LUISS Guido Carli
LIBERA UNIVERSITÀ INTERNAZIONALE DEGLI STUDI SOCIALI

Department of Economics and Finance

Chair of Capital Markets

Classic Cars: Money Pit or Investment Star?
A Study on Market for Vintage Cars
Under the Investor's Perspective.

Supervisor   Candidate
Prof. Paolo Vitale   David Bonanno – 187841

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Table of contents

1. Introduction

Since the last decades of the XIX century, cars have played a prominent role in human life. From being just a luxury good for extremely rich and bizarre people, it became a mass product that anyone could enjoy. Henry Ford was the first to understand the potential of cars as something to manufacture using an assembly line. In 1908, the Model T was indeed the first mass manufactured car, counting 15.007.033 vehicles after 19 years of production.[1]

From an economic point of view, standardised industrial products should not be worth a lot, since many of them are supplied in the market. Moreover, if products are outdated and technologically obsolete, the market value should be close to zero. In fact, if we think of first mobile phones or house appliances, they are worthless nowadays. Nevertheless, this does not seem to apply to classic cars. Of course the rarer the model, the more valuable it is, but usually rarity is not the only parameter that affects value. In fact, as Dietrich Hatlapa recognises, «it's a cocktail of things: rarity, technical sophistication, racing pedigree and continuing competitive success»[2] that may lead people to spend from little money to a fortune on a car that has for sure better replacement in current productions.

The passion for cars has always been present in lots and lots of gentlemen (and even ladies) since the invention of cars and, as the time passed, it transformed into passion for classic cars. A classic car represents a status symbol, a technical masterpiece, and sometimes also a design milestone. Some models, due to their importance or to their impact on society, are regarded as pieces of history. Let us just think of the role that the Fiat 500 and the Mini had for Italian and British middle class in the aftermath of WWII. Or of the Lamborghini Miura, the first rear engine supercar; from that point onward the limit, both in performance and in design, has always been moved a step beyond. Not to mention Ferrari models, always regarded as some of the best and most charming cars of the world.

Until some decades ago, owning a classic car was something that most of the middle class could have afforded. In the 80's, automobiles from the 60's were just old, not yet classic, and could have been a real bargain for enthusiasts. However, the value of classic has risen a lot since those days, and today even a so called "barn find", a rusty but complete car that has

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[1] Altorio (2012).
[2] Macalister (2013).

been stored for really long period in boxes or barns, can be sold for a huge amount. Alain Delon's 1961 Ferrari 250 GT SWB California, forgotten for more than forty years in the French countryside, was auctioned in Paris on 6th February 2015 and was purchased for over €16 million.[3]

It is clear that the time of classic cars as a minor and non-relevant market is long since gone, and that more and more people are orienting their business toward the classic car world. Famous restorers may be paid the total value of the car and even car manufacturers are opening special departments to take care of older models. FCA group and Lamborghini are only two of those that already did that. Jaguar pushed itself even further: six Lightweight E-types and nine XKSS's have been built ex-novo, marking the continuation of the production terminated in 1963 and 1957.

Also important financial newspapers, such as the Financial Times and Il Sole 24 Ore are becoming more and more involved in the classic car world. The Financial Time has indeed issued several articles regarding investments in this collectible, the first ones dating back to February 2013.[4][5][6] In March 2013, the same newspaper reported a growth of 395% in ten years according to Knight Frank's luxury index[7] and in May issued the first guide to invest in this world[8]. In April, June and August 2016 the FT writes again about classic cars as an asset class that has outperformed any other kind of investment, reporting data both form Knight Frank Luxury Investment Index (KFLII) and Historic Automobile Group International. The KFLII itself shows how cars outperformed all other collectibles during 2015.[9][10][11]

Tanks to modern technologies, that make information readily available and easily accessible, interest in classic cars seems to have spread over an always-increasing number of people. However, what is the effect of this more than ever intense interest in classic cars? Could classic car be considered a new asset class of collectibles in which invest? What are market trends and performance? Moreover: is classic car market in a speculation bubble at the moment? The objective of this thesis is to find answers to these questions.

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[3] Artcurial (2015).
[4] Frankel (2013a).
[5] Frankel (2013b).
[6] Warwick-Ching (2013a).
[7] Burgess (2013).
[8] Warwick-Ching (2013b).
[9] Pembrey (2016).
[10] Greenhalg (2016a).
[11] Greenhalg (2016b).

To do so, the remainder of this thesis is structured as follows. The next section reviews the literature of papers on collectibles used as an alternative asset class, while Section 3 discusses the phases of the Market for vintage cars. Section 4 illustrates the main ways to compute the returns of classic cars and Section 5 focuses on three famous market indices. In Section 6 the methodology used to analyse the data is introduced and in Section 7 results are exposed. Section 8 gives an idea on the benefit of using classic cars as an investment in portfolios and Section 9 focuses on the actual application in investment funds, considering also the idea of a possible speculation. Section 10 highlights some caveats and limitation of the analysis proposed. Section 11, the last one, delineates the conclusion of the thesis.

2. Literature review

Speculating in classic cars as an investment class is a quite new trend. For this reason, there is not much literature about this topic: prof. Stephen G. Martin has been the last to write a paper pointing in this direction at the end of 2016. In this paper, the author uses Hagerty market indices to find the holding period gross returns, average annual returns and variance of some classic cars classes and compares them to the analogous data of more widespread market instruments. Betas, Sharpe ratios and Treynor ratios analyses have been conducted as well. He also checks for correlation among the indices and the instruments. His framework will be adopted to conduct the analysis and results will be compared to his findings.

A prior study in on this topic was carried out in 2014 by Mische and Spizzirri, who compared the holding period return of HAGI indices to S&P500. On the other hand, this latter paper is very helpful for the description of the classic market evolution, which will be reported in the market description section.

Classic cars are just one of the last trends in exotic investments: in the last years, more and more investors have tried to diversify their portfolios using non-conventional assets. Collectibles of every kind have been used as different asset classes in order to enhance traditional instruments profits and hedge against losses. Burton and Jacobsen's paper "Measuring Returns on Investments in Collectibles" (1999) describes the main methods how returns can be computed on non-conventional assets. They also provide a table reporting the returns on several categories of collectible assets as found in different papers (interestingly not for cars) together with the period of study. It can be noticed how some enclosed studies claim certain classes such as ceramics, paintings and prints to have annual real return above 15%, 18% and 17% respectively.

However, there is no agreement on the correlation of all types of collectibles to the financial markets: e.g., «Ibbotson and Brinson (1987) assert that collectibles can provide a hedge against inflation» as they «find a negative correlation with returns on financial assets. Cardell et al. (1995) suggest [...] that stamps have opposite sensitivities to stocks in regard to inflation, default and term structure factors».[12] Greer (2000) finds the same result for commodities and highlights the potential of real assets for hedging against inflation, being positively correlated to it. On the other hand, Burton and Jacobsen (1999) find negative
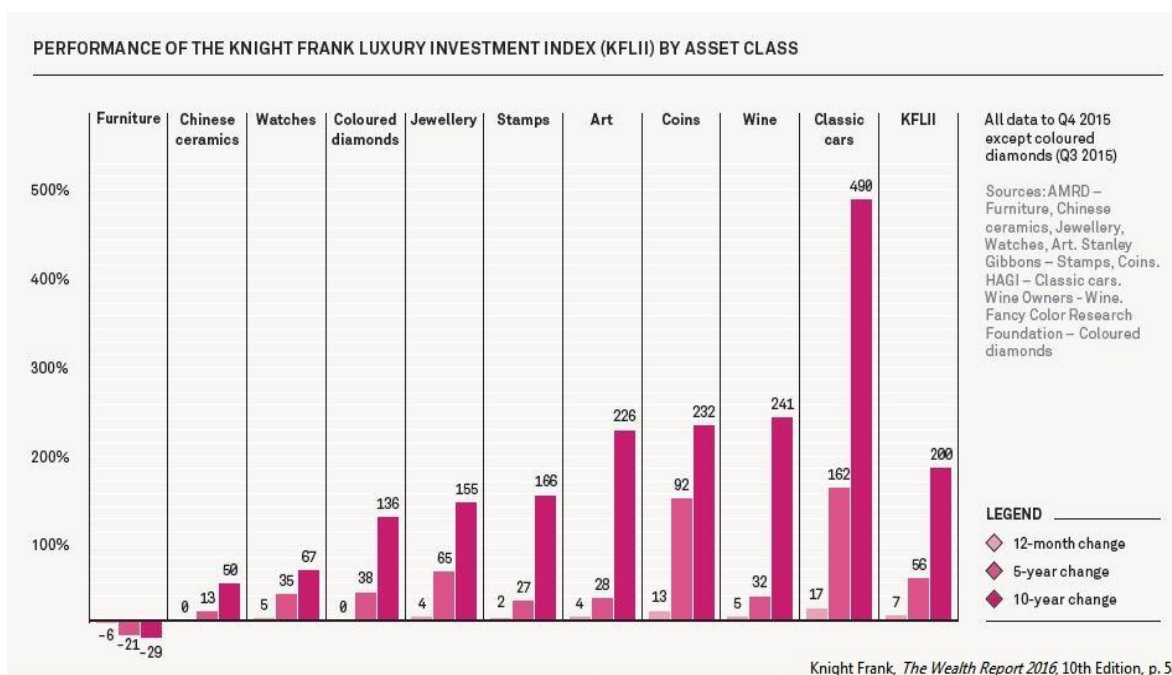
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[12] Burton and Jacobsen (1999).

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correlation on market expansion phase, but on market crashes, collectibles returns remain flat. On the completely opposite side, some studies (Goetzmann (1993), Chanel (1995)) point to a positive correlation in the case of art and financial markets. Another aspect to take into consideration is the variability of the returns: even if two collectibles belong to the same class of items, their returns are unlikely to be exactly equal, as the story and the peculiarity of each collectible is unique. E.g., Mei and Moses (2002) found standard deviations on their Art Index from 21.3% to 42.8% on return from 8.2% to 4.9% expanding the time span taken into consideration from 1950-1999 to 1875-1999.

Lately, classic cars have attracted the attention of wealth management and consultancy companies: e.g. Knight Frank, which publishes the Knight Frank Luxury Investment Index, claims that classic cars are the collectible class with the higher increase in value during 2015 at 17%, followed by coins (13%).[13] Today, there are at least three global classic car indices, the HAGI, which is published monthly, the K500, which is published quarterly, and the Hagerty, which is published every four months. They all account for the change of value of predetermined portfolios, created by specialists, according to the last prices bid at the most important auction of the world. Thanks to the availability of these data, it is now much easier to be informed (even in real time) of the valuation of a specific car and to perform studies on the profitability as investments.

Figure 1 – Performance of KFLII

PERFORMANCE OF THE KNIGHT FRANK LUXURY INVESTMENT INDEX (KFLII) BY ASSET CLASS

Knight Frank, *The Wealth Report 2016*, 10th Edition, p. 58

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[13] Knight Frank (2016).

3. Market situation

In order to analyse the classic car market, a brief introduction is needed in order to describe its evolution. Anyone who has been passionate about classic cars, or has had for some reasons connections to this market, will recognise that more and more people entered this sector, and, due to a limited supply, prices have risen. However, for the purpose of drawing some clear distinctions among the phases that the market passed through, Mische and Spizzirri (2014) reconstruction will be adopted. According to the authors, five main phases may be recognised: aristocratic collectors, exclusive collectors, collectors and hobbyists, enthusiasts and collectors, and global collectors and investors.

- Aristocratic Collectors (Pre 1950)

    Collectors were just very wealthy individuals, interested in hand built cars. The market was limited to a tight community of connoisseurs.

- Exclusive Collectors (1950-1980)

    Classic cars were still an interest of wealthy people, however private market circuits at local level started forming. Valuations were informal and variable even for the very same car.

- Collectors and Hobbyists (1980 - 1995)

    In this phase, the networks of the markets expanded, and the markets merged into regional clusters. This is the era where car club and associations became widespread and even non-high net worth individuals could afford to approach this world, as post WWII cars became classics.

- Enthusiasts and Collectors (1995 - 2005)

    In this phase, the market started to shape in the form we know nowadays. Once regional, it became national-wide, with larger access to information thanks to new ICT technologies. The market in Europe expanded also due to the recent creation of a common market and the elimination of trade barriers.

- Global collectors and Investors (2005 - Present)

    In present days, classic car market can be thought as global: access to information is total and immediate from everywhere in the world. People have realised the

potential gains that could be obtained from classic cars and started investing. Some companies have been set up for or have specialised in both consultancy and dealership, such as Kidston SA, which offers its expertise in the process of purchase, sale, or restoration of classics. Also auction houses such as RM Sotheby's and Christie's hosts now big auctions at well established classic car events like Concorso d'Eleganza Villa d'Este (held in May on the Lake of Como) or Pebble Beach Concours d'Elegance (held on August in the nearby of Monterey, CA). Just to bring an example, RM Sotheby's has organised Duemilaruote, one of the biggest auctions in the last years during Autoclassica in Milano, late November 2016. With 5.000 people registered for bidding at a registration price of € 100, auction house revenues were already € 500.000, without mentioning the auction fees on the 817 lots sold for over € 51 million.[14] In this phase of the market, as it will be soon shown, returns on classic cars outperformed conventional investment instruments, such as stocks and commodities.

Thanks to globalization and the Internet, classic car market attracts now investors from all over the world: new websites such as AutoScout24 (German based and covering the central Europe market) allow users' ads to be seen by millions of people in different countries. As mentioned above, important auctions are heavily advertised in the preceding months and the participants have dozens of nationalities. People can take part even via phone or through the auction house website. However, supply remains scarce: contrary to cars that are still in production, classic car supply cannot be raised according to the market demand and, therefore, prices will rise accordingly. Everyone who deals with classic cars can feel this, but empirical proofs of the increasing in price are needed; therefore, in the next section, it will be discussed how to price classic cars.

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[14] Milano (2016).

4. How to compute returns on classic cars

According to Burton and Jacobsen (1999) there are three ways to compute returns on a collectible. The first, and most popular way, is to create a composite index in which specific items of a set are included and whose value will be averaged. The composition of this index may be variable or fixed. In the first case, a given number of items are chosen randomly at a certain date and weighted to compute the spot value. On the other hand, in the second instance, the values to be weighted are the ones reached by a predetermined set of element identified a priori. An example reported by Burton and Jacobsen (1999) of varying market basket is given by Goetzmann's study on paintings in 1996: different portfolios are started up at ten year intervals from 1907 to 1977 and compared to 1987 prices. On the other hand, some examples of fixed basket found on the same paper mentioned above are given by Kane (1984) and Burton and Jacobsen (1998). The former creates a hypothetical portfolio of 120 coins believed to be representative of all the market. Prices are tracked between 1970 and 1979. The latter measures the change in price of a wine portfolio of particular châteaux created following the advice of two wine market experts. Another subdivision emerges from the difference of fixed basket example: baskets may be created randomly or according to experts' advices. E.g., both K500 indices and Hagerty indices fall into the latter categories. This will give the basis to argue against the pitfall of composite index identified by Burton and Jacobsen (1999): if composite indices are constructed by sector experts, there are limited chance that it might become non-representative, as unfashionable items are very likely to have not been included from the beginning. Indices of this kind are the easiest to track, as the amount of information needed on every item is very limited. In the case taken under examination, the model of a car, a general description on its condition and the selling price are enough to enter a record on a database. Of course, the more accurate the information, the most precise the value can be adjusted (e.g. for poor condition or for a particular overvalued year), but this is not indispensable.

The second mean to compute a price index is by running a so-called hedonic regression. This method will highlight how different characteristics will influence the value of a certain asset. In fact, regressing for different attributes allows to isolate the gain obtained from every different aspect taken into consideration, and by the inverse process, to evaluate it combining its characteristics. An example of this pricing methodology is used by Monson (2009) to predict houses prices. In his paper he brought three examples of calculating the price for a given real estate as «a function of each tangible & intangible building characteristic and other outside influencing factors». As for what concerns art market, Chanel, Gérard-Varet and

Ginsburgh (1996) constructed a price index for Impressionists and Modern Paintings based on hedonic regressions using bootstrapping techniques. This kind of pricing method is also very popular in pricing collectible wine. Among others, Di Vittorio and Ginsburgh (1996), Combris, Lecocq and Visser (2000) and Oczkowski (2015) investigated the auction markets for wine in order to create equations that might predict the price of a bottle of wine on sale, according to its peculiar characteristics. Some of the regressors they used were jury grades, sensory variables (acidity, finesse of aromas), age, bottle size and oxidation, vineyards and region of production. Specifically, considering only the variable "age", it can be computed how much an asset appreciated due to the time effect. Although this might be helpful for some kind of assets, it seems too restrictive for cars. On the other hand, this method might be helpful in order to predict a car price given a set of features, after having a hedonic equation which takes in consideration the main aspects that may vary.

A third way to compute returns on collectibles is through repeat-sale regression (RSR): when an object is purchased and sold again, the difference in the amount between the two transactions is recorded. When enough observations are available, they can be shaped into an index describing market trends. Mei and Moses (2002) use RSR to evaluate the fine art market. They choose this method as «the resulting index is based upon price relatives of the same painting that controls for the differing quality of the assets» and «it does not suffer from arbitrary specifications of a hedonic model»[15]. On the other hand, RSR have the disadvantage of a limited set of transactions: only items that have been sold at least twice can be taken into consideration. They assume that «continuously compounded return for a certain art asset i in period t, $r_{i,t}$, may be represented by μ_t, the continuously compounded return of a price index of art, and an error term:

$$r_{i,t} = \mu_t + \eta_{i,t}$$

where μ_t, may be thought of as the average return in period t of paintings in the portfolio.»[16] Therefore, the market index μ is a vector of dimension T, composed by spot period returns μ_t for $t = 1 \dots T$ and $\eta_{i,t}$ is the deviation of the return of asset i for the period t. The data used in this regression consist of pairs of consecutive sales: the first, at time b_i, when the item is bought at price $P_{i,b}$, and the second, at time s_i, when it is sold again at price $P_{i,s}$. If the asset is then sold again, it will constitute another observation. «Thus, the logged price relative for asset i, held between its purchase date b_i and its sales date, s_i, may be expressed as:

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[15] Mei and Moses (2002).
[16] Mei and Moses (2002).

$$r_i = \ln\left(\frac{P_{i,s}}{P_{i,b}}\right) = \sum_{t=b_i+1}^{s_i} r_{i,t} = \sum_{t=b_i+1}^{s_i} \mu_t + \sum_{t=b_i+1}^{s_i} \eta_{i,t}$$

» where «r represent the N-dimensional vector of logged price relatives for N repeated sale observations. Goetzmann (1992) shows that a generalized least-square regression [...] provide the maximum-likelihood estimate of μ»[17]. In order to compute standard errors associated with estimation error the δ method is applied. With respect to classic cars, this method is quite toilsome and the result may not be far away from hedonic regressions and composite indices. Furthermore, there would two options to account for repeated sale: record every sale of the same model of car (e.g. every sale of one of the 800 Lancia Fulvia Sport Zagato 1600) or record just for the very same car (identified by its unique chassis number) when sold twice. The former approach is much more convenient, but it does not take into consideration possible differences in different cars. The latter is the rigorous one, according to definition of repeat-sale regression. However, it is easy to understand that is difficult to have such data, as some cars have been kept for decades, and some may still be in the hand of their first owners!

For the purpose of this study, composite indexes compiled by major experts will be taken in consideration.

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[17] Mei and Moses (2002).

5. Famous classic car indices

As described in the preceding paragraph, the easiest way to compile a market index of the classic car market is using a predetermined basket. For this reason, the three most famous indices use this very method. Every index, constructed to be representative of the collectible automobiles market, relies on verifiable auction transactions and can be divided into different sub-indices that allow a deeper investigation of the market. The three indices are the following.

- Hagerty indices

    Hagerty is an American based insurance company. Over the year, it has specialised in classic car insurance, covering today over one million vehicles in the USA. On its website, it is possible to track their market indices: prices have been collected from 2007 to construct indices available to the public. Its indices allow to monitor seven main market segments: 1950s Americans, Affordable Classics, Blue Chips, British Cars, German Collectibles, Ferrari and Muscle Cars. Each index is the combination of several cars pertaining to given category. The indices are published quarterly.[18]

- HAGI indices

    «Historic Automobile Group International (HAGI™) is an independent investment research house and think-tank with specialised expertise in the rare classic motorcar sector. »[19] Its indices are published monthly and are divided into Top Index, Mercedes-Benz Classic, Porsche, Ferrari, and Top Index bar Ferrari and Porsche. Also this company uses aggregate indices, computing them on data which cover up to 50 different models (Top index).

- K500

    The K500 index is powered by Kidston S.A. and collects data for 500 individual cars. It has ten subdivisions: Pre and Post War European and American Cars, Ferrari (Pre-1958, 1958-1973 and Post-1973), Porsche, Post-War Racing Cars and Affordable Classics. Indices are updated quarterly and date back to the 1994.[20] Due to the large set of transactions, it is the one used in this thesis.

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[18] Hagerty website.
[19] HAGI website.
[20] K500 website.

Despite managed by different companies, the structure of the indices are comparable. It is interesting to notice the importance given to certain manufacturers by all three indices: a sub-index for Ferrari is always extrapolated from the main index. Also Porsche is taken into consideration, maybe due to the recent appraisal and consequent appreciation of its models. Anyway, all German cars are now under close observation: as Hagerty reports, its German Collectible index has almost doubled between January 2013 and January 2014. Another aspect to notice is that the overall behaviour for European Cars indices across companies is similar, with a large and quite smooth rise after 2010. On the other hand, indices regarding market value for American cars have a less linear pattern. All in all, we can verify the feeling described above: classic car prices have risen steadily in the last decade, when more and more people entered the classic car market. Figure 2 describes exactly this trend, plotting the percentage variation of K500 indices holding 1994 as base year. However, K500 is not the only one displaying this trend: after a cross comparison among all the three indices, analogies among them show that everyone is representative of the market and , thus, each one would be suitable to conduct this study.

Figure 2 – Performance of K500 index

Data from http://www.k500.com/

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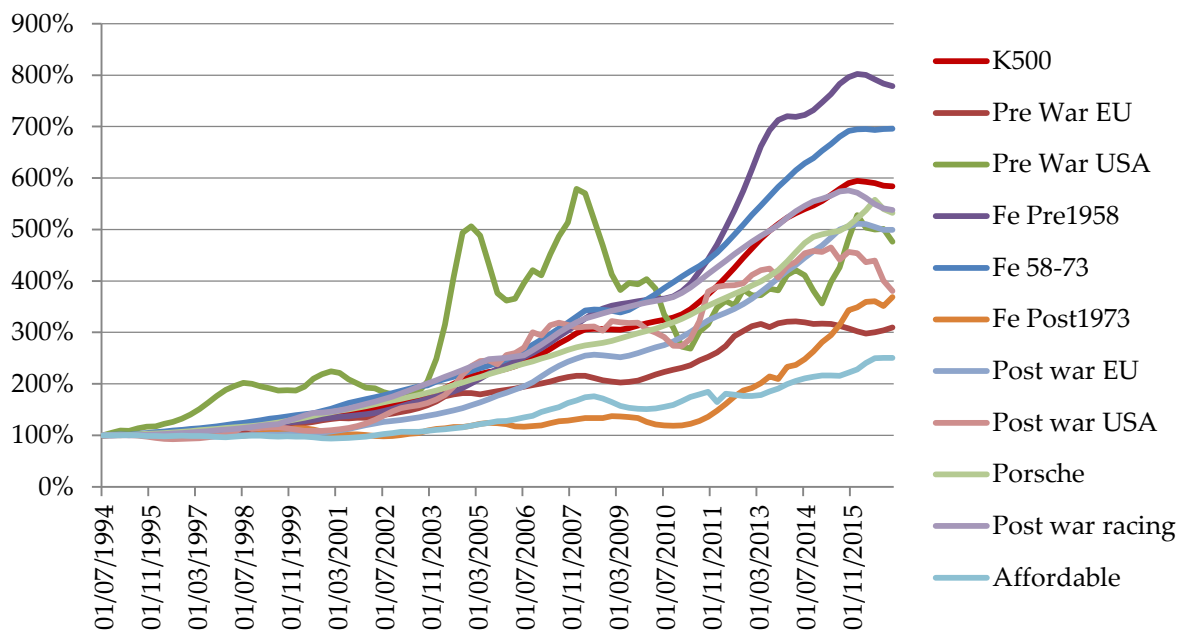
6. Methodology

The methodology used to assess the characteristics and performance of the market for classic cars is based on Martin (2016). He uses data recorded from 2007 to 2016 from Hagerty Collector Car Indices, divided into different classes. He compares the performance of each with the performance of traditional market instruments computing holding period gross returns, volatilities, as well as other statistical measurements. Then, he assesses the risk-adjusted returns analysing betas, Sharp ratios and Treynor ratios. Finally, he estimates the correlation among car classes and traditional market instruments.

This analysis replicates and expands Prof. Martin's one on data for classic cars based on K500 index, as it covers the time span from 1994 to 2017. This also allows to evaluate the behaviour of classic cars prices before last financial market crisis. All sub-indices are taken into consideration, so as to understand if some sectors of this market are safer to invest in.

In order to compare the performance of the market of classic cars vis-a-vis that of traditional instruments and asset classes, the same monitoring procedure as Martin (2016) is used. Dow Jones Industrial Average (DJIA), S&P500 and NASDAQ Composite Index are considered representative of the stock market, while Vanguard Long-Term Bond Index and Gold Fixing Price 10:30 A.M. (London time) in London Bullion Market represent the bond and the gold market respectively. All instrument prices have been calculated in US dollars.

In order to assess the profitability of classic cars as an asset class, performance of every index is calculated. To have an overall picture of how each class behaved, we determined the holding period gross return (HPGR) as

$$\text{HPGR} = \frac{P_{i,Q90}}{P_{i,Q0}}$$

(where $P_{i,Q0}$ is the first entry for a given index in June 1994 and $P_{i,Q90}$ is the last in December 2016) and compare with standard instruments. Then, average quarterly returns ($r_{i,t}$) are extrapolated from the indices as:

$$r_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right)$$

where $P_{i,t-1}$ and $P_{i,t}$ are the price level of a given index in two subsequent measurement. Standard deviations and other statistical measures are computed as well. S&P500 and the one-year Treasury rate are taken into account to compute Betas Sharpe ratios and Treynor ratios. In addition, index model linking extra returns to abnormal returns, market responsiveness

and residual random returns is taken into account to compute the non-systematic risk component as the ratio of the volatility of the residual return part of the asset i (σ_{ϵ_i}) and its total volatility (σ_i):

$$\frac{\sigma_{\epsilon_i}}{\sigma_i} = \sqrt{\frac{\sigma_i^2 - \beta_i * \sigma_{S\&P500}^2}{\sigma_i^2}}$$

where S&P500 is again a proxy for the market in order to verify the proportion of diversifiable risk. All these results are displayed in Table 1. Then, we want to verify the effectiveness of classic cars as investment assets when part of a portfolio. In order to do so, a correlation coefficient table (Table 2) has been created, using average quarterly returns computed on K500 indices.

Table 1 – Results of the analysis

	K500	Pre War EU Cars	Pre War USA Cars	Ferrari Pre-1958	Ferrari 58-73	Ferrari Post-1973	Post War EU Cars	Post War USA Cars	Porsche	Post War Racing Cars	Afford. Classics	DJIA	S&P500	Nasdaq	VBLTX	Gold
Overall HPGR	5.8405	3.0981	4.7603	7.7837	6.9603	3.6836	4.9914	3.8025	5.3219	5.3765	2.5031	5.2767	4.9729	7.7750	1.4354	3.0075
Mean Return (quarterly)	0.0196	0.0126	0.0173	0.0228	0.0216	0.0145	0.0179	0.0148	0.0186	0.0187	0.0102	0.0185	0.0178	0.0228	0.0040	0.0122
Standard deviation	0.0128	0.0167	0.0756	0.0188	0.0113	0.0307	0.0156	0.0413	0.0100	0.0139	0.0248	0.0660	0.0697	0.1091	0.0443	0.0704
Kurtosis	-0.4103	1.1187	1.1579	0.2221	0.1012	0.6070	-0.7905	1.6677	7.6394	0.2787	6.4503	1.1660	2.9201	1.3625	0.4758	2.5514
Skewnes	0.2403	0.4241	0.4855	0.7426	-0.6063	0.7123	-0.1797	0.6944	-1.7313	-0.4166	-0.9743	-0.6907	-1.1266	-0.3648	-0.3755	-0.6991
Max Gain	0.0454	0.0701	0.2570	0.0700	0.0390	0.1064	0.0523	0.1639	0.0406	0.0515	0.0916	0.1597	0.1747	0.3469	0.1196	0.1509
Max Loss	-0.0075	-0.0220	-0.1410	-0.0113	-0.0091	-0.0558	-0.0129	-0.0942	-0.0321	-0.0224	-0.1114	-0.1990	-0.2687	-0.3011	-0.1187	-0.2865
Beta	0.0089	0.0299	0.1447	-0.0238	0.0130	0.0137	-0.0010	-0.0463	-0.0024	-0.0129	0.0119	0.8719	0.9889	1.3320	0.0247	-0.0391
Non Systematic Risk	99.88%	99.22%	99.11%	99.61%	99.68%	99.95%	100.00%	99.69%	99.99%	99.79%	99.94%	39.20%	14.87%	52.50%	99.92%	99.93%
Sharpe ratio	0.9927	0.3410	0.1386	0.8458	1.3014	0.2482	0.7066	0.1933	1.1713	0.8509	0.1343	0.1760	0.1574	0.1461	-0.0642	0.0764
Treynor ratio	1.4368	0.1909	0.0724	-0.6709	1.1303	0.5577	-10.5483	-0.1725	-4.9754	-0.9174	0.2800	0.0133	0.0111	0.0120	-0.1151	-0.1377

Data based on US dollars from 1st July 1994 to 1st January 2017. S&P500 has been used as market proxy for computing Betas. One-year Treasury rate has been used to compute excess returns used in Sharpe ratio.

Table 2 – Correlation table

	K500	Pre War EU Cars	Pre War USA Cars	Ferrari Pre-1958	Ferrari 58-73	Ferrari Post-1973	Post War EU Cars	Post War USA Cars	Porsche	Post War Racing Cars	Afford. Classics	DJIA	S&P500	Nasdaq	VBLTX	Gold
K500	1.0000															
Pre War EU Cars	0.5815	1.0000														
Pre War USA Cars	0.5364	0.2433	1.0000													
Ferrari Pre-1958	0.7956	0.3663	0.1206	1.0000												
Ferrari 58-73	0.7758	0.4539	0.2046	0.5962	1.0000											
Ferrari Post-1973	0.4080	0.0913	0.1697	0.4324	0.1025	1.0000										
Post War EU Cars	0.6831	0.2719	0.0995	0.5772	0.7283	0.2504	1.0000									
Post War USA Cars	0.5052	0.1412	0.3520	0.3651	0.2511	0.2048	0.3851	1.0000								
Porsche	0.4450	0.1843	0.1105	0.2949	0.3832	0.1842	0.4818	0.4052	1.0000							
Post war Racing Cars	0.7251	0.4069	0.2198	0.5738	0.5449	0.2398	0.5671	0.4250	0.4348	1.0000						
Afford. Classics	0.2265	0.0180	0.0063	0.1456	0.3069	0.1142	0.4291	0.1364	0.3068	0.1289	1.0000					
DJIA	0.0163	0.1323	0.0995	-0.0975	0.0978	-0.0051	-0.0112	-0.0908	-0.0500	-0.1214	0.0095	1.0000				
S&P500	0.0423	0.1278	0.1304	-0.0939	0.0717	0.0349	-0.0055	-0.0813	-0.0179	-0.0704	0.0304	0.9304	1.0000			
Nasdaq	-0.0144	0.0789	0.0249	-0.0876	-0.0624	0.1082	-0.0488	-0.0925	-0.0537	0.0257	-0.0034	0.7263	0.8609	1.0000		
VBLTX	0.0412	0.0997	0.0289	-0.0873	0.0023	0.0541	-0.0246	0.2947	0.2031	0.0141	-0.0017	-0.0328	0.0405	-0.0314	1.0000	
Gold	0.0274	0.0730	-0.0778	-0.0127	0.0959	-0.0218	0.1781	0.0395	0.2106	0.0599	0.0806	0.0504	0.0161	0.0054	0.0135	1.0000

Data based on continuously compounded returns from 1st July 1994 to 1st January 2017 on quarterly basis computed as the natural logarithm of the ratio between price in US dollars at time t and at time t-1.

7. Results

Table 1 presents the statistics related to the K500 index and relative sub-indices, together with the ones of traditional market instruments. The highest increase in value among car classes between June 1994 and December 2016 is surely the one of Ferrari, both for Pre-1958 and for 1958-1973 cars, with 778.37% and 696.03% respectively. However, only the former outperformed NASDAQ, which increased its value by 777.50%. The holding period gross return for K500, which can be thought as the most representative of the whole market among the indices used, is over 584%, meaning that the value of a random chosen car has risen by almost six folds. Other holding period gross returns close to K500 belong to Porsche (532.19%) and Post War Racing Cars (537.65%), which slightly outperform DJIA at 527.67%. Below the threshold of 500%, there are Post War European Cars (499.14%) and S&P500 (497.29%) and Pre War USA Cars (476.03%), followed by Post War USA Cars (380.25%), Post-1973 Ferrari (368.36%) and Pre War European Cars (309.81%). Nevertheless, the lowest holding period gross returns are displayed by Gold (300.75%), Affordable Classics (250.31%) and long term bonds (143.54%).

It does not surprise that the average quarterly returns are directly correlated with the relative holding period gross returns for every investment opportunity. In fact, Pre-1958 Ferrari and NASDAQ have both average four-month returns of 2.28%, followed by 1958-1973 Ferrari (2.16%). Then there is the general K500 index (1.96%), Post War Racing Cars (1.87%), Porsche (1.86%) and the Dow Jones (1.85%). Once again Post War European Cars (1.79%), S&P500 (1.78%), Pre War USA Cars (1.73%) precede Post War USA Cars (1.48%), Post-1973 Ferrari (1.45%) and Pre War European Cars (1.26%). Eventually, quarterly average return ranking is closed by Pre War European Cars (1.26%), Gold (1.22%), Affordable Classics (1.02%) and long term bonds (0.40%).

Thanks to the returns just computed, it is easy to see how the gain on classic cars can compete with all respects with well established market investment instruments, such as commodities or stock. Yet, the most outstanding result from this study is the variability of these results. Standard deviation for cars appears to be consistently lower than for financial market instruments, especially if compared among same return classes: Pre-1973 Ferrari and NASDAQ have the same average returns; however standard deviation of the former is only 1.88%, while the one of the latter is the highest at 10.91%. K500 shows that the general level of standard deviation among cars as asset class is relatively low, only 1.28%, with a positive

17

record for Porsche (1.00%) and 1958-1973 Ferrari (1.13%), and that generally it's not higher than 2%. USA Cars of all eras are exceptions, with a standard deviation of 7.56% for Pre-War being the most volatile. Also Post-1973 Ferrari have higher volatility, with 3.07%, however not even close to DJIA, S&P500 and Gold (6.60%, 6.97% and 7.04% respectively).

Switching to the computation of the risk components of the remuneration, Beta of a given asset i are computed as:

$$\beta_i = \frac{\sigma_{i,S\&P500}}{\sigma_{S\&P500}^2}$$

being $\sigma_{i,S\&P500}$ the correlation between the asset taken into consideration and the S&P500, used as market proxy. The Beta analysis shows very low value below 0.03 for all classes of cars, with the exception for Pre War American Cars (0.1447) and, in some extreme cases, even negative, as it happens for Pre-1958 Ferrari, Post War cars both from Europe and America and for Porsche. This denotes very low systematic risk, meaning that the most relevant part of the risk can be eliminated through diversification. The record of non-systematic risk in Table 1 confirms this intuition, displaying values above 99% for every classic car category. This means that, through a careful diversification, almost all risk can be eliminated.

From the analysis of the Sharpe ratios, it can be shown that vintage cars seem to be a good investment, given a level of risk. In fact, with the exception for Affordable Classics (0.1343) and Pre War American Cars (0.1386), classic car Sharpe ratios are usually above S&P500 ratio (0.1574), used as market proxy. The highest ratios are displayed by Porsche, with 1.1713, and 1958–1973 Ferrari, with 1.3014. Also the analysis of Treynor ratios sustains the hypothesis of classic cars as good investment instruments. Again with the exception for Pre War Americans (0.0724), all other classes of automobiles are, in absolute values, above the market proxy (0.0111). It is interesting to note the value of Treynor ratios for Porsche and Post War European Cars, which are -4.9754 and -10.5483. It must be noted that this values are so high in negative terms not because of a severe underperformance with respect to the risk free rate, but due to a very low beta, which happened to be slightly negative. For this reason, these highly negative ratios represent good hedges again market risk, rather than poor performing assets.

Low standard deviations, high Sharpe and Treynor ratios and large rates of diversifiability are surely good signs for an investor; however, in order to assess the potentiality of classic cars as an investment alternative in a portfolio, there is another aspect

check. In fact, the main way to lower risk is by investing in assets which do not co-move together: in this way, given two low correlated assets, even if one is performing badly, it will not influence the other in a severe way. In Table 2, the correlation coefficients among all automobile classes and traditional financial instruments are reported.

From this table, it is quite clear how correlations among classic cars and equity, bond and gold are very low. More specifically, correlation between K500, the main index in analysis, and the S&P500 is 0.0423, close to the bonds (0.0412) and higher than the Dow Jones and the gold, at 0.0163 and 0.0274 respectively. The correlation is even negative, but still low, at -0.0144 between K500 and NASDAQ. Correlations tend to be low across the entire table when describing co-movements of cars and market instruments. Coefficient usually lays between -0.1 and 0.1, with only few exceptions: correlation between Pre War European cars and DJIA or S&P500 is around 0.13, as it is the coefficient describing the relation between Pre war American cars and S&P500. Higher correlation have been founded between Post War USA cars and bonds (0.2947), Porsche and bonds (0.2031), Porsche and gold (0.2106) and Post War European cars and gold. It is interesting to notice how Pre-1958 Ferrari are lowly (in absolute value) and negatively correlated to all the traditional financial instruments (-0.012 – -0.098) and that Post War American cars, despite being positively correlated with bonds, have low and negative correlation coefficients with equity (around -0.09), as it happens for Post War USA and European cars and Porsche.

These findings reveal that classic cars seem a good instrument to hedge against risk; however a deeper analysis will be conducted in Section 8.

8. Application in a portfolio

From findings in previous Section, it is easy to understand that the inclusion of low correlated assets would benefit a portfolio. Mean return and volatility of a portfolio P are computed as follows:

$$\overline{r_P} = \sum_{i=1}^{n} w_i * \overline{r_i}$$

$$\sigma_P = \sqrt{\sum_{i=1}^{n}\sum_{j=1}^{n} w_i * w_j * \sigma_{i,j}}$$

where w_i is the weight of asset i in the portfolio and $\sigma_{i,j}$ is the covariance between asset i and asset j, which can be computed from the correlation coefficient (ρ) table as

$$\sigma_{i,j} = \rho_{i,j} * \sigma_i * \sigma_j \,.$$

If two assets which are poorly correlated are added to a portfolio, its overall standard deviation will decrease. The following example will clarify this point.

An investor wants to diversify a portfolio consisting only of NASDAQ 100 (mean quarterly return of 2.28% with a standard deviation of 10.91%) by investing the same amount of money in the classic car market. She decides to do so by directly investing in (i.e. buying) a 1964 Ferrari. This car falls into the 1958-1973 Ferrari class, which has a mean return of 2.16% and volatility of 1.13% quarterly. The percentage of wealth w_i invested in each asset is 50% and therefore the combined mean return of the portfolio is

$$\overline{r_P} = 2.28\% * 0.5 + 2.16\% * 0.5 = 2.22\%$$

and the new standard deviation is (computing the covariance as stated above with data in Table 1 and 2)

$$\sigma_P = \sqrt{0.5^2 * 0.1091^2 + 2 * 0.5 * 0.5 * (-0.00108) + 0.5^2 * 0.0113^2} = 0.0497 \,.$$

It can be observed that, thanks to a direct investment which has lowered the expected return to 97% of the initial one, the standard deviation of the portfolio is just 45% of the volatility of NASDAQ 100 alone.

It is possible to investigate further and find the weight of each asset in order to achieve the minimum variance of this portfolio. The amount of cash invested

in NASDAQ 100 is denoted by w_1, while the investment in classic car is denoted by w_2. The sum of w_1 and w_2 is equal to 1. From the formula of the portfolio variance for two assets, we can obtain the first derivative and set it equal to 0. Solving it for w_1, it represents the fraction of the investment to be devolved to NASDAQ 100. This amount is given by

$$w_1 = \frac{\sigma_2^2 - \sigma_{1,2}}{\sigma_1^2 + \sigma_2^2 - 2\sigma_{1,2}} = \frac{0.0133^2 + 0.00108}{0.1091^2 + 0.0133^2 + 0.00216} = 0.0883$$

$$w_2 = 1 - w_1 = 0.9117 \,.$$

Therefore, if we invest 91.17% of the total investment in the classic car belonging to the 1958-1973 Ferrari and the remaining part on NASDAQ 100, we expect to have the lowest volatility achievable with these two assets (0.812%) with an expected return of 2.17% quarterly. Figure 3 displays the relation between the expected return on the portfolio and its standard deviation (short sell has been excluded as it makes little sense to sell a car which somebody does not own yet).

These results are due to the fact that, the lower is the correlation among assets multiplying the factors used to compute portfolio volatility, the more substantial will be the decrease of the overall standard deviation, even more if the correlation is negative as in this case. It is also important to notice that, the more assets are added in a portfolio, the higher is the non-systematic risk diversified away. Therefore, standard deviation values will tend asymptotically towards the systematic risk value.

Figure 3 – Relation between volatility and return of the portfolio of the example

21
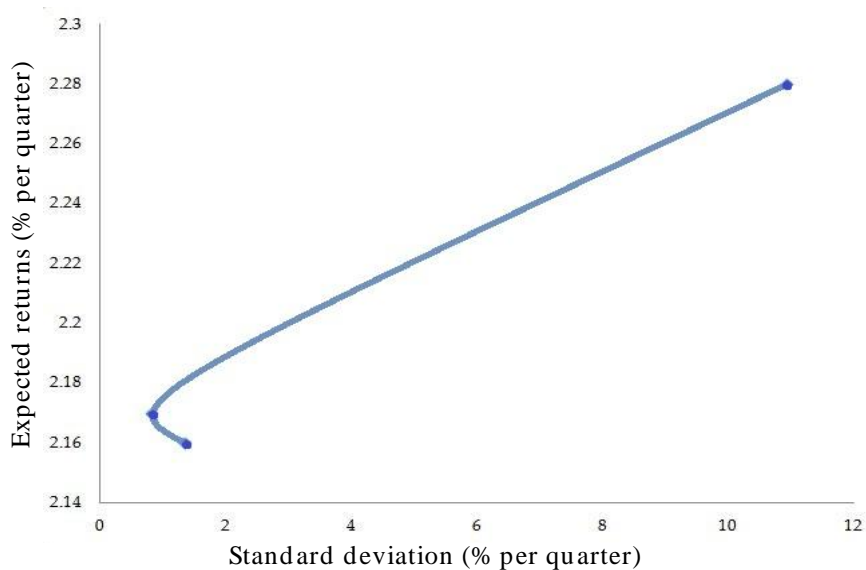
It is possible also to represent the capital market line which results from the combination of traditional financial instruments, the classic car market (the global K500 index is used as the proxy) and a risk free asset. If V is defined as the variance-covariance matrix, e as the vertical vector of the expected returns, $\mathbf{1}$ as the vertical vector of ones of the same length of e, r_f as the risk free rate, E_p as the expected return of the portfolio and σ_p as the standard deviation, the equation of the capital market line is

$$E_p = r_f + \sqrt{H}\sigma_p$$

with

$$H = (e - \mathbf{1}r_f)' V^{-1} (e - \mathbf{1}r_f).$$

The capital market line is tangent to the hyperbola attainable with the only use of risky assets (in this case K500, Dow Jones, S&P500, Nasdaq, Bonds and Gold) which has equation

$$\sigma_p = \frac{1}{\sqrt{D}} \left(CE_p^2 - 2AE_p + B \right)^{\frac{1}{2}}$$

with

$$A = \mathbf{1}'V^{-1}e$$
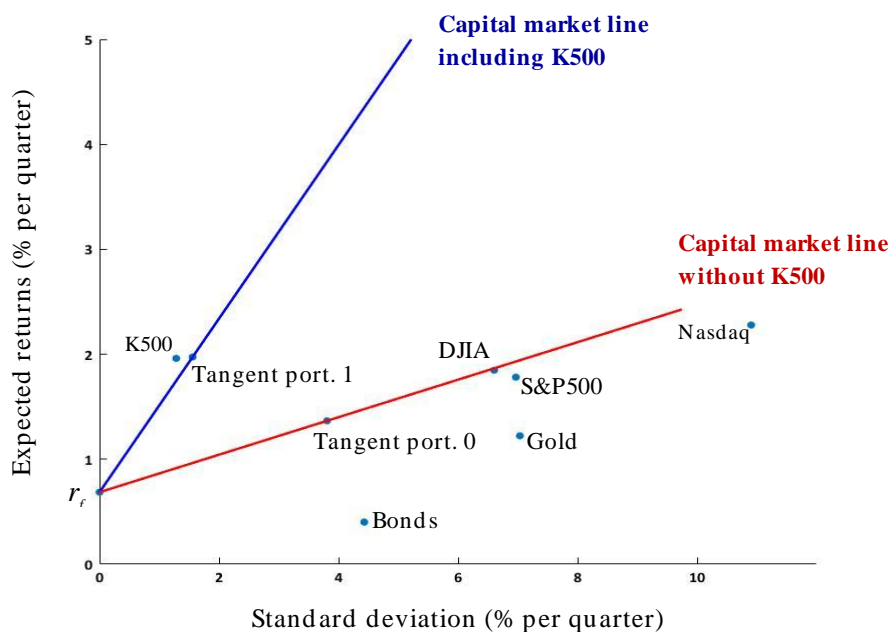$$B = e'V^{-1}e$$
$$C = \mathbf{1}'V^{-1}\mathbf{1}$$
$$D = BC - A^2.$$

The tangent portfolio can be reached without the purchase or the short-sell of the risk free asset and its Sharpe ratio is exactly $\sqrt{H}$. [21]

Figure 4 – Variation of the capital market line with and without K500

[21] Huang and Litzenberg (1988).

The advantage of including the classic car market as source for alternative investments is represented in Figure 4. The blue line is the capital market line which includes the K500 index, while the red one does not. It is clear that including vintage automobiles in a portfolio may advantage a possible investor as, for a given level of volatility, the expected return is always higher, thanks to the effects of diversification. From the example in Figure 4, it is possible to notice the increase of the slope of the capital market line when including K500: from an original slope of 0.1787, equal to the Sharpe ratio of the Tangent port. 0, the new slope of the capital market line is 0.8270, equal to the Sharpe ratio of the Tangent port. 1. Therefore, it is possible to conclude that the slope of the capital market line and the Sharpe ratio of the tangent portfolio when including classic cars are higher than the slope and Sharpe ratio of the tangent portfolio when it does not happen, and thus the former scenario is preferable.

9. Investment funds and possible speculation

In light of the findings unveiled in the previous chapter, some investment funds have been more and more interested into investing in collectible cars. Due to the large investments they require and the leverage they use, they can be usually considered as edge funds. Some of them that have been launched since 2011 are the IGA Automobile Fund, joined also by Nick Mason[22], the Ultimate Classic Car Fund, the CAF (Classic Auto Funds) and The Classic Car Fund. Some of them have been discontinued, but the latter is still running. It is managed by the Count of Custoza Family Office Ltd., a Swiss incorporated company. Through their website, it is possible to download the factsheets of the fund, divided into two classes: class-P, with a minimum initial investment of € 10,000, class-I, with a minimum initial investment of € 200,000. Immobilisations in cars are over 85% of the value, which today is slightly more than 23% higher than the initial value for both funds when launched on 13th September 2012. Performances through the years have been always positive, but variable: from 2013, annual returns have been 4.7%, 5.9% and 9.5% for class-P fund and 3.0%, 6.2% and 10.7% for class-I. In 2016 returns were considerably lower at 1.3% and 1.73% respectively, due to a loss of over 4% in the first quarter for each fund class.[23][24]

Since 2016, in fact, the classic car market is experiencing a slow down. This is noticeable form K500 index graph reported previously, but also from K500 data on auction sales: between 2015 and 2016 the number of cars sold at a price above the high estimate is decreased from 20% to 15% of the total while cars sold below lower estimate rose from 49% to 60%. Also the average value of cars sold shrank from $ 488,368 to $ 388,522 and the percentage of unsold cars increased from 16% to 22%.[25] This trend seems to be confirmed also by first auctions in 2017. For example, 2017 Amelia Island auction, held in March, has seen the percentage of cars sold above high estimate decreasing from 35% in 2016 to 8%, while car sold below lower estimate passed from 58% to 64%.[26] Also according to the recently issued Knight Frank Wealth Report 2017, classic car component in KFLII increased less than the previous year, leaving the best category performance to wines.[27]

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[22] Ruddick (2011)
[23] The Classic Car Fund (2017a)
[24] The Classic Car Fund (2017b)
[25] Milano (2017a)
[26] Milano (2017b)
[27] Knight Frank (2017)

This may be the beginning of the deflation of a possible market bubble. According to Stiglitz's definition, «if the reason that the price is high today is *only* because investors believe the selling price will be high tomorrow – when "fundamental" factors do not seem to justify such a price – a bubble exists. »[28] The hunch among the classic car market operators was that prices have been drove up by the increased demand of investment funds and investors that were not driven by car enthusiasm.[29] The question is why speculators entered the classic car market.

Reasonably they entered this market as they saw an opportunity that can only arise from capital gain, i.e. the difference between sale and purchase price. In fact, classic cars, contrary to usual market instruments, do not have any payout during holding period and there are no future cash inflows to discount (they actually involve cash outflows). If we exclude the increase in nominal value of physical assets typically connected to inflation, we may want to verify if the liquidity injections in the money market started in 2007[30] drove up the prices of collectible cars as well.

Table 3 – Change in returns after the 2007 crisis

	Quarterly mean return 1994-2007	Standard deviation 1994-2007	Quarterly mean return 2007-2016	Standard deviation 2007-2016	Percentage change in mean return
K500	0.0197	(0.0103)	0.0202	(0.0157)	3%
Pre War EU Cars	0.0142	(0.0130)	0.0130	(0.0205)	-8%
Pre War USA Cars	0.0304	(0.0747)	0.0045	(0.0694)	-85%
Ferrari Pre-1958	0.0206	(0.0130)	0.0248	(0.0265)	20%
Ferrari 58-73	0.0216	(0.0091)	0.0222	(0.0127)	3%
Ferrari Post-1973	0.0047	(0.0177)	0.0309	(0.0417)	561%
Post War EU Cars	0.0164	(0.0162)	0.0212	(0.0141)	29%
Post War USA Cars	0.0223	(0.0359)	0.0052	(0.0490)	-77%
Porsche	0.0184	(0.0069)	0.0197	(0.0141)	7%
Post War Racing Cars	0.0211	(0.0133)	0.0142	(0.0148)	-33%
Afford. Classics	0.0084	(0.0145)	0.0132	(0.0347)	56%
DJIA	0.0241	(0.0642)	0.0284	(0.0450)	18%
S&P500	0.0222	(0.0644)	0.0317	(0.0469)	43%
Nasdaq	0.0242	(0.1214)	0.0417	(0.0585)	72%
VBLTX	0.0033	(0.0363)	0.0060	(0.0496)	83%
Gold	0.0100	(0.0554)	0.0091	(0.0882)	-9%

[28] Stiglitz (1990)
[29] Gentili (2016)
[30] Atkins and Mackenzie (2007)

Table 3 shows how, from 2007 to 2016, traditional financial instruments quarterly mean returns increased from 18% to 83% with respect to the period from 1994 to 2007. However, if we exclude Post-1973 Ferrari (which seem an outlier), Pre-1958 Ferrari, Post War Europeans and Affordable Classics, the others do not seem to have enjoyed of the enhanced liquidity. Quarterly mean returns are indeed between -85% and 7% of pre-crisis ones. Even more, if K500 and S&P500 indices are taken as proxy of classic car and financial markets respectively, it is clear that they followed two different paths.

As we fail to recognise reasons that may have driven up the market of classic car so much, according to Stiglitz (1990), we may argue that there has probably been a bubble on classic automobiles market, which, as the recent stop in growth and some slight declines show, is starting to deflate as happened in the early 90s.

10. Some caveats and limitations of the presented analysis

While making the analysis of the returns, some assumptions have been made. First of all, expected returns are computed using historical data and therefore it must be assumed that the realised returns, on which the study is based on, cover all the possible outcomes and have same probability to occur. Then, the potential investor is considered risk averse: given an expected return, he will prefer the investment with lowest volatility. He will invest only according to returns and he will not be affected by passion for classic cars. This is a strong assumption that may not be valid for some collectors. In addition, in order to consider valid the results also for the future, we must assume the returns to be independent and identically distributed. By doing so we also imply that they are not serially correlated and therefore there are no cyclical patterns or predictable trends.

Furthermore, this analysis is based on another consideration made by Martin (2016): the so called "carrying costs" in which collectors incur while holding the asset are not taken into consideration: they are very volatile, as they may change among the different models of cars as well as according to the country of the investor, and tend to be negative related to the number of cars owned, due to their fixed component. Some examples of these costs are insurances, restoration and service costs, rents for garages, taxes and, of course, petrol. However, Martin (2016), «based in Edmundus True Cost to Own and the average value of the collectible automobiles in the study» estimates «the average carrying costs to be approximately 1.3% annually». Therefore, the results obtained «represent the upper bound of returns».[31] In order to achieve more precise results accounting also for carrying costs, an in-depth analysis on their impact should be conducted.

Another aspect to consider is the fact that investing directly on classic cars may be too onerous: the best automobile investment class that emerges from this study is composed of Ferrari manufactured after 1958. It is immediate how the majority of non high net worth individuals may find difficult to invest potentially millions of dollars in a single asset. Therefore, the ones to benefit from investing in automobiles are people who already have a considerable patrimony. On the other hand, it may be still possible to invest indirectly in classic cars through the mutual funds mentioned above.

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[31] Martin (2016).

In addition, while considering Stiglitz's definition for market bubbles, we recognise that speculators entered collectible automobiles market just because they expected higher values in the future, regardless of the "market fundamentals". However, the just cited "market fundamentals" in classics are very difficult to assess. In fact, it is not easy to understand which the base value of a car is: is it the cost of raw materials? Does it involve also manufacturing cost, even if 80 year old? And why may a rare small car be worth more than a truck (controlling for period of production)? This topic gives room for subsequent further researches.

11. Conclusions

Lately, collectibles have started to be considered as an asset class where to invest, maybe also due to the big crash of the market in 2008. While financial instruments are intangible, collectibles can be physically perceived and even enjoyed. Among all collectibles, the class that has captured more attention and performed better is classic cars. After having analysed the classic car market, a framework under which evaluate the performance of classic cars as an investment class has been drawn. Three main indices have been introduced and using K500, a database that collects observation on values of 500 different models between 1994 and 2016, overall holding period gross returns, volatility, and other statistical instruments have been computed. These results have been compared to the homologous of main financial market instruments, such as the Dow Jones, S&P500, NASDAQ, long term bonds and gold. The comparison shows that not only the returns on classic cars are comparable to those of traditional financial instruments, but volatility is even lower, making them a good investment class.

The next step was the correlation analysis: correlation coefficients between different classes of collectible automobiles and common financial instruments have been calculated and results show how they tend to be very low, close to 0. This means that classic cars are not only good stand alone investments, but also a smart way to diversify risk in a portfolio. An example of this usage has been illustrated and it confirms what just stated.

People already realised about these aspects around five years ago and, therefore, some speculation funds have been set up in order to exploit the rising market values of classic cars. Performance of one of these funds has been analysed, finding variable returns.

We also asses the possibility of the classic car market to be in a bubble. It has been found that, probably, the entrance in the market of speculators which are actually not passionate about classics, may have made price rise above what can be considered the "market fundamentals". However, recent developments seem to show that this bubble is bursting.

From these findings, we can conclude that classic cars may have been a wise investment if already undertaken in the past. However, due to the recent downturn, prospective investors may need to be more cautious while entering this market. Eventually, this downturn may be favourable to enthusiasts, as it would make cars more affordable to really passionate people.

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