Investing in collector cars: Passion or profit?

Investigating the potential of an alternative asset class

Master Thesis

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Abstract:

The main objectives of this study are to find the characteristics that together make the price of a collector car, the extent to which these characteristics influence the price, what the returns of collector cars are and if they would make a viable financial asset class. In order to study this, a database of 2029 observations was created and analyzed. Consequently, an index was built and compared to conventional and alternative asset classes such as stocks, bonds, T-bills, real estate, commodities and gold. This study concludes that collector cars can be used as an investment and are indeed a viable asset class, given their reasonably high risk/return trade off, while acknowledging there are some indirect costs attached to them that are hard to quantify and generalize. I would hereby also like to thank my supervisor, Dr. Luc Renneboog, who gave me a great amount of freedom to work on my thesis independently and helped me out by giving practical and useful advice when needed.

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1. Introduction

Investors have always looked for the highest returns with as little risk as possible. For many decades, people turned to asset classes that are generally accepted as conventional assets, like stocks, bonds, exchange traded funds, real estate investment trusts, commodities and many more. However, the recent financial crisis showed that the world is more and more intertwined, including financial markets. Returns were at all time lows and correlations between assets shot up, which caused assets pulling down others with them. Markowitz (1952) was the first one to notice that putting together certain assets could result in major diversification advantages by optimally exploiting the covariance between them. Since then, people have been looking for all sorts of diversification tools and many assets have been introduced over the years.

In the search for diversification, investors have begun to see the value of alternative investments. Luxury collectibles like wines, art and (classic) cars showed decent returns over the few last years and are said to have low (even negative) correlations with conventional asset classes. At first hand, this creates three potential advantages: high returns, diversification possibilities and hedging for certain risks like a financial crisis. As a consequence, a number of funds specializing in art have already arisen. Prices are often driven by scarcity and emotional factors like aesthetic and personal value, but there are certain traits that influence prices. The collectibles market is not only filled with enthusiasts anymore. Investors have also turned to these assets and “a number of financial institutions like JP Morgan and Citibank already accept art as collateral for loans” (Wealthinsight, 2013). As alternative investments are getting more and more popular, the amount of research also increases.

This thesis will look at the value drivers of collectible cars using the hedonic regression method. A hedonic regression, first pioneered by Andrew Court (1939) tries to estimate demand or value by decomposing the item (the car) into its constituent components and obtains estimates of the contributory value of each component. This thesis will thus try to find what characteristics will have an influence (and by how much) on the price of a collectible car. Consequently, an index will be created to compare the collectible car market with conventional stocks and other financial assets over a sample period of 15 years. A dataset is created on the basis of Sports Car Market’s database and contains 2029 observations. Sports Car Market keeps track of all significant classic/collectible car auctions in the world. The database contains cars produced from 1899 to 2010, cars with 4 horsepower up to cars

with 1200 horsepower, displacements of 248cc up until 13.5 liters and many different makes, colors, body styles etc. Some of the most spectacular cars and sales are:

- A Ferrari 250 TR Racer, year 1957, 2,953cc V12 engine, 300 Horsepower, roadster, one of only 34 ever made, sold at RM Auctions for USD 12,402,500 in May 2009
- A Porsche 917/30 Can-Am Spyder, year 1973, 5,374cc V12 Engine, 1200 horsepower, roadster, one of only 6 ever made, sold at Gooding & Co. for USD 4,400,000 in March 2012
- A Hurtu 3.5hp, year 1899, 1,600cc single cylinder engine, 4 horsepower, cabriolet, numbers produced unknown, sold at RM Auctions for USD 74,534 in September 2013
- A Mercedes-Benz 540K Special Roadster, year 1936, 5,400cc I8 engine, 180 horsepower, roadster, one of only 58 ever made, sold at Gooding & Co for USD 11,770,000 in August 2012
- A Talbot-Lago T150C SS Teardrop, year 1939, 3,996cc I6 engine, 140 horsepower, coupe, one of 11 ever made, sold at Bonhams for USD 4,874,000 in August 2008
- A Mercedes-Benz SSKL Replica, year 1931, 6,740cc I6 Engine, 180 horsepower, roadster, originally only 12 made, sold at RM Auctions for USD 2,203,762 in October 2007
- A Porsche S308 Tractor, year 1958, 2,625cc 3-cylinder engine, 38 horsepower, one of 125.000 ever produced, sold at RM Auctions for USD 27,950 in September 2013
- A Ferrari 365 GTB/4 Daytona Estate Wagon, year 1972, 4,390cc V12 engine, 352 horsepower, the only one ever built, sold at Bonhams for USD 254,880 in December 2003.

2. Literature Review

2.1 Collector cars

The first automobile, invented by Karl Benz in 1886, quickly became popular and soon replaced the traditional animal-drafted wagons. By that time, cars were nothing more than a mere transporting device. However, over the years cars became more and more a symbol of wealth and status. As a reaction, car manufacturers started competing for the best image and brands like Rolls Royce, Bentley, Mercedes-Benz, Duesenberg and sports cars like Ferrari and Lamborghini were able to get this status of quality cars. Technology evolved and cars became better, faster, cheaper and more fuel-efficient. However, as technology evolved, some people began favoring older cars for their looks, sound, uniqueness and historical and emotional value. At first, only car fanatics began buying and restoring old cars, but over time, investors also saw the potential of this alternative investment class and nowadays, there is a true rage going on for acquiring extremely rare and unique investment-grade collector cars. Collectibles often are a mix of intrinsic, historical and emotional value. That is why collectible investments are also often called emotional investments.

Although this thesis will use collector car and classic car interchangeably, the two do not strictly mean the same. One can find several differing definitions for a classic car. Orsi and Gazzi (2008) define a classic car as a car that is built between and including the years 1946-1964. The classic car club of America (n.d.) defines a classic car as follows: “A Classic is a ‘fine’ or ‘distinctive’ automobile, either American or foreign built, produced between 1925 and 1948. Other factors, including engine displacement, custom coachwork and luxury accessories, such as power brakes, power clutch, and ‘one-shot’ or automatic lubrication systems, help determine whether a car is considered a Classic.” The Koninklijke Nederlandsche Automobiel Club (n.d.), however, defines a classic car as a mechanically propelled road vehicle that is at least 30 years old, is not used on a regular basis and is in a good (original) state. Although the term collector car is used on a regular basis, there are few definitions for it. Lant Insurance Brokers (n.d.) define a collector car as a car that can fit either four categories: 1.) An antique or classic automobile of 25 years or older, 2.) A modified, street rod or custom automobile of 15 years or older, 3.) A special interest mobile of 0 to 24 years old and 4.) An exotic automobile of 0 to 14 years old. Throughout the rest of this thesis, a collector car and classic car will be treated identical and all cars in the auction data will be used for research.

Over the years, a serious market has evolved around classic cars and they are now sold for substantially higher amounts than what they originally were sold for. There are mainly two channels through which collector cars are sold, namely private sales and auctions. The highest prices for investment-grade collector cars have achieved through private sales. For example, the most expensive car ever sold in a private transaction is a 1963 Ferrari 250 GTO, which was sold for almost $52 million dollars to an anonymous buyer in June 2013. What characteristics of a car could justify such an extremely high price? In the media, experts dedicate this to several factors: First of all, the car is extremely rare. This particular Ferrari was the fifth in a series of only 39 ever made. Second, each of these 39 cars were hand crafted, which makes every car unique. Third, rumor has it that Enzo Ferrari himself ordered the production of this Ferrari as a response to the Jaguar E-type, which was an enormous success at the time. Lastly, the car has a distinguished racing history, having won the 1963 Tour de France road race. An indication that these factors add value to a car is the fact that the 2012 price record is taken by that same model, namely an apple green 250 GTO, made for the well-known race driver Stirling Moss, which was sold for $35 million in June 2012. These two examples are unique however, since in most private transactions prices are not published.

The second channel through which collector cars are sold is auctions. Auctions are public and the problem of non-published prices is therefore dealt with. There are several auction houses that have built a strong reputation of being high quality car auction houses, such as Gooding & Company, Christie's RM Auctions, Bonham's, Barret-Jackson, Brooks, Christie's, Kruse and Ebay. Most auction houses worldwide abide by the English auction, which starts with an opening bid from the auctioneer. Consequently, prices keep ascending until the bidding halts and the lot is sold, or hammered. The well-known auction houses constantly compete for having the highest quality, most expensive and desired car collections on offer. What is absent at a private sale but not at auctions are the premiums. Auction houses demand an average buyer's premium of around 10% of the hammer price. This premium is added to the final price a buyer pays. The seller's premium is somewhat lower. For example, RM auction demands a seller premium of 6% to 7% and Barret Jackson requires a standard of 8%. The seller's premium is however, unlike the buyer's premium, negotiable. Investors that sell their cars on a regular basis (think of Wayne Carini from the TV show *Chasing Classic Cars)* can negotiate their seller's commission and often pay close to zero per cent. Over the years, there is an observable trend of increasing demand for collector cars and in turn an increase in prices. Orsi and Gazzi (2008) researched many auctions, ranging from 1994 until 2008 and concluded that the classic car market has grown substantially, both in number of cars sold as well as the value of several cars. Total sales in the famous auction

houses have grown from $30 million in 1994 to $457 million in the last season of 2008. Furthermore, the number of cars sold for over $1 million dollar has risen from 2 to 84 in that same timespan. Many record sales prices have been broken recently. The most expensive car ever auctioned was a 1954 Mercedes-Benz W196, selling for almost $30 million at Bonham's in July 2012. With that, a 1957 Ferrari 250 Testa Rossa, sold for more than $16 million at Gooding & Company in August 2011, now stands at a second place. Furthermore, in August 2013, the record for total sales at an auction was broken at Pebble Beach Concourse d'Elegance, where during this one-week classic car gathering 5 auction houses sold 726 cars for a total of $301.9 million (Undercoffler, 2013). The value of all these cars account for an increase of 14% compared to last year, according to Hagerty (2013), which keeps track of classic car prices.

2.2 Collector cars as investment

Although there has not been done much scientific research on the actual returns and diversification benefits they could offer, investing in classic cars has had a lot of attention in the media recently. The Historic Automobile Group International (HAGI) is an independent investment research house that keeps track of collector car prices and creates indices in order to create transparency in the sector and enable investors to make well-informed decisions. Currently, HAGI releases index data for five indices. There is an index that tracks the 50 most rare and valuable collector cars, one tracks rare collector Porsches, one tracks rare Ferrari's, one tracks rare Mercedes-Benz's and one tracks rare collector cars excluding Ferrari and Porsche. HAGI started these market cap weighted indices in 2007. Hitherto, the index looks promising for investors as the value of classic cars increased by 39% in 2013 (HAGI) and thereby outperforms many other asset classes, such as the S&P500, which returned 22% in 2013. Especially Ferrari's have shown an impressive increase of almost 55%. Dietrich Hatlapa, a former investment banker and founder of HAGI said: "Classic cars have been a very good performer in terms of value appreciation, and the financial crisis helped classic cars and collectible markets." (Hatlapa, as cited in Cafariello, 2013)

A study by van Bergen (2009) on the potential of classic Ferrari's as a financial asset revealed many insights. His study showed that classic Ferrari's have a very low correlation with other financial assets such as stocks, which indicates that they could offer diversification benefits to the investor. They are however, as expected, highly correlated with other classic cars. This marginalizes the diversification benefits for a portfolio that already has classic cars in it. Furthermore, van Bergen found that returns are extremely volatile. This means that if an investor were looking for diversification of his portfolio for the sake of decreasing overall risk,

a classic Ferrari would not be ideal. On the other hand, high volatility assets are perfectly suitable for short-term investors and speculators.

As in any market, knowledge is power. Identifying cars that will increase in value is probably the most important factor in making profits from investing in collector cars. As the most rare and unique cars seem to have reached their limits, investors are looking for cars that still offer room for decent returns. In his book, Van der Vinne (2014) highlights a few characteristics that empirically should return high yields. Size of the batch produced is extremely important. The fewer cars there are made, the higher the value. Mileage, originality (the more original a car is kept, the more it is worth) and brake horsepower are also critical. One should note, however, states van der Vinne, that unlike stocks and gold, which are all identical, the value of cars can differ substantially. These characteristics will therefore be taken into account in this research. Section 2.5 will expand further on value drivers of classic cars.

With seemingly ever increasing prices over the last few years, people are starting to question whether this trend is going in the same direction of the classic car bubble of the 1980's, when young wealthy investors were buying exotic classics as pure investments. With the economy flourishing and investors looking for alternative assets to diversify their portfolio, prices of collector cars went through the roof. However, as Roll (1988) stated, "All major world markets declined substantially in October 1987 – an exceptional occurrence, given the usual modest correlations of returns across countries". With the global stock market crash driving global markets into a recession, the Gulf War starting in 1990 and oil prices almost doubling as a result of this war, the prices of collector cars plummeted and they did not recover until the late 1990's. Many experts say the current price increase is most likely not a bubble, for many reasons. Hilton & Moss (2013) give several causes. First, in the 1980's, collector cars were financed in order to enjoy leverage effects. When the stock market crashed, investors needed to get rid of their automobiles and consequently prices plummeted. Nowadays, investors pay for their collector cars with their savings, making the market far less volatile. Second, current interest rates are at an all time low. When accounting for inflation, wealthy individuals actually lose money by keeping it on their savings account. This makes investing in collector cars an attractive alternative, which also brings the added factor of the joy of having a classic car and the potential of making a decent return over time. Furthermore, where stocks evaporate into thin air when prices drop, collector cars stay put in their garage. Lastly, with an ever-increasing amount of HNWI's (High Net Worth Individuals) and only a limited amount of collector cars, demand is likely to outpace supply for many decades to come.

2.3 Comparison to art

In many ways, the collector car market shows similarities with the art market. Both have a relatively low intrinsic value, high emotional or historical value and their sales channels also show similarities. Both the art market and collector car market have auctions and private transactions. Furthermore, one can argue they can be valued in the same manner, namely using the hedonic pricing method, which tries to estimate demand or value by decomposing the item into its constituent components and obtains estimates of the contributory value of each component.

In contrast to collector cars, research in art as a financial investment started many years ago. One of the first economists that researched art prices and returns was Wagenführ (1965). Later came Anderson (1974), who studied auction prices of art. Currently, emerging market like Brazil and China are helping to boost the global art market, which is estimated to be worth $ 59 billion in 2013 (TEFAF, 2013). One of the most extensive researches was done William Goetzmann (1993), who researched financial returns of art, stocks and bonds for three long periods, namely 1716-1986, 1850-1986 and 1900-1986. Goetzmann constructed an art return index containing paintings brought to the market at least twice in the research period, as to whether a price change occurs. He found that art yielded substantially higher returns than the London Stock Exchange for the last two research periods (the first period is characterized by strong negative returns). Although returns were higher, art also experienced high volatility and positive correlation with stocks, which decimates the diversification advantage of adding art to a stock portfolio. However, low correlation with inflation creates the opportunity to hedge against inflation. These results suggest adding art to a portfolio would only be attractive for an investor that would otherwise invest in a risky portfolio, since high volatility would exclude risk-averse investors.

Only two years later, Agnello and Pierce (1995) studied a sample of paintings from 66 American artists, using a hedonic pricing method. They found that their sample portfolio yielded an annual 9.3% return, which is still less than company stock but it compares well to long-term government bonds and T-bills. They note, however, that certain works in the sample pulled down the average because of their style and topic and that investing in particular art works can yield substantially higher returns. Hence, investors should be well informed about style and other important characteristics at the time of trading.

In 2004, Worthington and Higgs researched the major painting and financial markets in the 1976-2001 period. They found lower returns and higher volatilities for art than for

conventional investments. Diversification would be a possibility at first sight, given the low correlation between art and conventional assets, but the lower risk/return ratio suggests that one should leave art out of a financial asset portfolio. Campbell (2005) researched investments in art and especially looked at their returns and diversification potential during bear markets, where a bear market is “a general decline in the stock market over a period of time” (0’ Sullivan and Steven, 2003). Campbell used art market indices and compared them to several other asset classes by constructing both an optimal portfolio with and without art in it. Campbell finds that the low correlation and positive returns in the long run (accounted for transaction costs) make art an attractive diversification asset on a conventional asset portfolio, which contradicts most previous studies.

Research done by Renneboog and Spaenjers (2013) finds evidence contrary to Campbell (2005) and this thesis will show many similarities to their study with respect to methodology. They researched the price determinants and investment performance of art using the hedonic pricing method, which is exactly what this thesis tries to do for collector cars (the hedonic pricing method will be extensively reviewed in section 1.5). They found that the risk/return ratio of art is much less attractive than that of financial assets, even before transaction costs, which can be, as with car auctions, substantial. Furthermore, they found that “artist reputation, attribution, signs of authenticity, medium, size, topic and timing and location of the sale are significantly correlated with price levels” (Renneboog & Spaenjers, 2013). However, other factors, like reputation of the auction house and timing, are also found to be highly correlated to prices.

An important matter, which is extensively researched in studies about art as an investment, is the so-called masterpiece effect, which means that the most expensive works of art yield the highest returns. This higher return would be caused by the fact that masterpieces are less affected by downturns than cheaper works and that demand steadily grows while supply stays at a stable level. Pesando (1993) was the first one who showed that masterpieces actually underperform. Later, however, Goetzmann (1996) found no masterpiece effect whatsoever. Mei and Mose (2002) found evidence in the direction of Pesando (1993). Most recently, Renneboog and Spaenjers (2013) found evidence contrasting Mei and Moses’ (2002) work. Their research showed that investing in high-end works yields higher returns but the difference with a ‘normal’ strategy is not significant. Evidently, although the main tendency favors underperformance of masterpieces, there is a still some dispersion in belief about the masterpiece effect and as record prices are currently being paid for collector cars, this study will research if there is a comparable effect for collector cars, given that there currently is no literature on this.

2.4 Value drivers of collector cars

In the quest for capturing value, investors look for certain traits that predict the value of a classic car. In above literature, some value determinants were already mentioned, namely rarity, racing pedigree, brake horsepower, mileage, originality and mystique. There is hardly any literature that accurately states which characteristics determine the value of a car. Souvrain (as cited in Orsi & Gazzi, 2008) names five characteristics that determine a classic car's value, namely rarity, architecture, racing pedigree, condition and beauty. Although these determinants sound logical, beauty would be hard to measure. Rarity could be measured by the amount of cars made of a specific marque and model. Architecture could be measured by looking at who designed the car, racing pedigree is usually known so that could also be measured as being either absent or present. Condition is usually enclosed at auctions by assigning the car a value in the scale of 1 to 5, where 1 stands for perfect concourse condition and 5 stands for bad maintained but restorable car (Sports Car Market, n.d.)

Since more literature on the price determinants of collector cars is currently non-existent, a broader view is taken by reviewing studies that research price determinants of cars in general. Again, Court (1939) was a pioneer in this matter, focusing his study by looking at dry weight, wheelbase and advertised horsepower. A few years later, Griliches (1961) expanded on Court's work by adding dummy variables for the car having a V8 engine, being a four door hardtop, having an automatic transmission included in the price, having power steering and brakes included in the price and for being compact. Griliches (1961) noted that his study excludes variables for which no data was easily available. These variables are mileage, acceleration, handling ease, durability and styling. Furthermore, brand and manufacturer were omitted because Griliches (1961) thinks these effects are captured by the numerical variables mentioned. His results showed that horsepower, weight, wheelbase (although not significant), presence of a hardtop, power steering and being a "compact" car (not significant) all have a positive influence on price. Having a V8 engine, ceteris paribus, has a negative influence on price, although not significant most of the time. Although at first it looks odd that a V8 engine has a negative price effect, it can be explained by the fact that the other possibility in sample was a 6-cylinder engine. Since horsepower is almost similar between these two options, more horsepower can be achieved with a V8 engine relatively cheaper. The presence of automatic transmission was found to be not influencing price. Since the dependent variable, price, is expressed in natural logarithm, the coefficients found are percentage changes in price. Furthermore, he found that the three main variables, namely horsepower, weight and wheelbase, are highly correlated, with correlation values ranging

from 0.72 to 0.96 between 1937 and 1960. After Griliches (1961), many researchers have followed but many state their issues with correctly and consistently measuring some important characteristics such as luxury and quality.

Triplett (1965) saw that Griliches' (1961) model leaned heavily on the weight variable, explaining most of the variance. He concluded that weight by itself is not a desirable factor, since it negatively affects mileage, speed and handling but that it "serves as an excellent proxy for a variety of characteristics which actually do constitute quality." Increasing car size or capacity, and therefore weight, will lead to more transportation possibilities, and thus higher quality. Furthermore, added extras as power brakes, power steering, automatic transmission and stronger components all increase quality, but also weight. Weight therefore also constitutes quality. Later, Griliches (& Ohta, 1976) extended his study by incorporating make, or brand, to account for hard to measure characteristics like reputation and quality that can be accredited to a make.

In 1983, Goodman extended previous research by focusing on fuel efficiency and other factors deemed important, such as presence of AM or FM stereo, handling (measured by turning diameter), air-conditioning, trunk space and the number of passengers car can carry Before him, little attention was given to this fuel efficiency mainly because of a lack of interest since gas prices were low in the 1960's. Griliches and Ohta (1976) included a measure of fuel efficiency in their study, but their dataset did not cover the oil shocks. Goodman (1983) found that, on average, an additional mile per gallon increases the price of car, ceteris paribus, with $93. He also found that foreign cars sell for a premium relative to domestic makes, where domestic refers to the USA.

The most recent study, done by Andrews and Benzing (2006), looks at price determinants of used cars in Internet auctions. This study, as opposed to previous studies, mainly focuses on auction characteristics as determinants for price but also at buyer and seller characteristics. Variables included are, amongst others, whether the seller is a dealer or not, the seller's reputation (measured by net rating given by buyers over time), whether the seller used a display service, whether the car had 1 month or 1,000 miles warranty, whether the lot has a clear title, number of pictures at auction, whether the car was listed using featured items, whether the auction ended between 5pm and midnight. Furthermore, standard variables like age, mileage, color and displacement were included. Andrews and Benzing (2006) noted that one of the most important variables in their study, seller reputation, is somewhat biased, since sellers that get negative feedback will often retreat from the auction or will go back changing identity. Also, since seller reputation is measured by adding all net ratings (positive

minus negative), this reputation is also a matter of longevity. They found that seller reputation significantly influences price, prices are higher when the auction ends between 5pm and midnight (since more people are available by that time) and remarkably they found that using a professional display service actually reduced the probability that a car is sold. Neither is there a price effect. Although there are many similarities between Andrews and Benzing's (2006) study and this one, there are also major differences. First of all, at a collector car auction, which is usually not online to begin with, age does not necessarily decrease value. Also, since collector cars are usually bought and sold by either fanatics or investors, I expect that the seller reputation effect be of less influence. Variables that are deemed important and thus included in this study will be listed in section 4.

2.5 Hedonic pricing method

The hedonic pricing method first originated from Court (1939) and it basically values an item by decomposing it into its value-determining characteristics and valuing each separate characteristic. Court (1939, as stated in Goodman, 1998) stated: "Passenger cars serve so many diverse purposes that such a single, most important specification can not be found. The simple method is inapplicable, but why not combine several specifications to form a single composite measure?" In this way, one can estimate the marginal hedonic price of a characteristic of the item. Court (1939) came up with the term hedonic to describe the relative importance of all the characteristics that an item entails. The price of an item is then a function of the values of its components and therefore one can measure the willingness to pay for the different components. Hedonic regressions are thus ideal for studying classic cars, as classic cars are highly differentiated products, but they are also used for other matters like the Consumer Price Index (CPI), real estate and electric consumer products like TVs and appliances. Rosen (1974) defined hedonic prices as "the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them." Griliches (1961) later revived Courts technique in order to measure the bias in existing indices, which were caused by "incorrectly accounting for quality changes in cars." (Reis and Silva, 2006). Even today, researchers argue how to best use a hedonic pricing model. One of the main issues in existing literature on hedonic pricing methods is the choice of functional form that is used. Although there is not one correct functional form, the most commonly used ones are linear and log forms, where one can distinguish between 'semi log' and 'double log' functions (Triplett, 1974). Another point of discussion is the approach in calculating quality-adjusted prices indices. One can either use a hedonic imputation (HI) or the dummy time hedonic (DTH) index. Both models correct for quality changes and provide in calculating price

changes in a market with rapid turnover and differentiated products but they provide different results. HI indices value a fixed period's bundle of components using base and current coefficients and take the ratio of the two. For HI indices the change in the parameters over time is the essence. The DTH approach, on the contrary, requires the parameters to stay constant over time and uses coefficients of time dummy variables to determine price changes. So the main difference between the two approaches is whether one keeps the parameters constant over time or not. Which approach and functional form will be used in this study will be stated and explained in section 4.

3. Problem Statement

Since investing in classic cars is a much bespoken topic in the media and existing literature on returns on collector cars is lacking or outdated, this thesis will try to come up with hard numbers on how well collector cars behave as pure financial assets by looking at tangible, intangible and auction characteristics. After controlling for many variables that influence a car's price, a price index will be created that stretches from 1999 to 2013 to give a clear overview on returns and volatility over a fifteen year time period. These returns will then be compared to various other asset classes like stocks, bonds, funds, commodities and real estate. In conclusion, the five main questions that this thesis would like to see answered are the following (and will be studied in this exact order):

1. *"What tangible and intangible characteristics influence the price of a collector car?"*
2. *"What are the average returns on collector cars over the past fifteen years?"*
3. *"Do average annual returns differ for different categories and by how much?"*
4. *"How well do collector cars perform compared to conventional asset classes?"*
5. *"Are collector cars a viable financial asset class?"*

4. Data & Methodology

4.1 Data and Variables

During the whole process of analyzing collector cars, this study will separate the variables into three categories, namely tangible characteristics, intangible characteristics and auction characteristics. Tangible characteristics have to be subtracted from an auction database.
Although auction houses often publish information on their latest history of sold vehicles, this information often lacks details and older auction results are hard to find, if present at all. In order to do a sensible hedonic regression, one needs a detailed, central database that also keeps historical records. The only database that suffices all these requirements, is one from a firm called Sports Car Market (SCM), which is a US firm that keeps track of historical auctions. The firm also publishes a magazine every month, which covers the most special sales of the month and comes with practical tips and tricks on buying a classic car. The SCM database contains over 30,000 detailed transactions that will be partly used in this study. The following traits are available for auction results: Make, model, production year, price (in US dollar), auction house, auction date, auction place, engine type, displacement, horsepower, reported mileage, induction type, body style, transmission type, drive (right or left hand drive), condition, type of wheels, type of seats and exterior and interior color. Engine type describes the setup of the engine, which could be the famous V-shape, but an engine can also have its cylinders in one straight line (the I-engine, which is typically seen in antique and vintage cars), horizontally (called a boxer engine, used for instance in Volkswagen Beetles and Porsches, also called an H-engine) or the highly unusual W-shape, which is the combination of two overlapping V-shaped engines (this engine only came in the Bugatti Veyron and Bentley engine in the 2000's). Displacement describes the volume of the engine and is defined as the volume swept by all cylinders from top dead center (TDC) to bottom dead center (BDC). Engine displacement thus does not include the total volume of all combustion chambers as a whole but by the volume that the cylinders displace. As the volume of an engine gets larger, ceteris paribus, its power will consequently increase. Induction in this study will be dummy variable taking the value of 1 if the car has either fuel injection, a supercharger or an intercooler and zero if otherwise. Condition is a characteristic created by SCM in order to categorize the lots for quality with 1 being national concourse standard (better than new) to 5 being good only for parts. Under market opinion, the SCM writers give their opinion on the price paid and a general market overview. Although this market opinion is useless in general, sometimes the writer states the number of cars produced for that specific model, which saves time. Unfortunately, many auction results in the SCM database are not as detailed as others. To overcome this problem, only auction

results for cars that were actually sold and for which a picture was available were selected, since this proved to get rid of lacking auction results almost entirely. Lacking information only on displacement or horsepower could be easily complemented by secondary sources as Wikipedia, www.concepcarz.com and www.supercars.net. A tangible trait that I think has a large influence on collector car prices but is not stated in the SCM database, is the number of cars produced of a specific model since scarcity has always attracted human beings. Information on numbers produced per model is collected from various sources like articles, databases, production records, forums and advertisements. The last two variables considered tangible are whether the lot is a racecar and or a replica. The dummy variable "race car" takes the value of 1 if the lot is a racecar and zero if otherwise. The "replica" dummy variable takes the value of 1 if the lot is a replica and zero if otherwise. Intangible characteristics of collector cars can be found by looking for subjective terms as beauty, design, history, image and mystique. The problem, however, as stated before, is that these terms cannot be quantified. In order to be able to study these traits, one needs to find (though subjective) lists or rankings that say something about beauty or design of cars. A study in 2009 by Classic and Sports Car Magazine surveyed 20 of the world's most renowned car designers of all time on what they thought were the most beautifully designed cars. They came up with a top 10 of most beautiful cars and a list with cars that were mentioned by designers at least once. The assumption is made that these 20 top designers know what beauty entails and that their opinion on it is in fact right. This study will create dummy variables for both lists, which will take the value of 1 if the car is either in the top 10 or list of mentioned cars and 0 if not. Appendix I lists the cars in the top 10 and the list with mentioned cars. Lastly, one could also argue that the make of a car is an intangible characteristic since a make holds substantial emotional value, history and reputation for car manufacturers and owners and is often times one of the most important traits a buyer looks at. However, this study categorizes the number of cylinders as a tangible characteristic.

In order to study the subjective term 'sportiness' and success of sports cars, this thesis uses a ranking made by Sports Car International (2009). They made a top 10 of the best sports cars of all time and five lists with a top 10 best sports cars for the 1960's, 1970's, 1980's, 1990's and 2000's. For this study, two dummy variables are created that take the value of 1 if the car in question is present in the list of best sports cars of all time or in either one of the five lists of best sports car of the decade and 0 if otherwise. Appendix III lists which cars are in the top 10 of best sports cars and best sports cars of their decade. Another intangible trait is whether the car in question is from a make that is distinct at the time of the auction because it could potentially add to a car's history.

The last category is auction characteristics. These variables are also stated in the SCM database, except for the added variable global recession. Since many newspapers state that investors turned to collector cars when the financial crisis hit at the end of 2007, this study will include a dummy variable that takes the value of 1 if the car is auctioned at the time of the global recession, which is assumed to be running from Q3 2008 to Q2 2009 (International Monetary Fund, 2013). The hypothesis is then that prices will be higher in times of the global recession since demand for collector cars will be higher. Furthermore, it should be noted that some auction houses in the dataset have stopped auctioning cars (because of bankruptcy, merger or discontinuation of their license). Brooks merged with Bonhams in September 2000, which made the combination the fourth largest auctioneer worldwide. In May 2010, Kruse International was forced to quit by the Indiana Auctioneer Commission by revoking their license. Reason for this was the inability of Kruse to pay clients who had sold cars through the firm. Consequently, RM Auctions acquired the auction park. Spectrum auctions, which appears in the dataset only seven times, is bankrupt but it is not clean when this happened. Lastly, The Auction Inc. based in Las Vegas has also stopped auctioning and again it is not clear when this occurred.

Since many variables in this study are categorical, dummy variables were created in order to analyze the data. Dummies were created production year, make, body style, color, condition, racecar, replica, transmission (1 for manual), make extinct at sale (1 if so), auction house, auction month, auction country, top 10 design, top design mentioned, top 10 sports car, top sports car of the decade and global recession. The variable year is split up in the dummy variables ‘py1890-1920’, ‘py1920-1940’, ‘py1940-1960’, ‘py1960-1980’ and ‘py1980-2013;. Body style is split up in the dummy variables ‘coupedum’, ‘cabrioletdum’, ‘saloondum’, ‘targadum’, ‘vandum’, ‘suvdum’, ‘pickupdum’ and ‘tractordum’. Appendix II lists for which makes dummies are created and which makes fall under “other make”, for which colors dummies are created and which colors fall under “other color” and for which auction houses dummy variables are created and which auction houses fall under “other auction”.

Since manually typing over 30,000 auction results would be too time consuming for this thesis (and unnecessary for a proper analysis), I have chosen to include every tenth page of the database. In this way, the sample will stay representative of the whole database since the results are not ordered on price or make. For example, if we filter the auction results to show only results for 1999 (considering only sold vehicles and lots with pictures, as stated before), we get 35 pages with 20 cars on each page. I have then taken over page 1, 11, 21 and 31, which gives 80 results for 1999 in total. Going all the way to 2013, this sample finally has 2029 observations in total after leaving out some lots that were motorbikes.

An issue that becomes apparent after some further investigation is the one of Multicollinearity. Logically, displacement, horsepower and the number of cylinders in an engine are highly correlated and this could potentially cause errors in predicting the coefficients. When we regress price against horsepower, displacement and number of cylinders separately, we see that displacement has a predictive power that is negligible (R^2 = 0.0012) as opposed to horsepower (R^2 = 0.0249) and number of cylinders (R^2 = 0.0614) and has the highest correlation with the other two. Hence, displacement will not be included in the analysis.

The last point of attention concerning the dataset is the prices that are stated for each lot. Since these prices are nominal, we need to discount all prices back to a basis year in order to be able to compare them. I have used inflation rates from the Consumer Price Index (CPI) data provided by the U.S. Department of Labor Bureau of Labor Statistics (2014). All prices are adjusted to 2013 prices using cumulative inflation rates from 1999 onwards. These rates are shown below in table 1:

Table 1: (Cumulative) inflation rates from 1999 to 2013

1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
39.8%	35.3%	31.6%	29.5%	26.6%	23.3%	19.3%	15.6%	12.4%	8.2%	8.6%	6.8%	3.6%	1.5%	-
1.398	1.353	1.316	1.295	1.266	1.233	1.193	1.156	1.124	1.082	1.086	1.068	1.036	1.015	1

4.2 Method and Functional form

As stated before, there are two main approached to hedonic indices, which are the hedonic imputation (HI) and time dummy hedonic (DTH) method. For HI indices the change in the parameters over time is the essence. The DTH approach, on the contrary, requires the parameters to stay constant over time and uses coefficients of time dummy variables to determine price changes. So the main difference between the two methods is whether one keeps the parameters constant over time. Since one of the main questions in this study is whether collector cars are a viable investment and thus if prices are going up through time, keeping all other parameters equal, this study will use the dummy time hedonic method. In this way, positive coefficients for the time dummies will prove that prices are increasing while controlling for car and auction specific effects.

The next issue is choosing a functional form for the analysis. According to Triplett (2004), the three most commonly used forms are the ‘linear form’ ‘semi-log form’ and the ‘double-log’ or

'log-log' form. The linear form will regress price against the chosen parameters, the semi-log form regresses the log of price against chosen parameters and the double log form regresses the log of price against the log of the parameters. The semi-log form is most widely used and accepted, so this study will follow and use the semi-log form. Formally, the semi logarithmic time dummy hedonic regression function be depicted as follows:

$$\ln P_{kt} = \sum_{m=1}^{M} \alpha_m X_{mkt} + \sum_{t=1}^{T} \beta_t \delta_{kt} + \varepsilon_{kt}$$

Where P_{kt} represents the price of good k at time t, X_{mkt} is the value of characteristic m of object k at time t, δ_{kt} is a time dummy variable which takes the value 1 if good k is sold in period t and 0 if otherwise and ε_{kt} reflects the error term. The coefficients α_m reflect the attribution of a shadow price to each of the m characteristics, while the antilog of the coefficients β_t are used to construct a hedonic price index. The regression can be interpreted as follows: An increase of $\alpha_m \, x \, X_{mkt}$ will lead to increase of $\frac{\partial P_{kt}}{P_{kt}}$ and $\frac{\partial P_{kt}}{P_{kt}}$ can be interpreted as the percentage change in P_{kt} when multiplying both sides with 100. Intuitively, a semi logarithmic function can be interpreted as the percentage change in the dependent variable when increasing one of the independent variables with one unit and keeping all other independent variables constant. Since dummy variables can only be either zero or one, the coefficient of a time dummy should be interpreted differently. The price impact of a time dummy variable can be found by taking the exponent of the dummy coefficient and consequently subtracting 1. Formally, this look like:

$$\frac{\partial P_{kt}}{P_{kt}} \, x \, 100\% = \left(e^{\beta_t} - 1\right) x \, 100\%$$

4.3 Models

The regression analyses will be divided into four main models, where the last model will be the final model with all variables included. Models are categorized according to variable characteristics. The four models will include:

1.) Tangible Characteristics
2.) Tangible Characteristics + Intangible Characteristics
3.) Tangible Characteristics + Intangible Characteristics + Auction Characteristics

4.) Tangible Characteristics + Intangible Characteristics + Auction Characteristics + Time dummy variables

An overview of the four models with variables included per model is showed at table 2 below. To overcome the dummy variable trap of perfect multicollinearity, for every variable for which dummy variables are created, one category is left out. The dummy variables left out in the regressions are: 'py1890-1920' for the production year variable, 'condition3' for car condition, 'saloondum' for the body style variable, 'red' for the color, 'chevrolet' for the make, 'Russo And Steele' for auction house, 'january' for month, 'switzerland' for auction country and 'y1999' for the auction year. This automatically means that these variables are the reference categories. Hence, when interpreting the coefficients, the values are a comparison to the reference category.

Table 2: Variables included per model

	Model:	**1**	**2**	**3**	**4**
Category:	**Variable:**				
Tangible variables	**Production Year**	Yes	Yes	Yes	Yes
	Body style	Yes	Yes	Yes	Yes
	Horsepower	Yes	Yes	Yes	Yes
	Displacement	No	No	No	No
	Number of cylinders	Yes	Yes	Yes	Yes
	Induction	Yes	Yes	Yes	Yes
	Odometer	Yes	Yes	Yes	Yes
	Color	Yes	Yes	Yes	Yes
	Condition	Yes	Yes	Yes	Yes
	Race Car	Yes	Yes	Yes	Yes
	Replica	Yes	Yes	Yes	Yes
	Number produced	Yes	Yes	Yes	Yes
	Transmission	Yes	Yes	Yes	Yes
Intangible variables	**Make**	-	Yes	Yes	Yes
	Extinct at sale	-	Yes	Yes	Yes
	Top 10 design	-	Yes	Yes	Yes
	Top design	-	Yes	Yes	Yes
	Top 10 sports car	-	Yes	Yes	Yes
	Top sports car	-	Yes	Yes	Yes
Auction variables	**Auction house**	-	-	Yes	Yes
	Auction month	-	-	Yes	Yes
	Auction country	-	-	Yes	Yes
	Global recession	-	-	Yes	Yes
Time dummies	**Auction year**	-	-	-	Yes

5 Empirical results

5.1 Explanatory power of the models

All four models are estimated using a Ordinary Least Squares (OLS) regression and the dependent variables is the natural logarithm of 2013 real prices (inflation corrected). The first model has a R^2 of 0.405, the second model has a R^2 of 0.523, the third model has a R^2 of 0.605 and the fourth and last model has a R^2 of 0.630, meaning that the last model explains 63% of the variance in the natural log of inflation corrected collector car prices. The first three models were merely created in order to see the explanatory power of the different categorized characteristics. From now on, when discussing coefficients, we are looking at model 4, which includes all variables. The model 4 results with coefficients, price impact, standard errors, t-values, P-values and confidence intervals are included in Appendix V.

5.2 Coefficients of the variables

Tangible characteristics

Starting with the production year of the car, one can see that, as the dummy 'py1890-1920' was left out as a reference category, all other dummies have negative and statistically significant values (at 5%), with values getting increasingly negative for later production years. This means that older cars sell for higher prices than newer cars, all else equal.

When considering body style, we see mixed results. As stated earlier, the reference category is a saloon body style. One can observe that only cabriolets and vans go for higher prices than a saloon. Coupes, targas, SUV's, pick-ups and tractors all sell for lower prices than a saloon styled car, ceteris paribus. However, only the coupe and van style are statistically significant (at 10%) so clearly body style is not an important value driver when looking at a collector car. Although it looks surprising that, ceteris paribus, a van will sell for more than a saloon car, this coefficient can be explained by the fact that the dataset only includes a handful of rare vans (including one that transported Ferrari race cars in the 1960's), which were all restored to better than new condition. This probably increased the van body style coefficient. The fact that coupes sell for less money than saloons, could be explained by the fact that the 42% of the dataset covers coupes and only 9.5% saloons so many average- and low priced coupes could drag the coupe style coefficient down compared to the often high priced saloons (like Rolls-Royces and Bentleys).

The coefficient for horsepower is statistically significant (at 1%) but its value is almost negligible. The same holds for the mileage for a given car. It turns out that engine power and mileage are not really important for collector cars. This is not surprising since many historical (and expensive) cars are more valued for their history, mystique, design or other traits. However, the number of cylinders in a car has a much larger and statistically significant effect on price (at 1%). Since this variable is numerical, one can interpret the coefficient as follows: an increase of 1 cylinder will lead to a price increase of 5.1% on average and ceteris paribus. Cars with many cylinders (in most cases V12's or V16's) thus are more expensive cars than the ones with fewer cylinders. This could be explained by the fact that these engines are more complex, mysterious and most of all desirable. Car enthusiasts simply love V12's for their unique sound and used technique.
The induction dummy variable shows a positive sign but is not statistically significant. This means that a car having either fuel injection, a supercharger or intercooler does not significantly changes the price. Although one could argue that this makes a car sportier and faster, it is apparently not an important issue for car collectors and does not add value on average.

As one would expect, overall condition is an important factor for car prices. With Condition 3 as the reference category, one can observe that, as was expected, condition 1 cars have the highest prices, followed by condition 2 cars. A condition 4 car will slightly decrease the price compared to condition 3 (although not statistically significant) and condition 5 will slightly increase the price but is again not statistically significant. The positive sign of condition 5 is somewhat surprising but could be explained by the fact the handful (7 to be exact) of condition 5 cars in the dataset are in fact rare and historical cars (like Rolls-Royces, Aston Martins etc.) so the coefficient is probably biased because of this and the small number of observations.

As for the color of the cars, we see mixed results when compared to the reference category, which is red. One can observe that almost all coefficients are negative, except for (from highest to lowest) silver, blue and other colors. This means that, compared to red cars, silver, blue and other (see Appendix II) colored cars go for higher prices than red cars but other colors will generally decrease the price. However, only the color silver is statistically at significant (at 5%). Hence, we could only conclude that silver significantly increases a car's price compared to red.

The highest coefficient in the whole analysis is the racecar dummy variable. With a statistical significance at the 1% level we can say that racecars sell for substantial higher prices than

non-racecars. This does not come as a surprise since racecars often have a well-documented history and higher emotional value for their participation or victory in some well-known races like Le Mans or the Mille Miglia. Another high (but negative) coefficient is the one of the replica dummy variable. We can say that, at a statistical significance level of 1%, replica cars decrease value compared to a genuine car. This does not come as a surprise as replicas often have the same great looks of the car it replicates, but not its sentimental and historical value. Still, good replicas fetch extremely high prices because they are most often made of the most rare and expensive cars.

As for the transmission of a car, a manual transmission will significantly increase the price compared to an automatic car (at the 1% level). This is not surprising since a manual gearbox is generally found to be sportier, but also from a practical point of view, they are easier to repair and maintain than an automatic gearbox. However, it should be noted here that the high coefficient could be partially explained by the fact that automatic gearboxes just were not present in larger numbers before the 1940's, when Oldsmobile introduced it as an option called "hydramatic". This thus could well be a case of bias in the sample. But still after taking this fact into account, it is not a surprising value.

What is surprising, however, is the statistically significant (at 1%) but negligible effect of the number produced of a specific model. Although the coefficient has a negative value, which makes sense because one would expect that the more rare a car is, the higher its price would be, this is not proven by the data.

Intangible Characteristics

One of the most important traits one could think of is of course the make. And indeed, all but a few coefficients show high and statistically significant values. Only Alfa Romeo and Cord have negative and insignificant and the makes under other make have positive and insignificant influence, compared to Chevrolet, which is the reference category. From high to low, Duesenberg, Delahaye, Aston Martin, Ferrari, Bugatti, Mercedes-Benz, Porsche, Shelby, Maserati and Lamborghini all sell, as was expected, for substantially higher prices than Chevrolet cars. Surprisingly Rolls Royce and Jaguar sell for lower prices. All these coefficients are statistically significant at the 1% level, expect for Jaguar, which is so at 10%. The fact that Chevrolets are apparently more expensive than Rolls Royces and Jaguars, ceteris paribus, could be explained by the fact many Chevrolets in the database are in fact rare, high performance cars that are highly sought after and by the fact that there are many average priced Rolls Royces in it as well. However, the figures are still somewhat surprising.

Next is the question whether car prices are higher when the make is extinct at the moment of auction. A negative coefficient tells us that a car make being extinct decreases the value, although it is not statistically significant.

As for the variables that try to capture sportiness and beauty, only the top design variable is statistically significant. This means that cars that are mentioned by the 20 top designers at least once and are therefore in the list, fetch higher prices than cars that are not mentioned. Although the top 10 design variable has a positive coefficient, it is not statistically significant. Concerning the sports cars variables, the top 10 sports cars of all times shows quite a high positive value (but not significant) and the top sports car of its decade variable (of the 1960's, 1970's, 1980's, 1990's and 2000's) shows a slightly negative value but is again not significant.

Auction Characteristics

For the variable auction house, Russo & Steel was left out as a reference category. Compared to Russo & Steel, only Silver Auctions and Kruse International (which went out of business in 2010 after the Indiana Auctioneer Commission revoked the firm's license) show negative values what means that, ceteris paribus, lower prices are paid at these two auction houses. However, only Silver Auctions is statistically significant. All other coefficients are positive and from high to low they are Gooding & Co., RM Auctions, Christies, Brooks, Barret-Jackson, Bonhams, Ebay, Mecum, H&H Auctions and other auctions. However, only Gooding & Co. and RM (at 1%), Christies (at 5%), Barret-Jackson (at 10%) are statistically significant. These results do not come as a surprise since Gooding & Co. and RM are the most prestigious ones in the market and Christies has a reputation of high quality auctions in general. In conclusion, there is nothing strange here with top auction houses at the actual top.

For auction month, December was chosen as reference category as it made up the largest part of observations (almost 18% of the data). When we look at the values, we see that only March and November have a negative sign which means they generally show lower prices paid for collector cars than December, although they are not statistically significant. All other months have positive signs, with from high to low values, January, October, August, May, September, April, June, July and February. However, only January and October (at 1%) and August (at 10%) are statistically significant. Most values can be explained since the famous Scottsdale (Arizona) auction takes place in January and the prestigious Concourse D'elegance at Pebble Beach (Gooding & Co.) is in August. Many top dollar cars are

auctioned at these two places, which boosts the average prices paid in those months. October is a bit harder to explain since there are no renowned auctions in that particular month.

Lastly, we look at the place of auction and whether or not the auction happened to be held during the global recession from Q3 2008 to Q1 2009. Firstly, we see that, compared to Switzerland, which is the reference, only in Italy and France prices are, ceteris paribus, statistically significantly higher (at 5% level). Prices in Sweden and the United states are also higher than in Switzerland, but not significantly. The countries with negative values are the United Kingdom, Monaco, Germany and Canada, where only the latter one is statistically significant. We can therefore conclude that prices in Italy and France are the highest, and the lowest prices are paid in Canada. However, it should be noted that Canada only makes up for a mere 1% of the total database, so results could be somewhat biased. Lastly, we can see that an auction being held during the global recession has a positive influence on collector car prices, which could be explained by the fact that investors turn to alternative investments instead of conventional assets like stocks, bonds etc., but that it is not statistically significant.

Outlier issue

In order to deal with problem of potential outliers affecting the analysis, an extra model is created where the dependent variable is the winsorized version of inflation corrected log prices. This is done by replacing the highest and lowest 5% of the observations in the dataset by the next value counting inwards from the extremes. The independent variables stay the same. When regressing the winsorized inflation corrected log prices against the variables in question, the coefficients with their statistical significance levels all stay around the same. The explanatory power of the model decreases only slightly to 62.6% as opposed to the 63.0% of the original dataset. Results are shown in Appendix V.

5.3 Coefficients for different subsets

It sounds logical that different types of cars have different value drivers. A vintage car from 1902 has different characteristics as an American muscle car from the 1970's but they can have the same price. Obviously, horsepower is not important for a vintage car and other factors like its history, rarity, looks or its technological innovations for that time can make such a car very pricy. For a muscle car, on the other hand, horsepower and other engine aspects are extremely important. Racecars probably have different value drivers than

‘normal’ collector cars. Appendix VI shows all regression coefficients for the production eras 1920-1940, 1940-1960, 1960-1980 and 1980-2013 and for racecars separately. These regressions thus only take into account cars with that specific trait and not the whole dataset. As one can observe, the coefficients differ substantially. Although it’s not worth mentioning all differences, the most interesting ones should be elaborated. Firstly, we see that for the whole dataset, cars in general are more valuable when they are older but this is not the case for racecars. Racecars made from 1920 to 1940 are the most valuable. These result are however not statistically significant. Furthermore, the coefficient for the number of cylinders is about 4 times higher than for collector cars in general (significant at 10%). This means that the number of cylinders is much more important for a racecar, which does not sound illogical. Since all racecars in the data are either coupes or convertibles, body type is not significant. The coefficient of the top design dummy is about three times larger than for regular cars and statistically significant at 10%. Other coefficients also differ but are not significant. Looking at production era, we see that cabriolets from 1960-1980 are worth less than saloons from that era, as opposed to the positive sign of cabriolets in the whole dataset. This means saloons from 1960-1980 are the most valuable. Horsepower stays around the same for all periods and is statistically significant for all era but 1940-1960. Interestingly, we see that the sign of the number of cylinders turns negative and doubles for 1980-2013 cars, which means less cylinders are more desirable for that production era. Color coefficients do not change with different subsets. The replica dummy goes from -0.466 for the whole set to -1.706 for 1940-1960 cars, which means the car being a replica from 1940-1960 decreases the value even more than for other production eras. Next, we see that the positive sign of the car having a manual gearbox changes to negative for 1980-2013 cars, which means automatic gearboxes are more desirable for these relatively new cars. This coefficient is not significant though. The most outstanding difference considering the make of a car is observable for Shelby cars. The coefficient for the whole set is 0.686 whereas the coefficient for 1980-2013 shows one of -1.933. It turns out that Shelby cars from this era are much less desirable, which could be partially explained by the enormous success of the Shelby cobra that was produced in the 1960’s. Furthermore we see that cars from 1960-1980 have a substantially higher coefficient for the top 10 design dummy, which could be explained by a bias in the data since most top 10 design cars are simply from this period. Next, the coefficient of the Gooding & Co. auction almost doubles for the 1940-1960 era, which means that cars auctioned at Gooding & Co. are even more expensive when they are from this era. Other coefficients from the subsets are either similar to the dataset including all cars or not statistically significant. Time dummy variables will be discussed in the next section.

5.4 Collector car price index and sub indices

In order to graphically show the auction year time dummies in model 4, we need to convert their coefficients into price impact values the same way we did for the other variables. This can be done, as said before, by taking the exponent of the coefficient and subtracting one. The Price index will be constructed from 1999 to 2013, with 1999 being the base year, which is standardized to start at 100. For example, a car auctioned in 1999 will be converted to 2013 prices by multiplying its price by the cumulative inflation rate from 1999 to 2013, which is 1.398. Below, table 3 shows the price index for all cars in the dataset:

Table 3: Price index for all cars

All cars	**N=1670**				
Year	**Coefficient**	**P > |t|**	**Price Impact in (%)**	**Index**	**Return**
1999	-		-	100	-
2000	0.330	0.060	39.08%	139	39.08%
2001	0.210	0.218	23.31%	123	-11.34%
2002	0.157	0.325	16.94%	117	-5.16%
2003	0.240	0.125	27.15%	127	8.72%
2004	0.223	0.161	25.03%	125	-1.67%
2005	0.477	0.002	61.17%	161	28.91%
2006	0.581	0.000	78.71%	179	10.88%
2007	0.775	0.000	117.00%	217	21.43%
2008	0.658	0.000	93.04%	193	-11.04%
2009	0.578	0.000	78.17%	178	-7.70%
2010	0.379	0.019	46.07%	146	-18.02%
2011	0.635	0.000	88.79%	189	29.25%
2012	0.738	0.000	109.17%	209	10.79%
2013	0.761	0.000	113.97%	214	2.29%
			Arithmetic average	**=**	**6.89%**
			Geometric average	**=**	**5.58%**
			Volatility	**=**	**17.53%**

Since it would be interesting for investors to see which cars have had the highest returns over the last 15 years, several sub indices will be constructed. Unfortunately, because for many makes and production eras there are not enough observations to make a proper index (none of the time dummy variables would be significant or there would be missing points in the index because of the fact that cars of a specific make were not sold during that year), only sub indices are created for Ferrari and Chevrolet. Furthermore, separate indices will be created for three different production eras that (1940-1960, 1960-1980 and 1980-2013) in order to see which production eras show the highest risk/return tradeoff over the years. These sub indices are created by regressing the natural logarithm of 2013 (inflation corrected) prices against all variables used so far in this study, except for the variables that represent the sub index and consequently looking at the time dummy variables. For example,

the price index of Ferrari will be created by regressing the natural log of 2013 prices against all used variables except for the make dummy variables (because we only look at Ferrari). The same holds for the production era price indices. Tables 4 until 8 show price indices for Ferrari, Chevrolet and the three production eras (1940-1960, 1960-1980 and 1980-2013).

Table 4: Price index for Ferrari cars

Ferrari	**N=350**					
	Year	**Coefficient**	**P > |t|**	**Price Impact in (%)**	**Index**	**Return**
	1999	-	-	-	100	-
	2000	0.414	0.235	0.513	151.34	51.34%
	2001	0.513	0.130	0.670	167.02	10.36%
	2002	0.347	0.283	0.415	141.55	-15.25%
	2003	0.444	0.182	0.559	155.88	10.13%
	2004	0.566	0.099	0.762	176.18	13.02%
	2005	0.739	0.036	1.093	209.29	18.79%
	2006	0.767	0.034	1.154	215.40	2.92%
	2007	1.065	0.002	1.902	290.15	34.70%
	2008	0.631	0.137	0.880	188.02	-35.20%
	2009	0.594	0.109	0.811	181.09	-3.69%
	2010	0.849	0.027	1.338	233.79	29.10%
	2011	0.913	0.018	1.492	249.15	6.57%
	2012	0.742	0.065	1.100	209.95	-15.73%
	2013	1.231	0.001	2.425	342.54	63.15%
				Arithmetic average	**=**	**12.16%**
				Geometric average	**=**	**9.19%**
				Volatility	**=**	**26.49%**

Table 5: Price index for Chevrolet cars

Chevrolet	**N=245**					
	Year	**Coefficient**	**P > |t|**	**Price Impact in (%)**	**Index**	**Return**
	1999	-	-	-	100	-
	2000	-0.350	0.501	-0.295	70.48	-29.52%
	2001	0.324	0.485	0.383	138.32	96.26%
	2002	0.191	0.614	0.211	121.07	-12.47%
	2003	0.320	0.374	0.377	137.72	13.75%
	2004	0.199	0.609	0.220	121.96	-11.45%
	2005	0.815	0.015	1.260	225.99	85.30%
	2006	0.132	0.713	0.141	114.15	-49.49%
	2007	0.264	0.459	0.303	130.25	14.11%
	2008	0.378	0.260	0.460	145.96	12.06%
	2009	0.329	0.341	0.390	138.99	-4.77%
	2010	-0.254	0.495	-0.225	77.54	-44.21%
	2011	0.174	0.646	0.189	118.95	53.40%
	2012	0.243	0.537	0.275	127.48	7.18%
	2013	-0.179	0.682	-0.164	83.60	-34.42%
				Arithmetic average	**=**	**6.84%**
				Geometric average	**=**	**-1.27%**

			Volatility	**=**		**44.80%**

Table 6: Price index for production era 1940-1960

1940-1960	**N=394**				
Year	**Coefficient**	**P > |t|**	**Price Impact in (%)**	**Index**	**Return**
1999	-	-	-	100	-
2000	-0.003	0.994	-0.003	99.68	-0.32%
2001	0.392	0.368	0.479	147.93	48.40%
2002	0.038	0.925	0.039	103.89	-29.77%
2003	0.203	0.609	0.225	122.49	17.91%
2004	0.352	0.377	0.422	142.24	16.12%
2005	0.432	0.256	0.541	154.06	8.31%
2006	0.357	0.351	0.429	142.93	-7.22%
2007	0.593	0.122	0.809	180.91	26.57%
2008	0.706	0.073	1.026	202.60	11.99%
2009	0.518	0.203	0.678	167.82	-17.17%
2010	0.190	0.625	0.209	120.89	-27.96%
2011	0.589	0.130	0.802	180.20	49.06%
2012	0.585	0.137	0.795	179.49	-0.39%
2013	0.561	0.149	0.752	175.21	-2.39%
			Arithmetic average	**=**	**6.65%**
			Geometric average	**=**	**4.09%**
			Volatility	**=**	**24.26%**

Table 7: Price Index for production era 1960-1980

1960-1980	**N=813**				
Year	**Coefficient**	**P > |t|**	**Price Impact in (%)**	**Index**	**Return**
1999	-	-	-	100	-
2000	0.361	0.095	0.435	143.48	43.48%
2001	0.106	0.612	0.112	111.18	-22.51%
2002	0.052	0.786	0.053	105.31	-5.28%
2003	0.246	0.165	0.279	127.88	21.43%
2004	0.220	0.237	0.246	124.58	-2.58%
2005	0.481	0.007	0.618	161.79	29.86%
2006	0.513	0.005	0.671	167.09	3.28%
2007	0.808	0.000	1.244	224.37	34.28%
2008	0.634	0.002	0.885	188.49	-15.99%
2009	0.558	0.006	0.746	174.64	-7.35%
2010	0.356	0.073	0.427	142.73	-18.27%
2011	0.572	0.004	0.772	177.17	24.13%
2012	0.868	0.000	1.381	238.12	34.40%
2013	0.881	0.000	1.413	241.26	1.32%
			Arithmetic average	**=**	**8.59%**
			Geometric average	**=**	**6.49%**
			Volatility	**=**	**22.10%**

Table 8: Price Index for production era 1980-2013

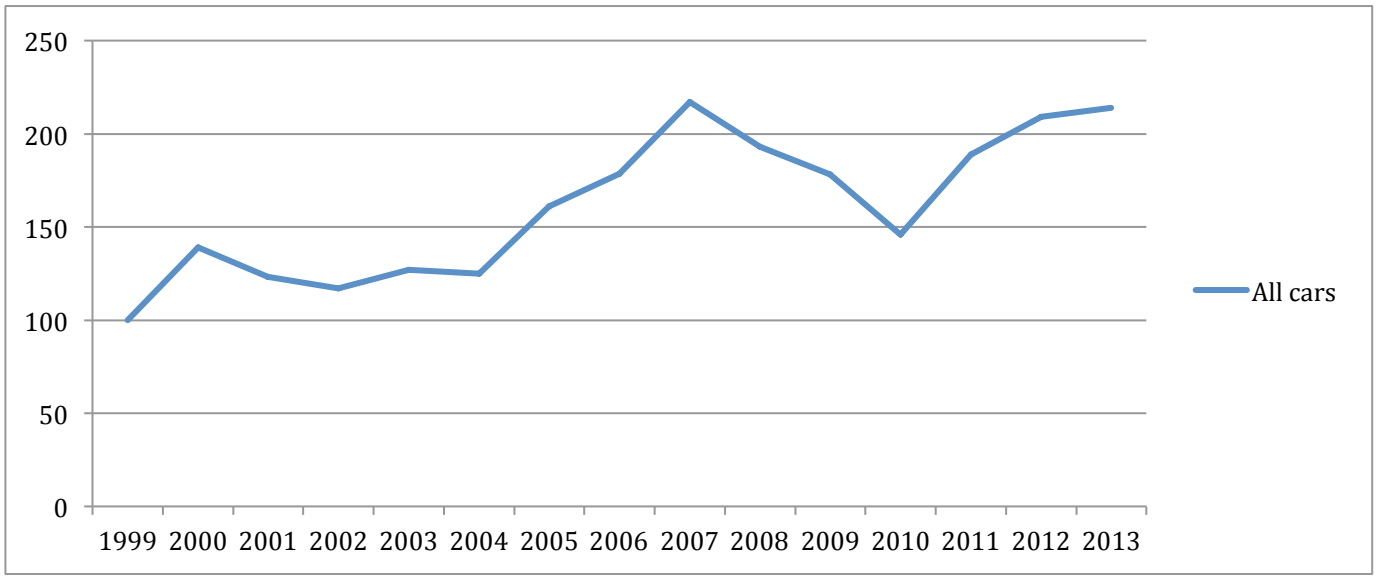
1980-2013	N=197				
Year	Coefficient	P > |t|	Price Impact in (%)	Index	Return
1999	-	-	-	100	-
2000	-0.090	0.872	-0.086	91.37	-8.63%
2001	0.312	0.606	0.367	136.66	49.57%
2002	0.102	0.851	0.107	110.73	-18.98%
2003	0.284	0.599	0.328	132.82	19.95%
2004	0.045	0.937	0.046	104.61	-21.24%
2005	0.101	0.862	0.107	110.66	5.79%
2006	0.212	0.740	0.236	123.61	11.71%
2007	0.044	0.940	0.045	104.54	-15.43%
2008	0.090	0.880	0.094	109.41	4.66%
2009	-0.042	0.940	-0.041	95.87	-12.38%
2010	0.168	0.777	0.182	118.24	23.34%
2011	-0.336	0.581	-0.286	71.44	-39.58%
2012	0.550	0.366	0.733	173.27	142.53%
2013	-0.234	0.741	-0.208	79.17	-54.31%
			Arithmetic average	**=**	**6.21%**
			Geometric average	**=**	**-1.65%**
			Volatility	**=**	**47.36%**

Looking at the overall index and the sub indices, we can see a general increase in prices, with a slight decrease from 2007 to 2010. This downturn could be explained by the financial crisis, which would mean investors are more hesitant to pay high prices during the crisis. This sounds logical, but it contradicts the positive coefficient of the global recession dummy variable in model 4, which indicated that during the global recession from Q3 2008 till Q12009, prices actually were higher than before and after the crisis. However, this coefficient was not statistically significant while the time dummy variables in the price index all are so (at the 1% level). We can thus follow the logic of the time dummies and conclude that prices significantly dropped in the 2007-2010 period, which is probably due to the financial crisis. Furthermore, we see a slight decrease that starts in 2000, which could be traced back to the tech bubble that burst abruptly by the early 2000's. It could well be that this economic downturn has had it effect on the collector car market as well. The time dummy coefficients for that period are not statistically significant though (the time dummies for 2001, 2002, 2003 and 2004 are not statistically significant whereas the rest of the coefficients is). The average geometric return of all cars in the database is 5.58% on an annual basis with a volatility (standard deviation) of 17.53%. This translates to a Sharpe ratio of 0.318. The Sharpe ration is calculated by dividing the expected return by its volatility. When we compare the 'all car' index to the indices of Ferrari and Chevrolet, we see a few differences. Ferrari shows a more profitable but also more volatile return history, whereas Chevrolet shows a slightly negative

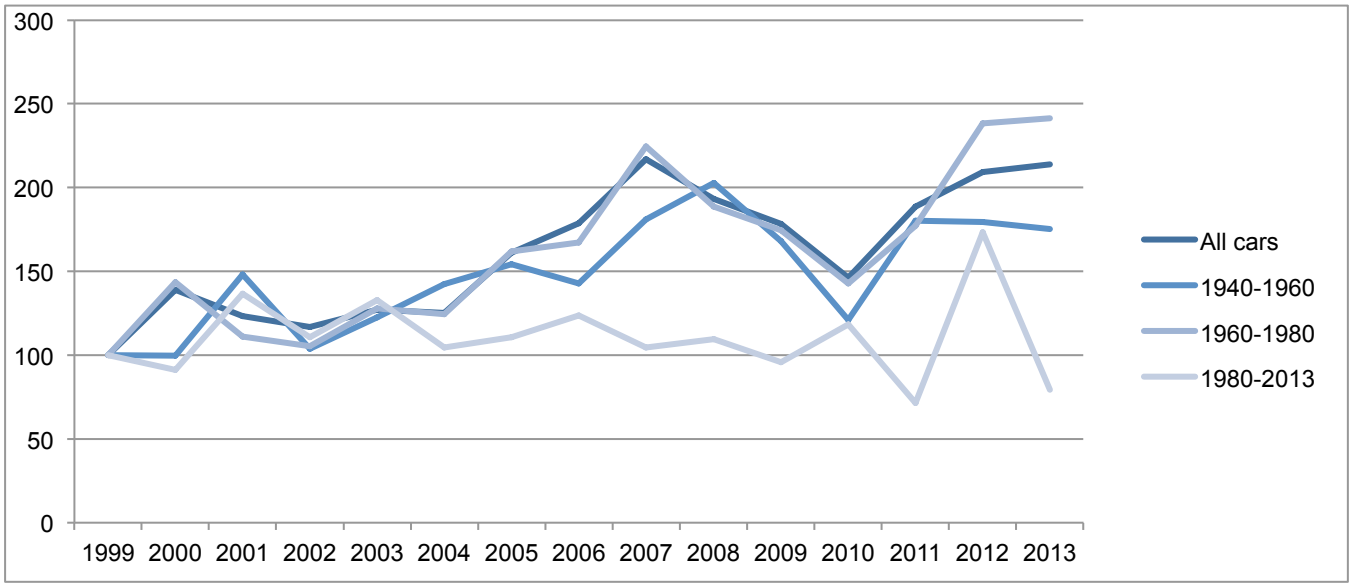
return over the last 15 years with an even higher volatility. Before concluding that Chevrolets, in general, are a bad investment, it should be noted that only one time dummy is statistically significant, as opposed to 8 of the time dummies for the Ferrari index and 10 for the all car index (base year 1990 has no coefficient so no significance level). With an average geometric return of 9.19% and volatility of 26.49%, which translates to Sharpe ratio of 0.347, one can conclude that Ferrari's have performed better than classic cars in general.

Looking at production eras, we see that the average geometric return of cars produced between 1940 and 1960 is 4.09% with a volatility of 24.26%, which translates to a Sharpe ratio of 0,169, which is much lower than the all car average. Cars that were produced between 1960 and 1980 show a higher average annual return of 6.49% and volatility of 22.10% (Sharpe ratio of 0,294), which is a slightly lower risk/return tradeoff than classic cars on average. Lastly, cars produced from 1980 to 2013 show an average geometric annual return of -1.65% and volatility of 47.36% (Sharpe ratio of -0.035). This result is not surprising since cars from this era are not really old yet, they are often less rare and it is not yet clear which cars will appreciate in value over the years, in contrast to cars that were produced earlier. Again, it should be stated that for 1980-2013, none of the coefficients are statistically significant, as opposed to 1 coefficient for 1940-1060 and 10 coefficients for 1960-1980. We can therefore not attach too much value to the indices for 1890-1920 and 1920-1940. Below are the graphical representations of the price indices.

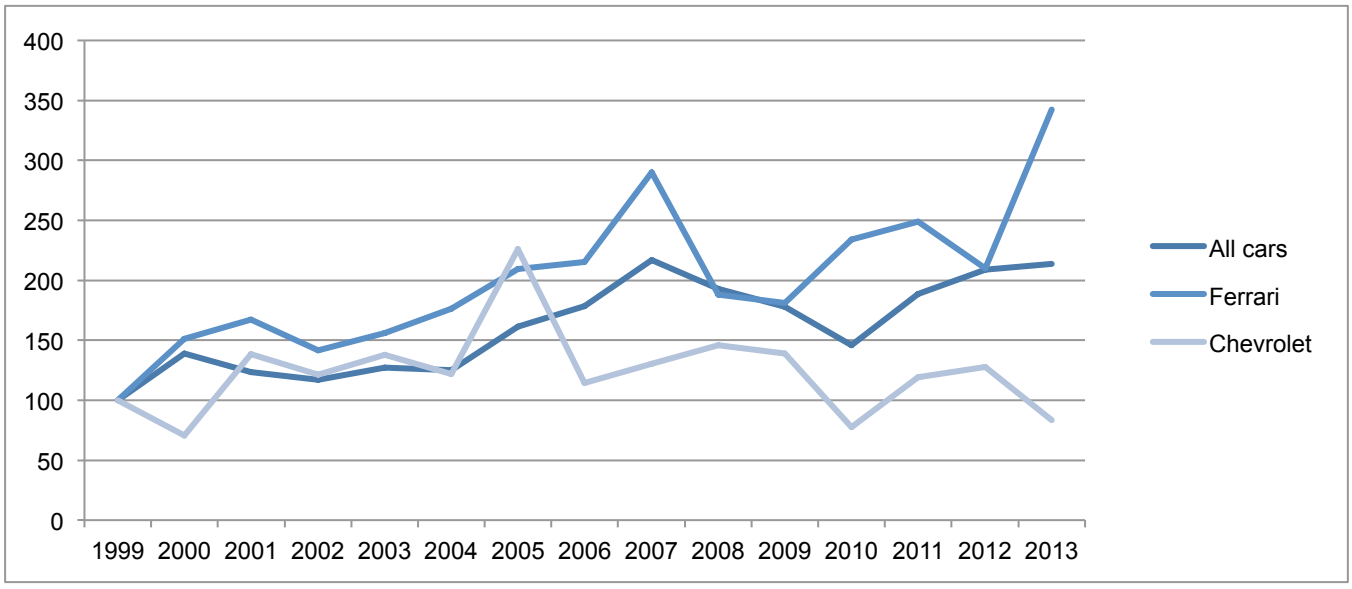
Graph 1: Price index for all cars



Graph 2: Price index for all production eras



Graph 3: Price index for Ferrari, Chevrolet and all cars



5.5 The masterpiece effect

As stated in 2.3, this study wants to look if there is something like a masterpiece effect in the collector car market. To do this, the regression is repeated, but now it is done for the 90th percentile. This means we're looking at the 10% most expensive cars. The table and graph are shown on the next page:

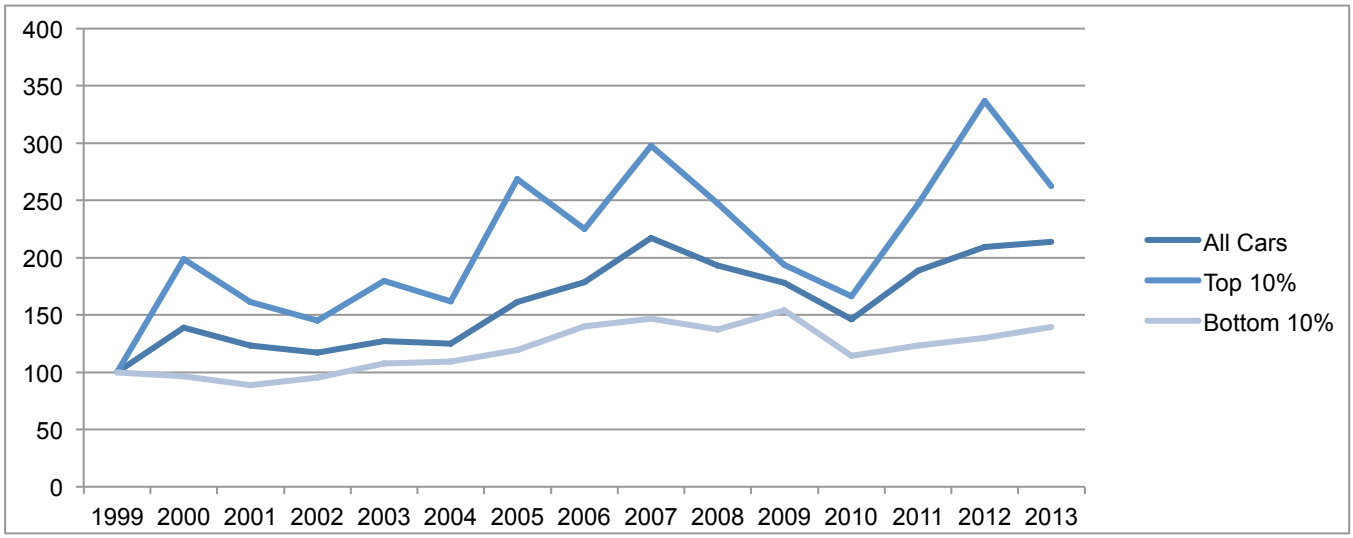
Table 9: Price index for the top 10% of observations

Top 10%	N=1670				
Year	Coefficient	P > |t|	Price Impact in (%)	Index	Return
1999	-	-	-	100	-
2000	0.688	0.000	0.989	198.91	98.91%
2001	0.477	0.000	0.611	161.13	-18.99%
2002	0.373	0.000	0.452	145.16	-9.91%
2003	0.585	0.000	0.795	179.50	23.66%
2004	0.482	0.000	0.620	161.99	-9.76%
2005	0.988	0.000	1.685	268.53	65.77%
2006	0.812	0.000	1.252	225.19	-16.14%
2007	1.091	0.000	1.977	297.71	32.20%
2008	0.906	0.000	1.475	247.52	-16.86%
2009	0.660	0.000	0.935	193.54	-21.81%
2010	0.509	0.000	0.663	166.31	-14.07%
2011	0.903	0.000	1.468	246.81	48.40%
2012	1.215	0.000	2.369	336.88	36.50%
2013	0.964	0.000	1.623	262.31	-22.14%
			Arithmetic average	**=**	**12.55%**
			Geometric average	**=**	**7.13%**
			Volatility	**=**	**38.67%**

Table 10: Price index for the bottom 10% of the observations:

Bottom 10%	N=1670				
Year	Coefficient	P > |t|	Price Impact in (%)	Index	Return
1999	-	-	-	100	-
2000	-0.036	0.000	-0.035	96.49	-3.51%
2001	-0.120	0.000	-0.113	88.68	-8.09%
2002	-0.048	0.000	-0.047	95.32	7.49%
2003	0.071	0.000	0.073	107.33	12.60%
2004	0.090	0.000	0.094	109.45	1.97%
2005	0.178	0.000	0.195	119.48	9.17%
2006	0.338	0.000	0.402	140.24	17.37%
2007	0.385	0.000	0.469	146.94	4.78%
2008	0.317	0.000	0.373	137.30	-6.56%
2009	0.431	0.000	0.539	153.92	12.10%
2010	0.135	0.000	0.145	114.46	-25.64%
2011	0.211	0.000	0.235	123.50	7.90%
2012	0.262	0.000	0.299	129.91	5.19%
2013	0.331	0.000	0.393	139.28	7.21%
			Arithmetic average	**=**	**3.00%**
			Geometric average	**=**	**2.39%**
			Volatility	**=**	**10.98%**

Graph 4: Price index for Top 10%, bottom 10% and all cars



As can be observed by looking at the index, average annual geometric returns (and volatility) are higher for top cars compared to the whole dataset. This means that the most expensive collector cars yield higher returns than average priced cars. However, their volatility is also higher and the Sharpe ratio is only 0.185, which is lower than the one for collector cars in general. When we do the same for the bottom 10% of the database, we see that the average annual return is 2.39% with a volatility of 10.98%. This constitutes a Sharpe ratio of 0.218, which is also lower than the general collector car index. Results thus indicate towards the presence of a masterpiece effect. This masterpiece effect could be explained by the fact that there is an ever-increasing amount of wealthy individuals in the world while the supply of top quality cars stays at a stable level, since these cars are not produced anymore.

5.6 Costs of investing in collector cars

It would be insufficient if this study would only look at collector car prices and their returns without paying attention to the extra costs that investing in classic cars brings. This paragraph has the goal of clearly listing and quantifying all other costs that investing in cars involves. Firstly, as stated before, there is the buyer's premium and the seller's premium.

"The company receives a 10% commission from the seller and a 10% premium from the buyer for marketing the car worldwide and putting on the auction." (Mr Gooding stated in LA Times, 2012). The same rate of 10% is mentioned at the website of Silver Auctions. This means that when an investor buys a car he has to pay a 10% premium and when he wants to sell the car another 10% of the selling price has to be paid. Theoretically this means an investor, on average over the last 15 years, would have to keep his car for at least four years

in order to make a profit (the average annual return is 5.58%, in four years this is 24.26%). This would be shorter for owning a Ferrari, which have to in possession just over 2 years.

Secondly, a valuable collector car would normally not be stalled outside but rather in a dry, safe place. One can assume, however, that an investor that is willing and looking to invest in the collector car market will only do so while having proper storage room, so this would then be a sunk cost, since the garage is probably already there. Assuming an investor does not have this room or rather wants his car in a safer and climate controlled space, he has to rent or a buy storage space. Several firms in the UK rent these spaces for prices ranging from £14 to £36.50 a week, which translates into annual costs of between $1,250 and $3,242. Different additional services like battery conditioning, periodical engine run up to operational temperature, driving the car on salt-free roads and turning the wheels periodically. Other firms, like a US based storage firm specialized in classic cars, charge anywhere from $1200 to $2750 a year depending on the services provided.

Thirdly, a collector car has to be insured just as every other car when the car will be driven. Although one would think that insuring a valuable classic would be much more expensive, surprisingly the opposite is true, due to several factors. Normal cars are insured on the assumption that they depreciate over time while collector cars hold their value and often appreciate over time. Moreover, car insurance firms that specialize in classic cars often offer lower quotes than regular insurers. The reason is quite simple: “Classic cars are pampered and driven infrequently and carefully” (LA Times, 2009). Furthermore, drivers are often between 35 and 70 years old which significantly decreases the risk of accidents. When the car is stored inside the price goes down as well. Lastly, there is a substantial difference between insuring a collector that is only displayed and a road-going car. Mr Heacock (2009, as stated in LA Times) states that a collector car can be insured for 1% of its value.

Since valuable collector cars are marketed internationally and attract buyers from all over the world, transportation costs should not be overlooked. Exact prices can differ substantially depending on distance and transportation type but a professional transport from one side of the US to the other would cost between $1,000 and $2,000 (Edwards, 2009).
Lastly, repairing a collector car is the second most expensive activity after the actual purchase. Again, it is hard to attach values to this since repairs could entail only replacing a light bulb to restoring a whole car back to new, which could cost hundreds of thousands of dollars. However, an investor should keep in mind that it’s a possibility and with many parts not being produced anymore, easy replacements could still be expensive.

6. Comparison with other financial assets

In order to find out whether classic cars are in fact a viable asset class, their risk and return should be compared to conventional and other alternative asset classes. In this section, we will compare the constructed price index with the following funds (only funds will be considered since these represent whole markets, as opposed to individual stocks):

- The US stock market: will be represented by the popular Spider S&P 500 ETF (Ticker: SPY). This ETF started in 1993.
- The European stock market: will be represented by the Vanguard FTSE Europe ETF, which covers stocks from all the financial heavyweights in Europe (Ticker: VGK). This ETF started in 2005.
- The US Treasury Bill market: will be represented by the Spider Barclays 1 to 3 month treasury bill ETF, which includes many us government T-bills varying from 1 to 3 months (Ticker: BIL). This ETF started in 2007.
- The US Government bond market: will be represented by the IShares 7-10 year Treasury Bond ETF, which tracks many government bond maturing in 7 to 10 years (Ticker: IEF). This ETF started in 2002.
- The US Real Estate market: will be represented by the IShares Real Estate, which is the only ETF that tracks real estate investment trusts (REITs) of all classifications. (Ticker: IYR). This ETF started in 2000.
- The US Gold market: will be represented by the Market Vectors Gold Miners ETF, which closely replicates the price and yield performance of the Gold Miners Index (Ticker GDX). This ETF started in 2006.
- The Commodity trading market: will be represented by the PowerShares DB Commodity Tracking ETF, which tracks an index composed of futures contracts for 14 commodities, including crude oil, natural gas, zinc, wheat, sugar etc. (Ticker DBC). This ETF started in 2006.

All data is extracted from DataStream on a monthly basis. Since several of the funds stated above started later than 1999, some annual returns are based on shorter periods than the collector car index. However, we can still compare their returns and risk. Table 10 on the next page lists the return, volatility, expense ratio, net return and Sharpe ratio per asset class.

Table 10: Comparison of financial assets to collector cars

	US Real Estate	Europe ETF	Gold	US Stock	US Bond	US T-Bill	Commodities	Collector Cars
Monthly return	0.66%	0.38%	-0.01%	0.33%	0.17%	0.00%	0.32%	-
Annual return	7.94%	4.61%	-0.14%	3.99%	2.00%	-0.01%	3.82%	5.58%
Monthly volatility	7.68%	6.86%	11.74%	4.85%	2.02%	0.11%	6.54%	-
Annual volatility	26.60%	23.78%	40.66%	16.80%	7.01%	0.37%	22.67%	17.53%
Expense ratio	0.46%	0.12%	0.53%	0.09%	0.15%	0.13%	0.85%	1.00%
Net return	7.48%	4.49%	-0.67%	3.90%	1.85%	-0.14%	2.97%	4.58%
Sharpe ratio	0.281	0.189	-0.017	0.232	0.264	-0.381	0.131	0.261

For collector cars, the expense ratio of 1% is the result of the average 1% insurance costs of collector car stated in the previous paragraph. As can be observed, collector cars hold quite well next to the conventional asset classes with a Sharpe ratio that ranks third in the list. Only real estate and long term US government bonds yield a higher Sharpe ratio. Since the US government bonds are assumed to be almost impossible to default, their volatility is much lower than for collector cars but their returns are also lower, in general. Real estate has the highest risk/ratio tradeoff and apparently is a profitable business. Our collector cars index outperforms the European Stock ETF, the gold miners index (which has a negative Sharpe ratio), the S&P 500 index, US Treasury bills maturing in 1 to 3 months and the Commodity index. It should also be noted that the volatility in the collector car index is lower than many other alternative investment classes like real estate, gold and commodities (and also lower than European stock). This suggests that investing in collector cars is not an unprofitable idea in general. However, again it should be noted that only insurance costs are included in this comparison. The largest indirect expenses of investing in cars, the buyer's and the seller's premium are not taken into account here. A collector car, on average, has to be kept in ownership for more than 4 years in order to break even on the premiums that have to be paid at the points of acquisition and sale. However, buyer and seller premiums are often negotiable and are in general much lower for individuals that buy and sell at auctions on a regular basis. This drastically decreases the indirect costs of investing in collector cars and improves chances of making a decent profit.

7. Conclusion and Limitations

This study tried answer several questions. In order to come up with well-grounded answers a database was created with 2029 auction transaction going from 1999 to 2013. The first goal of this study was to identify the most important characteristics that together result in a price. These characteristics could be separated by their nature into tangible, intangible and auction characteristics. The most important traits are: Age of the car (the older the car, the more

valuable it is), the condition of the car with the highest condition cars being the most valuable, whether or not the car in question is a race car (a race car is, ceteris paribus, twice as valuable as a non race car), the make of the car is extremely important (popular makes like Ferrari, Mercedes-Benz, Aston Martin, Porsche, Duesenberg, Bugatti and Delahaye are the most valuable, where, for example, a Duesenberg is, on average, four times as valuable as a Chevrolet, which was chosen as the reference category), whether the car in question was mentioned as having a top design by 20 of the world's best car designers, at which auction house the car is auctioned (on average, Gooding shows the highest prices of all main auction houses), and the month in which the car is auctioned (January and October are by far the most expensive months, which could also be explained by the fact that in those months, the most prestigious, annual auctions are held).

The second goal of this study was to investigate the average returns on collector cars. This was done by creating dummy variables for all years in the dataset, while controlling for all other variables, and converting their coefficients to annual return figures. Consequently, an index was built with base level 100 in 1999. It appears that the collector car database, which is assumed to represent the total population, returns 5.58% on a yearly basis. Indirect costs like buyer premiums, insurance, transportation, storage and restoration costs are not yet taken into account in this figure.

The third goal of this thesis was to discover whether different subsets of collector cars yield different returns. The subsets Ferrari, Chevrolet, production year 1940-1960, production year 1960-1980, production year 1980-2013, top 10% and bottom 10% all included a sufficient amount of observations to create separate indices, which are all shows in the graphs. As is graphically easily observable, One sees that Ferrari's, on average, outperform collector cars in general with an average annual return of 9.19% (and a higher Sharpe ratio) whereas Chevrolet cars generally underperform compared to the collector car market. Looking at production year, we can see that cars produced from 1960 to 1980 outperform the collector car market in general and that cars produced from 1940 to 1960 underperform. Cars from 1980 to 2013 even show negative returns, which could potentially be explained by the fact that these cars are not quite old, are produced in greater numbers and because it is still uncertain which cars will eventually become valuable collector cars. Furthermore, the results from analyzing the top 10% of the data suggest that something like a masterpiece effect is present, since this top 10% outperforms the general collector car index after controlling for the same variables that were used earlier. This means that expensive cars return higher yield for the mere reason that they are more expensive. This effect can be explained by several facts, including the prestige that is draped around these cars.

The last objective was to find out if collector cars perform as well as other financial assets. In this part, the collector car index was compared with US T-bills, US Government bonds, US stocks, European stocks, US real estate, gold and commodities. It turns out that collector cars hold out quite well in this list since their risk/return trade off ranks third out of the total of 8. This is after controlling for a 1% annual insurance fee for collector cars, which is assumed to representative for most cars (explanation in section 5.5).

This study comes to the conclusion that collector cars can be a profitable investment that holds up well next to conventional and alternative investments. However, indirect costs of investing in these cars can be substantial and are generally much higher than the transaction costs of other financial assets. This study devoted a chapter to these indirect costs and made clear that they can be quite high, but still cars can yield a nice return. A recommendation for future research could be an even more extensive database, which covers more years and cars. This would add to the statistical significance of the results and more observations result in the potential of creating more sub indices than is currently possible.

Investing in collector cars brings a lot more joy and excitement compared to conventional investment, which are all intangible. A collector car gives its investor beautiful design, historic and emotional value, amazing engine sound and a decent return. All in all, I think that collector car investors are more satisfied people than mainstream investors that will generally never actually hold their investment.

8. Bibliography

- Anderson, R.C. (1974). *Paintings as Investment.* Economic Inquiry, Vol. 12, pp. 13-26.
- Andrews, T. & Benzing, C. (2007). *The determinants of price in Internet auctions of used cars.* Atlantic Economic Journal, Vol. 35, Issue 1, pp. 43-57.
- Bergen, A. van (2009). *How do classic Ferrari's perform as a financial instrument? An investment analysis of classic Ferrari's.* (Master thesis. Tias Nimbas Business School. Tilburg, the Netherlands)
- Cafariello, J. (2013). *Investing in classic cars: Tuning a collection into cash.* Wealthy Daily, [Internet] 23 October 2013. Retrieved from: http://www.wealthdaily.com/articles/investing-in-classic-cars/4748 [Accessed on 25-04-2014]
- Campbell, R.A.J. (2005). *Art as a financial investment.* The journal of alternative investments, Vol. 10, No. 4, pp. 64-81.
- Classic Car Club of America. N.D. *What is classic car?* Retrieved from: http://www.classiccarclub.org/grand_classics/what_is_classic_car.html [Accessed 02-05-2014]
- Court, A. (1939). *Hedonic Price Indexes with automotive example:* The dynamics of Automobile demand. General Motors, New York.
- Goetzmann, W. N. (1993). *Accounting for Taste: Art and the Financial Markets over Three Centuries*. American Economic Review, vol. 83. No 5, pp. 1370-1376.
- Griliches. Z. (1961). Hedonic Price Indexes for Automobiles: An Econometric Analysis of Quality Change. National Bureau of Economic Research. 61(1). 173-196.
- Griliches, Z. & Ohta, M. (1976). *Automobile prices revisited: Extensions of the hedonic hypothesis.* Household Production and consumption
- Hilton & Moss. (N.D.). *What's happening to the Classic Car market?* Retrieved from: http://www.hiltonandmoss.com/blog-entry/whats-happening-to-the-classic-car-market-2
- Historic Automobile Group Index. (N.D).
- International Monetary Fund. (2013). *World Economic Outlook (WEO) April 2013: Statistical appendix – Table A1 – Summary of World Output.* 16 April 2013. Retrieved from: http://www.imf.org/external/pubs/ft/weo/2013/01/pdf/tables.pdf [accessed on 08-07-2014]
- Koninklijke Nederlandsche Automobiel Club. (2013). *Motie Bashir (SP) laatste kans.* Retrieved from: http://www.knac.nl/2013/05/03/motie-bashir-laatste-kans/ [Accessed 05-05-2014]

- Kristof, K.M. (2009). *Classic car auto insurance is cheaper than enthusiasts may think.* Los Angeles Times, [Internet] 23 August 2013. Retrieved from: http://articles.latimes.com/2009/aug/23/business/fi-perfin23 [accessed on 14-07-2014]
- Lant Insurance Brokers. (N.D.). *Collector Car Definitions.* Retrieved from: http://www.lant-ins.ca/collector.php [Accessed 04-05-2014]
- Markowitz, H. (1952). *Portfolio Selection: Efficient Diversification of Investments.* The journal of Finance, Vol. 7. No. 1, pp. 77-91.
- Mei, J. & Moses, M. (2002). *Art as an investment and the underperformance of masterpieces.* American Economic Review, Vol. 92, No. 5, pp. 1656-1668.
- O' Sullivan, A. and Sheffrin, S. (2003). *Economics: Principles in action.* Prentice Hall.
- Orsi, A. and Gazzi, R. (2008). *Hagerty's classic car auction 2006-2008 Yearbook.* Modena, Historica Selecta.
- Pesando, J.E. (1993). *The market for modern prints.* The American Economic Review, Vol. 83, Issue 5, pp. 1075-1089.
- Ramalho, E. and Ramalho, J. (2011). *Hedonic functions, hedonic methods, estimation methods and Dutot and Jevons house price indexes.* Mimeo, Universidade de Evora.
- Reis, H., Silva, J. (2006). *Hedonic prices indexes for new passenger cars in Portugal (1997-2001).* Economic Modeling, Vol. 23, Issue 6, pp. 890-908.
- Renneboog, L.D.R. & Spaenjers, C. (2013). *Buying Beauty: On prices and returns in the art market.* Management Science, Vol. 59, pp. 36-53.
- Roll, R. (1988). *The international Crash of October 1987.* Financial Analysts Journal. September/October 1988, pp. 19-35.
- Rosen, S. (1974). *Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition.* The Journal of Political Economy. 82(1). pp. 34-35.
- TEFAF (The European Fine Art Foundation) Art Market Report 2013. Press Release March 2013, Maastricht. Published on 03/13/2013.
- Undercoffler, D. (2013). *Monterey car auctions set a record -- $301.9 million in sales.* Los Angeles Times, [Internet] 19 August 2013. Retrieved from: http://www.latimes.com/business/autos/la-fi-hy-autos-pebble-beach-auction-results-20130819,0,4912729.story#axzz30OHgWYlO [Accessed 01-04-2014]
- Van der Vinne, V. (2014). *De auto als belegging*. Uitgeverij Siemes, Zutphen.
- Wagenführ, H. (1965). *Kunst als Kapitalanlage.* Forkel, Stuttgart
- Wealthinsight (2013). Luxury investments: A mix of passion and profit. Press release October 2013.

- Worthington, A. and Higgs, H. (2004). *Art as an investment: Risk, return and portfolio diversification in major painting markets*. Accounting and Finance, Vol. 44. No. 2, pp. 257-272.

9. Appendices

Appendix I: The top 10 design and top design mentioned

The two dummies used in this work are based on the study in 2009 from Classic and Sports car Magazine. The 20 designers surveyed were Dennis Adams, Roy Axe, Paul Bracq, Ian Callum, Russel Carr, Steve Crijns, Leonardo Fioravanti, Marcello Gandini, Giorgetto Giugiaro, John Heffernan, Tom Karen, Patrick le Quément, Paulo Martin, Gordon Murray, Ken Okuyama, Martin Smith, Peter Stevens, Julian Thomson, Tom Tjaarda and Oliver Winterbottom.

The Top 10 design ranking by classic and sports car magazine includes: Citroën DS, Jaguar XK120, Ferrari 275 GTB, Cord 810/812, Ferrari 250 GT Lusso, Ferrari 250 GT SWB, Jaguar E-type, Lamborghini Miura, Lotus Elan and Lotus Elite (’57).

The models included in the top designs mentioned include, of course, all the model from the Top 10 design ranking plus the following: Alfa Romeo Canguro, Aston Martin DB9, Audi A6, Bentley Continental GT, Bentley R-Type Continental, Bertone BAT 5, Bertone Marzal, BMW 328 Mille Miglia, Bugatti T41 Royale Coupé Napoleon, Bugatti T57SC Atlantic, Buick Riviera (1963-’65), “Cadzilla”, Citroën ID/DS, Cord 810/812, Delage D8-120S, Ferrari 166 Barchetta, Ferrari 250 GT Lusso, Ferrari 250 GT SWB, Ferrari 250 GTO, Ferrari 275GTB, Ferrari 330 P3/4. Ferrari Dino 206 S, Ferrari Dino 246 GT, Ferrari P6, Ford GT40, Hispano-Suiza H6 (Tulip Wood), Jaguar E-type, Jaguar XJ6 S1, Jaguar XK120, Jaguar XKSS, Lagonda Rapide, Lamborghini Countach, Lamborghini Gallardo, Lamborghini Miura, Lancia Stratos, Lincoln Continental (1961), Lotus Elan +2, Lotus Elan S3, Lotus Elite (1957), Maserati Boomerang, Maserati Khamsin, Mercedes-Benz 500K, Mercedes-Benz Gullwing 300SL, Mini, Pagaso Z102 ‘Thrill’, Phantom Corsair and the Triumph TR4

Appendix II: makes, colors and auction houses included

Dummy variables are created for the following makes: Ferrari, Mercedes-Benz, Aston Martin, Alfa Romeo, Rolls-Royce, Porsche, Duesenberg, Lamborghini, Maserati, Bugatti, Jaguar, Chevrolet, Shelby, Delahaye and Cord. Makes included in the dummy variable “othermake” are: Abarth, AC, Acura, American, Allard, Allis Chalmers, Alpine, Alvis, AMC, Amilcar, Amphicar, Asa, Aster, Auburn, Audi, Austin, Austin-Healey, Autobianchi, Avions, Baja, Bantam, Belsize, Bentley, BMW, Brabham, Bristol, Buick, Cadillac, Callaway, Caterham, Chalmers, Chaparral, Chrysler, Citroen, Clenet, Cooper, Crane-Simplex, Crossley,

Cunningham, Daimler, Delage, Delorean, Desoto, Detomaso, DKW, Dodge, Edsel, Facel Vega, Fiat, Ford, Ghia, GMC, Gordon-Keeble, Haynes-Apperson, Healey, Hillegas, Hispano-Suiza, Honda, Horch, HRG, Hudson, Humber, Hupmobile, Hurtu, Iso Grifo, Julien Boyer, Kaiser-Darrin, Koenigsegg, Lagonda, Lancester, Lancia, Land Rover, Le Zebre, Lea-Francis, Lincoln, Lister, Lloyd, Locomobile, Lola, Lotus, Lozier, Marmon, Martini, Matra, Maudslay, Mclaren, Mercer, Mercury, Messerschmitt, MG, Minerva, Mini, Mirage, Morgan, Mors, Nash, Nash-Healey, National, Offenhauser, Oldsmobile, Osca, Packard, Panhard et Levassor, Panoz, Peugeot, Pierce-Arrow, Plymouth, Pontiac, Railton, Renault, Riley, Rochet-Schneider, Salmson, Scarab, Siata, Sizaire-Naudin, SMA, Smart, Studebaker, Stuts, Sunbeam, Talbot-Lago, Tatra, Thomas, Tojeiro-Butterworth, Toyota, Triumph, Vauxhall, Volkswagen, Volvo, Vulcan, Washington, Willys and Wolseley-Siddeley.
Separate dummies are included for: red, yellow, blue, green, black, white, silver, grey and brown. Under “other color” variable the following colors are included: gold, copper, orange, tan, purple, pink and ivory.

Dummy variables are created for the following auction houses: Brooks, RM Auctions, Christies, Barret-Jackson, Bonhams, Gooding & Company, Mecum, Silver Auctions, Ebay, H&H Auctions, Kruse and Russo. Auction houses included in the dummy variable “Other auctions”, are: Vanderbrink Auctions, Hollywood Wheels, The Worldwide Group, Pioneer, Art Curial Breist, Carlisle Events, Pioneer, Branson, Shannons, Cheffins, Poulain Le Fur, The Auction Inc., Spectrum, McCormick and Dragone.

Appendix III: Best sports car dummy variables

A dummy variable is created for top 10 sports cars of all time, based on a top 10 sports car of all time ranking created by Sports Car International in 2009 include the Ferrari 250 GTO, McLaren F1, Jaguar E-Type, Lamborghini Miura SV, Mercedes-Benz 300SL, Porsche 911 Carrera RS, Porsche 356, Porsche Carrera GT, Shelby 289 AC Cobra and Mazda MX-5. The other dummy variable is created for the best sports cars of the 1960’s 1970’s, 1980’s, 1990’s and 2000’s. Cars included are in table on the next page:

1960's	1970's	1980's	1990's	2000's
Jaguar E-type	Ferrari 365 GTB/4	Porsche 959	Mazda MX-5	Porsche Carrera GT
Shelby AC Cobra	Datsun 240Z	Ferrari 288 GTO	Porsche Boxster	Ford GT
Porsche 911	Lamborghini Countach	VW Golf/Rabbit GTI	Ferrari 550	Ferrari Enzo
Lamborghini Miura	Lamborghini Miura SV	Audi Quattro	McLaren F1	Pagani Zonda C12S
Chevrolet Corvette	Ferrari 308	Ferrari F40	Porsche 911	Lotus Elise
Lotus Elan	Ferrari 246 GT Dino	BMW M3	Honda NSX	Porsche Boxster S
Ferrari 250 GT SWB	Mazda RX-7	Porsche 911 Carrera	Ferrari F355	Porsche 911 GT3
Ferrari 275 GTB/4	Porsche Carrera RS	Toyota MR2	Nissan 300ZX	Lamborghini Gallardo
Ferrari 250 GTO	De Tomaso Pantera	Renault 5 Turbo	Lotus Elise	Lamborghini Murcielago
Maserati Ghibli	BMW M1	Lamborghini Countach	Mazda RX-7	Subaru Impreza WRX
Porsche 356C				
Ferrari 250 GT Lusso				

Appendix IV: Descriptive statistics on all variables, categorized

Tangible characteristics

Description	Left out as reference	Variable name	Obs	Mean	Std. Dev	Min	Max
Horsepower		hp	2029	241.900	137.092	4	1200
Displacement (cc)		displacement	2029	4487.837	1842.849	148	13500
Number of cylinders		nrofcyl	2029	7560.867	2.407	1	16
Production year		year	2029	1960.200	19.344	1878	2010
Forced induction / fuel injection		induction	2025	0.174	0.424	0	1
Odometer		odometer	1697	37872.610	39851.140	0	620000
Racecar		racecar	2028	0.108	0.312	0	2
Replica		replica	2028	0.032	0.175	0	1
Number produced of model		nrproduced	1989	18826.400	118609.000	1	2194477
Transmission		manual	2029	0.775	0.418	0	1
Body style: Coupe		coupedum	2029	0.420	0.494	0	1
Body style: Cabriolet		cabrioletdum	2029	0.453	0.498	0	1
Body style: Saloon	Yes	saloondum	2029	0.095	0.293	0	1
Body style: Targa		targadum	2029	0.013	0.115	0	1
Body style: Van		vandum	2029	0.006	0.080	0	1
Body style: SUV		suvdum	2029	0.006	0.077	0	1
Body style: Pick-up		pickupdum	2029	0.006	0.077	0	1
Body style: Tractor		tractordum	2029	0.000	0.022	0	1
Color: Red	Yes	red	2029	0.286	0.452	0	1
Color: Yellow		yellow	2029	0.045	0.208	0	1
Color: Blue		blue	2029	0.164	0.370	0	1
Color: Green		green	2029	0.093	0.290	0	1
Color: Black		black	2029	0.123	0.328	0	1
Color: White		white	2029	0.111	0.315	0	1
Color: Silver		silver	2029	0.069	0.254	0	1
Color: Grey		grey	2029	0.031	0.173	0	1

Color: Brown	brown	2029	0.032	0.176	0	1
Color: Other color (see Appendix II)	othercolor	2029	0.045	0.208	0	1
Condition of car: 1	cond1	2021	0.256	0.436	0	1
Condition of car: 2	cond2	2021	0.454	0.498	0	1
Condition of car: 3	cond3	2021	0.252	0.434	0	1
Condition of car: 4	cond4	2021	0.034	0.180	0	1
Condition of car: 5	cond5	2021	0.003	0.059	0	1

Intangible characteristics

Description	Left out as reference	Variable name	Obs	Mean	Std. Dev	Min	Max
Make: Ferrari		ferrari	2029	0.204	0.403	0	1
Make: Mercedes-Benz		mercedes	2029	0.048	0.214	0	1
Make: Aston Martin		astonmartin	2029	0.052	0.223	0	1
Make: Alfa Romeo		alfaromeo	2029	0.000	0.000	0	0
Make: Rolls Royce		rollsroyce	2029	0.000	0.000	0	0
Make: Porsche		porsche	2029	0.028	0.165	0	1
Make: Duesenberg		duesenberg	2029	0.007	0.086	0	1
Make: Lamborghini		lamborghini	2029	0.012	0.108	0	1
Make: Maserati		maserati	2029	0.019	0.136	0	1
Make: Bugatti		bugatti	2029	0.008	0.088	0	1
Make: Jaguar		jaguar	2029	0.044	0.205	0	1
Make: Chevrolet	Yes	chevrolet	2029	0.137	0.343	0	1
Make: Shelby		shelby	2029	0.025	0.155	0	1
Make: Delahaye		delahaye	2029	0.003	0.059	0	1
Make: Cord		cord	2029	0.004	0.063	0	1
Make: Other (see Appendix II)		othermake	2029	0.400	0.490	0	1
Make extinct at sale		extinct	2029	0.231	1.261	0	1
Top 10 design		top10design	2029	0.053	0.225	0	1
Top design		topdesign	2029	0.085	0.279	0	1
Top 10 sportscar of all times		top10sportscar	2029	0.040	0.197	0	1
Top sports car of its decade		topsportscar	2029	0.182	0.386	0	1

Auction Characteristics

Description	Left out as reference	Variable name	Obs	Mean	Std. Dev	Min	Max
Auction house: Brooks		brooks	2029	0.010	0.099	0	1
Auction house: RM Auctions		rm	2029	0.218	0.413	0	1
Auction house: Christies		christies	2029	0.059	0.235	0	1
Auction house: Barret Jackson		barretjack~n	2029	0.041	0.199	0	1
Auction house: Bonhmas		bonhams	2029	0.291	0.454	0	1
Auction house: Mecum		mecum	2029	0.083	0.276	0	1
Auction house: Gooding & Co.		gooding	2029	0.079	0.270	0	1
Auction house: Silver Auctions		silverauctions	2029	0.020	0.139	0	1
Auction house: Ebay		ebay	2029	0.021	0.142	0	1
Auction house: H&H Auctions		hhauctions	2029	0.031	0.172	0	1

Auction house: Kruse		kruse	2029	0.014	0.119	0	1
Auction house: Russo & Steel	Yes	russo	2029	0.018	0.132	0	1
Other auction house (see appendix II)		otherauction	2029	0.101	0.301	0	1
Auction month: January	Yes	january	2029	0.091	0.288	0	1
Auction month: February		february	2029	0.036	0.186	0	1
Auction month: March		march	2029	0.106	0.308	0	1
Auction month: April		april	2029	0.070	0.256	0	1
Auction month: May		may	2029	0.077	0.267	0	1
Auction month: June		june	2029	0.081	0.273	0	1
Auction month: July		july	2029	0.035	0.184	0	1
Auction month: August		august	2029	0.159	0.365	0	1
Auction month: September		september	2029	0.071	0.257	0	1
Auction month: October		october	2029	0.087	0.282	0	1
Auction month: November		november	2029	0.006	0.080	0	1
Auction month: December		december	2029	0.179	0.383	0	1
Auction country: Switzerland	Yes	switzerland	2029	0.104	0.305	0	1
Auction country: United Kingdom		uk	2029	0.245	0.430	0	1
Auction country: United States		us	2029	0.583	0.493	0	1
Auction country: Canada		canada	2029	0.010	0.101	0	1
Auction country: France		france	2029	0.024	0.152	0	1
Auction country: Germany		germany	2029	0.001	0.038	0	1
Auction country: Monaco		monaco	2029	0.017	0.130	0	1
Auction country: Italy		italy	2029	0.015	0.121	0	1
Auction country: Sweden		sweden	2029	0.000	0.022	0	1
Auction year: 1999	Yes	y1999	2029	0.039	0.195	0	1
Auction year: 2000		y2000	2029	0.039	0.195	0	1
Auction year: 2001		y2001	2029	0.039	0.195	0	1
Auction year: 2002		y2002	2029	0.064	0.245	0	1
Auction year: 2003		y2003	2029	0.066	0.248	0	1
Auction year: 2004		y2004	2029	0.064	0.244	0	1
Auction year: 2005		y2005	2029	0.073	0.261	0	1
Auction year: 2006		y2006	2029	0.083	0.276	0	1
Auction year: 2007		y2007	2029	0.091	0.287	0	1
Auction year: 2008		y2008	2029	0.083	0.276	0	1
Auction year: 2009		y2009	2029	0.066	0.248	0	1
Auction year: 2010		y2010	2029	0.069	0.254	0	1
Auction year: 2011		y2011	2029	0.069	0.254	0	1
Auction year: 2012		y2012	2029	0.075	0.263	0	1
Auction year: 2013		y2013	2029	0.078	0.269	0	1

Appendix V: Model 4 regression results including price impact

Variable name	Coefficient	Price Impact	P > |t|	Std. Error	T-value	95% Confidence Interval		Winsorized (highest and lowest 5%) Coefficient	Price Impact	P > |t|
py19201940	-0.457	-36.65%	0.023	0.200	-2.280	-0.849	-0.064	-0.473	-37.67%	0.011
py19401960	-1.203	-69.97%	0.000	0.200	-6.030	-1.594	-0.811	-1.126	-67.57%	0.000
py19601980	-1.625	-80.30%	0.000	0.203	-7.990	-2.024	-1.226	-1.519	-78.11%	0.000
py19802013	-2.175	-88.64%	0.000	0.218	-9.960	-2.603	-1.747	-2.021	-86.74%	0.000
coupedum	-0.149	-13.86%	0.061	0.080	-1.870	-0.305	0.007	-0.141	-13.19%	0.055
cabrioletdum	0.057	5.87%	0.447	0.075	0.760	-0.090	0.204	0.049	4.99%	0.483
targadum	-0.148	-13.75%	0.400	0.176	-0.840	-0.492	0.196	-0.152	-14.07%	0.350
vandum	0.560	75.01%	0.071	0.309	1.810	-0.047	1.166	0.477	61.15%	0.095
suvdum	-0.297	-25.70%	0.203	0.233	-1.270	-0.754	0.160	-0.284	-24.72%	0.188
pickupdum	-0.177	-16.20%	0.547	0.293	-0.600	-0.752	0.398	-0.191	-17.37%	0.482
tractordum	-1.194	-69.70%	0.105	0.736	-1.620	-2.637	0.249	-1.138	-67.97%	0.094
hp	0.003	-	0.000	0.000	9.210	0.002	0.003	0.002	0.24%	0.000
nrofcyl	0.051	-	0.000	0.013	3.960	0.026	0.076	0.045	4.61%	0.000
induction	0.028	2.83%	0.672	0.066	0.420	-0.101	0.157	0.003	0.26%	0.966
odometer	0.000	-	0.153	0.000	-1.430	0.000	0.000	0.000	0.00%	0.111
yellow	-0.037	-3.61%	0.680	0.089	-0.410	-0.212	0.138	-0.050	-4.91%	0.541
blue	0.030	3.08%	0.593	0.057	0.540	-0.081	0.142	0.038	3.84%	0.473
green	-0.073	-7.08%	0.308	0.072	-1.020	-0.215	0.068	-0.049	-4.78%	0.462
black	-0.050	-4.86%	0.424	0.062	-0.800	-0.172	0.072	-0.039	-3.78%	0.503
white	-0.026	-2.57%	0.697	0.067	-0.390	-0.157	0.105	-0.010	-1.01%	0.870
silver	0.179	19.60%	0.017	0.075	2.400	0.033	0.325	0.142	15.24%	0.040
grey	-0.031	-3.08%	0.769	0.106	-0.290	-0.240	0.178	-0.042	-4.12%	0.669
brown	-0.137	-12.81%	0.184	0.103	-1.330	-0.339	0.065	-0.109	-10.36%	0.251
othercolor	0.120	12.75%	0.190	0.092	1.310	-0.060	0.300	0.136	14.52%	0.110
cond1	0.714	104.14%	0.000	0.055	12.950	0.606	0.822	0.658	93.13%	0.000
cond2	0.284	32.83%	0.000	0.046	6.190	0.194	0.374	0.269	30.83%	0.000
cond4	-0.065	-6.25%	0.542	0.106	-0.610	-0.272	0.143	-0.066	-6.37%	0.501
cond5	0.093	9.74%	0.758	0.302	0.310	-0.499	0.685	-0.138	-12.90%	0.621
racecar	0.686	98.53%	0.000	0.081	8.450	0.526	0.845	0.601	82.35%	0.000
replica	-0.466	-37.22%	0.000	0.114	-4.090	-0.689	-0.242	-0.417	-34.08%	0.000
nrproduced	0.000	-	0.000	0.000	-3.720	0.000	0.000	0.000	0.00%	0.000
manual	0.230	25.82%	0.000	0.050	4.600	0.132	0.328	0.236	26.61%	0.000
ferrari	0.967	163.00%	0.000	0.097	9.940	0.776	1.158	0.906	147.51%	0.000
mercedes	0.840	131.70%	0.000	0.110	7.610	0.624	1.057	0.745	110.54%	0.000
astonmartin	0.998	171.25%	0.000	0.118	8.480	0.767	1.229	0.955	159.76%	0.000
alfaromeo	-0.015	-1.53%	0.930	0.174	-0.090	-0.357	0.327	-0.040	-3.92%	0.804
rollsroyce	-0.628	-46.62%	0.000	0.147	-4.270	-0.916	-0.339	-0.535	-41.46%	0.000
porsche	0.711	103.58%	0.000	0.147	4.850	0.423	0.999	0.641	89.78%	0.000
duesenberg	1.486	342.16%	0.000	0.212	7.020	1.071	1.902	1.152	216.42%	0.000
lamborghini	0.533	70.40%	0.002	0.170	3.140	0.200	0.866	0.432	54.10%	0.006
maserati	0.567	76.36%	0.000	0.156	3.630	0.261	0.873	0.547	72.85%	0.000
bugatti	0.934	154.48%	0.000	0.245	3.810	0.453	1.415	0.957	160.29%	0.000

jaguar	-0.214	-19.26%	0.073	0.119	-1.790	-0.448	0.020	-0.160	-14.78%	0.147
shelby	0.686	98.53%	0.000	0.126	5.420	0.438	0.934	0.686	98.50%	0.000
delahaye	1.406	307.92%	0.000	0.333	4.230	0.753	2.058	1.420	313.64%	0.000
cord	-0.345	-29.19%	0.238	0.292	-1.180	-0.918	0.228	-0.173	-15.87%	0.523
othermake	0.110	11.67%	0.126	0.072	1.530	-0.031	0.252	0.124	13.25%	0.062
extinct	-0.061	-5.90%	0.302	0.059	-1.030	-0.176	0.055	-0.068	-6.56%	0.213
top10design	0.178	19.51%	0.193	0.137	1.300	-0.090	0.447	0.069	7.11%	0.587
topdesign	0.444	55.95%	0.000	0.107	4.140	0.234	0.655	0.441	55.49%	0.000
top10sportscar	0.003	0.26%	0.981	0.112	0.020	-0.217	0.222	0.056	5.76%	0.589
topsportscar	-0.013	-1.27%	0.827	0.059	-0.220	-0.128	0.102	-0.016	-1.57%	0.770
brooks	0.299	34.80%	0.379	0.339	0.880	-0.367	0.964	0.289	33.55%	0.357
rm	0.524	68.91%	0.000	0.132	3.980	0.266	0.783	0.476	60.99%	0.000
christies	0.340	40.52%	0.030	0.156	2.180	0.033	0.647	0.372	45.09%	0.010
barretjackson	0.256	29.24%	0.080	0.147	1.750	-0.031	0.544	0.230	25.92%	0.089
bonhams	0.203	22.49%	0.144	0.139	1.460	-0.069	0.475	0.217	24.25%	0.091
mecum	0.051	5.22%	0.721	0.142	0.360	-0.228	0.330	0.007	0.72%	0.956
gooding	0.836	130.68%	0.000	0.152	5.510	0.538	1.134	0.691	99.60%	0.000
silverauctions	-0.537	-41.57%	0.007	0.199	-2.700	-0.928	-0.147	-0.602	-45.22%	0.001
ebay	0.182	19.92%	0.283	0.169	1.070	-0.150	0.513	0.106	11.23%	0.496
hhauctions	0.014	1.39%	0.936	0.171	0.080	-0.322	0.350	0.052	5.33%	0.743
kruse	-0.121	-11.38%	0.563	0.209	-0.580	-0.531	0.289	-0.211	-18.99%	0.276
otherauction	0.012	1.19%	0.934	0.142	0.080	-0.266	0.290	-0.024	-2.37%	0.855
january	0.347	41.42%	0.003	0.118	2.940	0.115	0.578	0.276	31.80%	0.012
february	0.005	0.50%	0.970	0.133	0.040	-0.255	0.265	-0.066	-6.42%	0.588
march	-0.072	-6.98%	0.473	0.101	-0.720	-0.270	0.125	-0.081	-7.76%	0.386
april	0.076	7.90%	0.496	0.112	0.680	-0.143	0.295	0.013	1.34%	0.897
may	0.136	14.57%	0.189	0.103	1.310	-0.067	0.339	0.108	11.38%	0.260
june	0.074	7.73%	0.470	0.103	0.720	-0.128	0.276	0.028	2.79%	0.772
july	0.011	1.14%	0.932	0.132	0.090	-0.248	0.270	-0.018	-1.75%	0.885
august	0.186	20.46%	0.084	0.107	1.730	-0.025	0.397	0.095	9.96%	0.340
september	0.118	12.49%	0.245	0.101	1.160	-0.081	0.316	0.118	12.52%	0.207
october	0.340	40.47%	0.002	0.110	3.100	0.125	0.555	0.324	38.26%	0.001
november	-0.262	-23.04%	0.257	0.231	-1.130	-0.715	0.191	-0.215	-19.38%	0.314
uk	-0.096	-9.16%	0.402	0.115	-0.840	-0.321	0.129	-0.118	-11.15%	0.265
us	0.041	4.23%	0.752	0.131	0.320	-0.216	0.299	0.075	7.78%	0.537
canada	-0.995	-63.02%	0.000	0.245	-4.050	-1.476	-0.514	-0.921	-60.17%	0.000
france	0.400	49.16%	0.042	0.196	2.040	0.015	0.785	0.468	59.69%	0.010
germany	-0.413	-33.83%	0.435	0.529	-0.780	-1.451	0.625	-0.370	-30.91%	0.450
monaco	-0.130	-12.23%	0.498	0.192	-0.680	-0.508	0.247	-0.153	-14.16%	0.391
italy	0.431	53.91%	0.037	0.207	2.090	0.026	0.836	0.409	50.47%	0.033
sweden	0.075	7.75%	0.922	0.757	0.100	-1.411	1.560	0.255	29.02%	0.716
globalrecession	0.160	17.34%	0.218	0.130	1.230	-0.095	0.414	0.109	11.52%	0.363
y2000	0.330	39.08%	0.060	0.175	1.880	-0.014	0.673	0.271	31.16%	0.094
y2001	0.210	23.31%	0.218	0.170	1.230	-0.124	0.543	0.200	22.10%	0.204
y2002	0.157	16.94%	0.325	0.159	0.980	-0.155	0.468	0.130	13.90%	0.376
y2003	0.240	27.15%	0.125	0.156	1.540	-0.067	0.547	0.197	21.83%	0.172

y2004	0.223	25.03%	0.161	0.159	1.400	-0.089	0.536	0.182	19.97%	0.216
y2005	0.477	61.17%	0.002	0.157	3.040	0.170	0.785	0.451	56.92%	0.002
y2006	0.581	78.71%	0.000	0.159	3.660	0.269	0.892	0.552	73.65%	0.000
y2007	0.775	117.00%	0.000	0.155	5.010	0.472	1.078	0.717	104.84%	0.000
y2008	0.658	93.04%	0.000	0.164	4.020	0.337	0.979	0.627	87.27%	0.000
y2009	0.578	78.17%	0.000	0.162	3.570	0.260	0.895	0.587	79.93%	0.000
y2010	0.379	46.07%	0.019	0.162	2.340	0.061	0.696	0.362	43.64%	0.016
y2011	0.635	88.79%	0.000	0.163	3.910	0.316	0.955	0.549	73.16%	0.000
y2012	0.738	109.17%	0.000	0.165	4.480	0.415	1.061	0.654	92.36%	0.000
y2013	0.761	113.97%	0.000	0.164	4.630	0.439	1.083	0.715	104.48%	0.000
constant	10.539	-	0.000	0.328	32.180	9.896	11.181	10.333	-	0.000

Appendix VI: Value drivers per category (for production era and race car)

Variable:	All cars		1920-1940		1940-1960		1960-1980		1980-2013		Race cars	
	Coeff.	P>|t|	Coeff.	P>|t|	Coeff.	P>|t|	Coeff.	P>|t|	Coeff.	P>|t|	Coeff.	P>|t|
py18901920	-	-	-	-	-	-	-	-	-	-	-	-
py19201940	-0.457	0.023	-	-	-	-	-	-	-	-	0.811	0.440
py19401960	-1.203	0.000	-	-	-	-	-	-	-	-	0.347	0.641
py19601980	-1.625	0.000	-	-	-	-	-	-	-	-	0.172	0.785
py19802013	-2.175	0.000	-	-	-	-	-	-	-	-	-	-
coupedum	-0.149	0.061	0.026	0.904	0.001	0.993	-0.732	0.000	-0.329	0.293	-	-
cabrioletdum	0.057	0.447	0.175	0.270	0.177	0.170	-0.454	0.003	-0.263	0.423	0.782	0.175
targadum	-0.148	0.400	-	-	-	-	-0.770	0.001	-0.301	0.525	-3.037	0.427
vandum	0.560	0.071	-	-	-0.758	0.146	0.318	0.415	-	-	-	-
suvdum	-0.297	0.203	-	-	-0.343	0.265	-0.149	0.832	1.292	0.210	-	-
pickupdum	-0.177	0.547	-	-	0.683	0.209	-0.995	0.024	0.492	0.511	-	-
tractordum	-1.194	0.105	-	-	-1.191	0.154	-	-	-	-	-	-
hp	0.003	0.000	0.012	0.000	0.001	0.370	0.003	0.000	0.005	0.000	0.002	0.275
nrofcyl	0.051	0.000	-0.037	0.269	0.070	0.025	0.031	0.207	-0.110	0.005	0.216	0.091
induction	0.028	0.672	0.083	0.732	0.326	0.052	-0.164	0.112	-0.218	0.145	-0.355	0.543
odometer	0.000	0.153	0.000	0.273	0.000	0.064	0.000	0.053	0.000	0.299	-	-
yellow	-0.037	0.680	-0.191	0.545	-0.005	0.981	0.020	0.860	0.159	0.551	-0.293	0.601
blue	0.030	0.593	0.222	0.266	0.063	0.592	-0.030	0.683	-0.026	0.886	0.024	0.965
green	-0.073	0.308	-0.018	0.926	-0.094	0.530	-0.073	0.449	0.265	0.354	-0.669	0.399
black	-0.050	0.424	-0.067	0.696	0.051	0.697	0.009	0.928	-0.411	0.032	-0.782	0.406
white	-0.026	0.697	-0.127	0.630	0.145	0.260	-0.026	0.768	0.069	0.776	-0.325	0.682
silver	0.179	0.017	0.511	0.084	0.560	0.000	0.019	0.849	-0.133	0.545	-0.299	0.664
grey	-0.031	0.769	0.173	0.490	0.268	0.189	-0.395	0.048	0.268	0.336	-0.746	0.505
brown	-0.137	0.184	0.170	0.437	-0.105	0.627	-0.386	0.040	-0.344	0.262	-	-
othercolor	0.120	0.190	-0.082	0.814	-0.086	0.640	0.165	0.156	-0.775	0.053	0.238	0.803
cond1	0.714	0.000	0.423	0.008	0.657	0.000	0.657	0.000	0.899	0.000	0.864	0.106
cond2	0.284	0.000	0.128	0.336	0.312	0.000	0.268	0.000	0.442	0.052	0.463	0.394
cond4	-0.065	0.542	-0.334	0.274	-0.083	0.627	-0.250	0.119	0.411	0.600	-0.334	0.812
cond5	0.093	0.758	0.569	0.277	-0.838	0.231	-0.554	0.261	-	-	-	-
racecar	0.686	0.000	0.037	0.891	0.818	0.000	0.800	0.000	0.778	0.001	-	-

replica	-0.466	0.000	-0.639	0.050	-1.706	0.002	-0.601	0.000	0.373	0.313	-0.528	0.341
nrproduced	0.000	0.000	0.000	0.065	0.000	0.008	0.000	0.001	0.000	0.018	0.000	0.062
manual	0.230	0.000	1.811	0.000	0.082	0.444	0.224	0.001	-0.121	0.423	0.019	0.984
ferrari	0.967	0.000	0.026	0.953	1.266	0.000	1.045	0.000	1.061	0.000	0.979	0.395
mercedes	0.840	0.000	0.984	0.050	0.656	0.004	0.572	0.001	0.903	0.021	0.299	0.816
astonmartin	0.998	0.000	0.451	0.501	0.748	0.010	1.084	0.000	0.971	0.009	2.881	0.111
alfaromeo	-0.015	0.930	1.133	0.020	-0.519	0.132	-0.769	0.006	-	-	1.191	0.440
rollsroyce	-0.628	0.000	-	-	-1.368	0.012	-0.886	0.000	-0.061	0.897	-	-
porsche	0.711	0.000	-	-	0.364	0.393	0.500	0.008	0.630	0.146	1.648	0.122
duesenberg	1.486	0.000	-0.694	0.213	-	-	-	-	-	-	-	-
lamborghini	0.533	0.002	-	-	-	-	0.549	0.007	1.895	0.002	-	-
maserati	0.567	0.000	-	-	2.019	0.008	0.688	0.000	-0.375	0.481	-0.372	0.835
bugatti	0.934	0.000	0.421	0.418	-	-	-	-	1.159	0.115	-	-
jaguar	-0.214	0.073	-0.066	0.901	-0.045	0.859	-0.890	0.000	0.649	0.138	0.473	0.673
shelby	0.686	0.000	-	-	-	-	0.690	0.000	-1.933	0.037	-0.802	0.369
delahaye	1.406	0.000	0.931	0.400	1.373	0.001	-	-	-	-	-	-
cord	-0.345	0.238	-0.551	0.314	-	-	-	-	-	-	-	-
othermake	0.110	0.126	-0.373	0.354	-0.036	0.825	0.098	0.324	0.506	0.074	0.077	0.928
extinct	-0.061	0.302	0.074	0.614	-0.201	0.053	-0.087	0.358	0.134	0.688	0.116	0.835
top10design	0.178	0.193	-0.544	0.371	-0.232	0.533	0.477	0.005	-	-	-0.421	0.625
topdesign	0.444	0.000	0.154	0.626	0.286	0.309	0.439	0.002	-0.413	0.567	1.292	0.069
top10sportscar	0.003	0.981	-	-	-0.104	0.686	0.312	0.041	0.465	0.500	0.012	0.987
topsportscar	-0.013	0.827	-	-	-0.179	0.370	-0.034	0.633	0.054	0.706	0.276	0.522
brooks	0.299	0.379	-	-	1.551	0.132	0.215	0.605	-0.179	0.829	0.665	0.789
rm	0.524	0.000	0.369	0.582	0.982	0.010	0.230	0.167	0.199	0.632	1.638	0.349
christies	0.340	0.030	-0.112	0.868	0.845	0.042	0.072	0.732	0.449	0.425	3.025	0.141
barretjackson	0.256	0.080	-1.029	0.292	0.465	0.222	0.103	0.580	0.181	0.559	0.424	0.795
bonhams	0.203	0.144	-0.148	0.801	0.684	0.092	-0.021	0.910	0.069	0.879	0.829	0.697
mecum	0.051	0.721	-0.059	0.935	0.328	0.400	-0.099	0.576	0.220	0.629	3.969	0.061
gooding	0.836	0.000	0.434	0.529	1.548	0.000	0.535	0.012	-0.168	0.706	2.216	0.370
silverauctions	-0.537	0.007	-1.285	0.110	-0.156	0.735	-0.566	0.038	-0.254	0.775	-	-
ebay	0.182	0.283	-	-	0.046	0.933	-0.100	0.641	0.189	0.668	-	-
hhauctions	0.014	0.936	-0.368	0.575	0.418	0.336	-0.078	0.733	-0.640	0.494	-2.161	0.429
kruse	-0.121	0.563	-	-	0.257	0.653	-0.254	0.307	-1.338	0.074	-	-
otherauction	0.012	0.934	0.252	0.740	0.382	0.328	-0.095	0.585	0.296	0.499	-	-
january	0.347	0.003	0.692	0.289	0.541	0.031	0.361	0.024	0.105	0.799	0.717	0.776
february	0.005	0.970	1.111	0.198	-0.155	0.519	0.004	0.985	-0.610	0.123	1.302	0.618
march	-0.072	0.473	0.058	0.893	-0.237	0.250	0.000	0.999	-0.169	0.604	0.115	0.962
april	0.076	0.496	0.267	0.544	-0.014	0.950	0.123	0.424	-0.500	0.197	1.139	0.576
may	0.136	0.189	0.139	0.759	0.081	0.718	0.186	0.176	-0.265	0.494	-0.225	0.939
june	0.074	0.470	0.129	0.741	0.144	0.521	0.183	0.195	-0.106	0.802	-0.495	0.830
july	0.011	0.932	0.290	0.526	-0.314	0.325	0.004	0.985	0.135	0.744	-2.660	0.180
august	0.186	0.084	0.571	0.214	-0.045	0.842	0.246	0.122	-0.243	0.531	-0.058	0.980
september	0.118	0.245	-0.285	0.432	0.181	0.371	0.270	0.060	0.033	0.917	-1.839	0.378
october	0.340	0.002	0.070	0.873	0.284	0.278	0.482	0.002	0.407	0.339	-1.901	0.445
november	-0.262	0.257	-	-	-0.423	0.286	-0.166	0.563	-0.542	0.526	-	-

uk	-0.096	0.402	0.312	0.581	0.284	0.344	-0.178	0.240	-0.307	0.321	1.626	0.398
us	0.041	0.752	0.234	0.694	0.362	0.256	-0.018	0.921	0.222	0.602	-0.238	0.905
canada	-0.995	0.000	-1.773	0.064	-0.582	0.268	-0.838	0.011	1.014	0.273	-	-
france	0.400	0.042	-0.053	0.950	0.758	0.054	0.490	0.089	-	-	2.318	0.450
germany	-0.413	0.435	-	-	-	-	-0.039	0.941	-	-	-	-
monaco	-0.130	0.498	-0.802	0.318	0.277	0.570	0.082	0.736	-0.218	0.735	0.966	0.732
italy	0.431	0.037	2.325	0.008	0.717	0.274	0.446	0.102	0.689	0.250	-	-
sweden	0.075	0.922	-	-	-	-	-	-	-0.136	0.890	-	-
globalrecession	0.160	0.218	-0.478	0.398	-0.434	0.261	0.102	0.607	0.203	0.551	1.097	0.723
y2000	0.330	0.060	0.195	0.868	-0.003	0.994	0.361	0.095	-0.090	0.872	0.490	0.671
y2001	0.210	0.218	0.829	0.453	0.392	0.368	0.106	0.612	0.312	0.606	0.292	0.820
y2002	0.157	0.325	0.843	0.435	0.038	0.925	0.052	0.786	0.102	0.851	0.724	0.516
y2003	0.240	0.125	0.865	0.434	0.203	0.609	0.246	0.165	0.284	0.599	0.722	0.570
y2004	0.223	0.161	0.504	0.649	0.352	0.377	0.220	0.237	0.045	0.937	0.303	0.777
y2005	0.477	0.002	-	-	0.432	0.256	0.481	0.007	0.101	0.862	1.086	0.276
y2006	0.581	0.000	1.602	0.151	0.357	0.351	0.513	0.005	0.212	0.740	1.769	0.127
y2007	0.775	0.000	1.005	0.352	0.593	0.122	0.808	0.000	0.044	0.940	1.904	0.060
y2008	0.658	0.000	1.927	0.092	0.706	0.073	0.634	0.002	0.090	0.880	1.202	0.639
y2009	0.578	0.000	1.146	0.280	0.518	0.203	0.558	0.006	-0.042	0.940	1.840	0.237
y2010	0.379	0.019	0.761	0.488	0.190	0.625	0.356	0.073	0.168	0.777	0.827	0.603
y2011	0.635	0.000	0.781	0.486	0.589	0.130	0.572	0.004	-0.336	0.581	1.977	0.212
y2012	0.738	0.000	1.020	0.320	0.585	0.137	0.868	0.000	0.550	0.366	1.899	0.239
y2013	0.761	0.000	1.244	0.249	0.561	0.149	0.881	0.000	-0.234	0.741	1.477	0.309