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MY KINGDOM FOR A HORSE (OR A CLASSIC CAR)

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My Kingdom for a Horse (or a Classic Car)

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Abstract:

This paper investigates the price determinants and investment performance of classic cars comprising various categories starting from veteran cars (built between 1888 and 1907) up to modern classics (built between 1975 and 1990). We examine a sample of 29,000 classic car auction sales conducted globally between 1998 and 2017. A hedonic pricing methodology is used to construct several classic car price indices, which enable a risk-return analysis. Classic cars appreciated annually by 3.37% and 5.63%, respectively in real and in nominal terms before transaction costs. Investments in ‘blue chip’ classic cars (12.50%) and Italian classics (11.28%) generate the highest annual nominal returns. On a risk-adjusted basis, classic cars have outperformed equity and other emotional assets such as art, but underperformed bonds and gold over the past two decades. The risk-adjusted returns on the category of affordable classics are similar to those of equity investments.

Keywords: alternative investments, collectibles, emotional assets, hedonic regression, collectible cars, vintage cars

JEL codes: G11, G12, Z11, Z23

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1. Introduction

While trading in emotional assets yields financial returns, other benefits arise for these ‘investments of passion’. First, it is in the nature of emotional assets that part of the utility they produce to the owner is enjoyed in the form of an ‘emotional dividend’, which boils for example down to the aesthetic enjoyment of owning a collectible item or to the signalling of one’s wealth or social status. Second, the degree to which these type of investments are uncorrelated to traditional financial assets, such as equities or bonds, could make them attractive investment candidates from a portfolio diversification perspective. Within the investment class of collectibles, a vast range of different emotional assets have been studied, including wine (Burton & Jacobsen, 2001; Sanning, Shaffer & Sharratt, 2006; Dimson, Rousseau & Spaenjers, 2015), collectible stamps (Dimson & Spaenjers, 2011), fine violins (Ross & Zondervan, 1989; Graddy & Margolis, 2011), rare gemstones and diamonds (Renneboog & Spaenjers, 2012), and fine art (Baumol, 1986; Goetzmann, 1993; Mei & Moses, 2002; Renneboog & Spaenjers, 2013; Korteweg et al., 2016). To date however, no substantial research has been conducted into the risk and return characteristics of classic cars², which are enjoying an increased popularity and constitute a substantial international market.

Auction prices of high-end vintage cars such as classic Ferraris are regularly appearing in the news.³ In 2016, for example, a 1957 Ferrari 335S Spider Scaglietti was sold at a Paris auction for a record-setting €32 million (Sharman, 2016). And in August 2018, a 1962 Ferrari 250 GTO – one of 36

² The Classic Car Club of America (CCCA) defines a classic car as “a fine or distinctive automobile, either American or foreign built, produced between 1915 and 1948” (CCCA, 2016). In this paper, the term ‘classic car’ refers to the much less restricting definition of any car that is older than 25 years. Terms such as ‘vintage car’, ‘classic car’, and ‘collectible car’ are often used interchangeably.

³ “Best of Money: the classic car is the investment star”. Financial Times. April 8, 2016: <https://www.ft.com/content/fc2a08b8-f824-11e5-96db-fc683b5e52db>; “Passion investing in classic cars is gaining speed”. CNBC. January 4, 2016: <http://www.cnbc.com/2016/01/04/passion-investing-in-classic-cars-is-gaining-speed.html>; “Stop kidding yourself. A classic car is (almost) never a good investment”. Bloomberg News. August 14, 2015. <https://www.bloomberg.com/news/articles/2015-08-14/stop-kidding-yourself-a-classic-car-is-almost-never-a-good-investment>

ever produced – changed hands for €41.6 million, making it the most expensive classic car ever sold in an auction (De Standaard, 2018). The popular press, however, often fails to consider risk-return trade-offs and investment benchmarks in its reporting on the viability of classic car investments. Moreover, claims regarding this viability are insufficiently backed by academic research (which is largely lacking). This paper contributes to the literature by filling this gap and answers the question as to whether classic cars be regarded as a viable alternative investment class. In order to do so, we will apply hedonic pricing models on an extensive data set of car auction records. The validity of our findings is enhanced by the fact that we are able to collect for a large sample of auction sales (29,002) more than 20 different physical characteristics of each car including technical aspects of the car ('s engine), judgements of the condition, rarity, uniqueness, provenance etc. Hence, this analysis enables us to understand the price-determining factors of classic cars and as such whether prices are determined mainly by the physical car characteristics or by emotional considerations. In addition, we examine the financial aspects of this niche asset class which we can then compare to those of financial and other real asset classes. Within the segment of alternative investments, the collectable classic cars market is substantial as its auction segment alone represents about USD 1.3 billion a year (and the private market is estimated to be a multiple of this segment). The combined ownership value of classic cars around the world is estimated at USD 120 billion (Mische and Spizzirri, 2014).

We report the following findings. First, classic cars have appreciated at a yearly average nominal (real) rate of 5.63% (3.37%). These returns compare favorably to those of other asset classes, both in absolute terms as on a risk-adjusted basis (Sharpe ratio). From a risk-adjusted perspective, both gold and government bonds showed larger Sharpe ratios, but classic cars outperformed US and global equities even after controlling for risk. The return volatility of classic cars is lower than that of equities but larger than the volatility of bond returns.

Second, as few collectors would invest in all types of classic cars because they may face wealth constraints or have outspoken predilections for specific car types of marques, we calculate the financial characteristics of various sub-samples of classic cars. Collectors may indeed desire to specialize in specific production eras, have a preference for certain marques (e.g. Porsches or Ferraris) or cars built in specific countries (e.g. Italian or British cars), limit themselves to purchasing only the top end of the market (blue chip cars) or face wealth constraints (and can only invest in affordable classic cars). The returns of specific niche segments do indeed vary significantly. Strong nominal returns – above 10% annually - are found for blue chip classics, Italian classics, and Ferraris, but these higher returns go hand in hand with higher volatility than other types of cars. The category of affordable classics yields an annual nominal return of 6.34% with a volatility of 15.23% (which is close to that of the equity market). The lowest returns are generated by the niche markets of pre-war classics (the era of 1930-1946) and American classics.

Third, the hedonic model captures 70% of the price variation of classic cars, which shows that the trading in these emotional assets is still to a large extent based on physical characteristics (such as engine displacement, engine type, forced induction, condition, color, provenance, car type) and

transaction characteristics (auction house reputation, month of sale). Fourth, the low correlation with equities and the negative correlation with bonds, bills and gold imply that from a portfolio perspective, an investment in classic cars could yield higher portfolio returns.

The outline of this paper is as follows. Section 2 provides an overview of the literature on collectible investments and discusses the reasons to invest in and risks of the classic car auction market. Section 3 outlines the data sources and introduces the methodology. Section 4 presents the results. We test the assumption of changes in taste in Section 5. The conclusion is made in Section 6.

2. Literature background

2.1. Alternative investments

Background on alternative investments

Generally, alternative investments refer to asset classes that fall outside the scope of many traditional investments such as stocks, bonds, and cash (Baker & Fillbeck, 2013). A distinction can be made between somewhat ‘traditional alternatives’ and more or less ‘alternative alternatives’ with the former group comprising asset classes such as real estate, private equity, foreign exchange, hedge funds, and commodities, and the latter a wide range of exotic investments such as investments in timberland, carbon emissions, collectible assets, and catastrophe-linked bonds (Blessing, 2011).

Capital allocated to alternative assets has substantially increased in the past few decades (World Economic Forum, 2015). University endowment funds have played a leading role in this trend. Historically, they have been allocating a large portion of their capital to e.g. hedge funds, commodities, and private equity (Lerner, Schoar & Wang, 2008). An often-cited example is Yale’s successful endowment model: in 2015, its endowment’s capital was for over 70% invested in alternatives (Yale Investment Office, 2015). Pension funds are also increasing their investments in alternative asset classes that amount to about 27% of capital (Blackstone, 2016). While these developments mainly refer to ‘traditional’ alternative asset classes such as private equity and real estate, in recent years more niche alternative asset classes have also gained in popularity. Still, this is more so the case at the level of the high-wealth individuals. This phenomenon is mainly caused by an expansion of information being available through specialised data providers and price indices, better accessibility of alternative assets through investment funds, and the increased perception of collectibles as a viable asset class (Coslor and Spaenjers, 2016).

Collectibles and the market for classic cars

Unlike financial assets, emotional assets generally do not generate cash flows, which makes it hard to determine their intrinsic value and, unlike commodities, they cannot be used as part of an industrial process. Still, collectibles provide consumption value in the sense that one can derive pleasure from their usage or aesthetic appearance, or from the wealth signal or social status they can generate. Of all collectibles’ markets, the global classic cars market is one of the largest. Its auction segment alone

exceeds €1.3 billion a year ((Historica Selecta, 2016), and grew by 467% over the past decade (Knight Frank, 2016).

Several factors characterize the market for emotion assets, and classic cars in particular. First, the participants are collectors, “*people who, actively, selectively and passionately, acquire and possess things removed from ordinary use and perceived as part of a set of non-identical objects or experiences*” (Belk, 1995: 479). Especially the market participation of high-net-worth individuals drives prices as they spend significant amounts on passion investments (Capgemini & RBC, 2013). While motivations for collecting are often emotional and social, Burton and Jacobsen (1999: 195) state that “*a substantial proportion of collectors also hope for financial gains*”.

Second, transactions in collectibles’ markets occur through either of three channels: auctions, specialised dealerships, and private sales. Auctions are mostly organised in the form of an English auction, where it is common to place a reserve price on an item such that when the bidding fails to reach this price, the lot is held in. While information on transactions via dealerships and of private sales are not revealed, auction prices provide benchmarks for the other transaction channels.

Third, the markets for collectibles are usually characterised by illiquidity and geographic segmentation which is correlated with a lack of transparency. For the art market, Renneboog and Spaenjers (2014) argue that market segmentation can occur by legal barriers (important art objects may not be exported or are subject to a preferential purchase right), by practical hurdles (e.g. transport costs), and by nationality-induced demand (with exception of the international top-segment, demand for local artists is usually higher than cross-border demand). These effects are likely to play a role in the classic car market as well where trade and geographical barriers may even be higher: a car’s size and weight make transportation impractical, and legislation, registration, and import tariffs can make it costly. Given that car brands may still be symbols of nationalistic pride, a home country bias may also exist.

Over the last decade, several evolutions have occurred in the markets for collectibles. First, these markets have gained some transparency because specialised data providers now publish information on prices and market developments. This has enabled the aggregation of pricing information into indices that capture price evaluations of the global market, niche markets, or individuals types of collectibles (at the level of brand, producer etc.). Such an index can serve as a benchmark against which the performance of an investment in collectibles can be evaluated (Coslor and Spaenjers, 2016).⁴ Furthermore, price indices enable comparisons with other (financial) asset classes, and an evaluation of the portfolio diversification potential of the collectible. Second, collectibles have become more like a commodity and hence an investment asset class (Horowitz, 2011; Coslor and Spaenjers, 2016). A report by Deloitte and ArtTactic (2016), reveals that 78% of wealth managers feel that art and collectibles

⁴ These days, indices are available for fine wine, art, collectible stamps, diamonds, and rare coins. For instance, for wine: Liv-Ex, or London International Vintners Exchange, is an exchange for investment-grade wine and provides information about the Liv-Ex 100 Fine Wine Index (<https://www.liv-ex.com/>); for art: Artprice.com publishes several art indices (<https://www.artprice.com/>); for collectable stamps: there is the Great Britain 30 by Stanley Gibbons (<http://www.stanleygibbons.com/investment/gb30-rarities-index/>); for diamonds: see http://www.idexonline.com/diamond_prices_index/; for coins: see <http://www.stanleygibbons.com/investment/gb200-rare-coin-index/>

should be part of wealth management offerings. Third, specialized investment funds operate in every large market for collectibles. Similar to private equity funds, they gather investments and use the proceeds to invest in collectible items. Such funds also operate in the classic car market; e.g. the closed-end WMG Collectible Car fund raised £50 million of equity in the capital-raising phase (WMG Advisors, 2017), and intends to invest in 10 to 15 collectible cars that are to be held for about 3 years, targeting an annual return of 20%⁵. Other examples of funds in the classic car market are The Classic Car Fund and The Rolling Art Fund.

2.2. Reasons for investing in collectibles

The reasons for investing in collectibles can be partitioned into four categories: investment performance, diversification benefits, hedging benefits, and nonpecuniary rewards.

Performance

Most research concludes that, on average, investments in collectibles show lower risk-adjusted returns than equity investments. Some studies do find that collectibles' investments outperform government bonds: e.g. Renneboog and Spaenjers (2013) report real returns on art of 3.97% annually, over a period spanning 50 years starting from 1957. They conclude that corporate bonds and equities outperform art investments. For other collectibles classes, the results are mixed.

Diversification

Even when an asset does not provide an exceptional return, the inclusion of that asset into an investment portfolio can still improve its performance by reducing its riskiness when the asset is not or negatively correlated to the portfolio's other assets. Most studies report low correlations of collectibles with other financial assets, and even within the collectibles markets cross-wise correlations are low. For instance, Graddy and Margolis (2011) researched the investment performance of fine violins, which is negatively correlated with S&P 500 and FTSE returns. Sanning et al. (2007) apply the Fama-French three-factor model to wine prices and find that returns of wine co-vary only little with stock market returns. This indicates that wine investments have low exposures to equity risk factors, suggesting that in theory they could serve as diversifying investments. Similar results are found by Renneboog and Spaenjers (2012), Dimson and Spaenjers (2011) and Dimson et al. (2015), who report relatively low equity beta's for investments in respectively white and coloured diamonds, collectible stamps, and wine.

Hedging benefits

As most collectibles are real, tangible assets, some are regarded as 'stores of value' which entails that they ought to provide security against inflation and market downturns. This hedging property varies across the types of collectible assets. Diamonds, stamps and rare coins are traditionally viewed as such safe assets in that they are positively correlated to inflation. Renneboog and Spaenjers (2012) document

⁵ Personal communication by Pieter van Leuven, one of the fund's managers, June 2017.

that diamond returns are significantly above inflation. Sometimes called ‘paper gold’ (Wagenheim, 1976), collectible stamps are traditionally also regarded as an inflation hedging (Dimson and Spaenjers, 2011).

Nonpecuniary rewards

Campbell (2008) argues that emotional assets have consumption value; they augment utility in the form of aesthetic enjoyment and can signal the owner’s wealth. The consumption value from owning collectibles can be regarded as an income stream sometimes described as an aesthetic dividend as “*viewing pleasure and admiration of artistic skill or genius*” is such an emotional dividend relating to paintings (Spaenjers et al., 2015: 10). Thus, adding collectibles to a portfolio adds a unique dimension to investing, as it opens the possibility of transferring consumption value over time, which results in greater utility than traditional investments. Belk (1995) and Burton and Jacobsen (1999) describe the psychological and social benefits of collecting: the practice of collecting provides collectors with a sense of purpose and meaning in life. For some, it can yield a sense of expertise that is lacking in other parts of their lives and the search for new items and the anticipation when a much-envied item is obtained contributes to life’s excitement. Moreover, collecting may generate a sense of belonging in that it provides access to a social group with similar interests. Success in competing with other collectors may help to obtain or maintain status in the collecting community (Storr, 1983). The same general motivations apply to car enthusiasts who are enticed by the emotional aspects of owning cars, social aspects of the classic car community, and racing culture and automobile history (Tam-Scott, 2009).

2.3. Costs of investing in collectibles

Relative to financial investments, the costs of investing in collectibles can be substantial. These costs mainly relate to the transaction fees, illiquidity, maintenance, and insurance.

Transaction costs

A large share of transactions within the market for collectibles takes place through auction houses or dealerships which charge substantial fees. In the case of auctions, buyers are charged a premium and sellers a commission, which combined can easily amount to a quarter of the transaction value, even though most auction houses apply scales in which the commission percentages decline with higher hammer prices (Campbell, 2008). As a consequence of the high transaction costs, the average holding periods for collectibles investments are much longer than for traditional financial asset classes (Pénasse and Renneboog, 2017).

Illiquidity costs

Relative to most financial asset classes, the collectibles' market is more illiquid as auctions are not held continuously. Burton and Jacobsen (2001) report that it can take up to five months to liquidate a portfolio of wine. Therefore, in the unwelcome event that an investor is forced to liquidate his classic car collection, he may only be able to realize this at fire sale prices. Market downturns further increase illiquidity costs as an investor is then most likely to be forced to liquidate.

Other costs

For classic car investments, holding costs are large. A storage facility is needed with controlled temperature and humidity, and as most investment-grade classic cars are highly valuable, storage costs are further affected by the need for security. Also, regular maintenance is essential for the cars to appreciate in value. To be added are insurance and taxes. When one invests in cars that are not in pristine condition, restoration costs easily surpass the acquisition value.

2.4. The risks of investing in collectibles

The majority of academic studies concludes that collectibles are high-risk investments. Goetzmann (1993:1370) states that returns on art investments are “*no higher than would be justified by the extraordinary risks they represent*”. In the case of diamonds, Renneboog and Spaenjers (2012) find substantially higher volatility than for equity returns. Dimson and Spaenjers (2011: 444) confirm this statement for stamps, concluding that “*the volatility of these returns is much higher than that of bonds and closer to equities*”. The risks that a car collector faces include:

Stylistic risk. Collectibles' prices (and returns) depend on expectations about future demand which is hard to predict since tastes change over time (Dimson and Spaenjers, 2014a). This ‘stylistic risk’ may be underestimated when calculating risk based on past investment performance of classic cars, because returns may suffer from survivorship bias. Car types falling out of fashion are underrepresented in subsequent auction sales such that auction records fail to capture their (negative) returns. Investors may assume that past returns are largely indicative of future returns, while in fact they have been generated by means of a subsample that became or remained in vogue. Car design has changed continually over time, partly because of shifting stylistic preferences but also because of changing safety regulations. As a result, it might be hard to predict how enthusiasts' appreciation of beauty will change in the future.

Changes in income and wealth. These changes may have a direct impact on market participants' willingness and ability to invest in the collectibles' market. Goetzmann et al. (2011) examine this relation for art prices and conclude that the income distribution in the economy (the percentage of income received by the top 1% and top 0.1% earners) strongly affects art prices, as do changes in equity returns, which precede art returns by one year.

Price risk. David et al. (2013) examine the collectibles market's efficiency, and find that it is not weak-form efficient (Fama, 1970). Moreover, Baumol (1986) presents five arguments that the art

market is not competitive. First, pieces of art are heterogeneous in nature. Even two pieces by the same artist having a common theme can be sold for vastly different prices. Second, the rarity and desirability of some items makes owners monopolists. Third, transactions take place infrequently such that some lots are only sold every half century. Fourth, information is not publicly available and mostly concentrated with a few informed players. Fifth, in contrast with financial assets, there is no clear methodology to value a work of art. Baumol concludes that the occurrence of these five factors make it unlikely that forces in the art market will move prices towards an equilibrium. As a result, “*prices can float more or less aimlessly and their unpredictable oscillations are apt to be exacerbated by the activities of those who treat such art objects as ‘investments’*” (Baumol, 1986: 10). These arguments are likely to apply to a certain degree to the market for classic cars. Some types of cars are relatively rare because they (i) are old and few may have been able to withstand the test of time, (ii) have an interesting provenance (ownership, racing history), or (iii) are exclusive (concept cars, unique cars,...), which may make the owners of specific classic cars indeed quasi-monopolists. As in other collectible markets, classic car auctions are not continuous with the most important ones occurring in August and January, and the market is also characterized by a degree of opacity.

Speculative bubbles. Bubbles can arise in markets where investors behave myopically (Tirole, 1982) or irrationally (De Long, Schleifer, Summers & Waldmann, 1990), and bubbles can more easily occur in markets that impose short sales and borrowing constraints on participants (Scheinkmann and Xiong, 2003). These conditions are likely to be met more frequently in the collectibles’ markets. Indices on art prices show bubble-like behaviour such as short-term persistence and long-term reversion (Spaenjers, Goetzmann & Mamanova, 2015; Pénasse and Renneboog (2017)). Pénasse et al. (2014) study the relationship between sentiment and art prices by introducing a fads term in the pricing of artworks and find strong evidence that ‘faddish beliefs’ do indeed affect art prices. Moreover, other researchers find evidence for boom-bust cycles in the markets for fine art, rare coins, and stamps (Renneboog and Spaenjers, 2013; Kane, 1984; Dimson and Spaenjers, 2011). The classic car market has not been immune to pricing bubbles either. In the late 1980’s, speculators acquired classic cars, hoping to resell them quickly. This development was partially fuelled by the strong Japanese yen, which enabled wealthy Japanese buyers to purchase classic cars cheaply in the US. Around 1990, the market crashed, and especially high-end Ferraris and Porsches saw their values decrease severely. In 1989, a Japanese investor bought an extremely rare Ferrari 250 GTO for a little under \$14 million and a few years later, in 1994, a US-based Ferrari dealer acquired that same car for only \$2.7 million⁶.

Forgeries, frauds and theft. Scams and other forms of fraudulent behaviour exist in almost any kind of market and may be more prevalent in the market for collectibles. Dimson and Spaenjers (2014b) report a stamp fraud and mention several other occasions of forgeries in the market for violins and wine. While in theory a classic car could be counterfeited, this risk is in practice not severe. The risk of theft is more substantial; professional robberies occasionally occur that which can have serious financial

⁶ “The Ups and Downs of the 250 GTO”. M. Sheehan. September 2002. Retrieved from: https://web.archive.org/web/20100922134001/http://ferraris-online.com/Articles/SCM_0209.html

consequences for a classic car investor's portfolio. Other forms of fraudulent behaviour occur more frequently; a seller could, for instance, manipulate the odometer, maintenance history, or the engine registration or chassis numbers. Misrepresentations of the car's provenance may also occur in order to augment selling prices. For this reason, classic car owners go to great length to research the history of their cars, oftentimes consulting the help of specialised firms⁷.

2.5. Value drivers of classic cars

At auctions, price estimates are based on historical sales and taxations by experts, but the actual hammer price can deviate significantly from these estimates. In the end, a complex interplay of various factors plays a role in determining the value of a classic car, such as the initial produced quantity, the natural decay of the available stock through wear, damage and loss (Daxhammer & Klein, 2015). In *Historica Selecta* (2016), several determinants of classic car prices are mentioned:

Rarity. In general, cars produced in only a small quantity are more valuable. Indirectly, this also goes for cars that are unique because of their individual history, which for example occurs for cars that were previously owned by a notable person, or appeared in well-known movies. Classic car enthusiasts refer to the documentation of ownership and special events pertaining to the car as 'provenance'. In many cases, the association with celebrities and glamour also plays a role, as exemplified by the "Steve McQueen" effect, where any car previously owned by the actor commands a significant premium⁸. Similarly, a 1964 Aston Martin DB5 that was driven by Sean Connery in the James Bond movie *Goldfinger*, sold for £2.9 million in 2010 (\$4.6 million), while similar DB5's sold for sums between \$200,000 and \$300,000⁹. Age is a related factor as there are not many of the earliest automobiles left. Thus, cars from the earlier eras are in general more expensive than younger ones.

Condition. The finest (and most valuable) examples of classic cars are those that participate in events known as *Concours d'Elégance*, where the focus is mainly on condition and authenticity. Cars must be presented in flawless condition, and are often in a state better than new.

Authenticity. Besides condition, authenticity is also valued. Original cars, which never needed restorative work are valued at a premium. It is very important for a car's configuration to match the original factory configuration. Car enthusiasts denote this as 'correctness'. This can go very far. For example; "*hose clamps, ordinarily parts that cost a few cents, must be of the correct type and produced by the same manufacturer as originally supplied to the car*" (Tam-Scott, 2009: 116). A car that has all major parts authentic, including the engine, transmission, chassis, etc. is said to have 'matching numbers'. The presence of this denotation adds considerable value.

Design. The appearance of a classic car obviously matters in determining value. Of all value drivers, a car's aesthetic appeal is perhaps the most emotional one, and the hardest to quantify. In general, enthusiasts value proportion and functional form, such as an aerodynamic shape (Tam-Scott,

⁷ For example, Ferrari has an in-house department that provides such services, known as Ferrari Classiche.

⁸ See, for example: <http://www.latimes.com/business/autos/la-fi-hy-mcqueen-effect-20140816-story.html>.

⁹ http://www.rmsothebys.com/lots/lot.cfm?lot_id=568242

2009). Certain cars are also deemed attractive because their appearance exemplifies a certain epoqe. The design of a car does, however, not only refer to aesthetic appearance. The technical design also plays a role. Cars equipped with desirable or expensive options are generally worth more. The same goes for certain technical features; for example, cars equipped with automatic transmission are considered less desirable than their counterparts with manually-shifted gears.

Racing history. Racing cars are amongst the highest valued of all classics. Especially the machines that participated successfully in prestigious racing events, such as the Formula One, the 24-hour race of Le Mans or the *Mille Miglia* dominate auction sale records.¹⁰ These cars are extremely desirable, as they are rare and perceived as beautiful engineering masterpieces that shaped racing history.

Besides the aforementioned points, there are several more value drivers. An obvious one is a car's *marque or make*. Certain car brands have a reputation for luxury, quality, or outstanding performance. This reputation is strongly associated with racing pedigree. Marques such as Ferrari, Porsche and Mercedes-Benz with a rich and successful history produced some of the finest classic cars. Also important is *documentation* such as maintenance records, registration forms, ownership documentation, and records of special event. Lastly, the lower the *mileage* of a car, the more valuable it is. Unfortunately, we are not able to include reported mileage for three reasons: (i) the variable is in many cases missing from our data set, (ii) Sports Car Market reports odometer readings in some cases in miles, and in other cases in kilometres, but does not always indicate which unit applies, and (iii) the mileage is often reset after the car is renovated completely, or when the engine is replaced. For these reasons, we do not include odometer levels in our analysis.

Investment performance of classic cars

To date, only two studies focus on the performance of investments in classic cars, and both were written with limited rigor. Martin (2016) analyses a sample of 96 collectible automobile types provided by Hagerty Insurance Group (HAGI) from 2007 to 2016. The author reports annual returns (in nominal terms) ranging from 3.23% for American Muscle Cars to 18.22% for German Collectibles. In terms of risk-adjusted returns, investments in collectible cars compare favourably to equity investments. The former had a Sharpe ratio of 0.58, while the best performing equity index (NASDAQ Composite) reached a Sharpe ratio of only 0.23. Daxhammer and Klein (2015) use the returns of three car indices (the German DOX and OTX indices, and the HAGI index), and only study the correlations of these indices with financial assets. They report no significant correlations with equities (S&P500 and DAX30) and a strong correlation with gold and the AGI art index. Both studies lack scientific robustness as they make use of readily published classic car indices, the methodology of which is not disclosed. Furthermore, these indices suffer from selection bias as they include only the most popular marques. As a result, such indices are not a valid representation of the classic car investment universe.

¹⁰ To illustrate: out of the top 10 most expensive auction sales of classic vehicles, 9 were former racing cars. See: https://en.wikipedia.org/wiki/List_of_most_expensive_cars_sold_at_auction.

3. Data and Methodology

3.1 Data

Auction records of classic car transactions

We obtain data on classic car transactions through the online Sports Car Market's Platinum auction database, which comprises more than 200,000 records. Every auction record is separated into four panels. The first one contains *basic information*, including the make, model, production year, auction date, and the name of the auction house. The second is labelled *Description*, written by an expert affiliated to Sports Car Market magazine, and comprises information on the car's condition, the car's features, and other useful items. The third panel is called *Market opinion* and provides experts' advice on whether the car is a good buy. Even though this information is useful, it is missing in many cases or not quantifiable enough to be included into our analysis. The fourth panel is labeled *Vehicle information* and provides an extensive overview of the car's technical features such as the engine type and displacement, and the type of engine induction. The car's condition and mileage are also reported here, as well as exterior features such as paint color and body style. Unfortunately, the information provided in the 'vehicle information' section is not consistently available amongst all records. Some records, for example, only show the engine type and displacement, while other records provide information on exterior color, body type, engine type and mileage. To mitigate this problem, we only retain auction records including an image of the vehicle, as these entries are usually complete. Of this subset, we keep about 37,000 records that are actual sales as we drop the unsold lots from our database. We then exclude the cars produced after 1990 (as more recent cars are not considered classic cars) and younger than 25 years at the time of the sale. Furthermore, we remove the lots sold for an amount lower than \$1000 (in 2017 dollars). Subsequently, we hand-check the data to clear all transactions that relate to motorcycles, automobile memorabilia, individual parts (such as engine blocks and rolling chassis), horse carriages, tractors, and other non-automobile objects. Cars not in running condition are also removed. Subsequently, we verify whether observations include missing values, which are mostly about displacement, engine type, or body type, and try to retrieve this information from other online sources.¹¹ We subsequently delete the observations with missing information that cannot be identified. At the end of this selection process, we are left with a sample of 29,002 auction transactions.

Other data

In order to obtain real auction prices, we collect US CPI numbers from Thomson Reuters DataStream. We gather returns on various financial and real assets: yields on one-year US treasury notes and 3-month Treasury Bills (from the Federal Reserve Economic Data, FRED); equity, bond, and gold returns (from Thomson Reuters DataStream), and returns based on the Artprice Global Index (Artprice.com)¹².

¹¹ We make use of www.carfolio.com, www.conceptcarz.com, www.automobil-catalog.com and www.wikipedia.org to retrieve information on car specifications.

¹² Retrieved from: <http://imgpublic.artprice.com/pdf/agi.xls>

Descriptive statistics

The top 15 most expensive auction sales in our sample are presented in Panel A of Table 1, which shows that the top of the classic cars is dominated by Ferrari, although Mercedes-Benz, Jaguar, and Alpha Romeo also realize a top 10 place. The most expensive car is the Ferrari 250 GTO Berlinetta. Panel B presents the yearly average transaction price and number of auction sales per year in our sample. The average auction price (in real 2017 terms) in our sample amounts to \$218,182, with a median equal to \$55,902. Over the past two decades, the average car price (in real terms) has more than doubled. A total of 1,182 transactions had an auction hammer price of more than USD one million (inflation-adjusted).

[Insert Table 1 about here]

Roughly 52% of the cars sold are of American make; the rest mainly have the British, German and Italian nationality (17%, 12% and 11%, respectively). The most frequently auctioned classic car marque in the sample is Chevrolet, followed by Ford, Ferrari, Mercedes-Benz and Jaguar. Statistics on the frequency of car marques in our sample are reported in the Online Appendices 1 and 2. Almost a third of the classic cars have coupé body styles, but there is also an almost similar number of convertibles, in addition to many roadsters (see Online Appendix 3 for an overview).

For some key statistics that provide some insight in the sample, we turn to Table 2 that first shows that average prices and auction frequency for a selection of renowned marques. The average price of some top brands (Ferrari, Bugatti, Duesenberg, and Talbot-Lago) amounts to more than USD one million. We further partition the cars by the era in which they were built. About three quarters of the cars offered for auction are postwar classic cars (for definitions of the different era-related classifications, see *infra*). About 16.5% of the cars offered are in pristine condition. The most prestigious auction houses (Sotheby's, Christie's and Bonhams) only account for slightly more than 20% of the classic car auction market where some specialized auction houses maintain a large market share (e.g. RM Auctions, Barrett-Jackson, Mecum Auctions). The three most popular body types of the auction cars are coupes and roadsters.

[Insert Table 2 about here]

3.2 Methodology

Hedonic regression model

To estimate returns, we use a hedonic regression model, which assumes “*that goods are valued for their utility bearing attributes or characteristics*” (Rosen, 1974) such that implicit (or shadow) prices are attached to a car's attributes. There are two main approaches to construct hedonic indices: the hedonic imputation (HI) index, and the time-dummy hedonic (DTH) index. Both methods rely on correcting the price (return) of a car for changes in quality; e.g. the price of a car may rise because safety features are added such that if one wants to study the price evolution of the car in itself, one needs to

correct for such changes in quality. The difference between the indices is that the DTH index method constrains regression parameters to be constant across periods, while the HI index method allows for changing parameters (Diewert et al., 2008). When constructing HI indices, the focus is more on the changes in taste over time, which is important in the case of long time series spanning several decades (Silver and Heravi, 2007; Renneboog and Spaenjers, 2011). Our main analysis employs the DTH methodology and we will apply the HI approach in a robustness test. The time dummies of the model capture time effects on a quality-adjusted price index:

$$\ln P_{it} = \sum_{m=1}^M \alpha_m X_{mit} + \sum_{t=1}^T \beta_t \delta_{it} + \varepsilon_{it} \quad (1)$$

where $\ln P_{it}$ represents the natural log of the inflation-adjusted price of car i at time t , X_{mit} is the m -th characteristic X of car i at time t , and δ_{it} is a dummy equal to 1 if car i has been auctioned in year t (and equal to 0 otherwise). The shadow price of the m -th characteristic X is denoted by α_m .

We calculate DTH index levels using the following formula:

$$I_t = \exp(\beta_t) * 100 \quad (2)$$

where I_t is the collectible car price DTH index at time t , and β_t is the time dummy of equation (1), corresponding to year t . We give the year 2007 the value 100; β_{2007} has a value of zero. It is a well-established fact that least-squares estimation of log-linear models leads to unbiased estimates of the parameters (Teekens and Koerts, 1972). The returns derived from the index are geometric returns and still need to be corrected for the logarithmic transformation bias or Jensen's inequality (Triplett 2004):

$$I_t^* = I_t * \exp(SE_{\beta_t}^2/2) \quad (3)$$

where I_t^* and I_t are respectively the corrected and uncorrected index levels at time t , and $SE_{\beta_t}^2$ is the squared standard error of the dummy coefficient corresponding to year t . The resulting corrections are in all cases rather small. We obtain real return numbers by first-differencing the corrected yearly index levels.

A drawback of the aforementioned hedonic regression methodology in the computation of price indices is that it can underestimate the volatility of returns. There are two related reasons for this phenomenon. The first, common amongst emotional assets, is denoted as ‘appraisal smoothing’: assessment of an infrequently traded item’s value often “*depends on previous price observations and are only partially adjusted in any period*” (Dimson and Spaenjers, 2011: 452). Second, since our index level denotes averages of time-ordered variables, returns may suffer from serial autocorrelation, which is known as the ‘Working effect’ (Working, 1960). We test this issue and find it does not play a role in our index series; the returns are actually negatively auto-correlated, albeit not statistically significant. Applying this correction would in this case smoothen returns, rather than desmooth them as intended.

Hedonic characteristics

An important assumption underlying any hedonic regression methodology is that a large proportion of the variance in the dependent variable is captured by the hedonic characteristics. We therefore include as many valid car characteristics as possible:

Production year is the year in which a car is built. We classify the time periods according to conventions by several classic car associations (as applied by the Veteran Car Club of Great Britain, the Vintage Motor Car Club of America, and the Classic Car Club of America). Veteran cars (326 observations) were typically built in the period 1888-1907, Brass cars (493 observations) in 1908-1916, Vintage cars (1,212) in 1917-1929, Pre-war classic cars (3,650) in 1930-1946, Post-war classic cars (21,281) in 1947-1975, and Modern classics (2,040) from 1975 to 1990.

Displacement is the total volume of air that is displaced by a full stroke of all the engine's pistons and positively correlates with an engine's power. Since our sample also contains car that are steam- or electrically powered for which the notion of displacement does not apply, we cannot include displacement as a continuous variable, but instead order the displacements of gasoline-powered cars into intervals. Sports Car Market uses several different units in the reporting of displacement, including liters (L), cubic inches (cid) and cubic centimeters (cc). We convert all displacement numbers into cubic centimeters, and then classify them according to Table 3.

[Insert Table 3 about here]

Authenticity: classic car enthusiasts greatly value the extent to which a car is in its original state (the so-called 'correctness'). Our (albeit crude) measure capturing authenticity indicates the presence of the words 'matching numbers' (*dMatchingNumbers*) in the description of the auction lot. This means that all the major parts, such as engine, transmission and chassis, are the components present on the car when it came out of production. We also include in our models a dummy to capture the observations that are replica cars, made to resemble a unique, oftentimes expensive and well-known car. The dummy variables *Matching Numbers* and *Replica* occur respectively 312 and 491 times, and represent respectively 1.07% and 1.69% of the total sample.

Condition: Experts from Sports Car Market evaluate the condition of a car and give a rating between 1 and 6, where 1 indicates a car that is in perfect (Concours d'Elégance-level) condition, while 5 indicates a car that is "*a nasty beast that runs but has many problems*" (Table 4). We removed all cars from the lowest level, rating 6, as they are not in a running condition and very likely only useful as a course for parts.

[Insert Table 4 about here]

The *rarity* of a car is best proxied by the total number of cars produced by make and model. A few problems arise: first, production figures are only rarely mentioned in the SCM's Platinum database and additional searches were not always successful since production numbers of older automobiles are not always documented. We therefore introduce several indicator variables designed to proxy rarity: (i) *Unique* indicates whether the marque occurs only once in the complete data set (we have 275 observations). (ii) *ConceptCar* identifies cars made to showcase new styling and technology that are often displayed at motor shows to gauge the customer's reaction (35 observations). (iii) *Prototype* cars are made for testing rather than showcasing purposes and are therefore closer to the phase

of actual production (114 observations). Both concept cars and prototypes are rare and oftentimes desired by classic car enthusiasts.

Racing history. Within the category of body types, a racer corresponds to racing vehicles, of which we have 706 observations or 2.43% of the total sample. To indicate whether a car has participated in prestigious racing events, we construct several indicator variables: *FormulaOne*, *Indy500*, *MilleMiglia* and *LeMans*, which correspond respectively with participation in Formula 1 (33 observations), Indianapolis 500 (29), Mille Miglia (69), and the 24 Hours of Le Mans (24).

Make captures the marque's reputation and quality. All marques with 20 or more observations are assigned an indicator variable to be included in the regression models. The 95 different marques with such an indicator variables make up 27,310 observations, while the other 548 marques are grouped as the benchmark (see Online Appendices 1 and 2 for the full list).

Design indicates whether a sold car is regarded as part of the Top 10 Best Looking Cars of All Time, produced by Total Car Score, an automotive research company. A total of 920 observations from our data set fall into this category (see Table 5).

[Insert Table 5 about here]

Body type comprises 22 different body types, ranging from pickup trucks to convertibles, and from horseless carriages to station wagons. A complete overview is given in Online Appendix 3.

Exterior color captures the 24 different exterior colors used on the auctioned cars of our data set. The colors do not necessarily relate to the paint layer as some cars just show the bare metal or only show the primer (an initial layer of coating material applied so that paint better bonds). We will use black as the benchmark level in our models. The most frequently used colors are red, black, blue and white; the full frequency is given in Online Appendix 4.

The variable *Technical features* captures 21 different engine types, ranging from 1 to 16 cylinders in three different configurations (e.g. V8 for the widely popular 8 cylinder engine placed in a V-configuration). Other engine categories include steam, electric and rotary engines. A detailed overview of these engine indicator variables is given in Online Appendix 5. We use the common and inexpensive 'I4' engine as the base category in our models. *RHD* marks whether a car a right-hand drive vehicle (353 observations). *ThreeWheeler* indicates whether a car that has only three wheels (100 observations). *ForcedInduction* equals 1 in case the car's engine contains a fuel injection system, a turbocharger, or a supercharger, as engines with forced induction are generally more powerful than their naturally aspirated counterparts (2,715 observations). Lastly, we include the dummy *Automatic* to indicate the presence of an automatic gearbox (8,072 observations).

Twenty-five of the car *auction houses*, realize more than 200 sales; the other 49 houses accumulate 2,322 transactions.¹³ An overview is presented in Online Appendix 6. Furthermore, we

¹³ We include in our models indicator variables for the 25 auction houses with more than 200 sales and one dummy variables for all other houses. Exception is Rick Cole Auctions which realizes only has 20 sales but it is highly specialized at the top end of the market; its average sale price amounts to USD 2,827,000 (an average of USD 53,344 across all houses). The auction house 'Mecum Auctions' serves as the reference category.

include indicator variables (*PebbleBeach* and *Goodwood*) for automobiles sold at the prestigious Pebble Beach Concours d'Elégance (395 cases) and the Goodwood Festival of Speed (428 cases).

In order to generate index returns, we include *Time dummies* based on the year of the auction date (1998 serves as the base year) and control for seasonality by adding month of sale dummies (January serves as reference month).

4. Empirical results

4.1. Hedonic regression results

The semi-logarithmic hedonic regression models enable us to calculate nominal and real (inflation-adjusted) return series. In addition to the year dummies, we include variables capturing the production period, condition, marque, exterior color, body type, auction house, uniqueness, engine displacement, engine type, racing history, technical features, and month of sale. The hedonic variables included in our models manage to explain about 70% of the price variation: the R^2 of the real model equals 69.7% and amounts to 70.2% for the nominal one.

We first discuss the (statistically significant) hedonic characteristics with the strongest economic impact on classic car values. We convert characteristics' shadow prices to marginal price impacts (in percentages) to get an indication of their relative importance.¹⁴ When considering the era in which the car was built, we find an almost linear price increase going back in time, reflecting the scarcity from veteran, brass and prewar cars. For instance, one pays on average 6 times more for a veteran car than for a modern classic (see Table 6). Unsurprisingly, a car's condition affects prices: a car in top condition (condition 1) is worth 2.5 times a car in fair condition (level 4). Table 6 also shows the price effect of the marque whereby we note that the average Duesenberg, Bugatti, Talbot-Lago, Aston Martin, and Ferrari are sold at multiples of the average Chevrolet (our reference marque); they have relative price premiums of respectively 486%, 365%, 362%, 344%, and 325%. Relative to the prices at Mecum Auctions, our reference auction house which is already serving the higher end of the market, the highest auction prices are hammered in Rick Cole Auctions, Gooding & Co., and RM Sotheby's. We also control for the car type and find that the highest prices are paid for concept cars, racers, and roadsters. The car's exterior color has little impact on the auction price variation; we note that a white car is a slightly higher price than a black one (a 3.3% higher price impact), which is itself preferred over a red car (as it has a 3% lower price). As the provenance variables Le Mans and Mille Miglia show, racing history is indeed very important. The hammer prices go up almost monotonically with engine power, as captured by displacement and engine type. The highest prices are paid in the August auctions with the January auctions coming second.

[Insert Table 6 about here]

¹⁴ The formula is as follows: $\frac{\delta P_i}{P_i} * 100\% = (\exp(\alpha_m) - 1) * 100\%$, where $\frac{\delta P_i}{P_i}$ denotes the marginal price impact and α_m denotes the coefficient of characteristic m .

4.2. Classic car price index

General price index

The year dummies included in the hedonic model of Table 6 enable us to construct an index and calculate the nominal and real returns (see Table 7). The index starts in the year 1998 (which is set to 100) and continues until July 2017. Over the whole period, the nominal index appreciates 159% and the real one by 73%. This corresponds with an annual nominal (real) arithmetic mean return of 5.63% (3.37%). The annual geometric mean returns somewhat lower at 5.15% (nominal) and 2.91% (real), which Figure 1 depicts in graphical form. The volatility in these returns is rather modest as, for our nominal index, the standard deviation of annual returns amounts to 10.03%.

[Insert Table 7 and Figure 1 about here]

Specific prices indices

There are probably few collectors interested in investing in any type of classic car as both wealth and storage constraints may be binding, which is why collectors specialize in specific types of cars. For this reason, we will construct several indices based on subsamples. We will consider sub-indices for: (i) cars approved by the Classic Car Club of America, (ii) affordable classics, (iii) blue chip classics, (iv) cars of specific eras of production (veteran and brass cars, vintage cars, pre-war classics, post-war classics and modern classics), (v) cars of a specific nationality (we distinguish among automobiles of German, Italian, British and American makes), and (vi) specific marques (we focus on Ferraris, Porsches, and Mercedes-Benz's). The methodology to construct the indices and calculate returns is similar to the one used for the general model presented in Table 6. The subsample results are summarized in Table 8 and depicted in Figures 2, 3, 4 and 5.

[Insert Table 8 and Figures 2-5 about here]

First, to calculate the returns of *CCCA Approved Classics*, we use the Classic Car Club of America's (CCCA) definition of a classic car, which is "*a fine or distinctive automobile, either American or foreign built, produced between 1915 and 1948*" (CCCA, 2016) and the list of 'approved classics' the organization publishes on its website (see Online Appendix 7) to identify the CCCA approved cars in our sample which yields a dataset of 2,488 auction sales. The average annual arithmetic nominal (real) returns equal 5.28% (3.24%), as presented in Table 8 and Figure 2.

Second, we calculate the returns of *Affordable Classics*, for which we make use of the Hagerty's Affordable Classics constituent list as published on its website (see Online Appendix 8). This selection yields a sub-sample of 911 auction records. We disclose that affordable classics generate average arithmetic nominal (real) returns of 6.34% (4.09%) annually, with a volatility of 15.23% (Table 8 and Figure 2). As the volatility is similar to that of equity and the affordable classic cars generate returns higher than that of equity, the affordable car risk-adjusted return outperforms equity investments.

Third, Hagerty also identifies the most highly valued classic cars, called *Blue Chip Classics*, the definition of which is given in Online Appendix 9. A dataset of 833 Blue Chip automobile auction sales

yields high index returns, with an average annual nominal (real) price appreciation of 12.50% (10.04%) (Table 8 and Figure 2). So, it seems that the top end of the market yields the highest returns, which is similar to the ‘masterpiece effect’ found in other markets of emotions assets (such as art).

Fourth, given that the some collectors may prefer to collect cars of a specific country, we construct *Car Nationalities’ Indices* and focus on German, Italian, British and American automobiles. The returns of Italian cars exceeds that of the other nationality types. The average arithmetic nominal (real) returns on Italians amounts to 11.28% (8.87%) which is significantly higher – albeit with a higher return volatility - than that of German, British and American cars that yield returns of 7.01% (4.72%), 6.29% (4.03%), and 4.53% (2.28%) respectively (Table 8 and Figure 3).

Fifth, while we could calculate the returns of all the different *Marques*, for reasons of parsimony we extend our analysis to indices for Ferrari, Mercedes-Benz and Porsche only, as these marques are particularly popular with collectors. By means of the Ferrari index, we estimate an average annual nominal (real) return of 13.76% (11.29%), which reflects a higher average price appreciation than that on Porsches and Mercedes-Benz’s that reach respectively 9.44% (7.04%) and 6.95% (4.71%) (Table 8 and Figure 4).

Finally, we calculate the *Period Denomination Indices* for cars stemming from specific time periods. Because of data scarcity, we will group the veteran (1888-1907) and brass (1908-1916) cars, and also further construct indices for vintage (1917-1929), pre-war (1930-1946), post-war (1947-1975), and modern classics (1976-1990). The strongest returns are disclosed for the older denominations (Table 8 and Figure 5).

4.3 Classic cars versus other (financial) assets

We compare the returns on the overall classic car index to indices of equities, bonds, bills, art, and gold. For equities, we collect the S&P 500 and the global MSCI World index, for bonds we use the Bank of America Merrill Lynch Global Government Bond index which captures investment grade government bonds of all maturities issued by developed countries, and for T-bills we take the 3-month Treasury Bills obtained through Federal Reserve Economic Data. Data on equities, bills and bonds are downloaded from Thomson Reuters DataStream. Data on gold prices per Troy ounce as traded on the London Bullion Market is also collected via DataStream. The Art Price Global Index is obtained from Artprice.com.

When we compare the nominal returns on our general classic cars index to those on financial assets, we conclude that the former performs relatively strong. Over our limited time frame spanning two decades, the classic car index outperforms bonds, bills, and equities in nominal terms (Table 9). Still, it must be noted that the equity indices do not include dividend yields. Assuming a dividend yield of about 2% annually, we find that US and global equities as an asset class outperform classic cars. On a risk-adjusted basis, government bonds outperform our classic car index, as exemplified by its larger Sharpe ratio. Equities including dividends yield a Sharpe ratio that is similar to that of classic cars. We further compare the classic cars returns to those of real assets and report that classic cars outperform art

but have not been able to keep up with the appreciation in gold prices. When considering Sharpe ratios in real terms (Table 9), we note that classic cars underperform bonds and gold, but outperform equity markets, bills and art. Assuming a dividend yield of 2%, the Sharpe ratio of equities augments to around 0.30, which is close to that of classic cars.

The above analysis may still paint a flattering picture for classic cars (and art) because the many costs involved with classic car investments are not taken into account in the above comparative analysis. Transaction, storage, transportation, insurance, maintenance and restoration costs can be substantial for classic cars, and vastly surpass the costs of (financial) asset classes. For instance, the commissions on an auction round-trip (buying and selling) can account to more than 25%, collectors often build a show room to store their cars, and maintenance and insurance of high-end classic cars can severely reduce returns. Therefore, the classic cars' financial returns presented above should thus be regarded as a theoretical upper limit: a classic car investor would in real-life generate average returns that are far lower. Still, this point can be mitigated somewhat by the fact that the average holding periods for classic car investments are much longer than for other asset classes such that transaction and storage costs should be spread out over holding periods that could span decades and could thus be bearable on an annual basis. Furthermore, in most countries, capital-gain taxes are not applicable to classic cars, and the numbers do not include the benefits in the form of an emotional dividend. We now turn to pairwise correlation coefficients between classic car returns and the returns on the asset classes outlined earlier. Our classic car index shows moderate correlations with inflation, the MSCI World index and with art returns (Table 10) and are not statistically different from zero.

[Insert Table 9 and 10; and Figures 6 and 7 about here]

5. Robustness test on stability of investors' taste

A possible drawback of the above hedonic regression methodology is that the shadow prices of the hedonic variables are held constant over the whole time period which implies that investor preferences are assumed not to change. An alternative estimation method is the adjacent regression methodology (Triplett, 2004) whereby the hedonic regression is run multiple times over short time intervals (adjacent periods) of e.g. five or two years. The shadow prices are then only held constant over the short time window. We apply this method and take adjacent periods of just two years starting in 1998, which implies that we only include one year dummy at the time and run 19 regressions yielding a series of time parameter estimates needed to build the index. We find that the returns from the new index closely follow the returns generated by the method applied in Table 8. Only in the first three years, when our sample is thinner, does the adjacent year regressions produce somewhat higher returns, but over the rest of the period the adjacent-year returns are a little lower. The mean returns are however very similar. Co-movement between the indices is strong (Figure 8), as exemplified by the correlation coefficient of 0.90 between the real returns from adjacent period regressions and the hedonic method of Equation (1). We conclude that our findings are robust to the estimation method.

[Insert Figure 8 about here]

6. Conclusion

Investments of passion have become increasingly popular over the past decades as reflected in both increases in volume and auction prices. In contrast to other emotional investment classes such as art, wine, and stamps, hardly any research has been performed on this topic. In order to get some insight in the risk and returns of classic car investments, we have built a hedonic regression index by means of an extensive data set of worldwide auctions conducted between 1998 and 2017. Since 1998, the classic car index has appreciated at a yearly average nominal rate of 5.63%. Over this time frame, these raw returns compare favorably to those of other asset classes, both in absolute terms as on a risk-adjusted basis (Sharpe ratio). With regard to raw returns, only gold performed better over the sample period. From a risk-adjusted perspective, both gold and government bonds showed larger Sharpe ratios, but when equity index returns adjusted for the dividend yield (averaging to about 2% annually) the risk-adjusted performance of equity and classic cars is similar. Interestingly, the return volatility of classic cars is lower than that of equities (and larger than the volatility of government bond returns).

Few collectors would invest in all types of classic cars (from veterans of the end of the 19th century to modern classic of the 1980s) considering binding financial constraints and heterogeneous tastes, we calculate the risk and returns for various sub-samples of classic cars. Collectors may indeed desire to specialize in a specific production era, have a preference for certain marques (e.g. Porsches or Ferraris) or for cars built in specific countries (e.g. Italian or British cars), or limit themselves to purchasing only the top end of the market (blue chip cars). We demonstrate that the returns of specific niche segments of the classic car market can vary significantly. Strong nominal returns – above 10% annually - are found for blue chip classics, Italian classics, and Ferraris, but these higher returns go hand in hand with higher volatility. The lowest returns are generated by the niche markets of pre-war classics (the era of 1930-1946) and American classics.

It is important to realize that the returns are raw returns which do not incorporate the numerous costs involved in classic car investments. The auction transaction costs for a round-trip (buying and selling) may be up to 25%, which precludes frequent trading in periods without strong price increases and which therefore induces long holding periods. When a classic car is held for 25 years, the annual raw return should be reduced by 0.9% annually. In addition to transaction costs, the storage costs may be high as this often requires the collector to construct a garage or personal show room. In order to keep the cars in driving condition, maintenance-, restoration- and insurance costs are required. The raw returns presented in this paper should therefore be regarded as an upper limit and the net annual returns are likely to be 25% or 50% lower.

The hedonic pricing model also enables us to study the value drivers of classic cars. We demonstrated that high premiums are paid for older cars (e.g. the rare veterans or brass cars), racing cars (in particular those that took part in prestigious racing events such as the Mille Miglia or LeMans), and cars in the pristine condition. Several marques, including Ferrari, Duesenberg, Bugatti, Talbot-Lago, Aston Martin and Delahaye entice investors to the highest hammer prices.

While classic cars are considered as an asset class – as are other emotional assets – and hence store of value, they may also have considerable consumption value to collectors who are seduced by the design, lines and shape of classic car. Furthermore, the collection of classic cars may enhance collectors' social life and societal status through classic car club memberships or the participation to classic rallies. Thus, emotional and social reasons may be important determinants of the demand for classic cars and may more than compensate the purchase and holding costs and obliterate a possible shortfall in net returns.

All in all, classic cars seem a viable alternative investment in terms of raw and risk-adjusted returns even relative to financial and other real asset classes. In terms of net returns, classic car investments may be a source of enjoyment (consumption value) which may more than compensate at the personal utility level the substantial transaction and storage costs.

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FIGURES

Figure 1. Classic car price indices

This figure shows the development of our constant-quality classic car index over the time period from 1998 to 2017, in real and in nominal terms. Real returns have been deflated using the US CPI index. Arithmetic mean annual returns are presented in parenthesis. The index is set equal to 100 at the beginning of 1998.

Figure 2. Price indices for CCCA approved, Blue Chip and affordable classic cars

This figure shows the constant-quality real price indices for Blue Chip classics, CCCA approved classics, and affordable classics. The index levels are presented over the period 1998-2017, with the exception of the Blue Chip index which has been calculated over the period 2000-2017. The indices are set equal to 100 at the beginning of 1998 (2000=100 for the Blue Chip index). Average annual real arithmetic returns are presented in parenthesis.

Figure 3. Price indices for Italian, German, British and American classic cars

This figure shows the constant-quality real price indices for Italian, German, American and British classic cars. The indices are set equal to 100 at the beginning of 1998. Average annual real arithmetic returns are presented in parenthesis.

Figure 4. Price indices for Ferrari, Porsche and Mercedes-Benz

This figure shows the constant-quality real price indices for the marques Ferrari, Porsche and Mercedes-Benz. Average annual real arithmetic returns are presented in parenthesis. The indices are set equal to 100 at the beginning of 1998.

Figure 5. Price indices for classic cars by production era

This figure shows the constant-quality real price indices for production era denomination indices: Veteran & Brass cars (1888-1916), Vintage cars (1917-1929), Pre-war cars (1930-1946), Post-war cars (1947-1975) and Modern classics (1976-1990). Average annual real arithmetic returns are presented in parenthesis. The indices are set equal to 100 at the beginning of 1998.

Figure 6. The price indices of classic cars versus those of financial assets

The figure compares the nominal classic car index to indices of various financial assets (equities, bills, and bonds) for the period 1998-2017. Arithmetic annual nominal returns are in parenthesis. The indices are set to 100 at the beginning of 1998 (with exception of the Bond index which is at 100 at the beginning of 2000). All data comes from Thomson Reuters DataStream, except for the yields on 3M Treasury Bills which were obtained from FRED.

Figure 7. The price indices of classic cars versus gold and art

The figure compares the nominal classic car index to nominal indices of gold and art. Arithmetic annual nominal returns are presented in parenthesis. The indices are set to 100 at the beginning of 1998. Data on gold prices is downloaded from Thomson Reuters DataStream, and data on art prices are from Artprice.com.

Figure 8. Price indices from the general hedonic and adjacent-year method

This figure shows index levels obtained from the time-dummy hedonic regression and adjacent year (AY) regression methodologies.

TABLES

Table 1. Record prices of classic cars and yearly average transaction prices.

Panel A shows the 15 most expensive auction sales in USD millions (for the period 1998-2017). All auction prices are deflated using the US CPI series and reflect dollar values (Jul 15, 2017). Panel B reports the average real auction price by year (in real USD).

Panel A: Record prices					
Year	Marque and model	Price (Nom.)	Price (Real)	Auction Date	Auction house
1962	Ferrari 250 GTO Berlinetta	\$38.1	\$39.2	August 15, 2014	Bonhams
1957	Ferrari 335S racer	\$35.9	\$36.9	February 5, 2016	Artcurial
1954	Mercedes-Benz W196 racer	\$29.5	\$30.9	July 12, 2013	Bonhams
1956	Ferrari 290 MM racer	\$28.1	\$28.8	December 10, 2015	RM Sotheby's
1967	Ferrari 275 GTB/4S NART Spyder	\$27.5	\$28.8	August 17, 2013	RM Auctions
1964	Ferrari 275 GTB/C Speciale coupe	\$26.4	\$27.2	August 16, 2014	RM Auctions
1955	Ferrari 410 Sport roadster	\$23.0	\$23.7	August 17, 2014	Rick Cole Auct.
1955	Jaguar D-Type	\$21.8	\$22.1	August 19, 2016	RM Sotheby's
1939	Alfa Romeo 8C 2900B Lungo Spider	\$19.8	\$20.1	August 20, 2016	RM Sotheby's
1961	Ferrari 250 GT SWB California Spyder	\$18.6	\$19.3	February 2, 2015	Artcurial
1954	Ferrari 375 MM+ Sports Racer	\$18.3	\$18.9	June 17, 2014	Bonhams
1959	Ferrari 250 GT LWB California Spyder	\$18.2	\$18.4	August 20, 2016	Gooding & Co.
1964	Ferrari 250 LM coupe	\$17.6	\$18.1	August 15, 2015	RM Sotheby's
1961	Ferrari 250 GT SWB California Spyder	\$17.2	\$17.6	March 11, 2016	Gooding & Co.
1961	Ferrari 250 GT SWB California Spyder	\$16.8	\$17.3	August 16, 2015	Gooding & Co.
Panel B: Average prices					
Year	# Obs.	Average price (USD 2017)	Year	# Obs.	Average price (USD 2017)
1998	548	99,345	2008	1,948	211,748
1999	392	164,450	2009	1,230	182,698
2000	681	175,601	2010	1,576	178,844
2001	599	121,584	2011	1,653	202,874
2002	952	115,808	2012	2,475	215,559
2003	1,107	102,067	2013	2,498	277,722
2004	1,380	122,636	2014	2,365	342,327
2005	1,601	140,330	2015	1,544	412,269
2006	1,831	183,381	2016	1,525	313,239
2007	1,945	209,203	2017*	1,152	218,561

Table 2. Average auction prices for a select number of classic car categories

Auction prices have been converted to real 2017 dollars using the US CPI series. The values below *Condition* refer to Sports Car Market's condition rating scheme.

Category	Observations	Percentage	Average price (USD2017)	Median Price (USD2017)
<i>Make</i>				
Alfa Romeo	80	0.28%	\$638,084	\$83,518
Aston Martin	115	0.40%	\$534,287	\$266,160
Bugatti	183	0.63%	\$1,038,764	\$590,405
Cadillac	841	2.90%	\$116,743	\$69,337
Chevrolet	4,439	15.65%	\$77,615	\$49,033
Delahaye	85	0.29%	\$581,862	\$243,214
Duesenberg	145	0.51%	\$1,343,430	\$1,057,972
Ferrari	1,517	5.35%	\$1,224,458	\$309,050
Ford	2,833	9.77%	\$77,597	\$34,215
Lamborghini	186	0.64%	\$412,356	\$236,896
Jaguar	1,431	5.04%	\$176,877	\$75,640
Maserati	350	1.21%	\$401,652	\$122,214
Mercedes-Benz	1,439	5.07%	\$393,443	\$86,712
Porsche	992	3.50%	\$244,579	\$78,485
Talbot-Lago	70	0.24%	\$1,043,540	\$343,121
<i>Era</i>				
Veteran	323	1.14%	\$223,216	\$97,133
Brass	492	1.73%	\$281,565	\$90,064
Vintage	1,207	4.25%	\$268,916	\$78,783
Pre-war	3,600	12.69%	\$342,227	\$100,502
Post-war	21,896	77.19%	\$199,989	\$50,633
Modern classic	849	2.99%	\$128,124	\$31,583
<i>Condition</i>				
1	4,665	16.45%	\$499,314	\$137,195
3	9,138	32.21%	\$128,659	\$35,027
5	412	1.45%	\$96,514	\$14,776
<i>Auctioneer</i>				
Bonhams	4,726	16.29%	\$254,692	\$81,318
RM Sotheby's	414	1.43%	\$1,034,965	\$274,803
Christie's	899	3.10%	\$220,639	\$87,868
<i>Type</i>				
Coupe	8,484	29.91%	\$234,748	\$50,224
Racer	969	3.42%	\$936,663	\$204,251
Roadster	3,176	11.20%	\$383,531	\$83,873
Sedan	2,816	9.93%	\$80,269	\$26,494
Concept car	35	0.12%	\$862,838	\$474,205
Total sample	29,002		\$218,182	\$55,902

Table 3. Displacement interval classification

Displacement is reported in cubic centimeters (cc). In the regression models, we will use displacement (2,050;3,050] as the benchmark.

Displacement (cc)	Observations
(40; 1,150]	1,262
(1,150; 2,050]	3,611
(2,050; 3,050]	3,705
(3,050; 4,050]	4,029
(4,050; 5,550]	7,407
(5,550; 7,050]	7,158
(7,050; 27,000]	1,830
Total	29,002

Table 4. Condition ratings

A classic car's condition is categorized into 6 classes (we discard the lowest category which includes cars in very bad condition that are likely only be used as a source of parts). We will use condition 4 as the benchmark case in our models.

Rating	Description	Observations
1	National concours standard/perfect	4,755
2	Very good, club concours, some small flaws	11,464
3	Average daily driver in decent condition	9,692
4	Still a driver but with some apparent flaws	2,130
5	A nasty beast that runs but has many problems	961
6	Only good for parts	deleted
Total		29,002

Table 5. Beautifully designed cars.

The table below present the 10 best-looking classic cars of all times according to Total Car Score, an automotive research company that ranks and evaluates cars (<https://www.cnbc.com/2012/08/17/The-10-Most-Beautiful-Cars-of-All-Time.html>). We also report the number of times that the corresponding model occurs in our sample.

Year	Make	Model	# Observations
1954	Mercedes-Benz	300SL	270
1961	Ferrari	250 GT	286
1963	Chevrolet	Corvette	186
1964	Aston Martin	DB5	12
1965	Jaguar	E-Type	26
1966	Ford	GT40	2
1967	Ferrari	275 GTB/4	2
1970	Dodge	Challenger R/T	44
1971	Lamborghini	Miura SV	63
1973	Porsche	911 Carrera RS	29
Total			920

Table 6. Hedonic regression results (nominal and real models)

This table appendix presents the results of the general hedonic regressions in nominal and real. The nominal model uses the unadjusted auction price as the dependent variable, while the real model uses the deflated price (USD July 2017) terms. The table also reports relative price impacts (PI) and the *t*-stats. The reference category by type of variable is indicated with a #. ***, ** and * stand for statistical significance at the 10%, 5% and 1% levels, respectively.

	Label	Coeff.	PI (%)	t-stat	Coeff.	PI (%)	t-stat
		Nominal model			Real model		
Era							
	Veteran era	1.948***	601.53	27.26	1.948***	601.36	27.25
	Brass era	1.344***	283.47	27.38	1.344***	283.45	27.37
	Vintage era	0.805***	123.77	22.83	0.805***	123.73	22.82
	Pre-war	1.016***	176.27	36.63	1.016***	176.28	36.63
	Post-war era	0.739***	109.41	35.92	0.739***	109.42	35.91
	Modern classic#	n/a			n/a		
Condition							
	1	1.252***	249.81	60.22	1.252***	249.83	60.22
	2	0.817***	126.44	43.97	0.818***	126.49	43.98
	3	0.397***	48.72	21.44	0.397***	48.77	21.45
	4#	n/a			n/a		
	5	-0.09***	-8.60	-2.91	-0.09***	-8.61	-2.91
Marque							
	Chevrolet#	n/a			n/a		
	Ford	-0.143***	-13.36	-7.28	-0.144***	-13.37	-7.29
	Ferrari	1.448***	325.28	38.90	1.448***	325.47	38.90
	Jaguar	0.204***	22.61	6.99	0.204***	22.67	7.00
	Mercedes-Benz	0.591***	80.56	19.83	0.591***	80.57	19.83
	Porsche	1.056***	187.52	21.64	1.057***	187.73	21.65
	Rolls-Royce	0.522***	68.55	15.47	0.522***	68.57	15.47
	Cadillac	0.119***	12.60	3.76	0.119***	12.58	3.75
	Pontiac	-0.099***	-9.42	-3.20	-0.099***	-9.42	-3.20
	MG	-0.324***	-27.64	-8.12	-0.323***	-27.60	-8.10
	Buick	-0.202***	-18.28	-5.79	-0.202***	-18.30	-5.80
	Packard	-0.055*	-5.40	-1.38	-0.055*	-5.37	-1.37
	Plymouth	0.157***	16.96	4.40	0.157***	16.98	4.40
	Bentley	1.003***	172.73	25.41	1.004***	172.83	25.41
	Shelby	0.988***	168.60	27.22	0.988***	168.59	27.22
	Lincoln	-0.17***	-15.64	-4.38	-0.17***	-15.64	-4.38
	Volkswagen	0.028	2.85	0.43	0.029	2.89	0.44
	Dodge	-0.075**	-7.26	-1.99	-0.075**	-7.24	-1.99
	Oldsmobile	-0.188***	-17.15	-4.76	-0.188***	-17.17	-4.77
	Chrysler	0.041	4.15	0.99	0.041	4.19	1.00
	Maserati	0.955***	159.83	21.26	0.955***	159.99	21.27
	Fiat	0.138***	14.75	2.53	0.138***	14.79	2.53
	Mercury	-0.189***	-17.24	-4.04	-0.189***	-17.26	-4.05
	Lancia	1.057***	187.64	16.98	1.057***	187.82	16.99
	Triumph	-0.471***	-37.55	-8.68	-0.471***	-37.54	-8.67
	BMW	0.476***	60.96	8.24	0.477***	61.07	8.25
	Lamborghini	0.883***	141.71	13.27	0.883***	141.72	13.27
	Bugatti	1.538***	365.52	23.47	1.538***	365.52	23.47
	Studebaker	-0.327***	-27.89	-5.52	-0.328***	-27.94	-5.53
	Lotus	0.382***	46.55	5.74	0.383***	46.73	5.75
	Citroën	0.648***	91.10	9.39	0.648***	91.25	9.40
	Lagonda	0.764***	114.73	11.26	0.764***	114.73	11.26
	Duesenberg	1.769***	486.41	24.30	1.769***	486.60	24.30
	Cord	0.453***	57.27	6.22	0.453***	57.25	6.22
	Sunbeam	-0.154**	-14.29	-2.18	-0.153**	-14.22	-2.17
	Aston Martin	1.491***	344.06	19.92	1.491***	344.35	19.93
	Austin-Healey	-0.316***	-27.08	-4.13	-0.315***	-27.02	-4.12
	Isetta	0.431***	53.91	2.91	0.432***	53.96	2.91

Table 6. Regression results (Continued)

Label	Coeff.	PI (%)	t-stat	Coeff.	PI (%)	t-stat
		<i>Nominal model</i>			<i>Real model</i>	
Morris	-0.375***	-31.24	-4.47	-0.374***	-31.23	-4.47
Nash	-0.338***	-28.69	-4.17	-0.338***	-28.70	-4.18
DeSoto	0.045	4.59	0.56	0.044	4.52	0.55
Daimler	0.028	2.85	0.34	0.028	2.87	0.34
Hudson	-0.031	-3.08	-0.38	-0.032	-3.10	-0.38
Pierce-Arrow	0.068	7.05	0.80	0.069	7.10	0.80
Toyota	0.48***	61.55	5.21	0.48***	61.54	5.21
Delahaye	1.309***	270.36	15.25	1.309***	270.41	15.25
Morgan	0.11	11.63	1.03	0.111	11.70	1.04
Renault	0.151**	16.31	1.69	0.151**	16.29	1.69
Datsun	-0.6***	-45.14	-6.85	-0.601***	-45.15	-6.85
Alfa Romeo	0.783***	118.74	8.76	0.783***	118.75	8.75
Willys	-0.17**	-15.66	-1.78	-0.169**	-15.58	-1.77
Land Rover	0.034	3.41	0.32	0.034	3.41	0.32
Riley	0.325***	38.34	3.41	0.324***	38.28	3.41
Talbot-Lago	1.53***	362.05	16.31	1.53***	361.70	16.30
DeTomaso	0.267***	30.55	2.84	0.267***	30.64	2.85
Edsel	-0.388***	-32.14	-3.91	-0.388***	-32.15	-3.91
AC	0.435***	54.46	4.13	0.435***	54.45	4.13
Peugeot	0.47***	60.01	4.28	0.47***	60.08	4.28
Jensen	-0.127	-11.94	-1.18	-0.127	-11.91	-1.18
GMC	-0.089	-8.56	-0.80	-0.09	-8.58	-0.80
Facel Vega	0.865***	137.48	7.75	0.865***	137.44	7.75
Delage	0.702***	101.70	6.16	0.701***	101.60	6.16
Messerschmitt	0.82***	127.07	3.89	0.82***	127.14	3.90
International	-0.336***	-28.51	-2.86	-0.334***	-28.36	-2.84
Volvo	-0.154*	-14.24	-1.29	-0.153	-14.17	-1.28
Stutz	0.384***	46.80	3.22	0.383***	46.72	3.21
Jeep	-0.178*	-16.33	-1.35	-0.178*	-16.32	-1.35
Crosley	-0.423***	-34.52	-3.33	-0.424***	-34.56	-3.33
Nash-Healey	0.133	14.24	1.04	0.132	14.07	1.03
Vauxhall	0.545***	72.46	4.12	0.545***	72.52	4.13
LaSalle	-0.308**	-26.53	-2.29	-0.31**	-26.64	-2.30
DeLorean	0.731***	107.63	4.74	0.732***	107.83	4.74
Kaiser-Darrin	0.17	18.55	1.25	0.17	18.55	1.25
Imperial	-0.104	-9.91	-0.77	-0.105	-9.99	-0.77
Panhard et Levassor	0.53***	69.93	3.46	0.53***	69.89	3.46
Abarth	0.746***	110.90	5.29	0.747***	111.03	5.29
Bristol	0.415***	51.37	2.95	0.415***	51.40	2.95
Iso	0.439***	55.04	3.18	0.439***	55.14	3.18
Locomobile	-0.066	-6.37	-0.43	-0.066	-6.42	-0.44
Hispano-Suiza	1.193***	229.63	8.41	1.192***	229.43	8.41
De Dion-Bouton	0.536***	70.90	3.45	0.536***	70.84	3.45
Dual-Ghia	1.087***	196.54	7.75	1.088***	196.86	7.75
Autobianchi	-0.133	-12.47	-0.86	-0.132	-12.39	-0.86
Marmon	0.16	17.35	1.06	0.16	17.36	1.06
Fiat-Abarth	1.047***	185.02	6.91	1.047***	185.02	6.91
Rover	-0.522***	-40.69	-3.45	-0.524***	-40.76	-3.45
Stanley	0.375*	45.53	1.63	0.374*	45.37	1.63
Wolseley	-0.049	-4.75	-0.31	-0.048	-4.70	-0.31
Honda	-0.226*	-20.24	-1.40	-0.226*	-20.21	-1.40
Mini Cooper	0.41***	50.74	2.58	0.412***	50.92	2.59
Talbot	0.004	0.35	0.02	0.003	0.35	0.02
Isotta Fraschini	0.918***	150.49	5.63	0.918***	150.46	5.63
Siata	0.899***	145.81	5.34	0.899***	145.62	5.33
Hupmobile	-0.704***	-50.53	-4.17	-0.704***	-50.53	-4.17
Rambler	-0.646***	-47.61	-3.76	-0.645***	-47.53	-3.75
All other marques	0.28***	32.28	9.93	0.28***	32.31	9.93

Table 6. Regression results (Continued)

Table 6. Regression Results (Continued)							
Variable	Label	Coeff.	PI (%)	t-stat	Coeff.	PI (%)	t-stat
Nominal model				Real model			
Auction House							
	Bonhams	0.122***	13.00	5.62	0.123***	13.06	5.64
	RM Auctions	0.381***	46.42	18.09	0.382***	46.49	18.11
	Barett-Jackson	0.142***	15.28	6.16	0.143***	15.43	6.21
	Mecum Auction#	n/a			n/a		
	Silver Auctions	-0.655***	-48.08	-24.05	-0.655***	-48.05	-24.03
	Gooding & Co.	0.76***	113.92	20.53	0.76***	113.80	20.51
	Christie's	0.269***	30.87	8.14	0.27***	31.01	8.18
	Kruse	-0.149***	-13.83	-4.63	-0.148***	-13.78	-4.61
	Worldwide Auct.	0.1***	10.50	3.18	0.1***	10.57	3.20
	H&H Auctions	-0.222***	-19.95	-6.56	-0.222***	-19.88	-6.54
	McCormick's	-0.429***	-34.90	-12.05	-0.429***	-34.89	-12.05
	Russo and Steele	-0.118***	-11.17	-3.52	-0.118***	-11.13	-3.51
	Artcurial	0.421***	52.42	11.55	0.422***	52.53	11.57
	Branson	-0.182***	-16.66	-5.19	-0.182***	-16.62	-5.18
	Auctions America	-0.243***	-21.60	-6.70	-0.241***	-21.45	-6.65
	Silverstone	0.132***	14.12	3.13	0.131***	14.04	3.11
	Leake	-0.379***	-31.54	-9.13	-0.379***	-31.56	-9.13
	RM Sotheby's	0.715***	104.37	16.33	0.715***	104.38	16.33
	eBay	-0.577***	-43.86	-13.52	-0.578***	-43.91	-13.54
	Brooks	-0.029	-2.82	-0.52	-0.028	-2.76	-0.51
	AA by RM	-0.21***	-18.92	-4.17	-0.211***	-19.02	-4.19
	eBay/Kruse	-0.044	-4.30	-0.77	-0.043	-4.18	-0.75
	VanDerBrink Auct.	-0.936***	-60.76	-17.66	-0.933***	-60.67	-17.62
	Coys	0.116**	12.26	2.05	0.115**	12.24	2.05
	Bonhams & Brooks	-0.134**	-12.52	-2.07	-0.136**	-12.74	-2.11
	Rick Cole Auctions	0.781***	118.38	4.16	0.784***	119.03	4.18
	Other auctioneers	-0.287***	-24.97	-12.52	-0.287***	-24.92	-12.49
Car type							
	Buggy	0.636***	88.89	6.71	0.637***	89.00	6.71
	Concept car	2.326***	924.06	17.76	2.326***	924.09	17.76
	Convertible	0.636***	88.96	35.32	0.637***	88.99	35.33
	Coupe	0.402***	49.48	21.92	0.402***	49.50	21.93
	Cyclecar	0.749***	111.57	3.16	0.748***	111.28	3.16
	Hatchback	0.51***	66.51	5.77	0.511***	66.62	5.78
	Horseless carriage	0.294***	34.24	3.70	0.295***	34.29	3.70
	Hot rod	0.378***	45.87	4.12	0.378***	45.90	4.12
	Off-road	0.28***	32.28	2.35	0.28***	32.28	2.35
	Limousine	0.513***	67.01	15.08	0.513***	67.06	15.09
	Microcar	0.451***	57.01	3.57	0.451***	56.95	3.56
	Pick-up	-0.034	-3.34	-1.01	-0.034	-3.33	-1.00
	Racer	1.463***	331.83	40.87	1.463***	332.05	40.88
	Roadster	0.935***	154.68	42.31	0.935***	154.72	42.31
	Runabout	0.749***	111.47	7.38	0.751***	111.81	7.40
	SUV	0.22***	24.59	2.96	0.22***	24.65	2.96
	Sedan#	n/a			n/a		
	Station wagon	0.485***	62.37	14.04	0.485***	62.41	14.04
	Targa	-0.125**	-11.72	-1.86	-0.124**	-11.69	-1.85
	Tourer	0.779***	117.89	22.75	0.779***	117.94	22.75
	Utility	0.21***	23.33	2.70	0.21***	23.41	2.71
	Van	0.741***	109.72	11.83	0.741***	109.73	11.83
Color							
	Beige	-0.097***	-9.26	-3.16	-0.097***	-9.27	-3.16
	Black#	n/a			n/a		
	Blue	-0.039**	-3.78	-2.25	-0.039**	-3.78	-2.25
	Bronze	-0.098**	-9.30	-1.90	-0.098**	-9.34	-1.91
	Brown	-0.185***	-16.91	-4.19	-0.185***	-16.90	-4.19

Table 6. Regression results (Continued)

	Label	Nominal model			Real model		
		Coeff.	PI (%)	t-stat	Coeff.	PI (%)	t-stat
	Charcoal	-0.261**	-22.98	-2.07	-0.261**	-22.97	-2.07
	Copper	0.012	1.24	0.14	0.012	1.17	0.13
	Gold	-0.135***	-12.60	-3.23	-0.135***	-12.62	-3.23
	Gray	-0.086***	-8.24	-2.73	-0.086***	-8.25	-2.73
	Green	-0.023	-2.32	-1.24	-0.023	-2.31	-1.23
	Ivory	-0.034	-3.37	-1.04	-0.035	-3.42	-1.05
	Maroon	-0.047**	-4.58	-2.02	-0.047**	-4.58	-2.02
	Metal	0.043	4.37	0.59	0.042	4.26	0.57
	Orange	-0.009	-0.86	-0.27	-0.009	-0.88	-0.27
	Pink	0.036	3.71	0.70	0.036	3.65	0.70
	Primer	-0.264**	-23.22	-1.65	-0.264**	-23.20	-1.65
	Purple	-0.016	-1.56	-0.27	-0.016	-1.61	-0.28
	Red	-0.031**	-3.07	-1.89	-0.031**	-3.09	-1.89
	Rust	-0.461**	-36.95	-1.89	-0.461**	-36.94	-1.89
	Silver	0.017	1.72	0.77	0.017	1.73	0.77
	Turquoise	-0.039	-3.84	-0.72	-0.039	-3.85	-0.72
	White	0.032**	3.25	1.79	0.032**	3.24	1.79
	Wood	0.078	8.07	0.88	0.077	8.00	0.87
	Yellow	-0.118***	-11.17	-5.17	-0.119***	-11.20	-5.18
<i>Famous Race Provenance</i>							
	F1 provenance	0.887***	142.74	6.50	0.887***	142.83	6.50
	Indy500 proven.	0.02	1.97	0.13	0.018	1.83	0.12
	MM provenance	1.411***	310.16	8.99	1.413***	311.03	9.01
	LM provenance	1.552***	371.86	16.44	1.552***	371.99	16.44
<i>Design and Condition</i>							
	Matching numbers	0.1**	10.53	2.28	0.1**	10.49	2.27
	Beautiful design	0.819***	126.89	28.13	0.819***	126.92	28.13
<i>Sold at Famous Concours</i>							
	Goodwood	0.293***	34.09	7.07	0.291***	33.79	7.02
	Pebble Beach	0.075*	7.78	1.51	0.075*	7.81	1.52
<i>Displacement</i>							
	(40 cc,1150 cc]	-0.153***	-14.20	-3.69	-0.153***	-14.21	-3.69
	(1,150 cc; 2,050 cc]	0.063***	6.55	2.41	0.063***	6.54	2.41
	(2,050 cc; 3,050 cc]#	n/a			n/a		
	(3,050 cc; 4,050 cc]	0.152***	16.41	6.77	0.152***	16.37	6.75
	(4,050 cc; 5,550 cc]	0.269***	30.91	11.27	0.269***	30.87	11.26
	(5,550 cc; 7,050 cc]	0.413***	51.18	15.55	0.413***	51.15	15.54
	(7,050 cc; 27,000 cc]	0.553***	73.86	17.53	0.553***	73.83	17.53
<i>Forced Ind.</i>							
	Forced induct. engine	0.129***	13.82	6.91	0.129***	13.82	6.91
<i>RHD</i>							
	Right-hand drive	0.037	3.73	0.84	0.037	3.73	0.84
<i>Rare type</i>							
	Prototype car	0.031	3.13	0.43	0.031	3.10	0.42
	3-wheeled car	-0.212*	-19.10	-1.38	-0.212*	-19.07	-1.37
	Auto transmission	-0.311***	-26.75	-24.00	-0.311***	-26.75	-24.00
<i>Unique</i>							
	Marque occurs once	-0.139***	-12.94	-2.72	-0.139***	-12.96	-2.73
<i>Replica</i>							
	Replica car	-0.451***	-36.29	-12.78	-0.451***	-36.28	-12.77
<i>Engine Type</i>							
	1-CYL engine	-0.381***	-31.66	-4.77	-0.381***	-31.70	-4.77
	Electric engine	-0.514***	-40.18	-3.60	-0.513***	-40.15	-3.60
	H12 engine	0.448***	56.49	5.02	0.447***	56.44	5.02
	H2 engine	-0.165**	-15.24	-1.91	-0.165**	-15.19	-1.90
	H4 engine	-0.292***	-25.34	-5.35	-0.293***	-25.36	-5.36
	H6 engine	0.154***	16.68	3.05	0.154***	16.64	3.04
	H8 engine	1.088*	196.91	1.41	1.092*	198.00	1.42
	I2 engine	-0.151***	-14.03	-2.49	-0.151***	-14.05	-2.49
	I3 engine	-0.049	-4.74	-0.23	-0.048	-4.70	-0.22
	I4 engine#	n/a			n/a		
	I5 engine	0.244	27.66	0.90	0.245	27.76	0.90

Table 6. Regression results (Continued)

Variable	Label	Coeff.	PI (%)	t-stat	Coeff.	PI (%)	t-stat
<i>Nominal model</i>				<i>Real model</i>			
	I6 engine	0.448***	56.46	17.36	0.448***	56.49	17.36
	I8 engine	0.745***	110.70	18.63	0.745***	110.68	18.63
	Rotary engine	0.208	23.07	1.13	0.207	22.94	1.12
	Steam engine	-0.438***	-35.46	-2.47	-0.436***	-35.34	-2.46
	V10 engine	0.843***	132.42	3.09	0.847***	133.31	3.11
	V12 engine	0.699***	101.11	17.50	0.699***	101.15	17.50
	V16 engine	0.907***	147.75	10.17	0.907***	147.73	10.17
	V2 engine	0.423**	52.65	2.26	0.423**	52.71	2.27
	V4 engine	-0.666***	-48.63	-6.53	-0.666***	-48.65	-6.53
	V6 engine	0.342***	40.73	7.69	0.342***	40.73	7.69
	V8 engine	0.431***	53.86	14.57	0.431***	53.91	14.58
<i>Month of Sale</i>							
	January#	n/a			n/a		
	February	-0.093***	-8.88	-3.78	-0.096***	-9.16	-3.91
	March	-0.13***	-12.19	-6.05	-0.134***	-12.56	-6.25
	April	-0.314***	-26.96	-15.21	-0.32***	-27.40	-15.50
	May	-0.118***	-11.14	-5.36	-0.126***	-11.82	-5.71
	June	-0.253***	-22.34	-12.17	-0.262***	-23.09	-12.64
	July	-0.286***	-24.84	-10.13	-0.297***	-25.69	-10.53
	August	0.105***	11.10	5.26	0.09***	9.47	4.52
	September	-0.244***	-21.65	-10.71	-0.26***	-22.91	-11.42
	October	-0.238***	-21.21	-10.43	-0.257***	-22.64	-11.23
	November	-0.155***	-14.34	-5.57	-0.171***	-15.76	-6.17
	December	-0.215***	-19.33	-7.81	-0.235***	-20.93	-8.53
Year dummies	Yes				Yes		
Constant		7.671***		128.19	8.083***		135.06
Rsquared		0.702			0.697		

Table 7. Nominal and real returns on classic cars

This table presents the nominal and real price indices of classic cars. 1998 serves as the reference year and is set to 100. The nominal model uses the unadjusted auction price as the dependent variable, while the real model uses the deflated auction price. We apply the correction of equation (3) to the calculation of index levels. ***, ** and * stand for statistical significance at the 10%, 5% and 1% levels, respectively.

Year	Coefficient	Index	Return	Coefficient	Index	Return
<i>Nominal model</i>				<i>Real model</i>		
1998	n/a	100.00		n/a	100.00	
1999	0.025	102.57	2.57%	0.004	100.56	0.56%
2000	0.017	101.73	-0.83%	-0.036	96.54	-4.00%
2001	-0.100**	90.49	-11.05%	-0.181***	83.54	-13.46%
2002	0.059*	106.11	17.27%	-0.038	96.35	15.33%
2003	0.059*	106.08	-0.03%	-0.062*	94.12	-2.32%
2004	0.196***	121.59	14.62%	0.0501	105.20	11.77%
2005	0.412***	150.96	24.16%	0.233***	126.39	20.15%
2006	0.567***	176.35	16.82%	0.355***	142.76	12.95%
2007	0.609***	183.88	4.27%	0.370***	144.94	1.53%
2008	0.720***	205.43	11.72%	0.442***	155.73	7.45%
2009	0.689***	199.12	-3.07%	0.416***	151.70	-2.59%
2010	0.630***	187.77	-5.70%	0.341***	140.72	-7.24%
2011	0.699***	201.11	7.10%	0.377***	145.97	3.73%
2012	0.688***	198.98	-1.06%	0.346***	141.49	-3.07%
2013	0.893***	244.32	22.79%	0.537***	171.24	21.03%
2014	0.954***	259.56	6.24%	0.581***	178.91	4.48%
2015	1.065***	290.21	11.81%	0.691***	199.70	11.62%
2016	0.954***	259.59	-10.55%	0.568***	176.68	-11.53%
2017	0.953***	259.31	-0.11%	0.545***	172.59	-2.31%
Arithmetic mean return:			5.63%	3.37%		
Geometric mean return:			5.15%	2.91%		

Table 8. Returns of classic car sub-indices

Average returns for several sub-indices. All indices have been calculated over the period 1998-2017, except for those based on CCCA approved classics which were computed over the period 2000-2017. Panel A (B) reports results on a nominal (real) basis.

Panel A: Nominal results					
Sub-index	Obs.	Average return (Arithmetic)	Average return (Geometric)	Volatility (nom. returns)	Sharpe ratio
CCCA approved	2,488	5.28%	4.20%	15.60%	0.21
Affordable classics	911	6.34%	5.20%	15.23%	0.29
Blue Chip	833	12.50%	10.29%	22.60%	0.47
German classics	3,398	7.01%	6.02%	15.08%	0.33
Italian classics	3,164	11.28%	9.78%	19.09%	0.54
British classics	5,132	6.29%	5.16%	12.22%	0.35
American classics	15,025	4.53%	3.98%	11.17%	0.23
Ferrari	1,538	13.76%	10.81%	26.54%	0.44
Porsche	1,022	9.44%	7.60%	20.77%	0.36
Mercedes-Benz	1,495	6.95%	5.56%	17.44%	0.29
Veteran & Brass	819	8.23%	6.17%	21.71%	0.29
Vintage	1,212	8.98%	6.12%	25.45%	0.28
Pre-war	3,650	3.43%	2.20%	15.94%	0.09
Post-war	21,281	5.88%	5.35%	10.53%	0.37
Modern classic	2,040	7.16%	6.23%	14.30%	0.36
Total sample	29,002	5.63%	5.15%	10.44%	0.35

Panel B: Real results					
Sub-index	Obs.	Average return (Arithmetic)	Average return (Geometric)	Volatility (real returns)	Sharpe ratio
CCCA approved	2,488	3.24%	2.07%	15.89%	0.20
Affordable classics	911	4.09%	2.99%	15.23%	0.26
Blue Chip	833	10.04%	7.93%	21.95%	0.45
German classics	3,398	4.72%	3.77%	12.03%	0.38
Italian classics	3,164	8.87%	7.45%	18.43%	0.48
British classics	5,132	4.03%	2.92%	11.73%	0.34
American classics	15,025	2.28%	1.77%	10.72%	0.20
Ferrari	1,538	11.29%	8.45%	25.82%	0.43
Porsche	1,022	7.04%	5.30%	19.88%	0.35
Mercedes-Benz	1,495	4.71%	3.32%	17.15%	0.27
Veteran & Brass	819	5.96%	3.93%	21.71%	0.27
Vintage	1,212	6.74%	3.88%	25.45%	0.26
Pre-war	3,650	1.23%	0.48%	15.94%	0.07
Post-war	21,281	3.62%	3.13%	10.53%	0.33
Modern classic	2,040	5.05%	4.14%	14.30%	0.35
Total sample	29,002	3.37%	2.91%	10.03%	0.33

Table 9. Risk and returns of classic cars and other asset types.

Average returns on various financial and real assets over the period 1998-2017. Sharpe ratios have been computed using the return on 3M Treasury Bills as the risk-free rate. Data on gold prices (US\$/Troy ounce), equity indices (S&P 500 and MSCI World, both excluding dividends), bonds (according to the Bank of America Merrill Lynch Global Government Bond Index), and inflation (US CPI Series, Seasonally Adjusted) has been downloaded through Thomson Reuters DataStream. Art index returns stem from Artprice.com. We obtain yields on 3M Treasury Bills through FRED Economic Data.

	Mean annual return			Sharpe Ratio
	Geometric	Arithmetic	S.D.	
<i>Nominal returns</i>				
Classic cars	5.15%	5.63%	10.44%	0.35
S&P 500	4.03%	5.34%	16.30%	0.21
MSCI World	3.18%	4.20%	14.35%	0.16
Gov. Bonds	4.63%	4.87%	7.32%	0.40
Bills	1.80%	1.97%	2.09%	-
Gold	7.76%	9.13%	17.97%	0.40
Inflation	2.13%	2.14%	1.55%	-
Art	2.00%	2.92%	13.84%	0.07
<i>Real returns</i>				
Classic cars	2.91%	3.37%	10.03%	0.33
S&P 500	1.85%	3.08%	15.69%	0.19
MSCI World	1.01%	1.97%	13.68%	0.14
Gov. Bonds	2.52%	2.75%	6.99%	0.38
Bills	-0.34%	0.10%	1.93%	-
Gold	5.50%	6.72%	16.65%	0.40
Art	-0.13%	0.65%	12.76%	0.04

Table 10. Correlations between returns on classic cars and other asset classes.

The table reports the pairwise correlation coefficients between the nominal returns on classic cars and those on other asset classes for 1998-2017. Data on gold prices (US\$/Troy ounce), equity indices (S&P 500 and MSCI World, both excluding dividends), government bonds (according to the Bank of America Merrill Lynch Global Government Bond Index), and inflation (US CPI Series, Seasonally Adjusted, US Bureau of Labor Statistics) are collected from Thomson Reuters DataStream. Art index returns stem from Artprice.com. We obtain yields on 3M Treasury Bills from FRED. ***, ** and * stand for statistical significance at the 10%, 5% and 1% levels, respectively.

	Classic cars	Inflation	S&P500	MSCI World	Gov. Bonds	Gold	Art	Bills
Class. cars	-	0.329	0.141	0.338	-0.080	0.071	0.363	-0.093
Inflation	0.227	-	0.245	0.305	0.234	0.530**	0.611***	0.420*
S&P500	0.099	0.164	-	0.931***	-0.255	-0.121	0.491**	-0.350
MSCI World	0.294	0.212	0.929***	-	-0.269	-0.108	0.539**	-0.304
Gov. Bonds	-0.186	0.245	-0.332	-0.360	-	0.586***	0.284	-0.771***
Gold	-0.017	0.453*	-0.191	-0.194	0.497**	-	0.346	0.123
Art	-0.162	0.537**	0.457**	-0.373*	0.149	0.270	-	0.059
Bills	-0.271	0.519**	-0.045	-0.072	0.128	0.222	0.343*	-

ONLINE APPENDIX

Online appendix 1. Marque classifications (for high sales)

The cars of 95 manufacturers were sold at least 20 times in car auctions over the past two decades. The combined sales amounted to 27,310 auctioned cars. * The names under the marque Panhard comprise: Panhard et Levassor, Hispano-Suiza, De Dion-Bouton, and Isotta Fraschini.

Marque	# Obs.	Marque	# Obs.	Marque	# Obs.
Chevrolet	4,522	Duesenberg	145	Volvo	43
Ford	2,831	Cord	125	Stutz	43
Ferrari	1,538	Sunbeam	124	Jeep	41
Jaguar	1,461	Aston Martin	115	Crosley	40
Mercedes-Benz	1,461	Austin-Healey	114	Nash-Healey	37
Porsche	1,022	Isetta	101	Vauxhall	35
Rolls-Royce	891	Morris	100	LaSalle	33
Cadillac	841	Nash	94	DeLorean	33
Pontiac	743	DeSoto	94	Kaiser-Darrin	33
MG	675	Daimler	92	Imperial	32
Buick	599	Hudson	91	Panhard*	31
Packard	586	Pierce-Arrow	88	Abarth	31
Plymouth	541	Toyota	87	Bristol	31
Bentley	531	Delahaye	85	Iso	31
Shelby	520	Morgan	83	Locomobile	30
Lincoln	488	Renault	82	Hisp.-Suiza*	30
Volkswagen	481	Datsun	82	De Dion*	30
Dodge	471	Alfa Romeo	80	Dual-Ghia	30
Oldsmobile	429	Willys	78	Autobianchi	29
Chrysler	425	Land Rover	73	Marmon	28
Maserati	348	Riley	71	Fiat-Abarth	27
Fiat	335	Talbot-Lago	70	Rover	26
Mercury	290	DeTomaso	68	Stanley	26
Lancia	255	Edsel	61	Wolseley	25
Triumph	244	AC	56	Honda	24
BMW	206	Peugeot	52	Mini Cooper	24
Lamborghini	186	Jensen	52	Talbot	23
Bugatti	183	GMC	50	Isotta Frasch.*	23
Studebaker	177	Facel Vega	48	Siata	21
Lotus	159	Delage	47	Hupmobile	21
Citroën	156	Messerschmitt	46	Rambler	20
Lagonda	148	International	45	-	-

Online appendix 2. Marques' classification (low sales)

Of 548 marques, less than 20 observations were auctioned. The combined sales (in numbers) amount to 1,692. *These marques are in full: Armstrong-Siddeley, Watson-Offenhauser, Snowberger-Offenhauser, and Cottin & Desgouttes.

Marque	Obs.	Marque	Obs.	Marque	Obs.	Marque	Obs.
Frazer Nash	19	Diamond	10	Detroit Electric	6	Audi	4
Kaiser	19	Kissel	10	Oakland	6	Tojeiro	4
Mercedes	18	Holden	10	Matra	6	Suzuki	4
Cisitalia	18	White	9	Heinkel	6	Maybach	4
Bizzarrini	17	Chalmers	9	Special	6	Pegaso	4
Voisin	17	Berkeley	9	McLaughlin-Buick	5	Premier	3
Maxwell	16	Kurtis	9	Jensen-Healey	5	DuPont	3
Singer	16	Miller	9	Race	5	Columbia	3
Benz	16	Lanchester	9	McLaren	5	Chandler	3
Model	15	Darracq	9	Willys-Knight	5	British Leyland	3
Tucker	15	Moretti	9	Lotus-Climax	5	Durant	3
Invicta	15	Lea-Francis	9	Lorraine-Dietrich	5	National	3
Mazda	15	Essex	9	Stanguellini	5	Alpine	3
Franklin	14	DKW	9	Mors	5	Marcos	3
OSCA	14	Muntz	9	Stevens-Duryea	5	Bitter	3
Humber	14	Peerless	9	Napier	5	Chaparral	3
Austin	14	AMC	9	Holsman	5	Amphicar	3
REO	13	Innocenti	8	Knox	5	OM	3
Ghia	13	Standard	8	Ruxton	5	Swallow	3
Bricklin	13	Victoria	8	Borgward	5	Gordon-Keeble	3
Blackhawk	13	Lola-Chevrolet	8	Overland	5	Swift	3
Graham	13	Metropolitan	8	Rochet-Schneider	5	Terraplane	3
Batmobile	13	Vespa	8	DB	5	GAZ	3
Healey	12	Jowett	7	Clément	5	Monarch	3
Hillman	12	Pope-Hartford	7	Stoddard-Dayton	5	Chevron	3
Cooper	12	Thomas	7	Schacht	5	Belsize	3
Intermeccanica	12	Elva	7	Clément-Panhard	4	Fitch	3
TVR	12	Cunningham	7	Hillegass	4	Woodill	3
Lola	12	Autocar	7	Connaught	4	Clenet	3
Tatra	12	Winton	7	Monteverdi	4	Steyr	3
Saab	12	Simplex	7	Edwards	4	Metz	3
Mercer	11	Devin	7	Lozier	4	Salmson	3
Cooper-Climax	11	Wolseley-Siddeley	7	Crossley	4	Milburn	3
Auburn	11	Panther	7	Willys-Overland	4	Railton	3
Opel	11	Nissan	7	Kellison	4	G.N.	3
Mini	11	NSU	7	Trojan	4	Delaugère	3
Checker	11	Lister-Jaguar	6	Puma	4	Sears	3
Goggomobil	11	Frazer Nash-BMW	6	Rauch & Lang	4	G.N.U.	3
Panhard	11	Excalibur	6	Brabham-Repco	4	Dinalpin	3
Horch	10	Delaunay-Belleville	6	Simca	4	Decauville	3
Minerva	10	Alvis	6	Avanti	4	Kleinschnittger	3
HRG	10	March	6	BMC	4	F.M.R.	3
Subaru	10	Reliant	6	Trabant	4	American	3

Online appendix 2. Marques' classification (low sales; continued)

Marque	Obs	Marque	Obs.	Marque	Obs.	Marque	Obs
Bond Bug	3	Rosengart	2	American Bantam	2	Watson-Offenh.*	1
Hotchkiss	3	Crane-Simplex	2	Lister-Chevrolet	2	Griffin	1
Barré	2	Beck	2	Aster	2	Case	1
Skoda	2	Derby	2	Pierre Faure	2	Lombard	1
Haynes-Apperson	2	Meyers	2	Abarth-Simca	2	Rally	1
Fisson	2	Bayliss	2	Hustler	2	Otto	1
Waverley	2	Tojeiro-Butterworth	2	Clément-Bayard	1	Scarab	1
Talbot-Darracq	2	Gurney	2	Liver	1	Farman	1
Auto Union	2	Armstrong-Sidd.*	2	Fletcher	1	Goddeu	1
Kurtis-Offenhauser	2	Cleveland	2	Emeryson	1	Maudslay	1
Brewster	2	Vanden	2	Trumbull	1	SAVA	1
Cooper-Maserati	2	Haynes	2	Wills-Sainte	1	Krieger-Braiser	1
Nardi-Danese	2	Glasspar	2	Michelotti	1	Pratt-Elkhart	1
OTAS	2	Rockne	2	Lotus-BRM	1	Sterling	1
Brough	2	Rochdale	2	Thames	1	Victress	1
McLaren-Elva	2	Watson	2	Elva-Porsche	1	Dax	1
Chrysler-Ghia	2	Baja	2	ERA	1	Locust	1
Squire	2	Sharp	2	Lynx	1	Brabham	1
Mallock	2	Northern	2	Surtees	1	Rene	1
Merlyn	2	Le Bestoni	2	Lenawee	1	Matra-Simca	1
Calcott	2	Fournier-Marcadier	2	Bosley	1	Steyr-Puch	1
Richard Brasier	2	EMW	2	VOP	1	Midget	1
Georges Richard	2	Graham-Paige	2	Pkora	1	British Duryea	1
Paige	2	Gardner-Serpollet	2	Cole	1	KVA/Hi-Tec	1
Sabra	2	Flajole	2	Barris	1	Foose	1
Lotus-MG	2	Offenhauser	2	Nagant	1	Ballot	1
Meteor	2	Berliet	2	Turner-miesse	1	Rolland-Pilain	1
CGV	2	Brasier	2	Costin-Nathan	1	Economy	1
Martini	2	Hurtu	2	BRM	1	Francesco	1
Foyt	2	Brewster-Ford	2	Mercedes-Simplex	1	Atalanta	1
Humberette	2	Henry J.	2	McLaren-Cosworth	1	Safir	1
Star	2	Ed Roth	2	Santler	1	Pierce-MG	1
Theophile	2	Kaiser-Jeep	2	Pick	1	Cooper-Bristol	1
Miller-Ford	2	Mitchell	2	Siddeley	1	Galloway	1
Little	2	Proteus	2	Caterham	1	Riley-Ford	1
Austro-Daimler	2	Zundapp	2	Davis	1	Huff-Ford	1
Pope-Waverley	2	Am General	2	Cosworth	1	Westfield	1
Bertone	2	Sunbeam-Talbot	2	Elva-Ford	1	Sizaire-Naudin	1
MMC	2	Mathis	2	Cartercar	1	Kieft	1
Erskine	2	Stearns-Knight	2	Wisconsin	1	Lucenti	1
Darmont	2	Moon	2	Royale	1	March-Ford	1
Rexette	2	SS	2	E.J.S.	1	McLaren-Chevrolet	1
Dreyer	2	American Austin	2	Roesch-Talbot	1	Lotus-Bristol	1
Deep	2	Continental	2	MRE	1	Gulf	1
Henney	2	King	2	Brush	1	Gregoire	1
Itala	2	Peel	2	H.A.R.	1	Manta	1
Alpine-Renault	2	Mochet	2	McQuay-Norris	1	Tecno	1
Chevron-Ford	2	Velorex	2	Washington	1	Wombat Car Co.	1

Online appendix 2. Marques' classification (low sales; continued)

Marque	Obs	Marque	Obs	Marque	Obs	Marque	Obs
Bulant	1	Excelsior	1	Ogle	1	DRA	1
Kelmark	1	Lyncar	1	Gladiator	1	De Dietrich	1
BSH	1	B & Z	1	Wilson-Pilcher	1	Davies	1
Germain	1	Zagato	1	Buffum	1	Felday	1
Silver Stream	1	Dellow	1	Flexible	1	Rickenbacker	1
Chitty	1	Worth	1	Kougar-Jaguar	1	Interstyl	1
Marble	1	EMPI	1	Jurisch	1	Djinn	1
Krit	1	Bantam	1	Reyonnah	1	Diva	1
U.S.	1	Dutton	1	Avolette	1	Ladawri	1
Buckler	1	Longhorn	1	Maico	1	Auto-Carrier	1
Empire	1	Cheetah	1	Lightburn	1	Unic	1
Sparks	1	Lomax	1	Scootacar	1	Zebra	1
Stearns	1	Ferves	1	Eshelman	1	Crouch	1
Brisko-Dryer	1	Jackson	1	Benjamin	1	Zoe	1
Tom Beaty	1	Inter-State	1	Charron	1	Marlboro	1
Lola-Climax	1	McFarlan	1	Turner	1	Malicet	1
Kanzler	1	Thomas-Flyer	1	Glassic	1	Pininfarina	1
Veritas-BMW	1	Bergholt	1	Broc	1	Matra-Bonnet	1
Selden	1	Jewel	1	Le Zebre	1	Abarth-Osella	1
Orient	1	Neustadt-Perry	1	Modena	1	Gerin	1
Success	1	Frontenac	1	Holman-Moody	1	EMF	1
Duryea	1	Tourist	1	Epperly	1	Penske-march	1
Velie	1	Lazzarino	1	Gardner	1	Vinot	1
Mini	1	Argo	1	Cottin & Desg.*	1	Meskowski	1
Sbarro	1	Henny	1	Cyklon	1	Elgin	1
Glockler-Porsche	1	Gobron-Brillié	1	Lacoste	1	Citröen	1
Marlin	1	Hertz	1	IKA	1	Costin	1
Brouhot	1	Monica	1	Commer	1	Lion-Peugeot	1
Raymond	1	Phillips	1	Smith	1	Brawner	1
SMA	1	Cramer	1	Falcon	1	Raynaud	1
Van Blerck	1	Rounds	1	Vulcan	1	Georges Irat	1
Bromme	1	Lesovsky	1	McKee	1	Amilcar	1
		Snowberger-					
Chrisman	1	Off.*	1	Ginetta	1	DFP	1
John Fray	1	Alco	1	B.N.C.	1	HAZ	1
Beardmore	1	Kapi	1	Philos	1	Car Nation	1
Eldredge	1	David	1	Roamer	1	K.R.I.T.	1
Karns	1	PTV	1	Pegasus	1	Crofton	1
Kollins	1	Trident	1	Rapier	1	H.E.	1
Marion	1	Kougar	1	Osi	1	Apollo	1
Sebring	1	Fleur	1	Winfield	1	Bocar	1
Logan	1	Baker	1	Waltham	1	AAR	1
Chandler-Curtiss	1	Léon Bollée	1	Hesketh	1	De Sanctis	1
Giannini	1	Foers	1	Beaumont	1	Pullman	1
Alta	1	Buckmobile	1	Bean	1	Tempo	1
Pinzgauer	1	McIntyre	1	FMR	1	Tracta	1
Steyr-Allard	1	Woods	1	Diatto	1	Breguet	1

Online appendix 3. Body type classifications

We classify body types accounting for the categories below. In the regression models we use body type sedan as reference category.

Body Type	# Obs.	Feature(s)
Buggy	79	Lightweight automobile with off-road capability and sparse bodywork
Concept car	35	Made to showcase new styling and/or new technology
Convertible	8,278	Ability to convert from open-roof to closed-roof.
Coupe	9,434	Fixed roof, gradually sloping down on the back-side. Most often a car with two doors.
Cyclecar	37	Small, lightweight and inexpensive car popular in the 1910's and 1920's. Sometimes equipped with a motorcycle engine.
Hatchback	83	Same as station wagon, but shorter
Horseless carriage	151	The oldest of automobile types, essentially horse carriages equipped with a mechanical engine.
Hot rod	75	American car with large (often visible) engine modified for linear speed.
Off-road	57	Light-weight truck mostly used for its off-road capabilities.
Limousine	695	Luxurious car generally driven by a chauffeur with a partition between the driver and passengers' compartment.
Microcar	184	Very small cars, with light engines. Replaced cyclecars in the 1940's.
Pick-up	749	Light duty truck with enclosed cab and open cargo area.
Racer	698	Car that was built specifically built for the participation in racing events.
Roadster	3,249	Light, sporty, and open two-seat car.
Runabout	88	Light, basic automobile popular until around 1915.
SUV	150	Car with off-road features (e.g. 4-wheel drive, high ground-clearance) but that is generally meant for road use.
Sedan	2,890	Passenger car in three-box configuration, with a closed cargo compartment.
Station wagon	651	Sedan car with the roof extended rearward over a shared cargo compartment.
Targa	158	Semi-convertible car with a removable roof section and a roll bar behind the seats.
Tourer	947	Open car seating four or more people, meant for travelling.
Utility	126	Car used with a commercial purpose, or for carrying out a specific task.
Van	188	Minibus. Includes camper vans.
Total	29,002	

Online appendix 4. Exterior color classifications

We distinguish the following exterior colors.

Black is used as reference category in the regression analysis.

Exterior Color	# Obs.
Beige	731
Black	4,497
Blue	3,803
Bronze	235
Brown	323
Charcoal	37
Copper	79
Gold	370
Gray	690
Green	2,732
Ivory	623
Maroon	1,467
Metal	143
Orange	682
Pink	236
Primer	23
Purple	187
Red	4,967
Rust	10
Silver	1,762
Turquoise	212
White	3,558
Wood	79
Yellow	1,556
Total	29,002

Online appendix 5. Engine type classification

A total of 21 different engine types are distinguished. In most cases, engine types are depicted by two characters: (i) a letter followed by a number (for example 'V8'), which denotes the cylinder configuration and (ii) the number of cylinders (which range from a single cylinder up 16 cylinders). The dummy assigned to the I4 engine type will serve as reference category.

Engine Type	# Obs.	Feature(s)
1-cylinder	303	-
Electric	32	Electric vehicles were already widely used in the late 1890's.
H12	100	
H2	104	
H4	981	
H6	598	
H8	1	
I2	263	
I3	13	
I4	3,887	
I5	8	In an 'I'-engine, cylinders are next to each other in a straight-line configuration.
I6	5,666	
I8	1,274	
Rotary	18	
Steam	50	
V10	8	
V12	1,866	
V16	102	
V2	37	
V4	72	In a 'V'-engine, cylinders are in pairs, placed in roughly a 60° to 90° angle. Both shorter and lighter in comparison to a straight engine.
V6	564	
V8	13,055	
Total	29,002	

Online appendix 6. Auction houses

This table presents all the classic car auction houses in order of sales volume (number of cars sold). In addition to the traditional auction houses, the dataset also includes sales through eBay and through a cooperation of eBay and Kruse.

Auction house	# Obs.	Auction house	# Obs.
Bonhams	4,726	Potts Auction Company	73
RM Auctions	4,536	Classic Motorcar Auctions	73
Barrett-Jackson	2,640	GAA	72
Mecum Auctions	2,542	The Finest	67
Silver Auctions	1,271	Twin Cities Auctions	65
Gooding & Co.	988	Brightwells	55
Christie's	899	Dragone	50
Kruse	863	Kruse/Leake	46
Worldwide Auctioneers	854	Spectrum	45
H&H; Auctions	777	Aumann Auctions	42
McCormick's	757	Anglia Car Auctions	40
Russo and Steele	727	Keenan Auction Co.	37
Artcurial	698	Petersen	36
Branson	675	Hershey Auction	31
Auctions America	576	B-J/Coys	28
Silverstone	431	Cheffins	28
Leake	426	US Auctioneers	28
RM Sotheby's	414	Barons	27
eBay	392	Premier	24
Brooks	281	Poulain Le Fur	21
Auctions America by RM	272	James G. Murphy Co.	20
eBay/Kruse	271	Specialty Auto Auctions	20
VanDerBrink Auctions	246	Sportscar Auctions	19
Coys	217	Girard	18
Bonhams & Brooks	200	Motley's Auction & Realty	15
Rick Cole Auctions	17	Pioneer Auto Auctions	13
Carlisle Events	186	G. Potter King	12
Collector Car Productions	137	Blackhawk	11
Dan Kruse Classics	135	CCA	8
Shannons	110	Kucera Auction Service	7
The Auction Inc.	109	B&T; Classic Car Auctions	7
MidAmerica	107	Higgenbotham	7
Kensington	99	Rich Penn	7
Vicari	98	MotoeXotica	6
Hollywood Wheels	89	Morphy	6
Lucky Collector Car Auct.	84	ICA	4
Motostalgia	78	Santiago	2
Total			29,002

Online appendix 7. CCCA approved classic cars

The Classic Car Club of America defines a classic car as “*a fine or distinctive automobile, either American or foreign built, produced between 1915 and 1948*” (CCCA, 2016) which comprise the following list of ‘approved classics’.

Marque	Approved models	Marque	Approved models
AC	All 1925-1940	Corinthian	All 1922-1923
Adler	1928-1934 Standard 8	Cunningham	All V Series from 1916
Alfa Romeo	All	Dagmar	1922-1926; 6-70; and Series 6-80
Alvis	Speed 20; 3.5 Liter; Speed 25; and 4.3 Liter	Daimler	All 8- and 12-cylinder; 6-cylinder 3.5 Liter and larger; all 1925-1934
Amilcar	Application considered	Daniels	All 1916-1924; 8-cylinder
Apperson	1925-1926 Straightaway Eight	Darracq	1920-1926 Model D
Armstrong-Siddeley	1924-1933 Model 30; 1933-1939 Special	Delage	See Talbot
Aston Martin	All 1927-1939	Delahaye	1914-1926 GL and GLS; Model D8
Auburn	All 8- and 12-cylinder	Delauney	Series 135; 145; 148; 165
Austro-Daimler	All	Doble	All 6-cylinder
Ballot	2LS; 2LT; 2LTS; RH; RH2; and RH3	Duesenberg	All
Benz	All 1925-1926; 10/30; 11/40; 16/50; 16/50 Sport	DuPont	All 1919-1931
Biddle	All 1915-1922	Elcar	1925-1933 8-80, 8-81, 8-90, 8-91, 8-92, 120, 130, and 140
Blackhawk	All	Excelsior	1919-1926 Adex Models; 1925-1932 Albert 1 (Premier)
BMW	327; 328; 327/8; and 335	Farman	All 1925-1931
Brewster	All 1915-1925 and 1934-1936	Fiat	1923-1927 Model 519; 1928-1931 Model 525; 1938-1940 Model 2800
Brough Superior	All 1934-1939	Fox	All 1921-1923
Bucciali	TAV 8; TAV 30; TAV 12; and Dubble Huit	Franklin	All except 1933-1934
Bugatti	All except types 52 and 68	Georges Irat	Olympic
Buick	All 1931-1942 Series 90; all 1931-1933 and 1936-1939 Series 80; 1940 Series 80 Limited	Graham-Paige	1922-1929 2 Liter and 3 Liter; 1930-1934 Lycoming 6- and 8-cylinder
Cadillac	All 1915-1935; all 12 and 16; 1936-1948 63, 65, 67, 70, 72, 75, 80, 85 and 90; 1938-1947 60 Specials; 1940-1947 62 Series	Gardner	1928-1929 835 and 837; 1930 837; all 1930 Custom 8; 1931 834
Chadwick	All 1915-1916		1925-1926 Line 8 and Model 8A;
Chrysler	1926-1932 Imperial and Series 80; 1932-1939 Custom Imperial Series; 1934-1937 Airflow Imperial Eight; 1940-1948 Crown Imperial; Newports and Thunderbolts; all 1941-1948 Town & Country		1926-1927 Model 8B; 1927 Model 890 and Model 90; 1928 Model 8-85, 8-90, 130; 1928-1929 Models 85, 95; 1929 Models 125-135; 1930
		HAL	Models 145, 150; 1930-1931 Model 150; 1931 Models 148-158
		Heine-Velox	All 1916-1918
		Hispano Suiza	All 1921-1922
			H6 from 1919; All French models; Spanish models T56, T56BIS; T64
Cole	1915-1925 all 8-cylinder		
Cord	All	Horch	All

Online appendix 7. CCCA approved classics (continued)

Marque	Approved models	Marque	Approved models
Hotchkiss	1929-1940 all 3 and 3.5 Liter, AM80(S), 620, 680, 686 Paris-Nice, 686 Grand Sport	Mercer	All
Hudson	1929 Series L	MG	1935-1939 SA; 1938-1939 WA
Humber	1930 Pullman Model 6	Miller	All 1928 and 1932
		Minerva	All except 4-cylinder
Hupmobile	1930-1932, Series H and H-255, U and U237	Nash	1930 Series 490; 1931 Series 890;
Invicta	All through 1938		1932 Series 990 and 1090;
Isotta Fraschini	All from 1919 except Tip 8C Monterosa		1933 Series 1190; 1934 Series 1290;
Itala	All		1940 Sakhnoffsky Special Cabrio
Jaguar	1946-1948 2.5 and 3.5 Liter	National	All 1916-1919
Jensen	All 1936-1939 expect 2.25 Liter	Owen-	
Jordan	1929-1931 Models G, 90, Great Line 90 and Speed Way Series Z	Magnetic	All 1915-1921
Julian	All	Packard	All 1915-1924 except 116; All 6-cyl
Kissel	All 6 and 12-cylinder cars; all 1915-1924; 1923-1928 6-55; 1925-1927 8-75; 1928 8-90 and 8-90 White Eagle; 1929-1930 8-95 White Eagle; 1929-1931 8-126		226-233, 326-333, 426-433, 526-533;
Kleiber	1926 Model 212; 1927 Model 178; 1928 Model 133; 1929 Model 37		All 8-cyl 1923-1934; All 12-cyl 1932-1939; 1935 models 1200-1205,
Lafayette	All		1207 and 1208; 1936 Models 1400-
Lagonda	All models through 1940, except 1934-1940 Rapier, Two Post-War V12		1405, 1407 and 1408; 1937 Models 1500-1502, 1506-1508; 1938 Models 1603-1605, 1607 and 1608;
Lanchester	1919-1931 Model 21, 23, 30, and 40		1939 Models 1703, 1705, 1707, 1708; 1940 Models 1803-1808;
Lancia	1928-1939 Dilambda and Astura		1941 Models 1903-1908;
LaSalle	All 1927 through 1933		1942 Models 2003-2008; 1946-1947
Leach	All 1920-1923		Models 2103, 2106, 2126; All Darrin-bodied
Lincoln	L; From 1920 KA, KB and K; 1941 168 H; and 1942 268 H	Paige	All 1916-1927 6-55, 6-66
Lincoln Cont.	All	Pathfinder	All 1916-1917
Locomobile	All 1915-1924; All LHD models 48 and all model 90; 1927-1929 Model 8-80; 1929 Model 8-88	Peerless	1925 Series 67; 1926-1928 Series 69;
Lozier	All 1915-1916		All 1915-1924; 1921 Series 32; 1922
Marmon	All 1915-1924 Model 41, 48 and 34; All 12- and 16-cylinder; 1925-1926 D-74; 1927 E-75; 1928 75; 1930 Big 8; 1931 88 and Big 8	Pierce-Arrow	and up Series 33; all from 1925 Application considered
Maserati	Application considered		45HP to 1928; 40HP Reinastella, Reinasport; 1929-1934 8-cyl
Maybach	All		Nervahuit, Nervastella, Nervasport (Suprastella)
McFarlan	All 1915-1924, TV6 and 8	REO	1931-1934, Royale 8-cylinder
Mercedes	All	ReVere	All 1918-1926
Mercedes-Benz	All 230 and up; K, S, SS, SSK, SSKL; Grosser and Mannheim	Richeleu	All 1922-1923
		Roamer	All Rochester-Duesenberg 4-cyl; 1925 6-54E; 1925-1929 8-88; 1929-1931 8-125
			1928-1935 R, RA, F and FK
			All 1915-1948
			All
			All
			1932-1940 SS 1, SS 90, SS
			jaguar and SS Jaguar 100

Online appendix 7. CCCA approved classics (continued)

Marque	Approved models	Marque	Approved models
Simplex	All 1915-1924	Talbot	(GB) 105 and 110; (F), Darracq (GB); 1930-1935 Talbot-Lago (F) 8-cyl; 4 Litre 6-cyl 1936-1939; 4.5 Litre 1946-1948
Stearns Knight	All 1915-1924 6- and 8-cyl	Tatra	1927-1948 Models T70(A), T80, T77(A) and T87 with pre-war styling
Stevens Duryea	All 1915-1927	Templar	All 1915-1924
Steyr	1923-1929 Type VI Sport; VI Klausen; SS Klausen; and Austria	Triumph	Dolomite 8 and Gloria 6
Studebaker	1928 8-cyl President; 1929-1933 President except Model 82	Vauxhall	25-70 and 30-98
Stutz	All except 1915 HCS	Voisin	All
Sunbeam	8-cyl and 3 Litre Twin Cam	Wasp	All 1919-1924
		Wills Sainte Claire	All
		Willys-Knight	Series 66(A), 66B Custom
		Winton	All 1915-1924

Online appendix 8. Affordable classic cars

The following 12 cars are part of Hagerty's Affordable Classics index and are defined as cars from the 1950's-1970's and priced under UDS 40,000. Source:

[https://www.hagerty.com/apps/valuationtools/market-trends/collector-indexes/Affordable Classics](https://www.hagerty.com/apps/valuationtools/market-trends/collector-indexes/Affordable_Classics)

Year(s)	Make	Model	# Obs.
1967	Volkswagen	Beetle	254
1969	American Motors	Javelin	1
1949	Buick	Roadmaster 76S	5
1967	Volkswagen	Karmann Ghia	42
1972	Porsche	914 2.0	53
1963	MG	MGB	121
1971	Datsun	240Z	26
1965	Chevrolet	Corvair Monza	80
1965	Ford	Mustang GT	94
1972	Triumph	TR6	69
1963	Studebaker	Avanti	26
1962	Studebaker	Lark Regal	1
1970	Chevrolet	Camaro SS	139
Total			911

Online appendix 9. Blue chip classic cars

The following cars make up Hagerty's Blue Chip index and are described as the "most sought-after automobiles of the post-war era". Source: https://www.hagerty.com/apps/valuationtools/market-trends/collector-indexes/Blue_Chip

Year(s)	Make	Model	# Obs.
1967	Chevrolet	Corvette	236
1954-1957	Mercedes-Benz	300SL Gullwing	131
1966	Shelby	Cobra 427	1
1964	Shelby	GT350	1
1969	Toyota	2000GT	0
1959-1964	Maserati	5000GT Frua	10
1958	Ferrari	250 California LWB	
1954-1959	Lancia	Aurelia B24	31
1965-1972	Iso	Grifo	15
1970	Plymouth	Cuda	88
1956-1959	Bentley	S1 Continental	8
1964	Alfa Romeo	TZ-2	0
1957-1963	Mercedes-Benz	300SL Roadster	138
1953	Chevrolet	Corvette	3
1963-1965	Aston Martin	DB5	12
1973	Porsche	911 Carrera RS 2..7	26
1948	Tucker	48	15
1963-1964	Shelby	Cobra 289	26
1954-1959	Jaguar	D-Type	22
1956-1959	Porsche	356A 1600	29
1963	Ferrari	250 California SWB	
1957	Rolls-Royce	Silver Cloud I	0
1966-1968	Ferrari	275 GTB/4	50
1957-1959	BMW	507	12
1967-1972	Lamborghini	Miura P400 SV	17
Total			919