM Sotheby's has three sales over $25,000,000; a 1967 275 GTB/4 NART, a 1964 275 GTB/C Speciale, and a 1966 290 MM (see Table 3). Removing these three cars from the group drops the average price to $1,467,757 (see Figure 7).

Table 3. RM Sotheby's sales over $25,000,000

Model	Sales Price, $	Auc Date	Auc Location
1956 290 MM	28,254,765	Dec 10, 2015	New York, NY
1964 275 GTB/C Speciale	26,793,360	Aug 16, 2014	Monterey, CA
1967 275 GTB/4 NART	28,330,500	Aug 17, 2013	Monterey, CA

3.2 Summary of Vehicle Characteristics

When determining the value of a classic car, there are many factors that are taken into account which vary with each vehicle. Some of these include the manufacturer, model, history, condition, color, vehicle specifics, number produced, and mileage. These details for a car sale are not always documented and can be difficult to find. Even when these factors are known, there may not be a strong correlation with the price of a vehicle, as a buyer may have subjective reasons for making a purchase.

Subjectivity on the importance of this information can be shown in this study in a number of ways. Not all auction houses seek and provide the same information. A description of chassis #14819, a 1971 Ferrari 365 GTB/4 Daytona, sold by Barrett Jackson in 2003 includes few details. The first description is mileage, followed by a list of recently completed updates, and ends noting the original records and tool kit are included (Daytona-Barrett, 2003). This same car sold at a 2010 Gooding & Co auction and the information provided noted that it was verified by Ferrari expert Marcel Massini, it came with original books and tools, and was regularly serviced by “Ferrari Experts” (Daytona-Gooding, 2010). In 2013 and in 2016, #14819 was sold by RM Sotheby’s. Both times, the amount of information provided on the car is substantially more than either of the previous two sales. RM Sotheby’s description begins with a summary of the model history that details the story of how the car was developed, information and

specifics about the engine and vehicle performance, and includes the number of cars produced. This description is followed by the history of the specific car, noting where and when the car was first delivered, known owners, and any known repair or maintenance work done to the car. The summary concludes with information about the current condition of the car and how it will be presented in the sale (Daytona-RM1, 2013, Daytona-RM2, 2016).

While Barrett Jackson's car descriptions have changed from 2003 to include additional information, they do not provide the same level of detail as RM Sotheby's. This is a consequence of both the crowd that attends Barrett Jackson auctions and the focus of the company. Barrett Jackson caters to a larger audience than just high-end car collectors and therefore lists the mileage first because it is important for most vehicles and most buyers. RM Sotheby's notes mileage at the end of their description because it is not as important for vintage Ferraris and other classic cars. The vehicles in this study are between 42 and 70 years old and many of the cars are restored. Restoring a car usually resets the mileage to zero because so many mechanical parts of the car are taken apart, refurbished, and put back together. A car may be 50 years old with 50,000 miles, but a restoration project would bring the car to "new" condition.

3.3 Model Condition

Collectors generally have two points of view when it comes to driving a Ferrari: Ferraris are meant to be driven or Ferraris are too valuable to be driven. Cars that are driven need to be maintained and after years of wear are often restored. At the same time, originality is very important to a car collector. Documentation that shows history of

a car's repair work and any modifications adds to the value of a car. This documentation normally includes owners, races (if applicable), and award shows (if applicable).

There are also differing opinions about how a car should be maintained and the condition it should be kept in. Original condition normally means a car is unrestored and the only work completed has been for maintenance purposes. Everything on the car should be original as it came from the factory, including parts from the spark plugs to the tires. Because originality is important to a classic car buyer, restoration processes take time and when original parts cannot be found, duplicates might have to be made. Sometimes these duplicates are even made in the same fashion as the original parts; ie handmade vs machine made.

A restoration process returns a car to new condition, at the time of production. A restored 1967 330 GTC will look as good as it did when it came out of the factory in 1967. Many collectors prefer restoring a car because it takes away the effects of time and usually results in having a car that is capable of winning awards at concours events.

Preservation is a recent trend that cleans an old car using special techniques that do not disturb or damage the car. Whereas complete restoration will strip and repaint the car and update the parts with newer ones, the preservation process keeps the original parts, including paint, and cleans the car with delicate tools to preserve the quality of the original materials. The decision to preserve or restore a car can be very subjective, but as the trend becomes more prevalent at concours events, the aspect of objectivity will increase (Yeager, 2015).

3.4 Model Standardization

As mentioned, the first Ferrari models were individually unique because of the individualized handmade process. When sorting the collected data, a standardization process is required to combine model names and limit the impact of outliers. As an example of the number of models in the data collected, there are 21 different models and 206 observations with the "250" model name nomenclature. Model names are combined into thirteen groups and a summary of the sorting detail by sales price follows here. Additional factors were taken into account when combining models into similar groups, such as lineage, engine size, and year of production. This information is also discussed in more detail in the results section 5.1.

The model code 1 consists of the very first Ferrari road and race cars: 166 MM, 166 Inter, and 195 Inter. The twenty cars in this group sold for an average price of $1,733,537. Model code 2 includes the Dino road cars while model code 3 lists the 5 Dino race cars. There is a distinction due to the large difference in sale prices. The Dino road cars averaged $354,470 over 90 sales, while the five race cars sold for an average of $2,516,054. Model code 4 covers the 212 models as well as the 225 S cars. A total of 24 cars of these early production Ferraris are included in the group and are some of the most valuable road cars, averaging $2,251,974. Fifty-eight cars fill model code 5 and are the early 250 GT models, including the 250 GT, the 250 GT Boano, the 250 GT Ellena, and the 250 GTE. Produced in the mid-1950s, this group of road cars were aimed at Ferraris high-end clientele seeking luxury over than performance. The 58 examples in this data set sold for an average of $453,150. Model code 6 includes some of the rarest and most desired Ferraris ever produced, including the 250 GT California and the 250 Testa Rossa. The average sales price for the 69 cars in this group is $7,880,587.

The group for model code 7 contains the 275 GTB line, which were built in the mid-1960s. The data set includes 106 cars that sold for an average price of $1,777,636. Model code 8 contains just three cars due to their extremely high sales prices. A 275 GTB NART, a 275 GTB/C Speciale, and a 290 MM comprise the lot of this group with an average sales price of $27,792,875. 84 cars are included in model code 9, with an average auction price of $424,713. These cars are from the 330 line, which along with the previously mentioned early 250 GT models, are "2+2" cars, meaning they have 2 front seats and 2 rear seats for additional passengers. The 14 cars that comprise model code 10 sold for an average of $2,397,427. Most of the cars in this group are the 330 GTS, the open-roof, two-seat version of the 330 GTC. Model code 11 includes 17 special cars, the 340 sport prototypes and the 375 America road cars. These Ferraris were produced in the early 1950's to race in the world's most prestigious events like the Mille Miglia. The cars in this group sold for an average price of $3,669,412. Model code 12 is the largest group with 179 entries, and also the lowest average value at the auction block; $300,156. The majority of cars in this group are the 365 GTB/4 Daytona, a very popular car that had high production numbers and thus they are relatively numerous at classic car auctions. The 153 cars included in model code 13 sold for an average price of $2,785,120. This group contains a lineage of cars that are relatively related to each other, from the 250 Europa to the 400 Superamerica.

3.5 Color Standardization

Ferrari race cars are famously painted red and this characteristic usually carries over to the production cars as well. The association with the color red comes from the origins of international car racing in the early 1900's, when cars were painted to identify

which their country origination (Motorsportsmemorial.org, 2016). With Italy's color being red, almost all of Ferrari racing cars are painted red to represent their country. This trait carries over to the road cars as well and in this study, 413 of 822 cars are red. The other cars are various colors, including black, silver, yellow, green, and one that is purple. To simplify this variable, five dummy variables representing the different colors are created. The dummy variables include one each for red, black, silver, blue, and one for all other colors. Other than red, with 413 observations, and black, with 59 entries, the rest of the variables have approximately 100 observations each.

This variable is included to explore the possibility of a measurable relationship between sales prices and colors. Color preference is usually subjective and might have significant impact on the demand for a car.

3.6 Roof Standardization

Including a variable to differentiate between convertibles and coupes turns out to be more complicated than expected. From a manufacturer's standpoint, coupes are generally preferred for a performance or racing car because the whole body of the car acts as a single piece and is more rigid and weighs less upon construction. Taking away the roof normally reduces the stiffness of the car and causes it to flex. To accommodate for this, weight is added to strengthen the chassis. Additional weight comes from the folding top. Until the most recent Ferraris solved this problem through the use of exotic materials and clever engineering, body flex in a convertible has always been a noticeable and unwelcome characteristic for purist automobile enthusiasts.

There are plenty of people, however, who prefer an open roof. To meet the demand of the convertible, Ferrari has created convertibles, targas, and also helps with

"conversions." Conversions are factory coupes that have had the roof removed through an aftermarket shop. The Ferrari factory does approve and recognize some of these changes, thus increasing the value of the car, but an unauthorized conversion might have a negative impact on the value.

A targa is a hard top that can be removed. Typically, there are rear pillars on the car that helps attach the roof to the rest of the body at the windshield. When the roof is removed, there is an open space above the driver and passenger. The targa gives the sensation of a convertible, with the benefits of a hard top.

To simplify the model, this category features one dummy variable that is equal to one for hardtops, and zero for all others.

3.7 Economic Indicators

The two U.S. economic indicators included are U.S. Personal Consumption Expenditures and Crude Oil, using the Brent Crude Oil Index. The PCE provides a large scale view of the trends of the US economy and of what consumers are doing with their money. While the price of crude oil is an indicator of the strength of the economy, it is a good measure to include when relating the trends of the overall economy to automobile sales. Liddle (2012) shows that gasoline price does not Granger cause ownership of automobiles. While Liddle's study does not apply directly to vintage Ferrari sales, it does help provide an idea of what to expect when looking at the relationship with the oil price and the sales price of Ferraris. It should also be noted that someone with the wealth to purchase a million dollar Ferrari might not be concerned with the cost of fuel for a number of reasons, including the possibility that the car might not actually be driven.

This unobserved product trait might have an impact on the relationship between the indicator and the sales prices.

The natural logs of both indicators were used to show these quantities as linear functions against time. Using the natural logs also helps view the parameter as an elasticity. Figure 8 shows the natural log of PCE quarterly from July 2002 to January 2016. The overall trend increases, with a decline in 2008 marking the global recession. There is also a slight decline at the end of 2014, which followed the severe drop in oil prices.

The change in oil prices can be seen in Figure 9, which shows both the level form and natural log of the Brent Crude Index monthly from July 2002 to January 2016. Oil prices rise steadily until the 2008 recession, when a steep decline occurs. A rise is observed for a few years, followed by a plateau from 2011 until 2014, when prices steadily decline.

3.8 Additional Variables

Additional variables include the auction year, age of the car, and the square of the age. The auction year variable is a time trend. Age of the car may have a non-linear relationship with the price, therefore it is helpful to include its square which allows the model to more accurately reflect the effect of time.

Because the auctions take place around the world, a variable for the original currency of sale is included to determine if there is a trend associated with different locations. Currency code 1 is US Dollars, code 3 represent Euros, and code 4 is British Pounds. Because there is only one observation with Code 2, Danish Krones, it is dropped.

The independent variable, sale price, is converted to 2016 US Dollars to avoid any issues with inflation and differing currency strengths.

3.9 Model Variables

Table 4. Model variables

	Variable Description	Variable	Unit Type
Y_i	Nat. Log of Auction Sale Price	*ln*Price	US Dollars
X_1	Nat. Log of Crude Oil Price per Barrel	*ln*Oil (quarterly)	US Dollars
X_2	Nat. Log of Pers. Consump. Expenditures	*ln*PCE (quarterly)	% Change
X_3	Auction Year	Auc_year	Number
X_4	Age (Auction Year minus Year of Product.)	Age	Number
X_5	Square of Age	Age2	Number
X_6	Ferrari Model	Model_code	Dummy
X_7	Auction House	Auc_house	Dummy
X_8	Exterior Color	Color_code	Dummy
X_9	Roof	Roof	Dummy
X_{10}	Original Currency of Sale	Currency	Dummy

3.10 Multiple Sales Points

Chassis 0673GT (Figure 10)

When Ferrari brought the 250 Europa GT to the Paris Show in 1954, it set a precedent for future Ferrari 250 models and laid the foundation as the first road production model. Until that point, Ferrari road cars were handmade in very small numbers for wealthy clientele who followed the Ferrari race program. The 250 Europa GT was the first Ferrari to be built in higher production numbers to account for greater demand from new customers. Due to the demand, the coachbuilder Carrozzeria Boano built 67 cars.

The second to last Boano car to be built, serial number 0673 GT, was owned by a number of California residents, including a Hollywood movie producer. From 1999 to

2001, the car was taken apart and completely restored. When the restoration process was complete, the Ferrari won several awards at prestigious car shows around the United States.

In 2007, RM Sotheby's auctioned 0673GT for $850,944. Two years later, it sold at the Gooding & Company Pebble Beach auction for $618,805, a decrease of 27% from the 2007 price. In March, 2011, the Ferrari was brought back to RM Sotheby's and sold for $652,855, a decrease of 23% from the initial auction price in 2007. The 2007 price represents a bubble in the market, while the other two prices are more in line with the rest of the correct market pricing for this model.

For comparison, the average sales price of the 58 data points in model code 5 is $419,138. The 2007 auction of 0673GT took place in Scottsdale, Arizona, on January 10. RM Sotheby's was responsible for selling the car. The final price of $850,944 is more than double the average price of similar cars. A market bubble would explain why the 2007 price is so high, compared to successive auction events.

Chassis 2153GT (Figure 11)

Chassis #2153 GT is a 1960 Ferrari 250 GT Cabriolet Series II, the 98th of 200 Cabriolet Series II that were made by Ferrari from 1959-1962. During this time, Ferrari produced two different types of convertibles, the 250 GT Cabriolet and the 250 GT California. The Cabriolet is an open-top "touring" car that catered more toward a luxurious drive than a sporty one. Initially, forty Cabriolets were produced before some changes were made and an additional one hundred sixty "Series II" came off the production line. The second line of Cabriolets had some changes in the mechanics of the car as well as slight changes to the overall styling. Updated looks include open

headlights, a rounder nose, and rear fenders with longer tail light lenses. Additionally, more space was created in the interior giving the driver and passenger more room for comfort during long drives. There was also plenty of room was designed into the trunk to allow space for luggage alongside the soft convertible top. The latest version of the Ferrari V12 engine was installed in the Series II, which was an improvement on both power and reliability.

This specific car, 2153 GT, was originally sold to a Belgian owner in 1960, before being imported to the US in the late 1960s or early 1970s. Historical records indicate it moved around the country until 2012 when it was brought to California from Hawaii to be fully restored back to it's original color and condition. From 2013 to 2015, the car was taken apart, cleaned, painted, and put back together to a 1960 "new" condition. The original engine has stayed with the car, as have many of it's original parts.

In January of 2003, Ferrari 2153 GT sold at the Barrett Jackson Auction in Scottsdale, Arizona for $237,311. The buyer was David Walters, a known collector who kept the car in Hawaii where it remained until 2012 when his estate sold it. The new owner fully restored the car and in January of 2016, 2153 GT sold for $1,650,000 at the RM Sotheby's Auction in Scottsdale, Arizona. Over 13 years, the car increased in value almost sevenfold.

Chassis 1307GT (Figure 12)

In the late 1950s, the United States was establishing itself as the largest market for Ferrari sales. To help ensure this relationship, Ferraris US sales representatives convinced Enzo Ferrari that it would be a good idea to create a car specifically designed for the California market. A total of 106 "California's" were produced in two separate

groups. First, a "LWB" (long wheelbase) version was produced from 1958 to 1960. From 1960 to 1962, a "SWB" (short wheelbase) model was created. The California is often considered one of the most beautiful cars ever built. As with many of the other cars in Ferraris history, the California was actually designed by Pininfarina, who penned and created the body, before sending it to the Ferrari factory to be mounted onto the frame. This car, 1307GT, was the 23rd of 50 LWB California's produced. Being built by hand, each car differed from the others in small but noticeable ways. Certain features on this example make it unique among California's such as factory installed front fender vents, an air intake on the hot, and open headlights.

Shortly after the first owner purchased the car in 1960, he sold it to a racing driver who entered the car in a number of events. Racing history means a number of things for a car's history including that it was used and driven hard, repaired and maintained, and may have won races.

Following a few years of racing, the car was sold privately many times, being restored and race again several times. In 2009 and 2010, the owners invested to have the car brought up to show car standards, and the car was detailed, rebuilt, and certified by Ferrari Classiche, the official Ferrari classic car program. In 2011, 1307GT was sold for just over $3.5 million to an art collector. He only kept the car for two years, before selling it privately. In 2015, the car again was auctioned for $8.5 million, a 245% increase from 2011.

Chassis 6049 SA (Figure 13)

While Ferrari made the California and Cabriolet open seat cars, they continued to produce hard top coupes with more horsepower that were designed for clients who

wanted the best performance in a luxury car. The 500 Superfast was the last Ferrari coupe produced in low numbers. A 5.0 liter engine was fitted into the 500 Superfast, which is larger and more powerful than the 3.0 liter in the 250 Cabriolet or the 250 California which were produced at the same time. The engine in the 500 Superfast produces 400 horsepower, whereas the 3.0 liter in the 250's makes 240 horsepower.

These cars were typically sold to high-profile customers and 6049 SA was no exception, being purchased by Prince Sadruddin Aga Khan, the well respected UN High Commissioner for Refugees. The car had five previous owners and only 40,000 miles in 2013 when it spent two years being restored to original condition.

All three auction sales observed for this car were through Gooding & Company. In March, 2010, 6049 SA sold for $891,574 at the Amelia Island auction. The second sale was in January, 2012 in Scottsdale, Arizona for $1.153 million, a 129% increase over two years. After the 2013 two-year restoration project, the car was sold again in 2015 at Pebble Beach for over $3 million, a 264% increase in value from 2013.

Chassis 8601 (Figure 14)

After great success in the early 1960s with the Ferrari 250 GTE, an updated car was needed, not only as a replacement, but also to put Ferrari ahead of the competition. The all new design unveiled in 1964 was the 330 GT. With an updated chassis for a smoother ride, improved suspension, and better brakes, the car drove better than the outgoing model. The engine was also improved, enlarged and more powerful than the one in the 250 GTE.

An entry level Ferrari at the time, the 330 GT fits into Ferrari's "family car" range, adding two seats in the back that can fit adults or extra space for luggage. This

version was also produced in greater numbers than other models, with 1087 cars coming off the line.

Serial number 8601 was first auctioned at RM Sotheby's *Ferrari Leggenda e Passione* auction, in May of 2007 for $96,600. The next year, it was sent across the auction block again with RM Sotheby's, this time in March at Amelia Island. The hammer price was $120,774, a 125% price increase in less than 12 months. Five years later, in 2013, the 8601 sold at RM Sotheby's Scottsdale event in January for $198,313. The 2013 price is a 164% increase from 2008, and a 205% increase from the first auction sale in 2007.

Chassis 14819 (Figure 15)

The last new V12 Ferrari created before FIAT took control of road car production in 1969 was the 365 GTB/4 "Daytona." The nickname was given by the media after Ferrari finished first, second, and third at the 1967 24-hour race in Daytona, Florida and has stuck with the car since. Pininfarina designed the body while Scaglietti built it. The model was one of the last handmade production cars to come out of the Ferrari factory.

At the time the 365 GTB/4 was the fastest production car in the world, with a top speed 3 mph higher than its closest competitor, the Lamborghini Miura P400. Blending styling of both the 1960s and 1970s, the Daytona was a massive success for Ferrari.

This specific example was owned by only a handful of Americans, who did not drive it often. In 2001, the car was restored in California, ahead of a Barrett Jackson auction sale in April of 2003, when it sold for $194,163. The car kept changing hands and in 2010 sold at the Gooding & Co Scottsdale auction for $319,279, a 164% increase in sales price. April of 2013 saw a special RM Sotheby's auction from collector Don

Davis, which included 14819. At $419,291, the Ferrari again increased its value, this time by 131%. In January of 2016, the RM Sotheby's auction in Scottsdale saw 14819 go across the trading floor, to be sold for $687,000. This latest price was a 164% increase on the last sale in 2013, and a 353% increase since the original auction sale 13 years earlier.

Chassis 15117 (Figure 16)

As mentioned, the 365 GTB/4 Daytona was one of Ferrari's most successful cars, with 1,284 units produced. Because of the relatively large production numbers of this Enzo-era car, there is typically a selection of models available for sale. The 365 GTB/4 makes up roughly 10% of the sample size of this study. Chassis 15117 is another example to show the consistency in the rise in value of Enzo-era Ferraris. In 2004, it was sold at the May RM Sotheby's in Houston, Texas, for $214,584. Eight years later, at the prestigious Monterey Auction, the 365 GTB/4 crossed the auction block for $415,047, a 193% increase from the 2004 sale. Only two years later in 2014, the Ferrari sold again at an auction. This time, Gooding & Company was the host at Amelia Island and the car brought an increase of 161% from its last auction sale, to $669,834. This value represents a 312% increase from the original 2004 sale.

Chassis 03128 (Figure 17)

Ferrari's Dino cars hold a special place in the family as they were produced in honor of Enzo Ferrari's son, the heir to the company until disease claimed his life when he was 24 years old. Before he died, Dino had been an engineer working on V6 racing engines for Ferrari. Following his death, Ferrari created a mid-engine, V6 coupe, a first

of both for the firm. The Dino's styling helped it quickly become a success and approximately 3,800 were produced until 1974.

Example 03128 was a coupe that was converted to a targa; a hard roof that can be removed for a convertible-like experience. While many cars have conversion transformations completed by aftermarket shops, this specific car was converted by Ferrari factory representatives who ensured factory quality and craftsmanship. Additionally, this car has power windows and factory-installed air conditioning, both of which are uncommon for cars in the era. Furthermore, it was the subject of a three-year restoration project.

In 2008, the car sold for $176,516 at the Amelia Island RM Sotheby's event. The following year, it was again auctioned by RM Sotheby's, this time selling for $179,453, an increase of 102%. In 2015, Mecum Auction sold the car for $191,387, a 107% increase from 2009 and a 108% increase from 2008.

CHAPTER 4: METHODOLOGY

4.1 Hedonic Regression

Hedonic regression can be used to estimate the price of an automobile by specifying individual characteristics. Ohta and Griliches (1976) and Rosen (1974) describe the hedonic method as a way to view a good as a bundle of characteristics or attributes for which implicit prices can be derived from prices of different versions of the same commodity containing different levels of specific characteristics. Hedonic regression can also estimate the value of individual attributes, as done by Espey (2000) and Fan and Rubin (2010) who looked at automobile sales to examine the value of fuel economy. The hedonic model that fits the best will incorporate variables of statistical significance.

The following sections will discuss the data collection method, model specification, model functional form, collinearity, and heteroscedasticity.

4.2 Data Collection

The initial data collection began by contacting each of the four auction houses to determine if and how digital records of their auction events were available. As mentioned in the introduction, a number of other sources were also contacted in an effort to utilize existing data. This information proved to be unavailable, mainly because databases of this type have not yet been created.

Data for each vehicle sale were gathered directly from the four auction houses' websites. Each auction house provides different information; RM Sotheby's always provides the most information, typically including a description of the car and its history. Barrett Jackson and Mecum generally provide the least amount of information, however would often include the serial number, which is the most important piece of information to confirm a car's identity.

To supplement missing data, a variety of informational sources were used, including the *Official Ferrari Magazine*, *FORZA: The Magazine About Ferrari*, and the website barchetta.cc. If the name of the car was written in error and a serial number was not provided, knowing the auction date and approximating the name or knowing the sales price usually resulted in successful searches for confirming specific information and details.

Twenty-six variables for each of the cars was collected; including date of sale, location of sale, year of car, model of car, model trim, roof, engine cylinders, chassis number, and original price. While filling in those categories, the cars were divided into the three time periods discussed in the introduction: Enzo, FIAT, and Montezemelo.

4.3 Model Specification

Using the variables described in section 3.9, equation 4.1 shows the hedonic model without dummy variables.

$$\ln Y_i = B_0 + B_1 ATT_i + B_2 MACRO_i + e_i \,, \tag{4.1}$$

where B_0, B_1, B_2 are paratmeters to be estimated, ATT_i is a vector of car attributes, and $MACRO_i$ is a vector of macroeconomic conditions at the time of the sale of the

automobile. The variables are listed in Table 4 and a summary of the dummy variables follows.

- Let $D_1 = 1$ if the car model is a 166 MM Le Mans, 166 MM, 166 Inter SC, 166 Inter, or a 195 Inter and 0 otherwise.
- Let $D_2 = 1$ if the car model is a Dino 206 GT, Dino 206 GT Alloy, Dino 246 GT, Dino 246 GT L-Series, Dino 246 GT Alloy, Dino 246 GT Conversion, Dino 246 GTS, or a Dino 246 GTS "Chairs and Flares," and 0 otherwise.
- Let $D_3 = 1$ if the car model is a Dino 206 S or a Dino 206 SP, and 0 otherwise.
- Let $D_4 = 1$ if the car is a 212 Inter, 212 Export, 212 E Montagna, or a 225 S, and 0 otherwise.
- Let $D_5 = 1$ if the car model is a 250 GT, 250 GT Boano, 250 GT Ellena, or a 250 GTE, and 0 otherwise.
- Let $D_6 = 1$ if the car model is a 250 GT Cabriolet, 250 GT LWB California, 250 GT LWB California Competizione, 250 GT SWB, 250 GT SWB California, 250 GT Competizione, 250 GT Tour de France, 250 LM, 250 Testa Rossa, 1955 250 GT, 275 GTB/C, 330 TR/LM, or a 340 America, and 0 otherwise.
- Let $D_7 = 1$ if the car model is a 275 GTB, 275 GTB Alloy, 275 GTB Alloy Long-nose, 275 GTB NART Conversion, 275 GTB Short-nose, 275 GTB/4, 275 GTB/4 Competizione Speciale, 275 GTB/4 Alloy, 275 GTB/6C, 275 GTB/6C Alloy, 275 GTS, 275 GTS/4, 275 GTS/4 NART, or a 1969 312 Formula One Car, and 0 otherwise.
- Let $D_8 = 1$ if the car model is a 275 GTB NART, 275 GTB/C Speciale, or a 290 MM, and 0 otherwise.

- Let $D_9 = 1$ if the car model is a 330 America, 330 GT, 330 GTC, or a 340 MM, and 0 otherwise.
- Let $D_{10} = 1$ if the car model is a 330 GTS, or a 330 GTC Speciale, and 0 otherwise.
- Let $D_{11} = 1$ if the car model is a 340 America, 340 Mexico, 340 MM, or a 375 America and 0 otherwise.
- Let $D_{12} = 1$ if the car model is a 365 GT, 365 GT Chinetti NART, 365 GT Conversion, 365 GT4, 365 GT4 BB, 365 GTB/4 Daytona, 365 GTB/4 Daytona Conversion, 365 GTC, 365 GTC/4, 365 GTC/4 Straman Conversion, or a 365 GTS/4 Daytona Conversion, and 0 otherwise.
- Let $D_{13} = 1$ if the car model is a 250 Europa, 250 Europa GT, 250 GT Cabriolet Series II, 250 GT Lusso, 250 GT Speciale, 250 MM, 250 Monza, 365 California, 365 GTB/4 Daytona Competizione, 365 GTB/4 Daytona Speciale, 365 GTS, 365 GTS/4 Daytona, 400 Superamerica, 400 SWB, 400 Superamerica SWB Aerodinamico, 400 Superamerica LWB Aerodinamico Series II, 410 Superamerica Series I, 410 Superamerica Series II, 410 Superamerica Series III, 410 Sport, 500 Mondial, 500 TRC, 500 Superfast, 512 M, 750 Monza, 857 Sport, or a 860 Monza, and 0 otherwise.
- Let $D_{14} = 1$ if the auction house is RM Sotheby's and 0 otherwise.
- Let $D_{15} = 1$ if the auction company is Gooding & Company and 0 otherwise.
- Let $D_{16} = 1$ if the auction house is Barrett Jackson and 0 otherwise.
- Let $D_{17} = 1$ if the auction house is Mecum and 0 otherwise.
- Let $D_{18} = 1$ if the exterior color is red and 0 otherwise.

- Let $D_{19} = 1$ if the exterior color is black and 0 otherwise.
- Let $D_{20} = 1$ if the exterior color is silver and 0 otherwise.
- Let $D_{21} = 1$ if the exterior color is blue and 0 otherwise.
- Let $D_{22} = 1$ if the exterior color is white, yellow, brown, beige, copper, bronze, green, maroon, or purple, and 0 otherwise.
- Let $D_{23} = 1$ if the car has a roof and 0 otherwise.

To account for a potential collinearity problem, the first dummy variable from each parameter is removed.

Table 5 lists the descriptive statistics of the gathered data. Looking at the mean can show the balance of the variable; such as 68% of the cars being hard tops.

Table 5. Attributes and descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Unit type
*ln*Price	822	13.5071	1.222221	10.66	17.16	US Dollars
*ln*Oil	822	4.331231	0.42161	3.218876	4.888242	US Dollars
*ln*PCE	822	9.265212	0.1208005	8.913698	9.43222	% of Change
Auc_year	822	2010.639	3.529187	2002	2016	Number
Age	822	45.59611	7.158881	29	66	Number
Age^2	822	2130.192	669.941	841	4356	Number
Model_code	822	8.519465	3.884632	1	13	Dummy
Auc_house	822	1.418491	0.6731667	1	4	Dummy
Color_code	822	2.360097	1.553516	1	5	Dummy
Roof	822	0.6800487	0.4667414	0	1	Dummy
Currency	822	1.543796	1.009048	1	4	Dummy

4.4 Functional Form

The model uses a semi-log specification, with the natural log of price on the left and most of the right-hand side variables unchanged. The natural log form of Oil and PCE are used on the right-hand side to show elasticity. Varela-Irima (2014) notes that the previous studies of Dalen and Bode (2004) and Requena-Silvente and Walker (2006)

have discussed using this functional form for similar studies. This decision is made to achieve linearity in the model.

4.5 Collinearity

Automobile characteristics are frequently correlated with one another; name with engine size, horsepower with engine cylinders, horsepower with top speed and fuel economy, etc. Understanding this possible problem, the variables included in this study were tested for collinearity using the Stata command *collin*. The tolerances of the parameter estimates are given, as is the the variance inflation factor as a result of any collinearity in the variables. The collinearity diagnostic yields Table 6.

Table 6. First test for collinearity

Collinearity Diagnostics

Variable	VIF	SQRT VIF	Tolerance	R-Squared	Eigenval	Cond Index
lnprice	1.76	1.33	0.5667	0.4333	10.7073	1
lnoil	1.5	1.23	0.6658	0.3342	0.354	5.5
lnpce	32.64	5.71	0.0306	0.9694	0.2873	6.1049
auc_year	30.68	5.54	0.0326	0.9674	0.2783	6.2024
age	144.74	12.03	0.0069	0.9931	0.164	8.079
age2	138.34	11.76	0.0072	0.9928	0.14	8.7467
model_code	1.08	1.04	0.9217	0.0783	0.0581	13.5781
auc_house	1.17	1.08	0.8534	0.1466	0.0069	39.3689
color_code	1.07	1.03	0.9387	0.0613	0.0039	52.4134
roof	1.19	1.09	0.8375	0.1625	0.0001	284.2115
currency	1.2	1.09	0.8341	0.1659	0.0001	398.0699
Mean VIF	32.31					

	13738.577
Condition Number	2
Eigenvalues & Cond Index computed from scaled raw sscp	
Det(correlation matrix)	0.0001

Based on the results of the collinearity test, the PCE, Auction Year, Age, and Age2 variables need further investigation due to high VIF values and low tolerance values. Table 7 removes the PCE and age variables, yielding better VIF and tolerance figures.

Table 7. Second test for collinearity

Collinearity Diagnostics

Variable	VIF	SQRT VIF	Tolerance	R-Squared	Eigenval	Cond Index
lnprice	1.69	1.3	0.5922	0.4078	8.7411	1
lnoil	1.16	1.08	0.8622	0.1378	0.3521	4.9822
auc_year	1.39	1.18	0.719	0.281	0.2811	5.5766
age2	1.69	1.3	0.5922	0.4078	0.2782	5.6054
model_code	1.08	1.04	0.9263	0.0737	0.1584	7.4291
auc_house	1.16	1.08	0.859	0.141	0.1282	8.2586
color_code	1.06	1.03	0.94	0.06	0.0508	13.1138
roof	1.16	1.08	0.8589	0.1411	0.0066	36.3671
currency	1.16	1.08	0.8602	0.1398	0.0035	50.0136
Mean VIF	1.28					

Condition Number 2798.1605
Eigenvalues & Cond Index computed from scaled raw sscp
Det(correlation matrix) 0.3335

4.6 Heteroscedasticity

With the number of different auctions, dates, and locations, as well as unobserved buyer preferences, heteroscedasticity might be present in the model. The *hettest* command in Stata provides the Breusch-Pagan / Cook-Weisberg test for heteroscedasticity and gives the results noted in Table 8. Although it is not present, a time trend and standard robust errors are used to correct for heteroscedasticity.

Table 8. Test for heteroscedasticity

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of lnprice
chi2(1) = 0.01
Prob > chi2 = 0.9042

CHAPTER 5: RESULTS AND INTERPRETATION

Table 9. Stata model results

Number of obs	821			R-squared	0.785
F(25, 795)	162.5			Root MSE	0.576
Prob > F	0				

lnprice	Coef.	Rbst. Std. Err.	t	P>t	[95% Conf.	Interval]
lnoil	0.146	0.056	2.59	0.01	0.035	0.256
auc_year	0.112	0.011	10.35	0	0.091	0.134
age2	0.0001	0.0001	1.42	0.155	-0.00005	0.0003
model_code						
2	-1.296	0.254	-5.1	0	-1.795	-0.797
3	0.827	0.294	2.82	0.005	0.250	1.404
4	0.102	0.190	0.53	0.593	-0.272	0.476
5	-0.903	0.200	-4.5	0	-1.296	-0.509
6	1.712	0.191	8.94	0	1.336	2.088
7	0.433	0.226	1.91	0.056	-0.011	0.877
8	2.630	0.319	8.24	0	2.004	3.257
9	-1.088	0.227	-4.8	0	-1.534	-0.643
10	0.099	0.258	0.38	0.702	-0.407	0.605
11	1.115	0.235	4.74	0	0.653	1.577
12	-0.781	0.254	-3.07	0.002	-1.280	-0.282
13	0.427	0.202	2.12	0.035	0.031	0.824
auc_house						
2	0.074	0.049	1.52	0.129	-0.022	0.171
3	-0.489	0.143	-3.41	0.001	-0.770	-0.207
4	-0.272	0.174	-1.56	0.119	-0.615	0.070
color_code						
2	0.002	0.087	0.02	0.981	-0.169	0.174
3	-0.122	0.058	-2.09	0.037	-0.236	-0.007
4	-0.128	0.060	-2.14	0.032	-0.245	-0.011
5	-0.035	0.061	-0.57	0.567	-0.155	0.085
roof	-0.256	0.055	-4.63	0	-0.364	-0.147
currency						
3	-0.045	0.061	-0.74	0.458	-0.165	0.074
4	-0.169	0.065	-2.6	0.01	-0.297	-0.041
_cons	-212.8	21.5	-9.88	0	-255.1	-170.5

5.1 Model Codes

Compared to model 1, models 2, 5, 9, and 12 are sold at large discounts; -127%, -79%, -99%, and -75%, respectively. Models 6, 8, and 11 are purchased at much higher values; 182%, 267%, and 116%, respectively. Models 3, 7, and 13 command slightly larger sales prices; 89%, 55%, and 53%, respectively. Models 4 and 10 are almost the same as model 1, with values of 16% and 23%, respectively. Models 4 and 10 are also the only cars that are not statistically significant, with t-statistic values less than one.

Models in group 1 are some of the first Ferraris produced, commanding an average of $1,733,537. They are rare and individually unique vehicles commanding higher prices. Model group 2 are the Dino road cars, which sell at the second lowest prices of the Enzo-era Ferraris. This low price is due in part to their performance characteristics, which are not as notable as the other Ferraris of the era. Dino road models were also produced in larger numbers than most of the other cars, making them more available. The five cars in model code 3 represent two types of Dino race cars, the 206 SP and the 206 S. Production numbers are very low for these two cars; eighteen of the Dino 206 S were produced and seventeen Dino 206 S.

Model 4 also consists of cars that were produced in low numbers. The 212 Inter and 212 Export are immediate successors to the cars in model group 1, thus the similar but slightly higher prices. The cars in model group 5 include the early 250 GT cars, which focused on luxury and high end clientele, rather than straight forward performance. As a result, these cars command lower auction prices. Model code 6 is a special group that includes the 250 GT California's. Produced in low numbers, these famous cars are some of most sought after Ferraris. The Ferrari 275 GTB, 275 GTB/4, and 275 GTS

comprise most of model group 7. The cars provided higher performance and a more aerodynamic and eye-pleasing design than the 250 GT it replaced (model code 5). Model code 8 separates three unique race cars that brought near record auction prices approaching $30,000,000. The cars in model group 9, the 330 GT, are direct decedents of model group 5 and likewise, do not command high prices at auctions. They are 2+2 cars that are designed for luxury over performance. Model code 10, the 330 GTS, is the "sports car version of the 330 GTC" (Ferrari). Removing the two rear seats, removing the roof, and changing the styling helps increase the auction prices of this car.

The cars in model group 11, the 340 America, 340 Mexico, 340 MM, and 375 America, saw success in the major sports car races of the era. As race cars, they demand a higher premium at auction houses. Model code 12 represents the 365 GTB/4 Daytona, as well as a few other similar models. Being one of Ferrari's most successful and numerous models of the Enzo-era, there is plenty of supply and most of these cars do not represent award quality models. The models in group 13 are grouped based on their similarities in being the V12 "flagship" cars that Ferrari produced during the time. The model code includes the 250 Europa, 400 Superamerica, and 500 Superfast.

5.2 Auction Houses

RM Sotheby's is the auction house to which the others are compared in this model. Gooding & Company sees results that are almost even with RM Sotheby's, having a markup of 7%. Barrett Jackson and Mecum both have large discounts compared to RM Sotheby's, 40% and 27%, respectively. All auction house results are statistically significant.

These results are not unexpected. As discussed in Section 3.1, which notes the are differences between the auction houses, the cars included in each event, and the participants who attend. RM Sotheby's and Gooding & Company are both on a different level than Barrett Jackson and Mecum.

5.3 Exterior Colors

When using red as the color to which the others are compared, black sees a sales price increase of 1%. Black, however, is statistically insignificant, with a t-statistic of 0.11. All other colors, however, see discounts in auction prices. Silver and blue are statistically significant, and have discounts of -12% and -14%, respectively. The color group 5, comprising of white, yellow, brown, grey, beige, copper, bronze, green, maroon, and purple, sees a discount of only 2%. This group is also statistically insignificant, with a t-statistic of -0.4.

5.4 Roofs

Whether or not a car has a roof is a complicated variable to study, as unobserved buyer preference might play a role. A roof might not be an option for certain models, like the vintage Ferrari California's. For other models, an open top might increase the value of the car. The average price for Ferrari 365 GTB/4 Daytona hardtops is $603,297, and $1,130,640 for convertibles. Overall in this study, hardtops sold for 23% less than convertibles and are statistically significant.

Of the sixteen Ferraris in this study that sold for more than $10,000,000, eight are open tops and eight have roofs. Of the eight with open tops, four are California's, the highly desirable convertible road cars. The other four are race cars. The eight coupes are mainly race cars, with a couple of extremely rare road cars included.

Table 10. Sales prices greater than $10,000,000

Auc Date	Model	Chassis #	Roof	Sales Price, $
Aug 17, 2013	1967 275 GTB/4 NART	10709	No	28,330,500.00
Dec 10, 2015	1956 290 MM	626	No	28,254,765.00
Aug 21, 2011	1957 250 Testa Rossa	0666TR	No	17,686,449.00
Aug 16, 2015	1961 250 GT SWB California	3095GT	No	16,952,859.00
Aug 17, 2014	1961 250 GT SWB California	2903GT	No	15,406,182.00
May 17, 2009	1957 250 Testa Rossa	0714TR	No	12,187,282.80
Aug 19, 2012	1960 250 GT LWB Calif. Comp.	1639 GT	No	11,817,327.50
May 18, 2008	1961 250 GT SWB California	2377GT	No	10,949,361.28
Aug 16, 2014	1964 275 GTB/C Speciale	6701	Yes	26,793,360.00
Aug 15, 2015	1964 250 LM	6105	Yes	17,728,480.00
Aug 16, 2015	1961 250 GT Bertone Coupé	3269GT	Yes	16,620,450.00
Nov 21, 2013	1964 250 LM	6107	Yes	14,731,860.00
Aug 15, 2015	1956 250 GT Tour de France	0557GT	Yes	13,296,360.00
May 25, 2013	1953 375 America	0320AM	Yes	12,745,710.21
Aug 16, 2014	1964 250 LM	6045	Yes	11,722,095.00
Aug 16, 2014	1967 275 GTB/4 NART	10621	Yes	10,326,607.50

5.5 Currency – Global Location of Sale

Compared to cars sold in the United States, those sold on mainland Europe have a 6% discount upon purchase. Ferraris sold in Great Britain are done so at an even larger difference, with a negative coefficient of 0.23. Both of these values are statistically significant. The primary reason for this difference is the impact of the prestige of the event in which a car participates. The Scottsdale auctions are the first of the calendar year and for Barrett Jackson, the January auction is historically the largest one of the year. The Monterey auction event caps off a special, week long automobile focused festival that includes the revered Pebble Beach Concours D'Elegance. This awards event is considered the most difficult to be invited to and the hardest to win. It is the pinnacle of the automobile awards events. With these factors together, the auction events in Monterey are the perfect location for the world's highest sales. London does not have

these environmental factors and thus does not draw the sales in the way the others do. An interesting study to be included in the future would be to explore the effect of the specific location on the sales price of the car rather than just the country of sale.

5.6 Additional Variables

The impact of the oil market did not have an effect on the price, with a 3% markup but a statistically insignificant t-statistic. The PCE indicator has a coefficient of 4.77 and is statistically significant, indicating a strong impact on the price of vintage Ferraris. Age shows a discount of 11%, indicating as a car gets older, it's value decreases. This is counterintuitive, but there are certain years, like 1961 and 1964, that see higher sales prices (see Table 10). The results of the auction year are also counterintuitive, as there is a 3% decrease in price as the auction year increases.

5.7 R-Squared and Overall Significance

With an R-squared value of 0.7937, the variables included in the model are relatively accurate in predicting a sales price. Removing the two economic indicators drops the R-squared value to 0.7846, indicating the structure of the model including the vehicle characteristics is consistent (see Table 13).

CHAPTER 6: CONCLUSION

While using hedonic regression to explore the price of an automobile as it relates to its characteristics is common, focusing on a single make is not. Most cars are sold and resold multiple times over their lifetimes, but many times these transactions are not recorded for future examination. The recognition of the importance of tracking data on a Ferrari helps a buyer learn about the car and confirm its history. Due to the low number of Ferraris in existence, it may be possible to create a database including all of the cars, their characteristics, and their sales prices.

This study explores the impact certain characteristics have on the auction price of a vintage Ferrari. The specific type of Ferrari is important, with the results showing a range of differences in prices between models. Also notable is the auction house that sells the car, with RM Sotheby's and Gooding & Company commanding premium sales pricing. Exterior colors that are not red or black see a slight discount in sales price, while coupes are valued 23% higher than convertibles.

Perhaps the most interesting results of the study include the age of the car and the year of the sale. Respectively having a 3% and a 11% discount factor on the price of a model, this goes against intuition that prices are rising and older cars are more valuable. Despite this result, Figure 1 clearly shows an increasing trend in average prices of vintage Ferraris, indicating more work needs to be done to determine an accurate forecast for future sales prices.

Because of the number of physical characteristics, environmental and economic factors, there is still work to do to determine the best relationship between the value of a vintage Ferrari and its characteristics. As this study continues, the most important addition will be including more observations. A number of Ferrari sales were not included in the data set; most notably from the two notable automobile auction companies, Russo and Steele, and Bonham's. Ferraris are also sold through aftermarket sales in dealerships or through secondhand experts like Michael Sheehan. It may be possible to track the sales of individual Ferraris which would provide a good picture of the market for those specific models. Being able to capture these details will help improve the economic model's ability to forecast prices in the future.

Another improvement will be the inclusion of additional vehicle characteristics. One observation that might require layers of detail is the impact of race history on a sale. The aura of owning a Ferrari and the popularity of the brand can largely be attributed to the company's race history. Ferrari was immensely successful in the sports car racing world during the 1950's and 1960's and Ferrari is also the most successful manufacturer in Formula One, and the only team that has participated in every Formula One World Championship since the inception of the formula, in 1950. This success on the track has translated to success in the showroom (admittedly, an empirical study of this statement is intriguing to the author). Unlike the cars of today, after a 1950's Ferrari was raced by the factory, it was usually sold to the public through the dealership network. Many of these cars still exist with collectors and race history will be one of a number of observations included as the study moves forward.

REFERENCES

Andersson, Henrik. (2005). *The Value of Safety as Revealed in the Swedish Car Market: An Application of the Hedonic Pricing Approach*. link.springer.com/article/10.1007/s11166-005-1154-1

Barchetta. *The Classic and Sports Car Portal*. barchetta.cc/All.Ferraris/ferrari.by.serial.number.summary/index.html

Barrett-Jackson.com

Cowling, Keith and John Cubbin. (1972). *Hedonic price indexes for United Kingdom cars*. Econ J 82(327):963–978

Dalen, Jan van and Ben Bode. (2004). *Quality-corrected price indices: the case of the Dutch new passenger car market, 1990–1999*. Applied Economics Vol. 36, Iss. 11, pp 3.

Daytona-Barrett. Lot #169. 1971 Ferrari 365 GTB/4 Daytona. barrett-jackson.com/Events/Event/Details/1971-FERRARI-365-GTB/4-DAYTONA-19900.

Daytona-Gooding. 1971 Ferrari 365 GTB/4 Daytona. goodingco.com/vehicle/1971-ferrari-365-gtb4-daytona/.

Daytona-RM1. Lot 126 1971 Ferrari 365 GTB/4 Daytona Coupe by Scalietti. rmsothebys.com/dd13/the-don-davis-collection/lots/1971-ferrari-365-gtb-4-daytona-coupe-by-scaglietti/1057748.

Daytona-RM2. Lot 220 1971 Ferrari 365 GTB/4 Daytona Berlinetta by Scaglietti. rmsothebys.com/az16/arizona/lots/1971-ferrari-365-gtb-4-daytona-berlinetta-by-scaglietti/1078358.

Edgar, William. (2011). The Archaeologist. *FORZA: The Magazine about Ferrari*. April 2011. edgarmotorsport.files.wordpress.com/2012/07/marcel-massini-forza-edgar.pdf

Espey, Molly and Santosh Nair. (2000). *Automobile Fuel Economy: What is it Worth?* ageconsearch.umn.edu/bitstream/20102/1/sp04es12.pdf?origin%3Dpublication_detail

Fan, Qin and Jonathan Rubin. (2010). *Two-Stage Hedonic Price Model for Light-Duty Vehicles*. Transportation Research Board of the National Academies. researchgate.net/profile/Qin_Fan3/publication/269528044_Two-Stage_Hedonic_Price_Model_for_Light-Duty_Vehicles/links/56eaeefd08ae2a58dc49ca1a.pdf

Federal Reserve Economic Data: FRED. Federal Reserve Bank of St. Louis. research.stlouisfed.org/fred2/.

Ferrari. Digital. auto.ferrari.com/en_US/ongoing-heritage/company/history/
Ghini, Antonio. (2015). The Official Ferrari Magazine. *Gran Turismo Models & Genealogies, 1947-2015*, 1-143.

GoodingCo.com

Goodman, Allen. (1997). *Andrew Court and the Invention of Hedonic Price Analysis*. Journal of Urban Economics. econ.wayne.edu/agoodman/research/PUBS/Deep/Court-JUE.pdf.

Graeser, P. (1993). *Rate of Return to Investment in American Antique Furniture.* Southern Economic Journal*, 59*(4), 817. nclive.org/cgi-bin/nclsm?url=http://search.proquest.com/docview/212100068?accountid=13217.

Griliches, Zvi. (1961). *Hedonic Price Indexes for Automobiles: An Econometric of Quality Change*. nber.org/chapters/c6492.

Kroonenberg Nellie and Cramer JS. (1974). *A hedonic price index for the Dutch car market*. De Economist. 122(4):357–366.

Liddle, Brantley. "The Systemic, Long-run Relation among Gasoline Demand, Gasoline Price, Income, and Vehicle Ownership in OECD Countries: Evidence from Panel Cointegration and Causality Modeling." *Transportation Research Part D: Transport and Environment* 17.4 (2012): 327-31.

Mecum.com

Monopoli, AV. (2016). *Barrett Jackson Timeline 2016 through 1971*. auto-appraisers.com/barret-jackson-timeline/

MotorsportsMemorial.org. *Country abbreviations and racing colours*. motorsportmemorial.org/misc/colours.php?db=ct.

Murray, Jonathan and Sarantis Nicholas. (1999). *Price-quality relations and hedonic price indexes for cars in the United Kingdom.* Int J Econ Bus 6(1):5–27.

Ohta, Makoto and Zvi Griliches. (1976). *Automobile Prices Revisited: Extensions of the Hedonic Hypothesis*. nber.org/chapters/c3966.pdf.

Ohta. Makoto. (1987). *Gasoline cost and hedonic price indexes of U.S. used cars for 1970–1983*. J Bus Econ Stat 5(4):521–528

Prado, Sylvain. (2009). *European used-car market at a glance: Hedonic resale price valuation in automotive leasing industry*. Economics Bulletin. economix.fr/pdf/dt/2009/WP_EcoX_2009-22.pdf

Reis, Hugo J and Silva JS. (2006). *Hedonic prices indexes for new passenger cars in Portugal (1997–2001)*. researchgate.net/profile/J_Santos_Silva/publication/4833612_Hedonic_prices_indexes_for_new_passenger_cars_in_Portugal_1997-2001/links/0c9605257c558b1b26000000.pdf.

Requena-Silvente, Francisco and James Walker. (2006). *Calculating hedonic price indices with unobserved product attributes: an application to the UK car market*. Economica, 73 (291). pp. 509-532. ISSN 1468-0335.

RMSothebys.com

Rosen, Sherwin. (1974). *Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition*. The Journal of Political Economy. https://www.jstor.org/stable/1830899

Roush, Cathy. (2014) *Who Do You Trust.* Ferrari Market Letter. January 4, 2014.

Saran, Edmond. (2012) *Marcel Massini: The Information King.* November 19, 2012. le-monde-edmond.com/marcel-massini-the-information-king/

Sheehan, Michael. *Ferrari Market Update*. Forza Magazine. Various issues.

Sheehan, Michael. (2009) *How Many Ferraris are There?* ferraris-online.com/pages/article.php?reqart=SCM_200903_SS

Sheehan, Michael. (2011) *Ferraris Cycle of Booms and Bust.* ferraris-online.com/pages/article.php?reqart=SCM_201109_SS

Sheehan, Michael. (2012) *Are Ferraris Booming or Bubbling?* ferraris-online.com/pages/article.php?reqart=SCM_201206_SS

Silvia, John and Azhar Iqbal. (2014) *Economic and Business Forecasting: Analyzing and Interpreting Econometric Results*, 1-382.

Sports Car Digest. (2009) *Barrett-Jackson Scottsdale Results*. January 24, 2009. sportscardigest.com/barrett-jackson-scottsdale-results/

Tomat, Gian Maria. (2002). *Durable goods, price indexes and quality change: an application to automobile prices in Italy, 1988–1998*. Working Paper 118, European Central Bank. zentral-bank.eu/pub/pdf/scpwps/ecbwp118.pdf.

Triplett, Jack. (1969). *Automobiles and Hedonic Quality Measurement* Journal of Political Economy, vol. 77, issue 3, pages 408-17.

Weber, Bruce. *Gerald Roush, Font of Ferrari Knowledge, Is Dead at 68*. The New York Times, May 29, 2010. nytimes.com/2010/05/30/business/30roush.html.

Vaughn, Mark. *Sold! GM Heritage Cars*. Autoweek, January 29, 2009. Digital. autoweek.com/article/car-news/sold-gm-heritage-cars

Varela-Irimia, Xosé-Luís. (2014). *Age effects, unobserved characteristics and hedonic price indexes: The Spanish car market in the 1990s*. link.springer.com/content/pdf/10.1007%2Fs13209-014-0108-8.pdf

Yeager, Robert. (2015) *A New Class of Ferrari Takes a Bow at Pebble Beach: Unrestored*. The New York Times, August 13, 2015. nytimes.com/2015/08/14/automobiles/collectibles/a-new-class-of-ferrari-takes-a-bow-at-pebble-beach-unrestored.html

APPENDIX A: SUPPLEMENTAL TABLES

Table 11: Initial model results before removing PCE and age

Number of obs	821			R-squared	0.7937	
F(27, 793)	157.85			Root MSE	0.56453	
Prob > F	0					
lnprice	Coef.	Rbst. Std. Err.	t	P>t	[95% Conf.	Interval]
lnoil	0.0281036	0.0598214	0.47	0.639	-0.0893235	0.1455306
lnpce	4.776081	0.9707958	4.92	0	2.870448	6.681714
auc_year	-0.0325278	0.0313188	-1.04	0.299	-0.0940053	0.0289497
age	-0.1079566	0.0473445	-2.28	0.023	-0.2008919	-0.0150213
age2	0.0012407	0.0004723	2.63	0.009	0.0003135	0.0021679
model_code						
2	-1.269013	0.2560473	-4.96	0	-1.771624	-0.7664023
3	0.8894047	0.2944718	3.02	0.003	0.3113682	1.467441
4	0.1567168	0.1922909	0.81	0.415	-0.2207424	0.5341761
5	-0.7901787	0.1999388	-3.95	0	-1.182651	-0.3977068
6	1.819689	0.1958455	9.29	0	1.435252	2.204126
7	0.5501619	0.2263641	2.43	0.015	0.1058181	0.9945056
8	2.676791	0.3198826	8.37	0	2.048875	3.304708
9	-0.9927074	0.2262585	-4.39	0	-1.436844	-0.548571
10	0.2282849	0.2574961	0.89	0.376	-0.2771695	0.7337394
11	1.16072	0.2335986	4.97	0	0.7021748	1.619264
12	-0.7457846	0.2544339	-2.93	0.003	-1.245228	-0.246341
13	0.5266065	0.2039125	2.58	0.01	0.1263344	0.9268786
auc_house						
2	0.0720815	0.0474752	1.52	0.129	-0.0211103	0.1652734
3	-0.4037369	0.1573904	-2.57	0.01	-0.7126879	-0.094786
4	-0.2692351	0.174035	-1.55	0.122	-0.6108588	0.0723886
color_code						
2	0.0095701	0.0859621	0.11	0.911	-0.1591701	0.1783102
3	-0.1196333	0.0560279	-2.14	0.033	-0.2296139	-0.0096528
4	-0.1408201	0.0568988	-2.47	0.014	-0.2525101	-0.02913
5	-0.0238242	0.0594128	-0.4	0.689	-0.1404491	0.0928007
roof	-0.233655	0.0565383	-4.13	0	-0.3446375	-0.1226725
currency						
3	-0.058783	0.0589758	-1	0.319	-0.1745503	0.0569842
4	-0.2318636	0.0643507	-3.6	0	-0.3581815	-0.1055457
_cons	37.12708	54.73609	0.68	0.498	-70.31767	144.5718

Table 12: Model results without economic indicators

Number of obs	821			R-squared	0.7846
F(25, 795)	160.46			Root MSE	0.57609
Prob > F	0				
lnprice	Coef.	Rbst. Std. Err.	t	P>t	[95% Conf.	Interval]
auc_year	0.1262616	0.0126447	9.99	0	0.1014406	0.1510826
age	-0.0994712	0.0455572	-2.18	0.029	-0.1888979	-0.0100445
age2	0.0011342	0.0004542	2.5	0.013	0.0002425	0.0020258
model_code						
2	-1.337045	0.2559508	-5.22	0	-1.839464	-0.8346258
3	0.8919559	0.3000651	2.97	0.003	0.3029423	1.48097
4	0.1155206	0.1906972	0.61	0.545	-0.2588089	0.4898501
5	-0.8363048	0.2007695	-4.17	0	-1.230406	-0.4422038
6	1.785784	0.1939251	9.21	0	1.405118	2.16645
7	0.4846814	0.225757	2.15	0.032	0.0415313	0.9278316
8	2.681135	0.3247525	8.26	0	2.043661	3.318609
9	-1.042055	0.2258172	-4.61	0	-1.485324	-0.5987866
10	0.1504676	0.2532699	0.59	0.553	-0.3466892	0.6476244
11	1.184326	0.2319327	5.11	0	0.7290533	1.639599
12	-0.8011682	0.2548558	-3.14	0.002	-1.301438	-0.3008983
13	0.4862908	0.2024588	2.4	0.017	0.0888738	0.8837077
auc_house						
2	0.0946225	0.0486693	1.94	0.052	-0.0009131	0.1901581
3	-0.5796199	0.1367866	-4.24	0	-0.8481255	-0.3111142
4	-0.2428959	0.1746515	-1.39	0.165	-0.5857285	0.0999367
color_code						
2	0.0184825	0.0878369	0.21	0.833	-0.153937	0.1909021
3	-0.112637	0.0585207	-1.92	0.055	-0.2275103	0.0022363
4	-0.1228895	0.0586337	-2.1	0.036	-0.2379847	-0.0077944
5	-0.0250863	0.0606031	-0.41	0.679	-0.1440474	0.0938747
roof	-0.2385119	0.056829	-4.2	0	-0.3500645	-0.1269593
currency						
3	-0.0248918	0.0613141	-0.41	0.685	-0.1452485	0.0954649
4	-0.1305064	0.0654788	-1.99	0.047	-0.2590383	-0.0019745
_cons	-237.8942	24.61694	-9.66	0	-286.2161	-189.5724

APPENDIX B: FIGURES

Figure 1: Average prices of Enzo-era Ferraris, 2003-2015

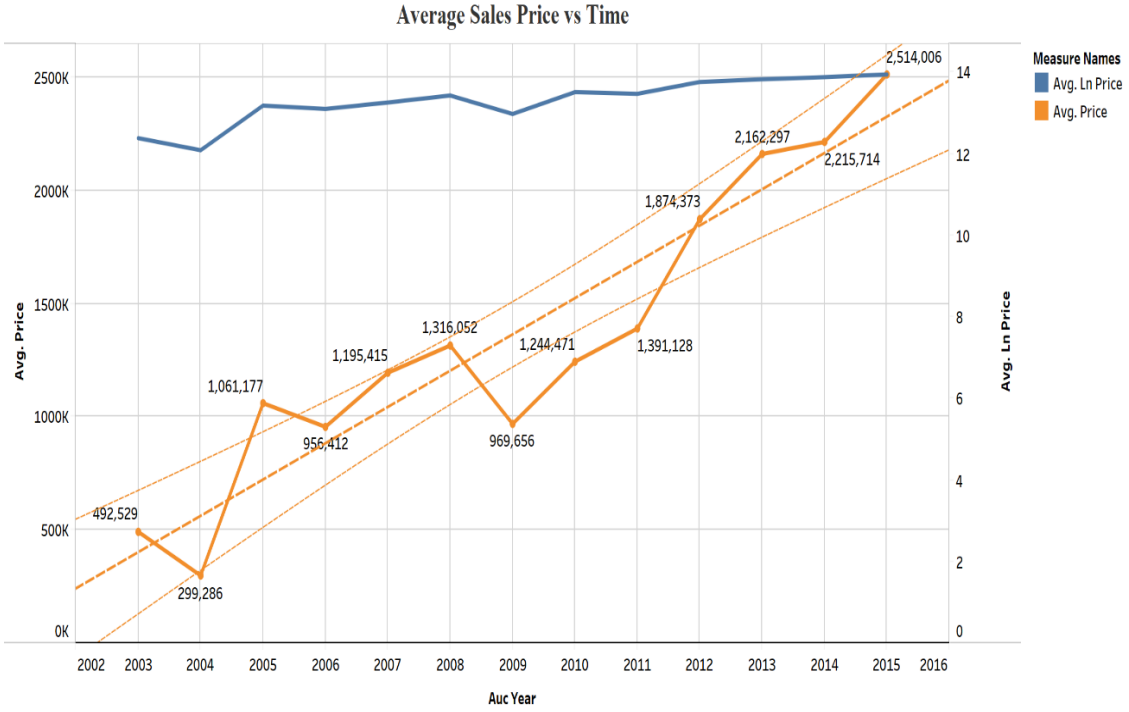

Figure 2: Avg. prices of Enzo-era Ferraris at Barrett Jackson auctions, 2003-2015

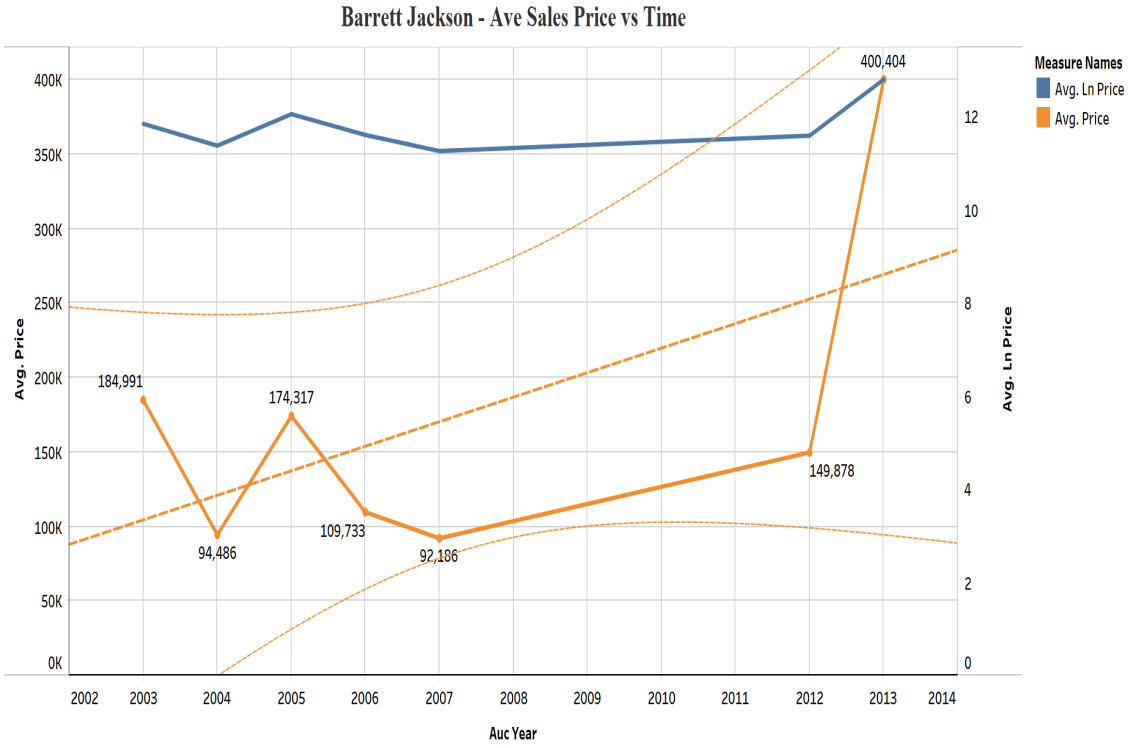

Figure 3: Avg. prices of Enzo-era Ferraris at Mecum Auctions auctions, 2009-2015

Figure 4: Avg. prices of Enzo-era Ferraris at Gooding & Co auctions, 2004-2015

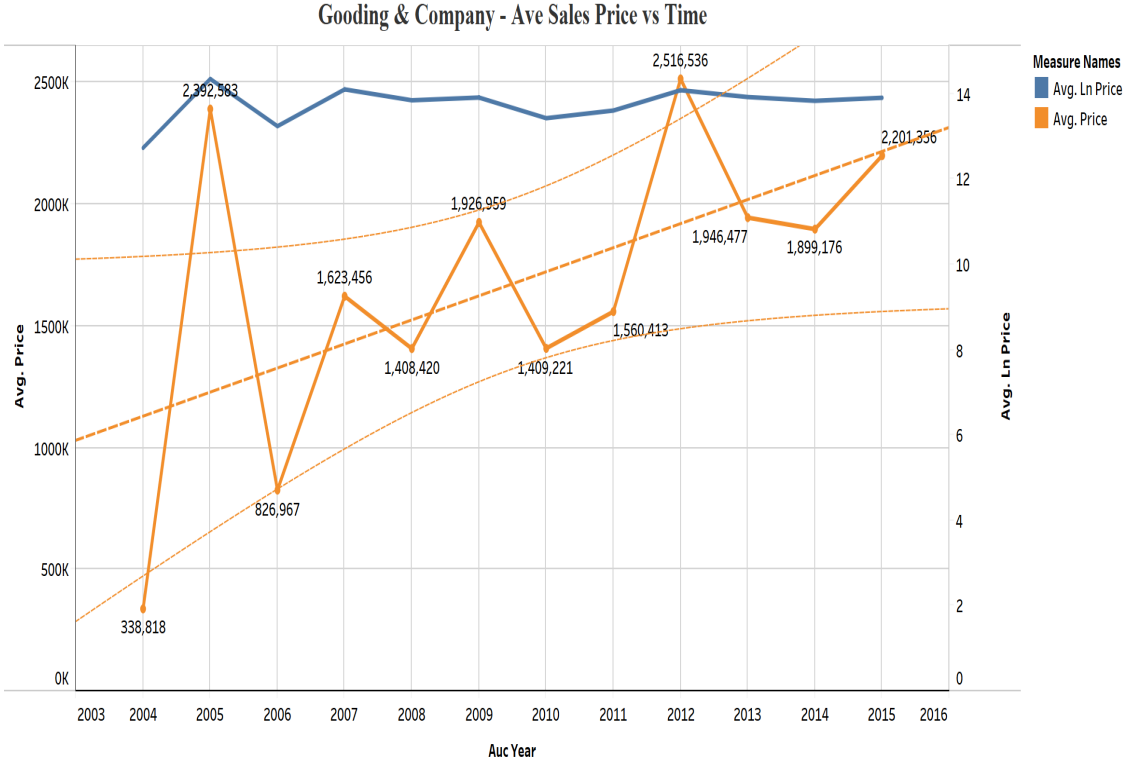

Figure 5: Avg. prices of Enzo-era Ferraris at Gooding & Co auctions, 2004-2015; prices under $15,000,000

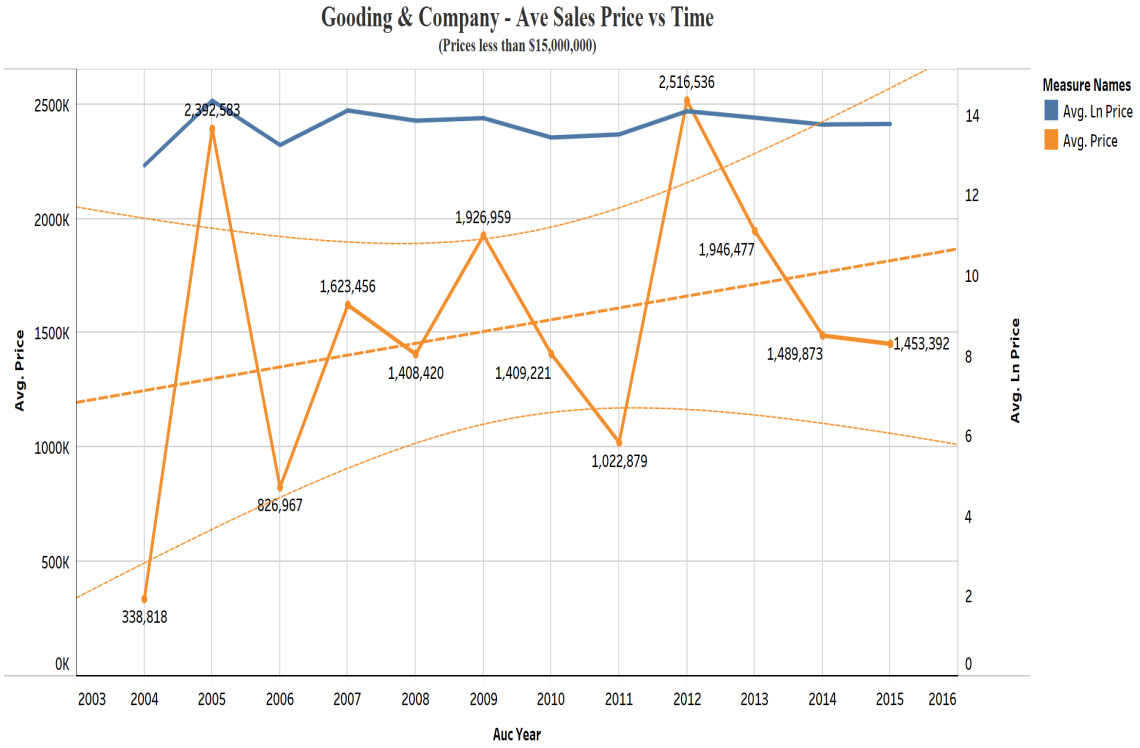

Figure 6: Avg. prices of Enzo-era Ferraris at RM Sotheby's auctions, 2003-2015

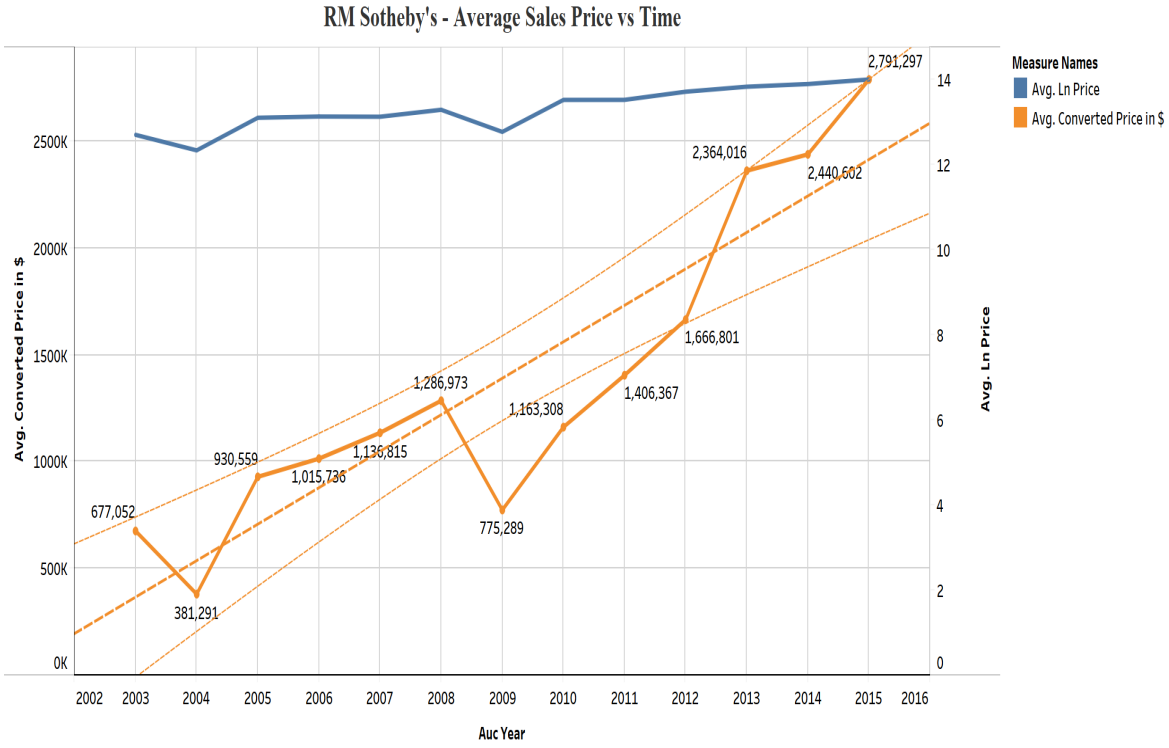

Figure 7: Avg. prices of Enzo-era Ferraris at RM Sotheby's auctions, 2003-2015; prices under $25,000,000

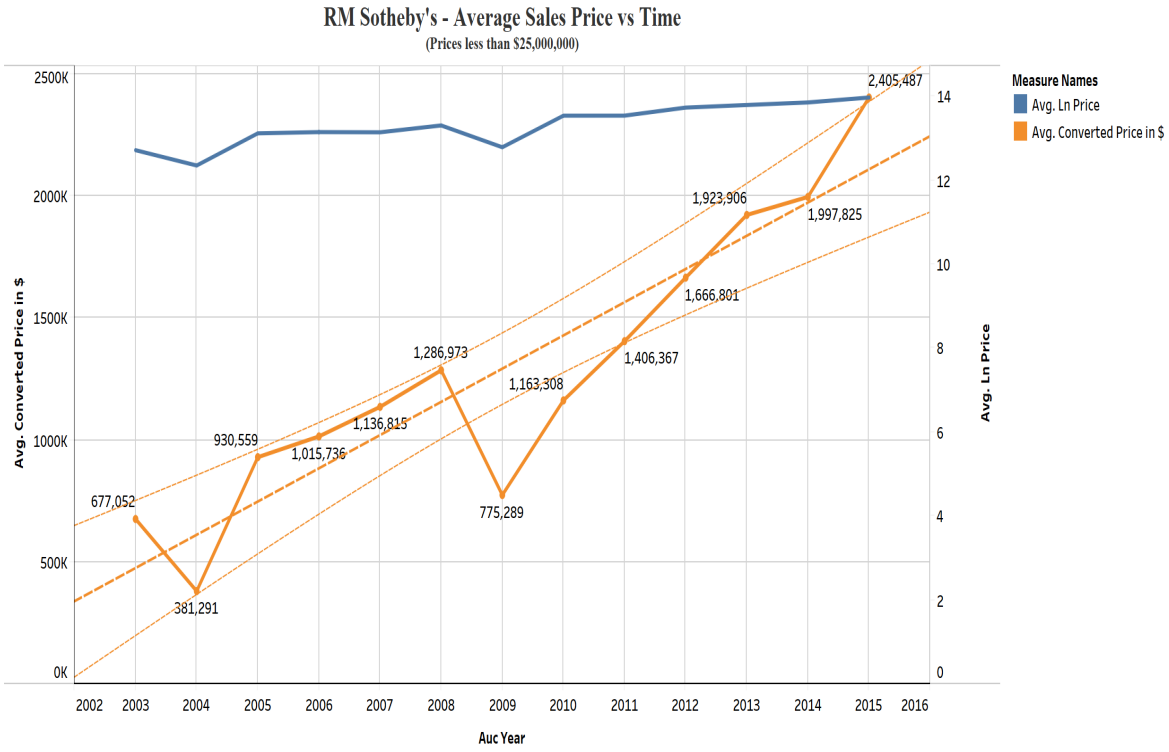

Figure 8: PCE, ln PCE, 2002-2016

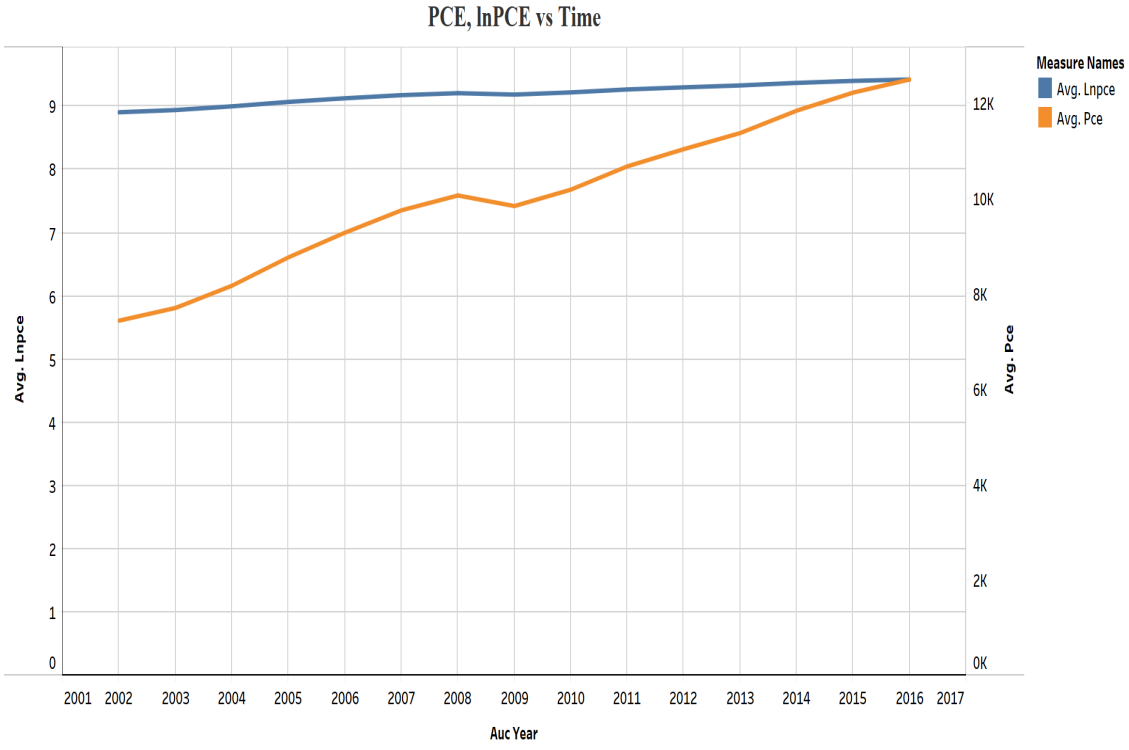

Figure 9: Oil, ln OIL, 2002-2016

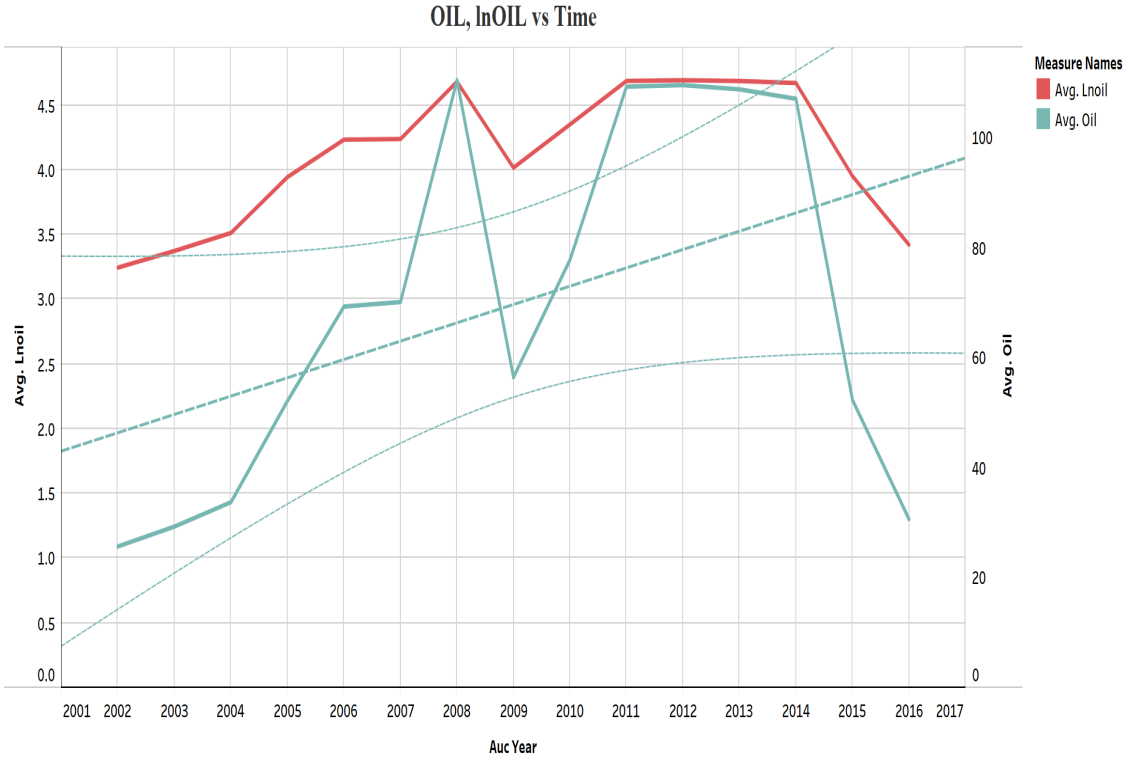

Figure 10: Sales prices of Chassis 0673GT

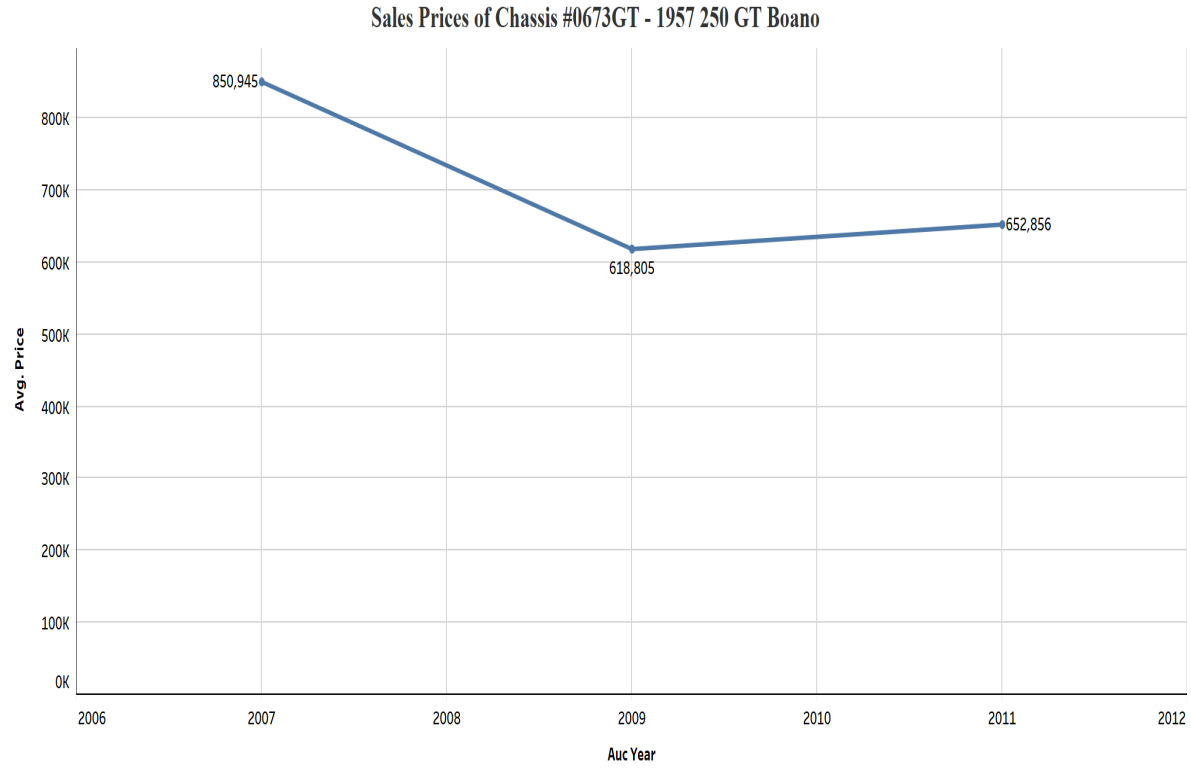

Figure 11: Sales prices of Chassis 2153GT

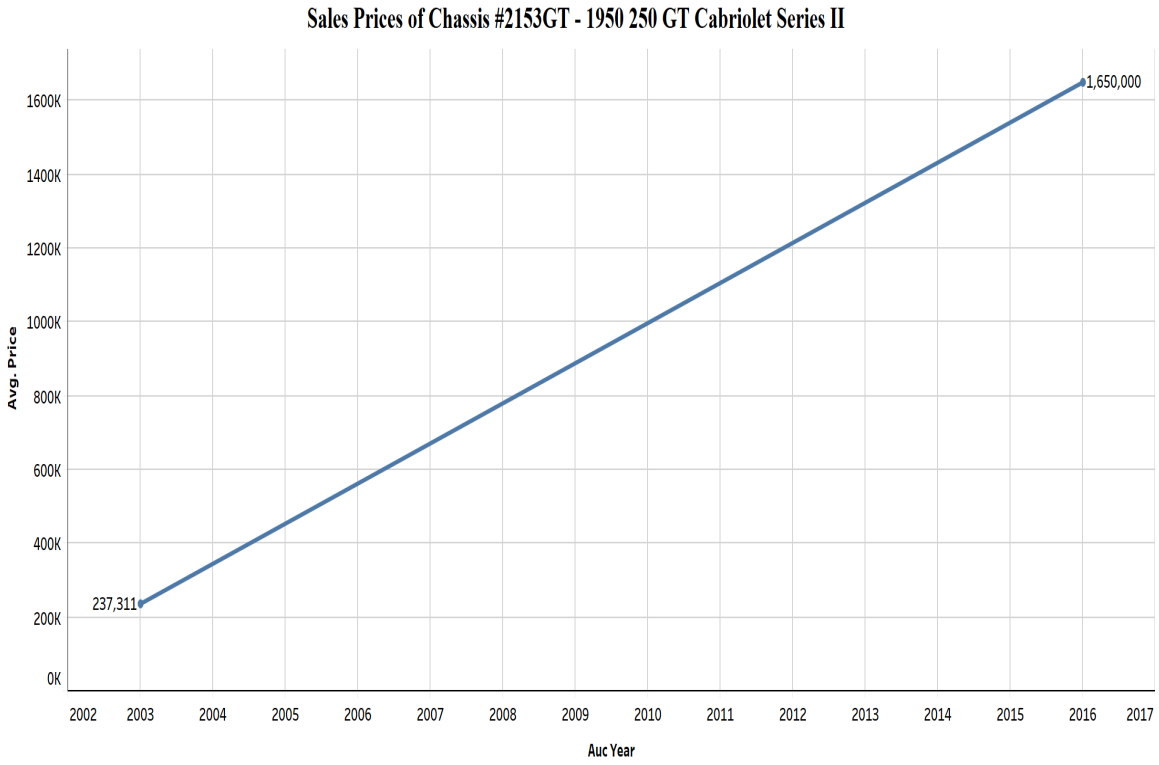

Figure 12: Sales prices of Chassis 1307GT

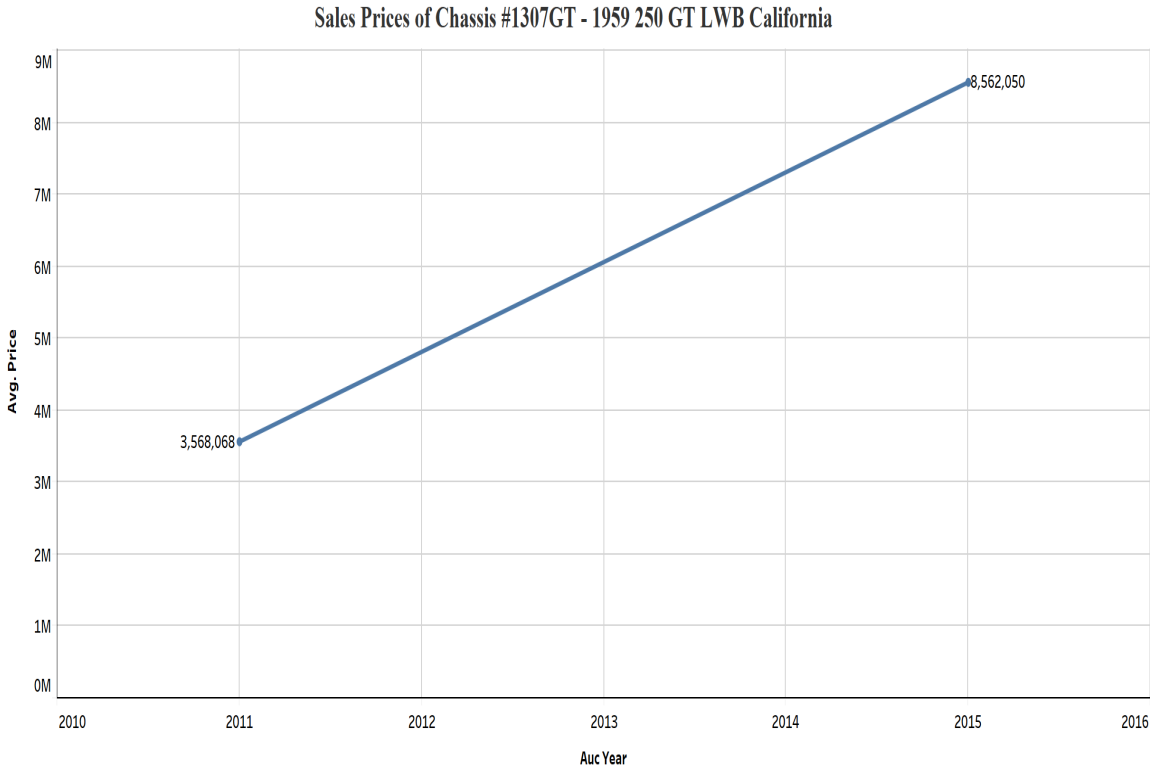

Figure 13: Sales prices of Chassis 6049 SA

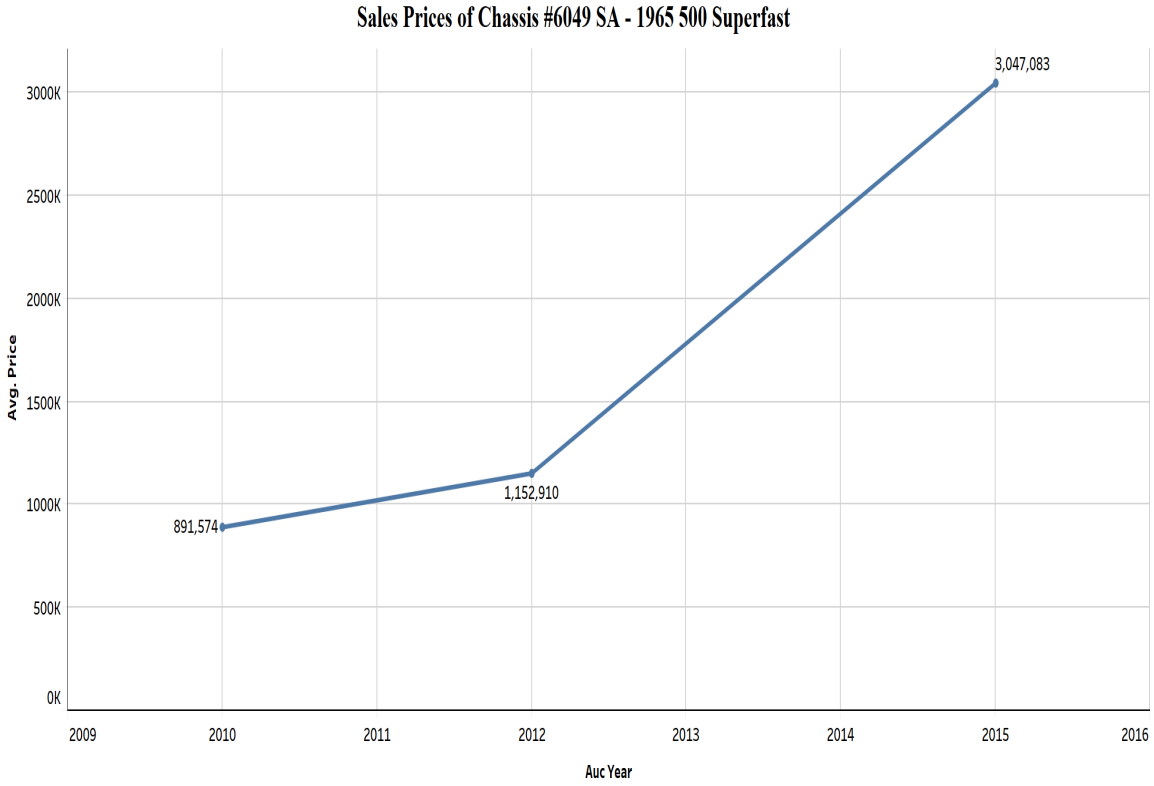

Figure 14: Sales prices of Chassis 8601

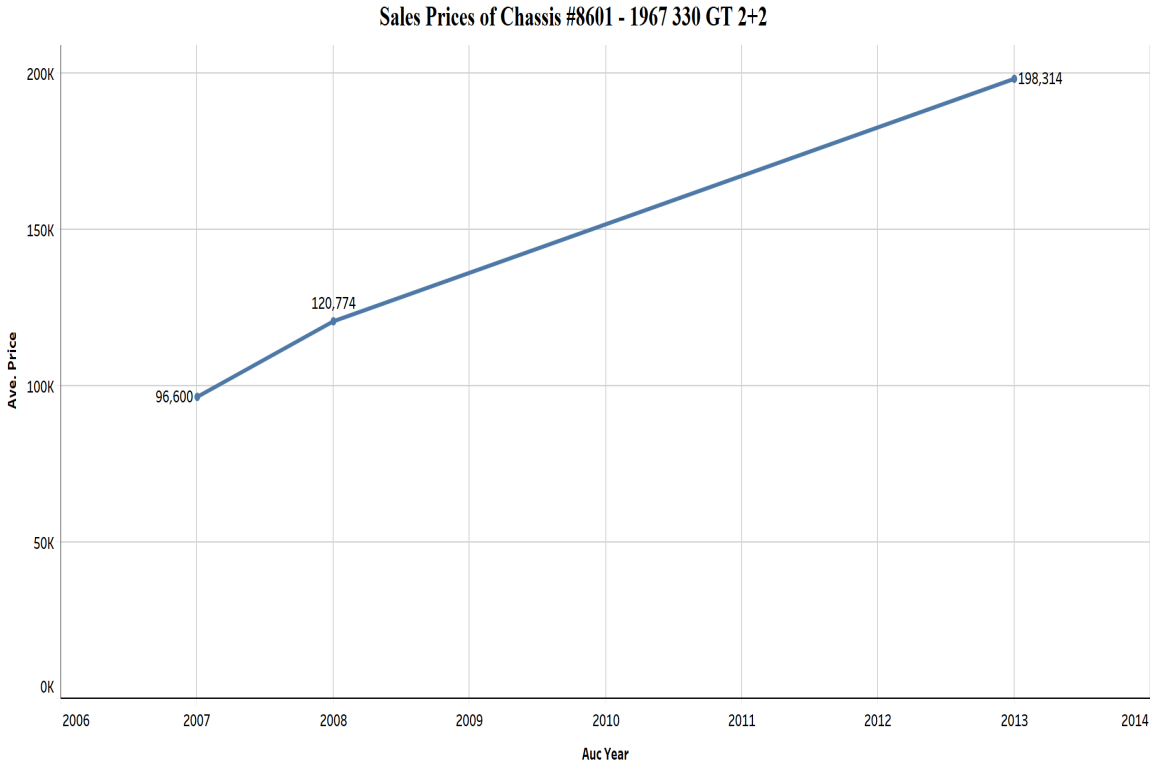

Figure 15: Sales prices of Chassis 14819

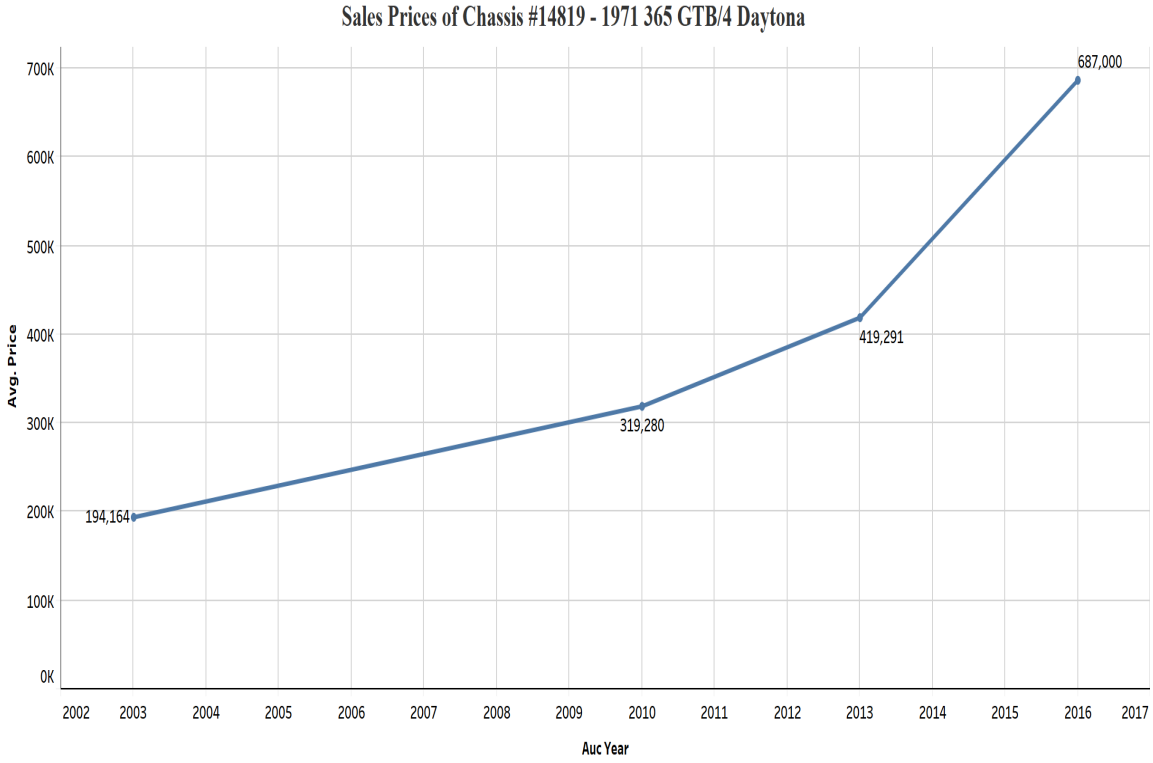

Figure 16: Sales prices of Chassis 15117

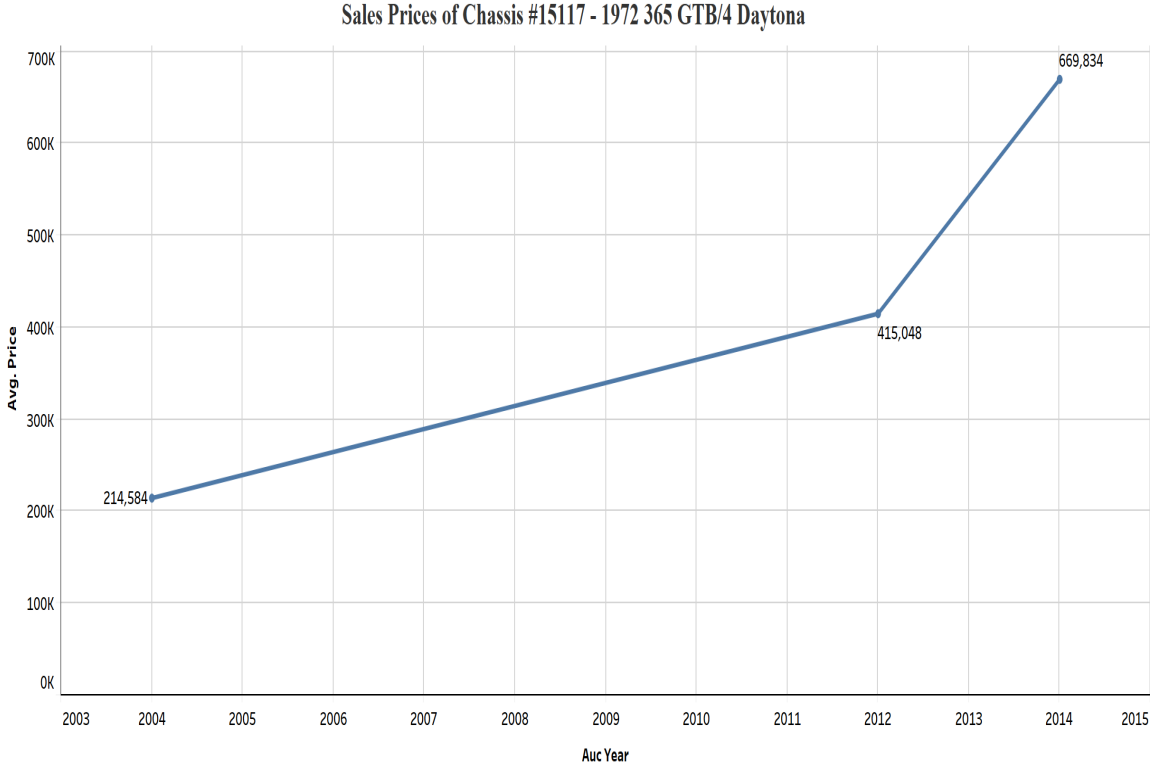

Figure 17: Sales prices of Chassis 03128