Investment in Wine

An Empirical Analysis of the Return of Fine Wine from 1978 to 2014 and its Diversification Benefit

Rasmus Bonde Greis

CBS
COPENHAGEN
BUSINESS SCHOOL
HANDELSHØJSKOLEN

Author: Rasmus Bonde Greis
Finance and Strategic Management – Department of Finance
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Supervisor: Finn Østrup
Department of International Economics and Management

Executive Summary

Historien om vin går århundrede tilbage, krige er udkæmpet og imperier er faldet, men kendte vinregioner som Bordeaux og Bourgogne har ført deres traditioner ned gennem generationerne og producerer stadig de samme prestigefyldte vine. Prisen på vin har været stigende i århundrede, men op igennem de seneste 50 år er fænomenet "investering i vin" opstået. Nye teknologier og nye markeder har gjort handel med vin mere tilgængeligt og øget likviditeten i markedet. Efterspørgslen for de prestigefyldte luksus produkter er steget i takt med den økonomiske udvikling, og eksporten steg, først til USA i 80erne, til Japan i 90erne og senest til Kina i 00erne. Priserne er steget markant og vine er blevet solgt for mere end $39,000 pr flaske.

Denne afhandling er udarbejdet med interessen for hvordan der kan investeres i vin, med det formål at forstå de underliggende forhold som påvirker vinprisen, samt en forståelse af de forskellige markedsdeltagere. Udgangspunktet er at introducere det heterogene marked for vin og differentiere mellem vine med lagringegenskaber og vine lavet til øjeblikkeligt forbrug. Måderne hvorpå en investor kan opnå eksponering til vin er analyseret, ligesom de ikke-finansielle motiver for køb af vin er diskuteret. Ydermere er omkostningerne ved at lagre og handle med fine vine undersøgt, eftersom der er højre omkostninger forbundet handel med af alternative aktiver.

En regressions model med vinprisen som den afhængige variable anvendes til at bestemme hvilket makroøkonomiske faktorer, der påvirker prisudviklingen. Testeperioden indeholder månedlige observationer fra juli 1976 til december 2014. Resultatet er at ændringerne in vinprisen ikke er korreleret med ændringerne i det amerikanske og japanske aktiemarked, udviklingen i guldprisen, ændringerne i inflationen, ændringerne i renten og ændringerne i første lag af tidsserie variablerne. Kun første lag af vinprisen og ændringerne i USDGBP spot kursen er signifikante, henholdsvis positiv og negativ. Vinprisens uafhængighed af disse variabler gør vin til et god gardering mod de traditionelle investerings aktiver.

Vinprisindekset, som er udarbejdet til denne afhandling, er basseret på prisudviklingen af de mest prestigefyldte vine fra Bordeaux regionen. Disse vine haft et årligt nominelt afkast på 10,67% og et årligt reelt afkast på 7,19% mellem 1978 og 2014, dog handles disse vine øjeblikket nominelt 31% under toppunktet i 2011. Volatiliteten på vinprisen har været stigende gennem analyseperioden, primært drevet af den stigende handel og spekulation gennem udviklingen af nye handelsplatforme. Vin har sammenlignet med aktier, obligationer og guld givet et højere finansielt afkast igennem analyseperioden, og har i 3 ud af 5 underperioder givet en højere Sharpe ratio en aktier og guld. Eftersom afkastet på vin er uafhængigt af afkastet på aktier, obligationer og guld er vin et attraktivt aktiv for porteføljе diversificering. I afhandlingens modelporteføljer har en vin positiv vægt både i de varians minimerende og de Sharpe optimerende

porteføljer. Investering i vin er imidlertid associeret med andre risici og omkostninger end de traditionelle aktiver, som en potentiel invester skal overveje før en investering i dette niche investerings aktive foretages.

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1. Introduction

In 2007, the world entered in financial turmoil, which developed, into a global recession. During the next one and a half year the main stock indices lost more than 50% of its value. International trade collapsed and the credit lines crunched. Large financial institutions were bailed out by national governments, and cities and countries filed for bankruptcy. Unemployment rose significantly in the advanced economies hence consumer confidence and consumption plummeted (IMF, 2009). The GDP felt in the advances economics and the growth stagnated in the emerging markets. Many economists considered the crisis as the worst since that great depression in the 1930s.

Meanwhile aggressive bids on wine auctions were not uncommon, Sotheby's sold a case of DRC Romanée-Conti 1985 for $157,300, more than $13,000 a bottle (Winespectator, 2008), and even though the American auction houses reported declining sales of collectible wine, then one market seemed unstoppable, namely Hong Kong. The revenue on the Hong Kong wine actions rose 113% in 2009 and the wines were sold at price well above the American average prices (Winespectator, 2009). The *En Primeur* price of the 2009 and 2010 vintages rose with almost 400% compared to 2008, and in 2011, the Dow Jones Industrial Average was still 10% below its peak in 2007 the leading wine index was up 60% in the same period. Auction houses continued to break one record after another and in 2013 a case of 12 bottles of 1978 Romanée-Conti was sold for $474,000, equitant to a bottle price of $39,500 or almost $5,000 per glass (Bloomberg, 2013).

Wine is for many considered as beverage made of fermented grapes, that typically is enjoyed with a meal Saturday evening. The market is heterogenic with thousands of different variants in all price categories. Consumers tend to have a preference for a certain wine determined either by grape variety or origin, without having any deeper knowledge about product. However, news stories about wines sold for $5,000 a glass automatically make questions appear: What makes a wine worth so much? What explain the movements of wine prices? Is wine a good investment? And is wine becoming too expensive to drink?

Therefore the aim of the paper is to: 1) Define the market for fine wine, what makes a wine investment-graded and how can wine be traded. 2) Identify factors that affect the movement of wine prices. 3) Determine the return of wine, whether wine can be used for portfolio diversification, and how big a proportion of wine an investor should hold in order to maximize return and minimize risk.

The definition of fine wine and the methods to invest in wine is conducted to differentiate the investment-graded wine (hereinafter: IGW) from an average wine. An investor needs to understand the difference and be able to distinguish between wine suitable for investment and wine made for pure consumption. Wine is, unlike many other commodities, a heterogenic product; thus, just very few wines have the characteristics to

be stored for years and treaded as an investment. Further, an investor needs to know how wine can be traded both directly and indirectly. Historically, it has not been possible to look up spot prices for wine. However, development of new technologies has made the market more transparent. These topics will be analyzed in chapter three of this paper.

The return of storing IGW and the macro environmental drivers behind the price moments are essential to understand in order to determine the risks associated with the investment. The general macroeconomic drivers along with the wine specific demand and supply are analyzed in chapter four and five of the paper.

Using wine for portfolio diversification is interesting, hence modern portfolio theory is a well-known theory that argues that the combination of two or more assets at different proportions in a portfolio makes it possible to either, achieve a fixed return to a lower risk, or achieve a better return to a fixed risk, than any of the individual assets could provide (Bodie et al, 2011). This is useful in any kind of economic climate, typically stock underperforms in recessions, thus investors might benefit for placing a higher proportion of bond in the portfolio, when the economy is booming stocks tend to outperform, thus investors benefits from obtaining more stocks in the portfolio. The theory makes it possible to combine infinite assets, thus it is interesting to analyze which proportion IGW should obtain in such a portfolio. The analysis of stocks, bonds, wine, and gold will be presented in chapter six of this paper.

1.1. Research question

Summing up the discussed purpose of this paper leads to the formulation of following questions to guide the research:

- Is IGW an applicable asset to diversify a portfolio with stocks, bonds, and gold in order to maximize the return and minimize the risk?

In order to answers this question following sub questions need to be answered:

- What defines IGW and how can it be traded?
- What are the relevant factors that affect the price of IGW?
- What is the annual risk and return of holding IGW?

1.2. Delimitation

The focus of the paper is to determine whether IGW is a good asset to include in an investment portfolio, for a global investor who can invest in stocks, bonds, gold, and IGW. Due to the scope of the paper the investment opportunities are limited to these four asset classes, which each are represented by one leading index. This limitation is a necessity due to the complexity of this paper. It is realized that there are a lot of other financial products in the real world, which can be included in an investment portfolio.

Another limitation of the paper is that it is not in the scope to forecast the price development of wine, the model build in chapter five is only to test which underlying global economic factors that are correlated with the price of IGW.

1.3. Research design

The objective of the paper is to create a comprehensive analysis of the return of holding fine wine and whether IGW is a good asset for portfolio diversification. In order to do that the paper is reflecting upon the three sub questions, which will guide the research. Meaning that the thesis is structure it into three main areas. **First**, an introduction to the market of investment-graded wine is conducted, to give the reader an insight to the market and an understanding of the motives behind investments in IGW and how an investor can obtain an exposure to IGW. Further, the chapter will analyze the movements in global supply and demand to determine the global trends that are moving the wine prices. **Second**, the research will analyze the price development of fine wine. It will highlight the economic events and wine related events that have effected the price determination. Further, the chapter will determine the costs of trading and storing wine. Lastly a regression model including different macroeconomic factors will be created to determine which factors that influence the IGW price. **Third**, the research will analyze the risk and return of IGW and compare it with alternative investment assets, in order to determine the optimal asset allocation in an investment portfolio during the period between June 1978 and December 2014, which can provide guidance for real world investments. Finally, the thesis will reflect upon the findings and the answers of the research questions will be transformed into a conclusion and recommendation.

1.4. Contribution of the paper

The existing literature about wine includes several findings in regard to the price determination of wine and the return of holding wine. Further, academics have touched upon the diversification benefits of wine.

The aim of this paper is to build on the published literature about the return of wine and wine's contribution to portfolio diversification. The paper will extend the analysis period to 36.5 years in order to get a more profound analysis of the IGW price development during different economic cycles. This will contribute with valuable information about the long-term performance of wine compared to other financial assets. This information might be omitted in studies of shorter time periods. The analysis is built on up to date time-series data, collected from leading auction houses, merchants, and online trading platforms.

Additionally, the paper will build a model to determine which macro environmental factors that influence the price movement of fine wine. The model will treat wine as a homogenous financial asset, meaning that climate, grape composition, and expert ratings will not be included. This will contribute with information about the diversification benefits of fine wine and will further be used to create optimal portfolios for the

whole analysis period as well as for shorter economic cycles. To sum up, the paper contribute with following:

- Comparison of the different options to obtain a financial exposure to fine wine.
- Explanation of the main supply and demand trends on the wine market.
- Test the factors, which influence the price movements of wine from July 1978 to December 2014 including the gold price, Dow Jones Industrial Average, Nikkei 225, the USD exchange rate to the British Pound Sterling, the inflation rate, and the interest rate.
- Analysis of the return of wine and a comparison with the return on stocks, bonds, and gold.
- Optimal portfolio calculations on fine wine, stocks, gold, and bonds.
- Comparison of wine's portfolio diversification benefit during 3 different economic cycles.

2. Literature Review

Academic literature about wine economics has emerged rapidly during the recent decades. Strochmann (2012) writes that the Google Scholar hits on wine have risen 338% from 1980s to the 2000s, compared to a 127% increase on beer and 79% on water. The first academic paper on wine economics is dated back to 1979, where Krasker (1979) published a study on wine prices. Before that literature about wine just claimed, that wine should be acquired young, stored until maturity where prices would have risen up to three times, though with no scientific study behind the claims (Johnson, 1971; Fadiman & Aaron, 1977). Economists before 1979 had noticed wine and Adam Smith, David Ricardo, John Stuart Mill, and Karl Marx uses wine as either reference or examples (Chaikind, 2012).

Since Krasker's paper, many academics have contributed to the literature; particularly Princeton economics professor Orley Ashenfelter has made a large contribution to the literature. He published a series of wine related papers through his newsletter *Liquid Assets – The International Guide to Fine Wines,* established in 1986. His approach to wine is very quantitative and he has analyzed topics like "The Bordeaux Classification of 1855", "The impact of wine critics on wine prices", and "The correlation between weather data and wine prices" (Ashenfelter, 1988, 1992, 1997).

Up through the 2000s several studies on wine as an investment and wine as portfolio diversification were conducted along with many other wine related studies. This led to establishment of several academic conferences with the American Association of Wine Economists (AAWE) as the largest, with more than 200 wine economists participating worldwide (Stochmann, 2012). In 2006 the AAWE furthermore created the *Journal of Wine Economics*, which not just covers wine economics, but also studies about trade, growth, and

environmental economics. From 2006 to 2012 the journal was released twice a year, and from 2013 it increased to three times a year (AAEW, 2014).

2.1. Definition of wine as investment asset

Wine as an investment asset has characteristics that differ from traditional investments assets, and can be compared with the characteristics of other collectables such as art. First, wine does not pay any dividend in the holding period. Second, investors have to pay for storage costs. Third, the market is relatively illiquid, meaning that liquidation of a wine collection can take several months. Fourth, a bottle of wine can break or lose its value if not stored correctly (Sanning et al., 2008).

Burton and Jacobsen (1999) highlight the market for investments in collectables. One side of the literature argues that collectables should be compensated for the illiquidity and the holding costs and thereby provide a higher return. The other argues that the returns should be lower due to the owner's nonpecuniary returns from holding the asset; for example owning a famous painting which the owner can enjoy and show friends. Other academics have argued that holding collectibles is a hedge against inflation. Ibbotson and Brinson (1987) discovered a negative correlation between different indices for collectibles and the traditional financial assets.

Ashenfelter and Jones (2013) argue that fine wine differs from collectables, like stamps and fine art, hence wine traditionally has been purchased in order to drink, meaning that owning fine wine does not give any nonpecuniary returns before consumption. Further Strochmann (2012) looks at alternative classifications for wines. He compared wine and agricultural products, and described four differences between them. First, a bottle of wine are relatively expensive compared to other agricultural products, a bottle can cost more than $1,000. Second, IGW can increase its value when ageing. Third, wine is extraordinary sensitive to weather conditions. Forth, wine is an experience good, meaning that it is difficult to say anything about the quality before consumption and it is further hard to determine the optimal time for consumption.

The different types of good are classified by Nelson (1970), he distinguish between search goods, experience goods, and credence goods, where wine can be classified as an experience good, hence the quality cannot be evaluated before consumption. However, Ashton (2014) further argues that wine also can be a credence good, hence it is hard to determine to quality before the wine is fully mature. Therefore the consumer typically uses reputation, ratings, and price level to determine the quality.

2.2. Literature about factors affecting the price and quality of wine

Walking into a wine store reveals a great selection of different wines, making the market very heterogenic compared to purchasing for example beer. Hundreds of different brands, grape varieties, countries, regions, appellations, and vintages makes the decision hard, further the prices differs from a few dollars per bottles to more than $1,000 for another. This market has caught the researchers attention and several studies on which factors that determine wine prices have been conducted.

Ashenfelter has done several quantitative studies on how the weather affects the price on wine. In his study from 2008 he used weather data from Bordeaux to predict the quality (and price) of different wines. He concluded that a consumer or investor only need to know the quality of the vintage and the producer in order to determine the quality of the wine. *"Good vintages produce good wine in all vineyards and the best wines are produces in the best vineyards in all vintages"* (Ashenfelter, 2008). His model shows that 80% of the price variation of the average Bordeaux price is explained by the vintage. Further, it shows that vintages with summer temperatures above average and rain during harvest season below average are the best, meaning that it is possible to predict the quality (and price) before even tasting a drop of wine. Ashenfelter thereby question the role and value added proposition of the wine critics.

The role of the wine critics is further questioned by Ginsburgh et al. (1996), they ran a regression on every single factor in the wine making process (Climate, soil, grape varieties, exposure of the vineyard, age of the vine, every step of the winemaking technique, appellation, classification, and aging in bottles) on a sample of 102 producers in Bordeaux. They concluded that the 1855 classification and the climate are the two most important factors to determine the quality of the wine. Additionally, they conclude that 85% of the variance of prices can be explained by the observable factors, meaning that the 1855 classification still provides the quality signal. Thus they concluded that wine experts have a tendency to overestimate high quality vintages, meaning that experts are generous with high scores and at the same time reluctant to give low scores.

Lecocq and Visser (2006a) researched the price effect of the observable information mentioned on the label, such as vintage, name, and ranking. They compared this information with a jury of blind tasters' opinion about the wine. The blind tasters did not know the information on label, which made them unbiased towards a brand or vintage. The study was conducted on three samples, two from Bordeaux and one from Burgundy. The results showed that the major price differences came from the directly revealed information on the label. The jury's grades had a significant effect on the prices, however the effect was small.

Jones and Strochmann (2001) developed a model to identify the relationship between the factors influencing the quality (climate and grape composition) and the factors influencing the price (quality, evaluations, and

age of the wine), where the model used Parker-points to determine the quality evaluation. The model showed that the relative level of Parker-points had a large influence on the price, particularly if the wine is *Cabernet Sauvignon*[1] dominated. Furthermore the model showed that smaller producers are more sensitive to single point jumps hence achieving higher relative gains per point.

Ashenfelter and Jones (2013) concluded in a study that expert ratings are inefficient predictors for the price of mature Bordeaux hence they do not include all available information. However, quantitatively the ratings reflected the same factors as the available weather data, meaning that expert ratings are useful when no other information is available. Additionally, the study discovered that weather data is a significant predictor of expert ratings, and when the weather data is included in the equation, just the highest expert ratings add additional value to the wine. Finally, the study questions whether expert ratings influence on price makes it as self-fulfilling prophecies, meaning that high score wines obtain character of collectibles.

Even though academics question the need for wine critics, then the market for expert opinions is large. Strochmann (2012) reports that the seven major U.S. wine magazines have more than 500,000 subscriptions. Wine consumers rely on the expert opinions hence it seems like the easiest way to obtain information about the quality of the experience good before purchasing (Ashton, 2014). Not just the consumers rely on the expert opinions, also the financial markets for wine use the ratings to determine which wines to include in the indices, several of the leading wine indices from Liv-ex has a score above 95 points from a leading wine critic as one of the selection criteria (Erdos and Ormos, 2013).

2.3. Literature about investing in wine

As a consequence of the increased number of academic papers, more economists have researched about the risk and return on investment in wine. The data collection differs from one study to another in terms of wine regions, analyst periods, and price calculation. The studies mainly focus on specific wines from the Bordeaux region, California, and some Australian icon wines. The analysis period differs from one year to 16 years, and in regard to the data collection the methods differs between cross selection and time-series (Strochmann, 2012).

Wine traders and wine critics have for decades argued that wine is a great asset to for investment as well a portfolio diversification. One of the less financial arguments is: “if it fails you can drink it” (Burton and Jacobsen, 2001), another is the investment strategy of “Buy two, drink on for free” (Kumar, 2005). Wine writer Hugh Johnson (1971) claims that the wine should be bought at its opening price and stored until

[1] One of the most recognized red wine grapes in the world, widely used all over the world and a main grape in the production of high quality wines in Bordeaux and California (Robinson, 2002).

maturity where the price would have tripled, and wine merchant Sokolin and Bruce (2008) reported about abnormal returns on his selected portfolio of Bordeaux wines between 1986 and 2007. He further predicts that the abnormal returns will continue in the future and that the volatility on the wine market is lower than on the stock market, due to the argument that people will not stop consuming and that the increasing number of worldwide high net worth individuals does not need to liquidate their assets in bad economic years. The rising wine prices led to wine expert Steven Spurrier (1997) talking about auction fever where he drew parallels to the Dutch tulip-mania in the 1630s. In addition to the less academic predictions and claims about the movement of the wine prices, economists have conducted studies about investments in wine.

The first academic paper about the return on storing wine was published by Krasker (1979), his empirical investigation concluded that selected Bordeaux and Californian wines did not give a significant return different from the riskless asset between 1973 and 1977, where the Dow Jones fell 0.3% p.a. and the T-Bill returned 6.9% p.a. Jaeger (1981) extended Krasker's data set to 1969 in order to minimize the effect on the 73-77 recession. She calculated the rate of return, to be between 8.5% and 16.6% p.a. depending on storage costs, this is significantly higher than the Dow Jones and the T-bills that just increased with 0.3% and 6.5% in the analysis period.

Weil (1993) tracked and analyzed 68 transactions, between 1976 and 1992, in an actual portfolio consisting of wines from Bordeaux, Burgundy. His analysis included actual transactions costs, clearance fees and storage costs. The analysis compared each transaction to the Dow Jones for the same period. He concluded that the portfolio underperformed the stock market with 12.8% annually. Hence the nominal return on wine was 6.5% p.a. where the Dow Jones returned 19.3% and the T-bills 8.6% p.a.

Burton & Jacobsen (2001) used a repeat-sale regression to calculate returns on Bordeaux wines from 1986-1996, on a data set including 10,558 observations. They calculated the annual return to 7.9% compared to 13.5% on the Dow Jones. They further categorized the wines into sub-groups such as: First growth, 1982 vintage, Parkers top 15, and Sokolin's 1985 portfolio. Only two groups (1982 vintage and Parkers top 15 of 1982 vintage) performed marginally better than the Dow Jones including sales commission and storage costs, however the dividends on the equity market were not included.

Haeger and Storchmann (2006) used cross-selection data to calculate returns of U.S. Pinot Noir between vintage 1994 and 2001, on a sample of 451 wines. The analysis was conducted on a time period between 1998 and 2003. They concluded that the return on wine was significantly lower than the Dow Jones index for the same period. Jones and Storchmann (2001) conducted a similar study on 21 Cru Classés wines from Bordeaux from 1996 and 1997 and reported returns below the common stock.

A more recent study from Fogarty and Sadler (2014) analyzed the impact of the statistical methods there have been used to estimate the return on wine. They discover that the return is overestimated when using the repeat sales method, and they suggest the hedonic method to work better when estimating returns on heterogeneous assets. They further calculated the diversification benefit on holding wine to be small and just applicable to portfolios close to the global minimum-variance portfolio.

Along with the studies on pure performance of wine compared to traditional investment opportunities, several academics have researched about fine wines' abilities to improve portfolio diversification. Sanning et al. (2008) used the Fama-French Three-Factor model and the CAPM model to analyze a data set containing information of auction prices on Bordeaux wines. Their results are agree with Jaeger (1981), thus disagreeing with Krasker (1971), hence they calculated that wine returns 7.5% to 9.5% above the riskless rate, additionally wine has a beta value close to zero, meaning that wine has little exposure to the traditional markets and the common risk factors, thus suited for portfolio diversification.

Masset and Weisskopf (2010) analyzed the wine performance from 1996 to 2009 with special empathy on the financial crisis. Not only did wine perform better than the stock and bond market in the period, but they also concluded that wine is beneficial to add into a portfolio with stock and bonds hence wine has a low beta coefficient and a significant positive alpha. Particularly in the economic down turn between 2001-03 and 2007-09 wines defensive characteristics led to reduction in the portfolios volatility and improvement of the skewness and kurtisus.

Masset and Henderson (2010) also examined data that included the financial crisis. They concluded that the correlation between Liv-ex 100 and S&P 500 increased during the crisis due to the flight to liquidity phenomenon, after the panic sales the correlation returned to a level relatively close to the pre-crisis level. They further concluded that including wine in a portfolio delivers higher expected returns, lower volatility and more attractive skewness and kurtosis for most investor preferences. Finally, they examined that the first growth wines and the "100-point Robert Parker" wines deliver the best tradeoff of risk and return.

Fogarty (2010) studied how selected Australian wines performed in an already diversified portfolio between 1990 and 2000. He concluded that both the return and the risk adjusted excess return for the selected wines were below the traditional financial assets. However, he examined that including wine in the portfolio could reduce the risk without reducing the return. Additionally, Fogarty (2006) concluded that more expensive Australian wines are less risky than less expensive wines, further the more expensive wines provide a better return, finally, he concluded that over a seven-year period the Australian wines offered higher returns than Bordeaux wines.

Kumar (2005) conducted a study on wine investment for portfolio diversification between 1982 and 2002. He concluded that the Fine Wine 50 Index has a correlation coefficient with FTSE 100, the Dow Jones Index, and UK government bonds on 0.02, 0.03, and 0.00 respectively. He further tested several other periods between 1983 and 2003, with the conclusion that all correlation coefficients are below 0.05, meaning that IGW is unaffected by movements on the financial markets, which makes IGW a good hedge against traditional investment vehicles.

Finally, Cevik and Sedik (2014) used IGW along with oil to conduct a research on the extreme fluctuations on commodity prices between 1990 and 2000. Their study concluded that the behavior of fine wine and oil had statistical similarities, and they concluded that the global fundamental macro environmental factors dominate the price trends. Thus, they questioned whether fine wine would improve portfolio diversification. Bouri (2013) builds on Cevik and Sedik's results. She examined IGW and oil's volatility and co-movements before and after the financial crisis. Along with agreeing on the previous study, she further determined that both markets respond stronger to bad news and that volatility increased during the financial crisis. However both markets returned, to some extent, to pre-crisis levels, which demonstrates comparable movement patterns.

3. Structure of the wine market

This chapter gives an overview of the wine market and a differentiation between wine and IGW. Further it aims to define the different types of wine investors and the motives behind an investment in wine. Additionally, it analyzes the different ways an investor can obtain exposure to the IGW, and finally it estimates the market size, and how the global supply and demand have developed during the recent decade.

3.1. What is wine?

Wine is an alcoholic beverage, based on a fermented agricultural product such as fruit, rice or honey, with grapes as the most common. The first known wine is dated back to 7000 BC estimated on findings of fermented fruit residue in China, the oldest winery is found in a cave in Armenia, dated back to 4100 BC (Robinson, 2002).

Winemaking is the art of producing wine and it starts with a selection of grapes. *Vitis vinifera* is the most common grape vine, which has between 5,000 and 10,000 varieties. Winemaking is subject to the uncertainty of nature. The biochemical development of the fruit is influenced by the weather and the region's "*terrior*"[2] and the winemaker needs to work in cooperation with nature in order to transform the grapes to the

[2] The special characteristics of the climate, geology, and climate of a certain place (Robinson, 2002)

final bottle of wine. These endless combinations of grape varieties, weather conditions, local *terrior*, along with human intervention result in a heterogenic market with thousands of different wines.

The world's production of wine was just above 283 million hectoliters in 2013. Western Europe, being the largest wine-producing region, produced 41,4% of the total market volume. France and Italy are the largest European producers with a Western European market share each of approximately 20%. The country with the fastest growing wine production is China, which has increased the production of grape based wine with 133% throughout the last 5 years. China's output is just 8% smaller than France's and China is estimated to become the world's largest wine producer in the coming years (Euromonitor, 2014, 2015).

3.2. Investment-graded wine

Wine suited for investment – investment-graded wine – is a relatively small share of the total wine market. These wines originate from a few selected regions, from a few producers in the best vintages. The main regions for IGW are Bordeaux, Burgundy, Rhône, California, along with selected wines from Italy, Spain and Australia. However, the most important region is Bordeaux. Due to its volume, size, and liquidity in the trade, it is estimated that Bordeaux accounts for more than 70% of the IGW market (Robinson, 2002) and it is weighted by 84% in the Liv-ex 100 index (Liv-ex, 2014). This region is therefore seen as the "blue chips of wine investment" (Sokolin, 2008).

Bordeaux is an old historic wine region located in the southwestern part of France. Its wine traditions are traced back to the 1st century where the Romans introduced winemaking to the region. The region has 54 different appellations and covers as much as 120,000 hectares divided between approximately 7,300 different producers. The region typically has a yearly production of 675 million bottles, which is equivalent to 15-20% of the total French production and 1.5-2% of the world production (BBR, 2011). In terms of value the yearly production is worth more than 2 billion euros. However, out of all these wines just a small part of them are considered as IGW. The prestigious bottles suited for investment comes from between 80-100 different producers (BBR, 2011; The Wine Cellar Insider, 2015a).

One of the major differentiations points between Bordeaux and other investment graded wine regions is that the leading producers at the Bordeaux left bank got classified in 1855 by their reputation and trading price, which at efficient markets can be a used to determine quality. The classification ranks the wines into five different tiers (growths) and has only been modified twice since 1855 (Robinson, 2002). The classification has been under critique several times. Time has changes, producers have changes owner, and some producers has been divided, meaning that the classification does not give an up to date picture of the current quality ranking. However, this system has traditions and history, and it is consumer friendly, meaning that it makes

left bank Bordeaux much more transparent than Bourgogne, Piedmont, California among others. The Médoc Classification of 1885 is attached in Appendix A.

3.3. Why invest in wine?

Wine in general – particularly fine wine – is a luxury. Luxury is not a necessity but an asset that provides comfort or elegance, meaning that the demand for luxury increase when income increase. Luxury goods have been around for centuries and have been concentrated around the upper classes in major empires such as the Ancient China, Egypt, and the Roman Empire. During the recent centuries Luxury has been concentrated around Europe and later North America. After WWII the Japanese market have been a fast growing market, and it is estimated that 94% of Japanese women own a product from Louis Vuitton. In the last decades the luxury industry has emerged around Hong Kong, China, and the Middle East. The Chinese luxury industry has grown twice as fast as the GDP up through the 00s and has today surpassed the Japanese's. 70% of the Chinese indicates that the goal in life is to make money and own luxury items (Tvede, 2010).

The shift to emerging new markets is one of the trends that have changed the luxury industry in recent decades. The rising upper middle class has been driven by so-called *"Nouveau riche"* – self-made wealth. New rich behave differently from the "old rich". Self-made wealth demands more luxury items, due to the assumption that "I earned, I deserve", whereas inherited wealth is more conservative and preservative. The new rich want to show social status and prestige, to which luxury items are used. It can be shown through a luxury car, a watch, fashion, tourism or a prestigious bottle of wine at a fancy restaurant. Particularly, the global urbanization leads to increasing wealth and higher demand for luxury. This urbanization has already taken place in the old markets: Europe, North America, and Japan, two of the BRIC counties: Russia, and Brazil. And it is currently taking place in China. However, India and many South East Asian counties are still rural, meaning that the demand for luxury in these areas will rise in the coming decades (Worldbank, 2015a).

The major global luxury brands are primary based in Europe, where 20 out of the 22 most profitable are located. The characteristics of the luxury brands are that they are well know with international fame, with long history and from an area with long traditions, this is illustrated by luxury watches form Switzerland, fashion from Paris and Milan, luxury cars from Germany and Italy, Furs from Denmark, and fine wine from France (Tvede, 2010).

In addition to the luxury status, wine can be purchased as a collectible, and be compared with other collectibles or treasures like stamps, fine art, paintings, sculptures, classic automobiles, jewelry etc. A survey made by Barclays Wealth and Investment Management and Ledbury Research (2012) asked more than 2000 High Net Worth Individuals (HNWI) across the globe about their motivation behind investment in

collectibles, 62% answered it was for pure enjoyment, 35% answered it is a part of the family traditions and culture, 26% like to show it to people, 21% believe it provides a financial security if conventional investments fails, 18% answered that investments in collectibles were for pure financial reasons like hedge against inflation and devaluation of currencies as well as portfolio diversification, 12% did not want anyone else to own the collectibles, and 10% believe that other people respect them for owning the collectibles.

Geographically, the motivation for investing in luxury items and collectibles differs from one country to another. In the old countries people typically invest in collectibles for enjoyment, cultural significance and the heirloom; in new rich countries there are other perspectives in play. In Singapore, China, and India the show off effect plays an important role, hence the rareness of the collectible is important. In Saudi Arabia, Qatar, and India the financial security and the pure investment are weighted higher than enjoyment. As a consequence the high net worth individuals (HNWI) in the emerging markets holds a larger share of the portfolio in collectibles and treasures. The HNWI in UAE, Saudi Arabia, and China hold 17% of collectibles, where those in the US hold 9% and in the UK 7%; the world average is 9.6%. As for wine, Singapore and Hong Kong are the only markets where fine wine is in the top three of most held collectables (Barclays, 2012).

3.4. The motives behind an investment in fine wine

The emotional and aesthetic returns for holding collectibles differ from one investor to another. Some collect for enjoyment, passion and knowledge and others for the purpose of sharing and discussing with friends, however, the following three categories can be used to categorize the emotional return: **enjoyment**, **social** and **heritage**. Enjoyment returns means that the investor acquires the asset because he/she gains pleasure from having it – it is seen as a part of the individual's personal holding rather than an asset in an investment portfolio. Social returns come from showing and sharing the asset with friends and relatives. Finally, heritage returns are achieved by investors, which acquire collectibles for their heritage value, these investors enjoy owning them and want their descendants to enjoy them too, which makes them reluctant to sell. The different motives differ according e.g. to the geographical region and the asset class.

Investing in fine wine is by nature a social investment, since the owner of the asset will gain return from the investment by consuming the bottle, and presumable a larger return by sharing it with someone. 69% of the collectors enjoy sharing wine with friends, which is the highest percentage of social return on any asset class. Number two is classic automobiles (43%) followed by fine art (38%). Classic automobiles (53%) and fine art (39%) are the leading collectibles when comes to showing off to other people. Wine collections do not have the same "show off effect", since just 23% of wine collectors likes to show their collections off to other people. A similar trend can be seen when it comes to gaining respect – just 10% of collectors believe that a wine collection gives them respect, whereas 33% of the classic automobiles believe that.

Since wine is an experience good with social features, or a luxury, the heritage motivation is not applicable for investment in fine wine. Just 15% of collectors own fine wine in order for it to be enjoyed by children/grandchildren, and only 10% thinks that it is part of the family values and culture. This makes it differ from other collectibles such as antique furniture, fine art, and jewelry, which mainly are driven by the heritage motivation; hence they can be enjoyed from one generation to another.

Investing in wine due to financial motives is rather uncommon – only 10% collects wine for pure financial perspectives. Only rugs have a lower score (6%). The same is applicable when it comes to wine as a security against other investments (7%). On the other hand investments in precious metal is mainly driven by financial motives.

Fine wine as a luxury or collectible is characterized by its **authenticity**, **scarcity**, and **prestige**. As mentioned in chapter 3.2, then fine wine is concentrated around a few regions and producers, where the most famous are located in France.

Authenticity is achieved by long traditions and history, the same vines and production methods have been used for generations and the unique history is impossible to replicate. The French producer Chateau d'Yquem has "400 years of passion", Chateau Latour dates it history back to 1331, and the estate of Chateau Lafite Rotcshiled was the property of Gombaud de Lafite in 1234. (yquem.fr; chateau-latour.com; lafite.com; 2015). Wars have been fought, kingdoms have fallen, technologies have developed, but these producers still use the same soil and produce the same kinds of wine.

The production of fine wine is limited to classified areas like Bordeaux, Bourgogne, and Champagne, which have been unchanged for centuries. Further, the producers only have the soil belonging to the estate, meaning that it is impossible to increase the output significantly. Chateau d'Yquem can only produce from the 188 hectares belong to the estate, besides that some producers only produce in the best vintages, meaning that the poor vintages are sold under other labels. This creates a scarcity of the fine wine hence the production cannot be increased if the global demand increases (European Business Review, 2015).

Fine wine is further associated with prestige. Owning a bottle of rare classified Bordeaux from an extraordinary vintage creates prestige among wine aficionados that can talk for hours about the history of that bottle and what it might taste like. Further, the luxury of uncorking a rare bottle at a gourmet restaurant shows social status and symbolizes success, wealth, and lifestyle.

3.5. Who invest in wine?

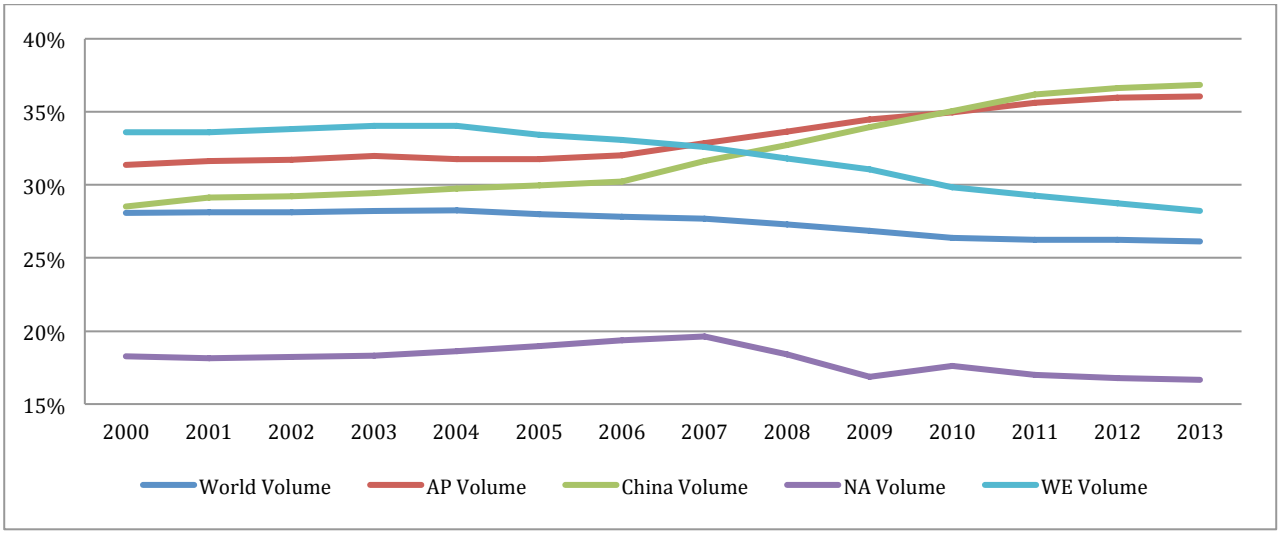
There are three kinds of buyers of wine: The investor, the collector, and the consumer. The pure investor is relatively new in wine. As the name indicates the investor is a person or fund that purchase the wine, with the perspective of selling the wine for a higher price at a later stage in time. The investor has in particular emerged during the last decades where new technologies have made wine trading less costly and more liquid. This will be discussed further in section 3.6.

The collector is as the name indicates a person, wine club, or company that purchase wine as a part of a collection, either for later consumption, tasting, or simply for the joy of collecting. This kind of investor typically buys the wine young, store it until maturity where half of the collection is sold in order to finance the kept wine and new purchases "buy two, sell one and drink one". The collector is normally the most wine passionate of the three, which gain joy from talking about the collection, the history of the wine and about future and past tastings. According to Barclays research (2012), then the typical wine collector is a HNWI, usually a senior manager of large company, entrepreneur or a professional financial worker. He holds around 12% of his wealth in treasures and collectibles including 2% in wine. There is a large probability that he owns a classic automobile as well. The investment is made from a social rather than a pure financial perspective; hence, 39% of the wine collectors view their collection as priceless.

The consumer purchase the wine with the objective of consumption in the near future, this can be an average wine but also a luxurious fine wine. The consumptions can be at a restaurant, for a tasting, or simply just for the joy of the consumption. According to Oxford Companion to Wine then the investor is typically European, the collectors American, and the consumers Asian (Robinson, 2002). This is a very strict distinction, however many new rich are purchasing wine in order to consume it, due to its prestige and social features as discussed in the chapter above.

These different purchasing habits can be noticed in the on-trade consumption on the different markets. In China and the Asian Pacific region the on-trade consumption is higher than any other market, meaning that people enjoy to consume wine at restaurants, pub, clubs, and hotels – public places – both for the immediately enjoyment but also for signaling social status. On the other hand North America has the lowest on-trade consumption compared to total consumption, meaning that much of the wine in the region is bough for investment, collection or enjoyment in private.

Figure 3-1 On-trade as percentage of total market volume



3.6. How to invest in wine

Investment in wine can be done either directly or indirectly. The direct way is to buy the actual bottles, store them and later on sell them, for a higher (lower) price in order to achieve a capital gain (loss). Indirect investment in wine can be done either through specialized wine funds that buy and sell the bottles or by investing in wine companies' stocks, assuming that the stock price is correlated to the performance in the wine market. The advantages and disadvantages of the different methods will be analyzed in depth. The best method varies from the individual investor's needs, knowledge, and risk preference.

3.6.1. Direct investment in wine – investment in actual bottles

Buying and selling IGW bottles can be done in two different ways. The primary market is called: *En Primeur* (Wine Futures), where the buyer purchases the right to a specific wine before it is bottled. The secondary market is where the buyer purchases the actual bottles with instant delivery either from a wine merchant or through an auction. The following section will highlight the advantages and disadvantages of the two markets.

3.6.2. Primary market – *En Primeur*

"*En Primeur*" is French for "as being new". In the world of wine it means that a consumer is buying a specific wine in a defined vintage before the release of the actual bottle, in other words a future contract on a defined wine. This system has been around since the early 1920s and has gained the public's attention up through the 1970s and 1980s (Ecep, 2014). The system works in the following way: Every spring, barrel samples from the previous year's harvest are tasted by the leading wine critics, who give their comments and scores for the quality and the potential of the wine and the vintage in general. The producers release a portion of the harvest, also called a *tranche*, for being sold as *En Primeur*. The buyers of the *tranche* are wine brokers who have long-term contracts with the producers, making them obliged to buy every year regardless

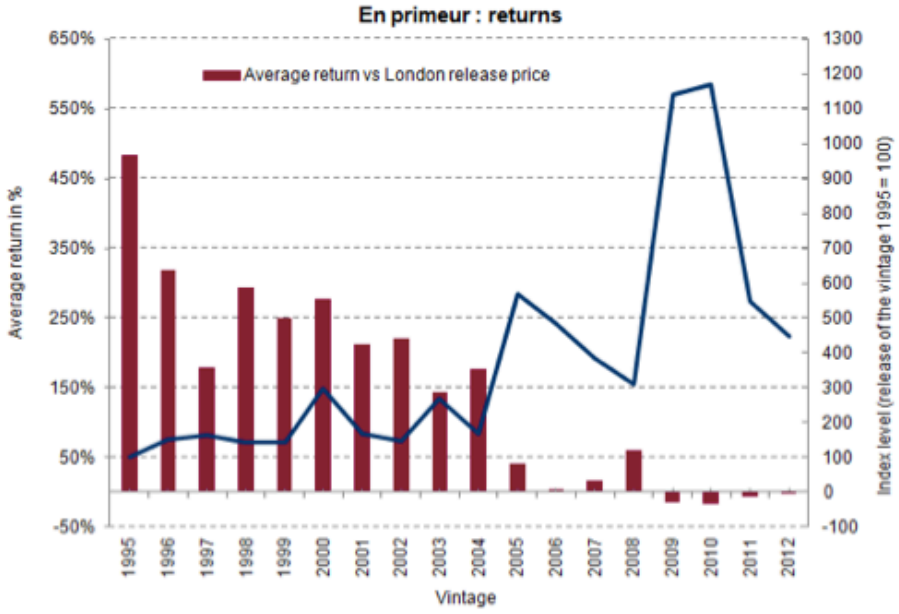
of the quality of the vintage. The wine brokers sell the contract to a merchant, which sells it on to the end consumer or investor.

This chain of transactions basically moves risk from the producer to the consumer/investor, and cash from the consumer/investor to the producer. The producers are the most obvious beneficiaries of the system; wine production and ageing of the wine ties up a lot of capital – this can be reduced by selling a product in production for cash prior to the delivery. *En Primeur* is therefore a cheap form of financing for the producers. Further, the contract with the wine brokers can be seen as a hedge against bad vintages for the producers. The broker, as the middleman, is in charge of the distribution and marketing of the wine and for this transaction a spread is charged (typically between 15-20%). Finally, the investor/consumer buys the future contract under the belief that the price will rise when the wine is released on the market. The investor/consumer further benefits from knowing the track history of the bottle, which minimizes the risk of fraud and bad storage.

The risk for the broker is the obligation to buy a minimum number of bottles in bad vintages, in order to keep the right to buy in good vintages and to keep the good relationship with the producer. Another risk for the broker is a low demand for less attractive vintages, which can lead to increasing stock costs. The risk for the investor/consumer is that the actual price for the wine when it is released on the market is lower than the price paid *En Primeur*, leading to a financial loss when the wine is delivered. A further disadvantage for the consumer is that it might not be possible to buy the desired amount of bottles in great vintages, due to the high demand (Decanter, 2014).

Studies on the pricing of *En Primeur* show that the latest years have been the sellers' market. Every vintage since 2008 has underperformed, meaning that the release price has been lower than the *En Primeur* price (Liv-ex, 2014a). This has led to an increasing pressure on the brokers, thus their balance sheets are growing (due to growing stocks) and the demand is declining. Further, the buyers are losing faith in *En Primeur* as a good investment hence the producers have increased prices dramatically since 2004 and squeezed most of the profit out of the *En Primeur* market.

Figure 3-2 *En Primeur* price index and return (Source: Liv-ex)



3.6.3.Secondary Market – Merchants and Auctions

This section will describe the different ways of buying wine on the secondary market such as auctions and wine merchants. It will further analyze the pros and cons of the different channels; however, country specific regulations or taxations will not be included in the analysis.

Buying IGW from a fine wine merchant is an easy way to acquire a wine asset as the transaction takes place like any other retail transaction. The merchant typically offers a range of the latest vintages to listed prices and delivery takes place instantly. This means that an investor knows exactly what he is buying and at what cost. The fixed price makes the transaction calm, compared to trading stocks or buying wine on auctions. Several merchants offer storage of the wine under perfect conditions, meaning that it is possible to make a transaction by just calling or e-mailing the merchant. A further benefit of buying from a merchant is the possibility of knowing the wines track record. Since the merchant typically trades with a number of suppliers who's business it is to trade with importers and/or brokers, all is documented, meaning that it is possible to track the movement of the wine, which is a benefit both in terms of maintaining the correct storage conditions and preventing counterfeit bottles.

The disadvantages of trading IGW with a local wine merchant is first of all that the prices tend to be higher due to the many middlemen and due to the lack of local competition. Furthermore, it might not be possible to find the desired bottles or quantities, both from younger vintages but particularly from older vintages.

The Internet has increased the transparency on wine prices; sites like wine-seacher.com have made it possible for consumers and investors to compare prices on specific bottles from merchants all over the world. This is a great advantage for the investor; however, it leads to less loyalty to one specific merchant, meaning that the benefits from trading with a wine merchant discussed above will be less applicable. Another advantage of trading wine on the Internet is that a series of wine brokers have established online platforms where it is possible to trade IGW. The same broker will also offer storage, meaning that the delivery will not take place physically, which makes is possible to trade wine more like trading stocks, bonds, or commodities.

The increased possibilities of trading online have created an interesting market for scammers. Trading in wine is an unregulated market, meaning that principally anyone can set up a website and offer IGW to attractive prices. The investor therefore risks purchasing a wine that does not exist or a wine that is a counterfeit. Less serious disadvantages of trading from merchants online are the lack of personal due diligence and the possibility of buying incomplete cases.

The other player in the secondary market is the auction house. Buying wine on auction has been common for decades and the big auction houses like Sotheby's and Christie's have special wine departments; however, it is also possible to trade wine on many smaller online and offline auction houses. The thrill about auctions has attracted mankind for centuries, and the whole idea of making a bargain is also applicable for wine. The main advantage of buying wine on auctions is the access to rare wines from great vintage. However, the disadvantages of the auctions are many – the main risk is buying counterfeit bottles. The number of counterfeit IGW on the market have increased along with the wine prices throughout the last decades, therefore many auction houses use specialized wine agents to detect potential fraud bottles before they go on auction. The pricing of the bottles might also lead to become a disadvantage for the investor; first of all the auction houses typically charge a 10%-25% commission for both seller and buyer (Sotheby, 2013). Second, the occurrence of auction fever might lead to prices much higher that the investor estimated - consequently the bargain disappeared. Another disadvantage of the auctions is the labor intensity involved; it is required to research which lots and bottles that are on auction when and where, and as always the investor is not sure to get the actual bottles for the desired price.

3.6.4. Indirect investment in wine – funds and stocks

There are two indirect ways of investing in wine. The more direct of the two is to invest in a fund, which then invest in the actual bottles. The second option is to invest in firms that operate in the wine industry, such as producers or merchants. This section will highlight the two indirect ways of investing in wine and analyze the pros and cons of them.

3.6.5. Wine Funds

A fund investing in wine is a relatively new phenomenon, started around the millennium, the first wine fund, Ascot Wine Management, started in 1999 (FT, 2011). The market is estimated to be small with no more than 20 registered funds, which are less than 10 year old, mainly located in Europe, with a few in Asia and USA (FT, 2013). In 2011 the total markets for wine funds were estimated to worth £150-200m (FT, 2011).

The advantages of investing through a fund are several. The first is diversification; the fund will invest in several different cases from different vintages and producers, where the personal investor typically just can afford a few. Expertise and convenience are other advantages, the funds have experts to follow the wine market daily, they have subscriptions on all the magazines which give access to the latest ratings, which is both costly and time consuming for the individual investor. Finally, the fund will take care of the storage and delivery, meaning that the individual will not have to worry about the due diligence and the storage conditions.

Investing through a wine fund also has a number of disadvantages. The different funds change fees for their management and returns, typically a 1.5%-2% management fee, a performance fee between 10% and 20%, meaning that the investor might lose money if the fund do not have a return higher that the fixed fees By investing through the funds the investor have no-control over the portfolio and own preferences and believes are not taken into account in the investment. Finally, the investor losses the "show-off effect" where the investor can tell about the specific IGWs he/she owns and show-off the bottles to relatives and wine enthusiasts. The performance of selected wine funds compared to the Liv-ex Fine Wine Investable can be found in Appendix B.

Due to the lack of regulation, the inefficient transparency on the pricing, and the illiquidity of IGW there exist several examples of fraud and failing funds. The most common cause is lack of liquidity, when the markets experience poor performance, investors want to liquidate their positions, meaning that open ended wine funds are holding illiquid assets (IGW) funded with short-term capital (FT, 2013; Thinkadvisor, 2013). Vintage Wine Fund, once holding more than $100m ran out of cash in 2013 and was forced to liquidation (NYT, 2014; FT, 2013). Ascot Wine Management, the first fund, faced liquidation only 5 years after its launch, mainly because the assets were peripheral to the core IGW and therefore even more illiquid (FT, 2013). Luxembourg based Nobles Cru is another example of a failing fund, once the world's largest with assets worth €109m, used alternative pricing methods instead of following the widely used Liv-ex index. They claimed that their wines were more rare than the standard IGW to give higher valuations (FT, 2013). Lastly, Bordeaux Fine Wine can be classified as a classic "Ponzi Scheme" where the invested money was used to pay salespersons and payoff early investors, the funded faced a shortfall of £12m (Telegraph, 2014).

3.6.6. Public listed wine related firms

Investing in wine related firms on the stock market is an indirect way of investing in wine. There exist a range of listed firms that operates in the wine industry. Investing in wine firms as an alternative to the actual bottles is based on the assumption that when the wine prices rise, the profitability of the firms increase as well.

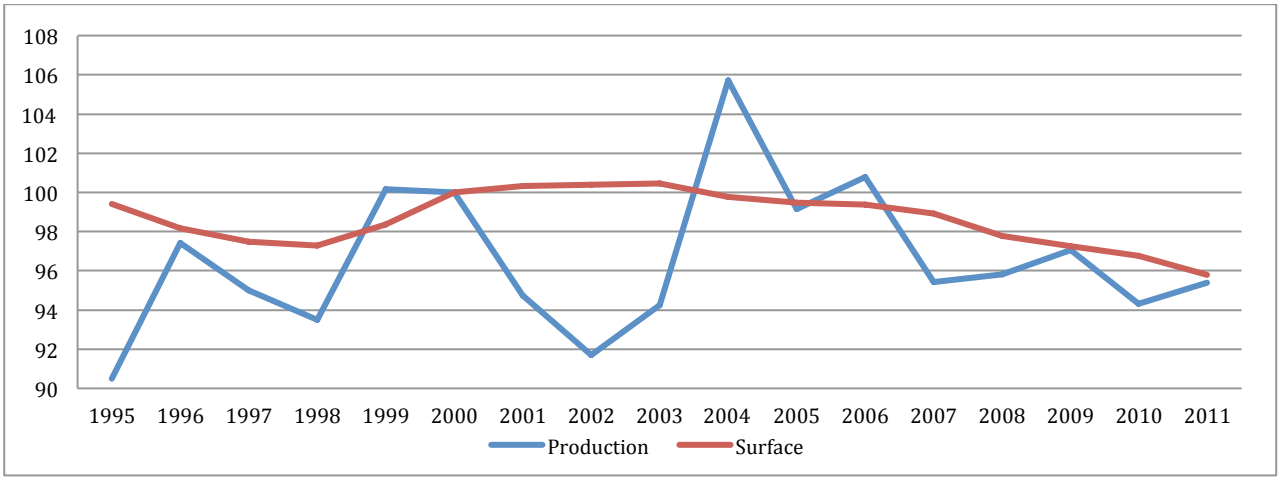
The benefits of investing in these firms are that the transaction costs are low and the liquidity is high, even though some of the firms are illiquid compared to the general stock market. However, very few of the producers behind IGW are listed on the stock market, meaning that an investment in the listed wine firms would be like investing in a mass-producing cars producer instead of buying the actual high-end vintage car. Other shortfalls of investing in the wine related firms are that management decisions influence the performance of the firms. Further many of the largest wine firms are conglomerates, which are not only operating in the wine industry but in a broader brewery or luxury industry. Well-known firms like Altria Group (former Philip Morris Companies Inc.), LVMH, and Pernod Ricard, own some of the big wine brands: Chateau Ste. Michelle, Dom Perignon, Chateau d'Yquem, and Pierre Jouët. However, just a small percentage of the firms total revenue comes from wine related activities. 2% of Altria Group and 14% of LVMH's revenue came from wine related activities (LVMH; Altria, 2013). The performance of the listed stocks in the wine industry in comparison with the wine index will be analyzed in chapter 4.2.

3.7. The size of the market and the global supply

The world supply of wine has undergone some important changes throughout the last decade, and the trends are estimated to continue up through the next decade. The surface area of the world's vineyards has been decreasing since 2003, where it peaked with 7.88 million ha. It is in particular the old world (Europe) that is decreasing. Since 2000 Spain lost 16% of the surface, Italy 15%, and France 11%, on the other hand China grew with 87%, Australia 24%, Chile 16%, and Argentina 8%. The declining European producing is mainly related to the subsidiaries from the European Union. Through years the EU subsidized farmers' and wine growers' production, measured by produced quantity, which led to an overproduction of wine. Recently the EU has changed strategy and has in recent years paid farmers to uproot vineyards, leading to a significant drop of cultivated area.

The production of wine is volatile due to weather conditions, however, it follows the same trend: the traditional markets are producing less wine and the new markets more. The Chinese production grew with 43.92% between 2009 and 2012 and is estimated to become the world's largest wine producer during the coming decade (CWI, 2012). Other new world countries like Australia, New Zealand, and Chile have also experienced a rapid production growth during the last decades, driven by both consumer preferences and favorable weather conditions.

Figure 3-3 World Production of Wine and Cultivated Surface (Source: OIV, own creation)



In terms of IGW the supply is more static. The wine regions used for IGW are determined centuries ago and every square meter is planted with vines. Bordeaux has 113,000 hectares of *appellation controlee*[3] wine (Kumar, 2005) and the current number of suppliers of IGW worldwide is estimated to around 80-100 producers (Decanter, 2014b). The value of the IGW market is estimated to $4 billion a year (Liv-ex, 2011). It is unknown how much the number will increase in the future, when the new markets gain more experience and history, but every wine region will always have its own cult wines. There already exist several cult wines from California, Australia, and Chile, which are traded like IGW. Particularly, the Californian fine wine production caught the world's attention at the famous "Judgment of Paris" tasting in 1976. Where fine wine merchant Steven Spurrier organized two blind tasting to compare the best red and white wines from France and California. At the time no one considered Californian wine as a serious contender to the fine wines from Bordeaux and Burgundy, but surprisingly the French judges rated California over France in both tastings. In the aftermath the tasting received criticism for both the heterogeneity of the grading system and for the small size of the data sample. However, the tasting was replicated in San Francisco in 1978 and in Paris in 1986 and both times the Californian wines won (Taber, 2006).

Weather is an important factor for the supply of IGW. As described in the literature review, several academics have conduced research on how weather effect on the quality of the wine. The years with a wet winter, a warm growing season, and a dry August and September produce higher quality grapes and thereby higher quality wine (Ashenfelter, 2008). The volatility of the weather conditions damage the supply of fine wine, hence poor vintages does not supply high quality wine, meaning that the market for wine investment will not receive new stock. After as series poor performing vintages in a row the supply of IGW is short, on the other hand when the market experiences several great vintages in a row, the supply will be above normal.

[3] French classification system that controls the geographical origin of wine and diary products (Robinson, 2002)

In addition to yearly weather fluctuations, then the trend of global warming has led to rising average temperatures. The full consequence of global warming effect of wine production is still unknown. However, the topic is a threat against the wine production in several famous areas. Already warm areas like Rioja, Southern France, Tuscany, and the Central Valley of California are facing an issue of too warm temperatures, where the grapes get too ripen and thereby contain too much sugar and too little acidity. Further the access to water is a rising problem, latest seen at the water shortage in California. Likewise the warm weather and limited access to water can lead to increased grape disease, which is a great threat to the production of wine and fine wine.

As new technologies emerge the knowledge and precision of every step in the wine production is rising. Romantics might criticize the emerging use of technologies in the wine production; however, the technological improvement both in the vineyard in the production does limit the failures and improve the quality. The new technologies help to develop the quality of the fruit, for example by new watering systems. It help to analyze the perfect timing of harvest, an example is tractors with cameras and GPS locators, which determine the perfect harvest period for specific areas of the vineyard. Further, better pressing machines and temperature control of the fermentation are some of the machines that have improve the quality of the work in the production (Economist, 2013).

It can be argued that the technological development has lead to rising quality in the wine production, decades ago it was assumes that there was two or three extraordinary vintages per decade. However, in recent decades it seems like one vintage after another is "the vintage of a century". This is illustrated by the rising number of good vintages (above 90 points) and extraordinary vintages (above 95 points) during the last decades. In the 70s there were 2 extraordinary vintages in the selected sample, this rose to 6 in the 80s, 11 in the 90s, and 24 in the 00s (The Wine Advocate, 2014).

Table 3-1 Number of good and extraordinary vintage per decade (Source: The Wine Advocate)

	70-79[4]		**80-89**		**90-99**		**00-09**	
Points	*>90*	*>95*	>90	>95	>90	>95	>90	>95
Bordeaux (St Julien/Pauillac/St Estephe)	*0*	*0*	4	1	3	2	5	4
Bordeaux (Pomerol)	*2*	*0*	3	2	3	2	6	4
Burgundy (Cote du Nuits)	*0*	*0*	0	0	3	0	4	2
Burgundy (Cote de Beaune)	*0*	*0*	0	0	2	0	2	2
Rhone (Chateauneuf du Pape)	*1*	*1*	1	0	5	3	7	4
Piedmont (Barolo)	*4*	*1*	5	3	6	3	9	4
California, North Coast (Cab.)	*3*	*0*	4	0	8	1	9	4
Total	*10*	*2*	17	6	30	11	42	24

Likewise the number of poor vintages (below 80 points) has been decreasing from 25 in the 80s to only 5 in the 00s. Whether it is a consequence of technological improvement, global warming, increasing optimism

from the critics, or just a coincidence, is unknown. However, trend is that more and more vintages are suitable for production of IGW and the supply new fine wine of is currently increasing.

Table 3-2 Number of poor vintages per decade (Source: The Wine Advocate)

	70-79[4]	80-89	90-99	00-09
Points	*<80*	<80	<80	<80
Bordeaux (St Julien/Pauillac/St Estephe)	*0*	2	3	0
Bordeaux (Pomerol)	*0*	2	1	0
Burgundy (Cote du Nuits)	*2*	6	2	0
Burgundy (Cote de Beaune)	*2*	6	2	2
Rhone (Chateauneuf du Pape)	*2*	5	2	1
Piedmont (Barolo)	*0*	2	3	1
California, North Coast (Cab.)	*1*	2	1	1
Total	*7*	25	14	5

Another way to notice the change in both the global weather conditions as well as the technological development is the new rising wine regions. South England seems to be the new region for sparking wine, where the limestone soil around Sussex, Kent provides *terroir* for quality sparking, and the total cultivated surface in the UK has increased from 196 ha in 1975, to 761 in 2004, and 1,884 in 2013 (Food Standards Agency, 2014). Likewise the white wines from the New York state and wines from China are stating to gain higher international reputation, most significantly when the Chinese, Ha Lan Qing Xue's Jia Bei Lan 2009 won the best Bordeaux Varietal over £10 International Trophy (Decentar, 2009).

Finally, the supply of IGW is influenced by the global stock of older vintages. First, consumption never stops, meaning that the stock of mature IGW is constantly decreasing. However, the pace is influence by the consumer confidence and the general economic environment. When the economy is booming the consumption is higher than in recessions. Second, natural disasters like earthquakes or floods, or the outbreak of a war can destroy old stock of IGW. However, professional storage in secured storage house and a stable political environment have decreased the risks. Third, the market might experience shocks, when a large amount of IGW is for sale. This is typically applicable if a wine fund or a large private collector is running into financial troubles and the whole stock is liquidated, this does not change the total global stock, but it increase the supply side and send the prices down.

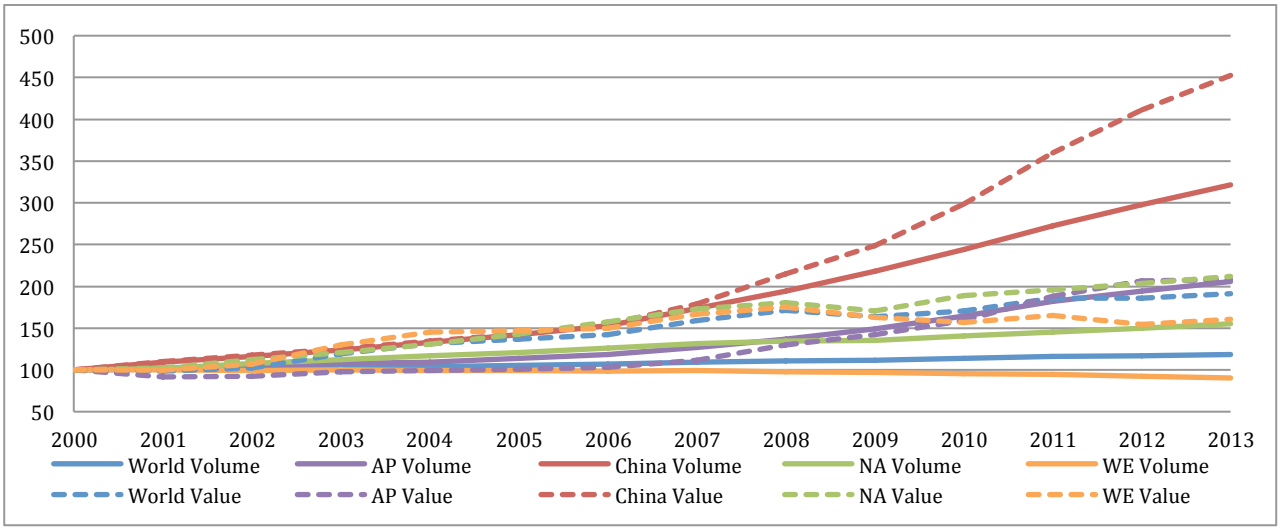
[4] Just the better vintages are included in the 70s (70,71,75,76,78,79). 72, 73, 74, and 77 are all considered as poor vintages in Bordeaux (Robinson, 2002; The Wine Advocate, 2014).

3.8. The major global wine trade trends

The world demand for luxury and wine has increased during the last decades. Particularly, the development of emerging economies has led to an increased demand for luxury products; hence consumers are looking for products that show status, this also counts for wine (Tvede, 2010).

The total world trade of wine was $318 billion in 2013 up from $166 billion in 2000, equal to a yearly growth of 5.12%. In terms volume the world traded 28 billion liters in 2013 up from 24 billion liters in 2000, equitant to a yearly growth of 1.29%. The graph below shows the total trade in volume and value for the world as well as selected areas and countries. It shows that China has outperformed all other regions both in terms of volume and value, with a volume growth of 221% and a value growth of 352% between 2000 and 2013. Western Europe is the only major region that underperformed the total world market, the volume felt with 10% in the period where the world grew 18% and the Western European trade value increased with 60% where the world market grew with 91%.

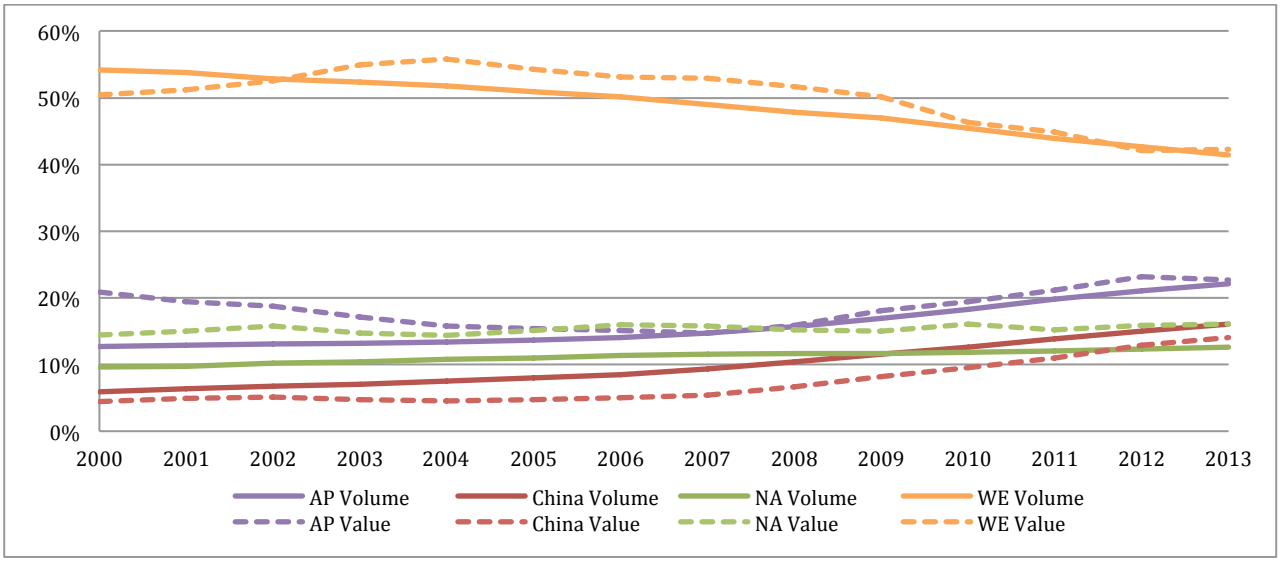
Figure 3-4 Wine trade in volume and value (2000=100) (Source: Euromonitor, own creation)



Even though Western Europe is performing below the world, then the area is still the largest both in terms of volume and value with a market share above 50% in 2000 and about 42% in 2013. The Asian Pacific region has the second largest market share around 20% of the world value. The Asian Pacific market share decreased from 2000 to 2007, mainly due to a poor performance on the Japanese market where the trade value decreed from $24 billion in 2000 (14.66% of the market) to $18 billion in 2007 (6.88% of the market). However, the Chinese growth from 2007 an onwards, led to an increase in the Asian Pacific market share from its 2007 low of 14.67% to 22.65% in 2013. North America has been stable throughout the analysis period with a volume growth from 9.61% to 12.62% and a value growth from 14.46% to 16.01%. This shows that the demand for wine is shifting, the oldest market, Western Europe, is stagnating both in absolute

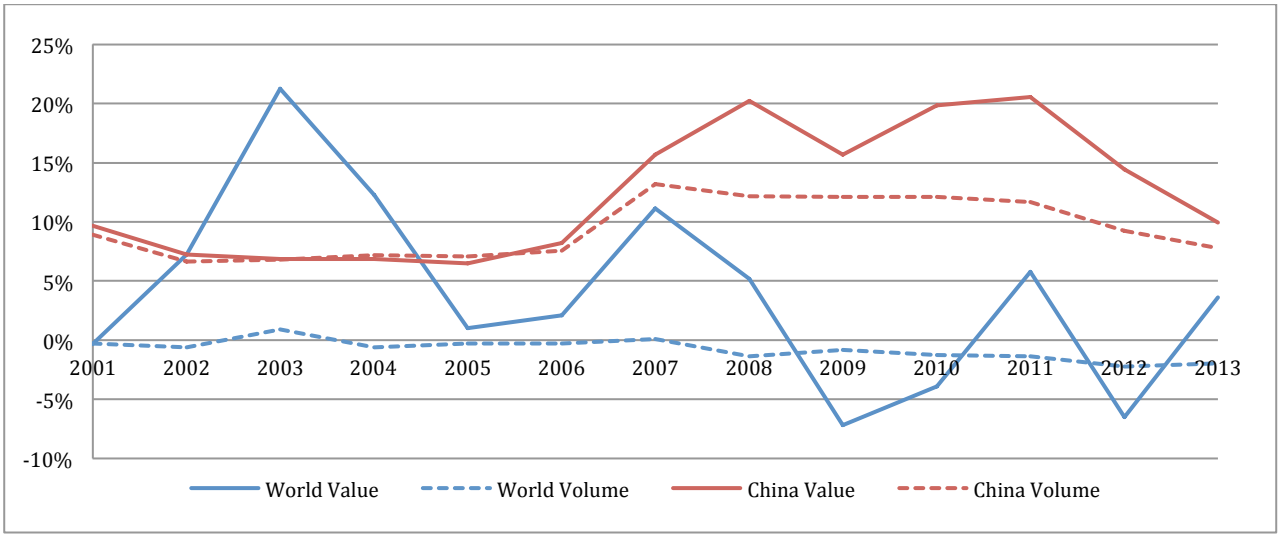
and relative terms. Another old market, North America, is growing with the world market, meaning that it is keeping its market share. The new growth market, China, is growing fast both in terms of volume and value, and their market share is increasing rapidly, from 5.44% of the world value in 2007 to 14.03% in 2013.

Figure 3-5 Market share of world market in volume and value (Source: Euromonitor, own creation)



The strong Chinese performance is shown in the graph below, where the annual growth in volume and value is compared to the world growth. Between 2007 and 2011 the Chinese wine trade value grew with more than 15% per anno, before slowing down to a 9.95% growth in 2013. In the same period the value of the world trade of wine fluctuated between 11.13% and -7.19%. Comparing the volume and value, shows that the Chinese value is growing faster than the volume, meaning that China is demanding more expensive bottles. This trend is also applicable on the world market, where the volume are stable in the begging of the period and stagnating from 2007 an onwards.

Figure 3-6 Yearly growth of trade in volume and value (Source: Euromonitor, own creation)

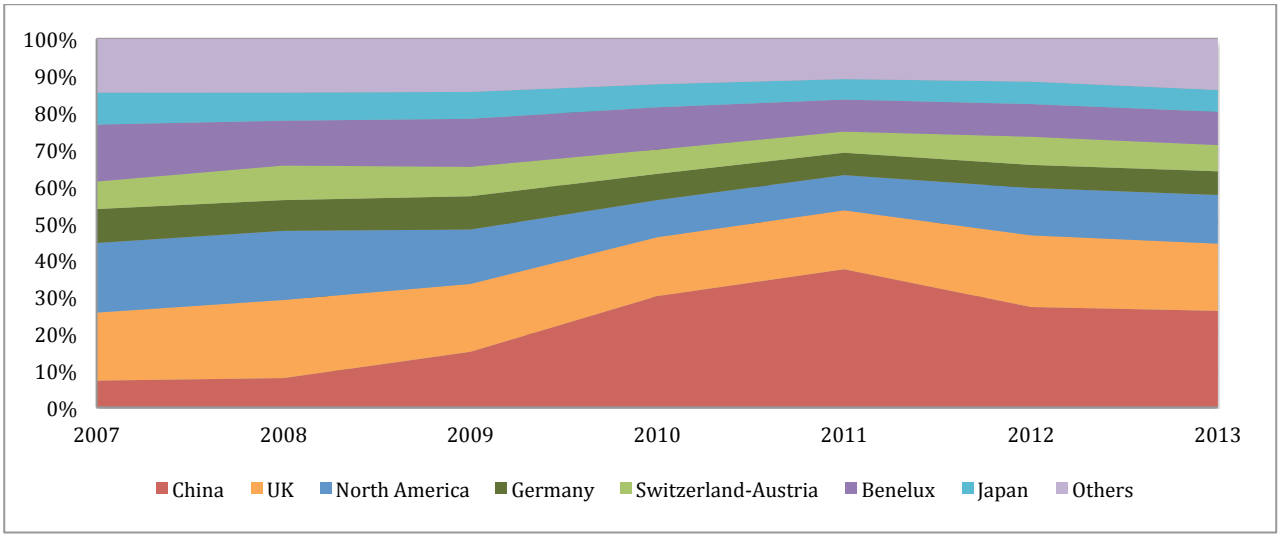


3.9. Trends on the Bordeaux export market

This section will analyze the export statistics of Bordeaux wines between 2007 and 2013. First the development in main export markets in total values and volumes will be highlighted followed by a more IGW specific analysis of the most expensive price level. Bordeaux's position as the main market for IGW makes the analysis of the Bordeaux statistic valuable in order to explain the price development of IGW. The data used for the analysis is collected by the Bordeaux wine industry's trade organization: CIVB (Conseil Interprofessionnel du Vin de Bordeaux).

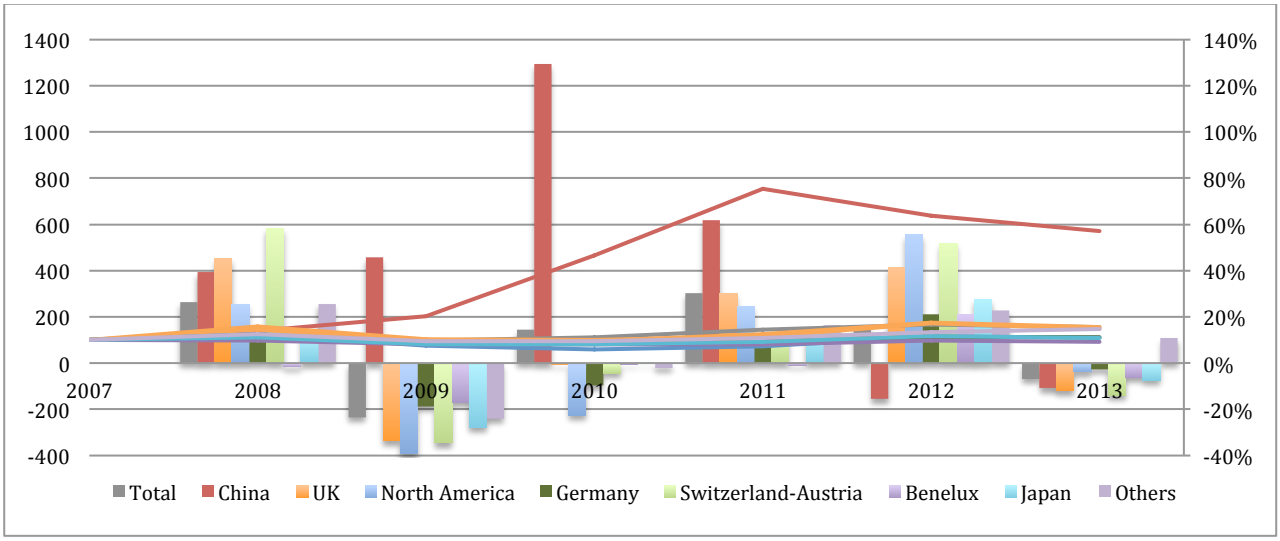
The total Bordeaux export market is reported to worth €2.05 billion in 2013 by exporting 282.5 million 0.75 cl bottles. The largest export market is China, which had a market share 26.11% of the export value, followed by the British Isles (18.31%) and North America (13.21%). The changes in the market share over the 7-year analysis period are illustrated in the graph below. It shows that China has moved from a position as a smaller market with at market share of 7.18% in 2007 to be the absolute biggest. China peaked in 2011 with a market share of 37.46% but has since then lost 11.35 percentage points. The British Isles and North America have traditionally been the two main markets. The UK has kept its market share around 18%, while North America has lost 5.59 percentage points. Benelux has experienced the largest loss of 6.48 percentage point form 15.52% in 2007 to 9.04% in 2013.

Figure 3-7 Market share of Bordeaux export value (Source: CIVB, own creation)



The trend in export value for the selected markets and the yearly growth are showed in the graph below. The value of the total export market grew with 44.73% throughout the period and peaked in 2012. The only year below index 100 was 2009, where the total market lost 23.63%, the only market that did not decrees was China. Likewise China was the only growing market in 2010, with a growth of 129.41%, which led to a total export growth of 14.46%. The only market that grew faster than the total export market throughout the period was China. The British Isles grew with the same pace as the total market and Benelux was the only market with negative growth.

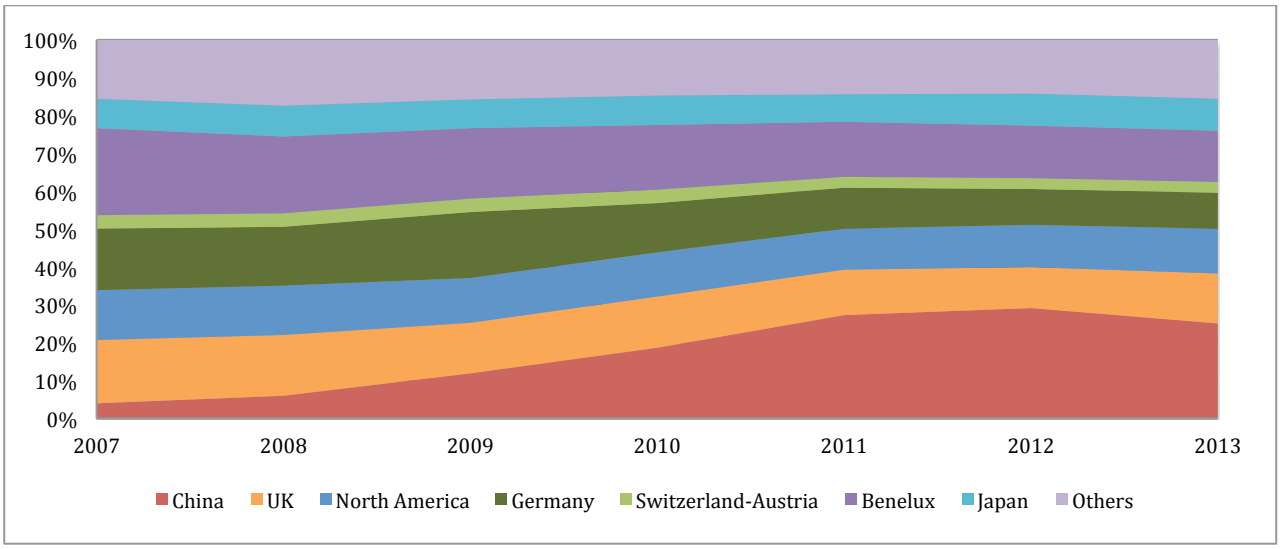
Figure 3-8 Bordeaux export in value and yearly growth (2007=100) (Source: CIVB, own creation)



In terms of volume China had 25.07% of the market share in 2013 followed by the Benelux (13.56%) and the British Isles (13.30%). The main markets changed significantly throughout the analysis period. In 2007, China was a minor market in terms of volume hence just 4.02% of the volume was exported to China.

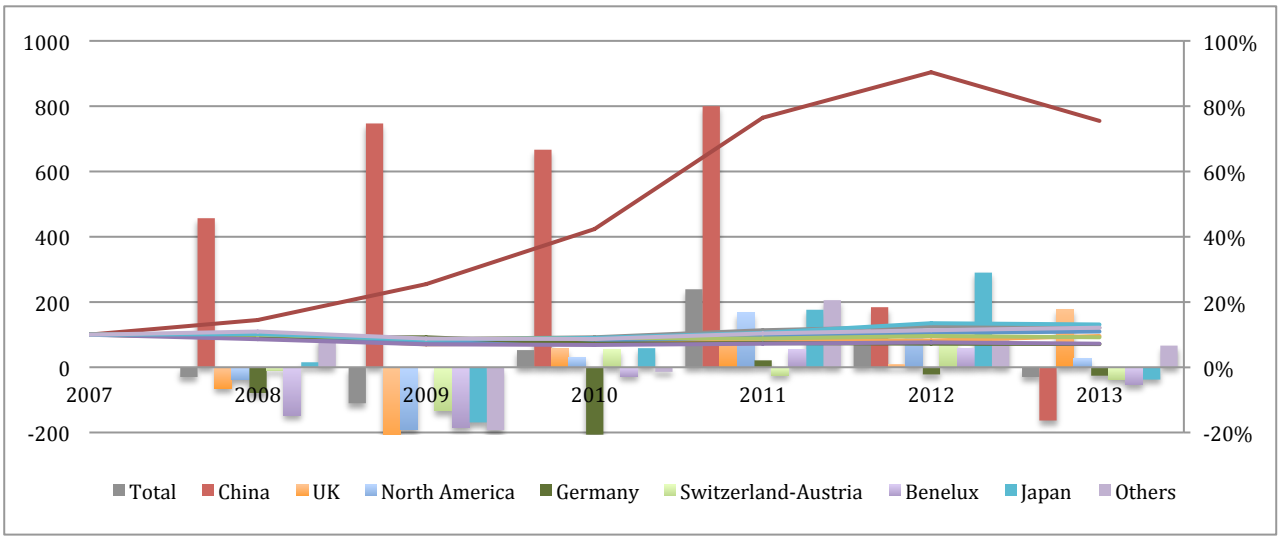
However, the country has increased its market share significantly throughout the period. All other main markets, except Japan (+0.11 percentage points), have lost market share, most significantly are Benelux, felt from 22.98% to 13.56%, and Germany, felt from 16.27% to 9.54%. Finally, North America's and the British Isles' market share decreased marginally throughout the period.

Figure 3-9 Market share of Bordeaux volume export (Source: CIVB, own creation)



The strong Chinese volume growth is clearly illustrated in the following graph. The total export market grew 21.10% during the period, where China grew with 655.86%. The growth was strongest between 2007 and 2011 where the Chinese market grew with 66.25% annually. The only other main market that had a positive return in that four-year period was Japan with a yearly growth of 1.21%. In 2013 China experienced the first negative growth rate of -16.38% the lost Chinese market share returned to the traditional market, the British Isles, which grew with 17.77% in 2013.

Figure 3-10 Bordeaux export in volume and yearly growth (2007=100) (Source: CIVB, own creation)



Combining the value and volume trends shows that China has established them as the largest export market both in terms of value and volume. The second largest export market is the British Isles, which kept its position around 18% in value and decreased a bit in volume from 16.10% to 13.30%, thus the price level in the exported bottles is increasing. The next three main export markets are Benelux, North America, and Germany which all are losing market share in terms of volume and value.

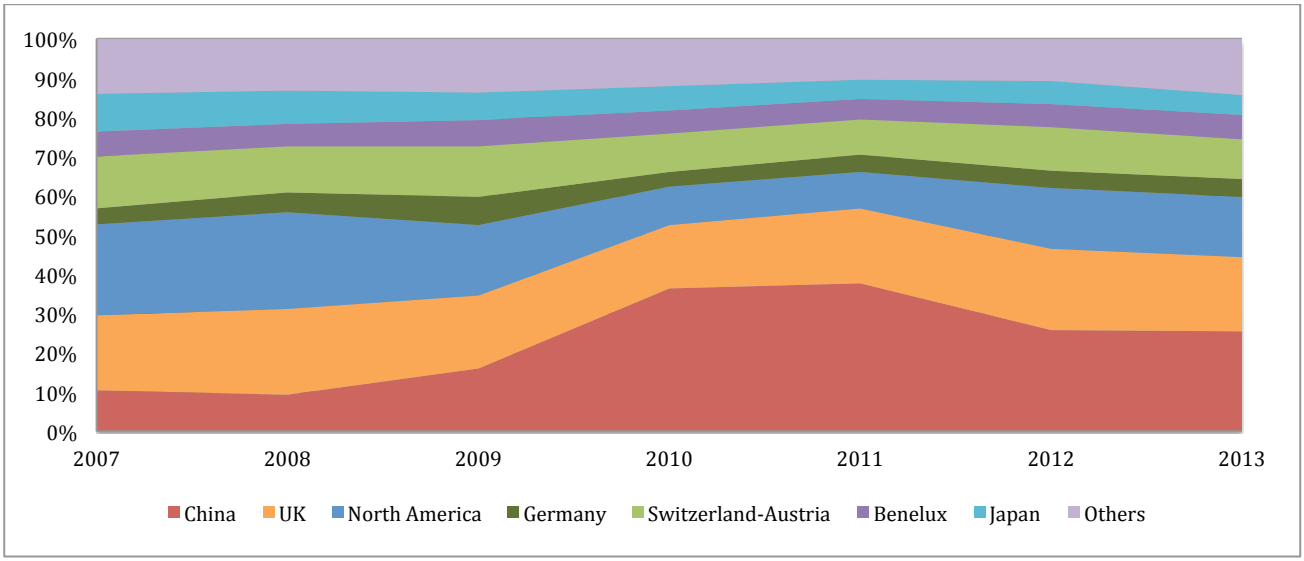
The average bottle price on the different regional markets provides information about what kind of wine the markets are importing, higher average price means higher quality wine. It shows that the average price per bottle increased with 29.25%, form 5.6 euros per bottle in 2007 to 7.25 euros per bottle in 2013. It further shows that Switzerland-Austria is importing the wine at the highest average price followed by the UK, meaning that these regions demand more expensive bottles. The average price in China has decreased throughout the period hence the volume of Bordeaux has increased faster than the value, thus China are buying more average bottles and not just premium. Germany and Benelux are bulk market rather than premium with prices significantly lower than the world average.

Table 3-3 Average bottle export price on selected markets (Source: OIVB, own creation)

	2007	2008	2009	2010	2011	2012	2013
World	5.60	7.30	6.29	6.84	7.19	7.54	7.25
China	10.01	9.58	7.99	11.00	9.88	7.07	7.55
UK	6.22	9.65	8.64	8.13	9.56	13.36	9.98
North America	8.04	10.47	7.86	5.91	6.31	8.69	8.14
Germany	3.17	4.02	3.26	3.71	4.00	4.95	4.95
Switzerland-Austria	11.55	18.47	13.95	12.65	14.78	20.68	18.44
Benelux	3.78	4.36	4.44	4.55	4.27	4.89	4.83
Japan	6.20	6.87	5.97	5.64	5.42	5.35	5.15
Others	5.29	6.12	5.76	5.72	5.51	6.17	6.42

A deeper look into the different price layers is interesting in regard to IGW. The CIVB categorize the export into 8 different price categories with +€22.5 per bottle as the highest level. The following graph shows the market share of bottles above €22.5. It illustrates that China is fastest growing, with a growth from 10.47% in 2007 to 25.49% in 2013, making China as the largest premium export market in 2013. North America was the largest premium Bordeaux market in 2007, however a loss of 7.94 percentage points throughout the period led to a position as number 3, the UK has been stable and kept the position as the second biggest market.

Figure 3-11 Market share of export of wines above €22.5 per bottle (Source: CIVB, own creation)



The table below compares the average price of the value of the exported premium wine on the different export markets. The average price in the premium wine segment has increased 65.63% from 52.36 euros per bottle in 2007 to 86.72 euros per bottle in 2013, meaning that the price of the premium wines is increasing faster then the whole Bordeaux market. China and the UK are the only markets that buy premium wines above the market average, particular the UK has established themselves as the main market for high premium wines. Switzerland-Austria and North America were both above the world average in table 3-4, however below in the premium price level. Hence the markets are buying a small amount of the lowest price levels and a lot of the mid and upper mid-level, but not as many very expensive premium bottles as China and the UK.

Table 3-4 Average price of wines above €22.5 on selected markets (Source: CIVB, own creation)

	2007	2008	2009	2010	2011	2012	2013
World	52.36	66.82	65.84	76.44	77.69	83.81	86.72
China	64.00	69.59	79.70	88.19	97.68	85.91	93.04
UK	64.88	80.63	85.74	94.82	88.61	112.41	113.96
North America	45.97	58.95	58.83	59.11	48.53	63.44	67.67
Germany	45.90	58.22	42.35	57.05	53.00	84.16	85.60
Switzerland-Austria	44.92	77.87	59.97	62.66	63.84	80.88	82.30
Benelux	42.11	56.97	54.04	61.94	47.99	72.90	74.17
Japan	49.20	53.59	53.98	49.51	45.55	51.32	56.87
Others	52.95	62.87	61.36	66.01	63.75	79.62	79.28

To sum up, the rapid Chinese growth has placed them as market leaders in terms of volume and value, as well as leaders on both the bulk and premium Bordeaux market. The increased demand has not just changed the ranking of the export market is has also led to average prices increases on Bordeaux wines, thus traditional consumers have searched for alternatives from other regions. Germany and Benelux were large

importers on the bulk market, however the higher prices driven by the Chinese demand has led to a significant loss of market share. On the premium market China and the UK are the main actors throughout the whole period. The price of fine wines is increasing, however the demand is still strong; hence the buyers either are investors who are speculating in further price increases or HNWI, which are buying for the luxury of consuming fine wine.

3.10. Overview of the fine wine market

This chapter has highlighted the main characteristics of the wine market, and defined that IGW is best wines, from the best produces in the best regions. The main regions for IGW are the historical regions of Bordeaux and Burgundy in France, nevertheless there exist a range of IGW from cult producers in California, Tuscany, Piedmont, Australia among others; however, the wines from Bordeaux are dominating the invest scene, due to its size, volume, liquidity, and ranking.

Fine wine can be categorized as a luxury and as a collectible. The buyers are categorized into the investor, the collector, and the consumer. Buying an expensive wine provides a social return and is associated with prestige and wealth. Consequently, there has been a rising demand from the "new rich", particularly from the emerging markets, which buy and consume wine in order to show social status and success. Thus, a larger share of the wine consumption in Asia is taking place on-trade, compared to the European and North American market.

Wine can be traded directly or indirectly. Directly is by purchasing the actual bottles, which is applicable for the consumer or collector, hence it provides the social return, the social status, and the prestige. The indirectly investment is either through a fund or by purchasing stocks in a wine related company, this type of investment does only provide a financial return, thus more applicable for the investor.

Throughout the analysis period the global supply of wine as been stable, though the European markets have decreased the output and the "new world"[5] has increased it. The most famous wines and the majority of the IGW is still European, however as new markets emerge new prestigious fine wines are produced, this is already seen in California and Australia, which have wines that are traded along with the fine wines from Bordeaux and Burgundy. However, on a global scale the IGW from France is still dominating the investment and collection scene. The supply is further affected by the changing global climate and the technological improvements. The rising temperatures and more extreme weather change the conditions for the traditional regions, meanwhile new regions are emerging. Further, the technological improvements help the grape

[5] In wine, the new world is used as a term for everything outside Europe (Robinson, 2002)

grower and winemaker to create a higher quality grapes and wines. The number of great vintage has been increasing significantly throughout recent decades, which increase the supply of IGW.

Finally, the demand side is analyzed. As the demand from the emerging markers has risen and the wine trade has undergone significant changes, especially China has moved from an insignificant player in the 80s to a main market both in terms of quality and quantity throughout the last decade. The Bordeaux region experienced a 44% growth in export between 2007 and 2013, where China was the main driver. The Chinese market share grew from 7.18% in 2007 to its peak of 37.46% in 2011, meaning that all other export markets lost market share in the period. Thus, China is the most important export market for Bordeaux followed by the USA and the British Isles. The average price of the exported Bordeaux wines grew throughout the analysis period and Switzerland-Austria is buying at the overall highest average price, however China and the British Isles are buying the most expensive fine wines.

The overview of the wine market helps the reader to understand the different motives behind and investment in wine. Further, the different market players have proven to change the historical global supply and demand significantly. The analysis of the major supply and demand trends through the last decade will be used as the fundament for the further analysis about the price development of fine wine.

4. The price development of wine

Pricing of wine is, like most other goods and services in the competitive market, determined by the theory of supply and demand. As described in the literature review in chapter 1.5, the quality of IGW is determined by several factors such as region, grape composition, weather conditions, and human intervention. Further, several other factors, such as expert opinions, branding, and the world economic influence the demand for IGW. The following section will calculate the return of fine wine between 1978 and 2014, and explain the underlying factors that have influence the price development. Further, the costs of storing and trading wine will be estimated, and finally, the wine return will be compare with the return of wine related stocks, to determine whether the listed stocks are a good proxy for an investment in wine.

4.1. Assumptions

For the analysis in this chapter and the following assumptions are made:

The Dow Jones Industrial Average Index represents the investment opportunity in stocks. The index is price weighted of the 30 large publicly traded companies.

The US Consumer Price Index (CPI) – all urban sample, is used to measure the inflation rate, and convert nominal prices to real prices.

Trading commodities, bonds, and stocks on the market has transaction costs. Hence the costs are relatively low it is assumed that there are zero transaction costs.

Trading IGW has both storage and transaction costs, which are estimates to be higher than the trading costs of stocks, bonds, and commodities. The costs will be calculated in chapter 4.4 However, in order to compare the returns between the different asset classes, to create general results, and not to violate the modern portfolio theory in chapter 6, it is assumed that there are no transaction and storage costs related with trading and storing wine.

This paper does not include tax in any calculations.

4.2. Collection of empirical data

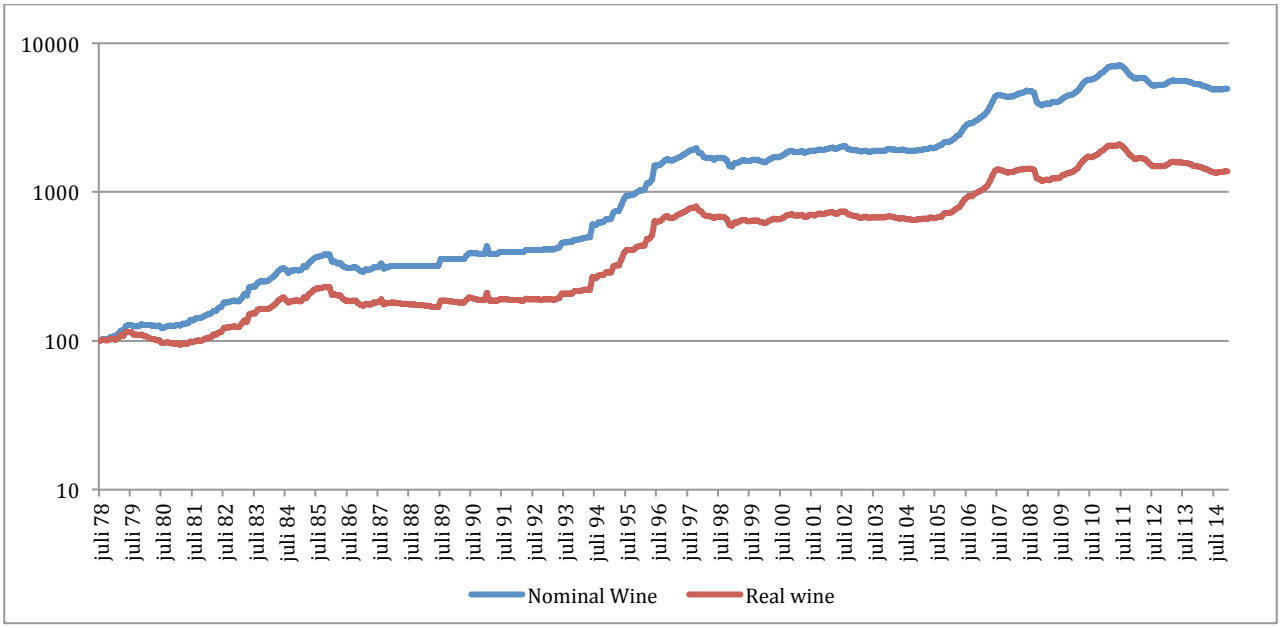
Throughout the paper empirical wine-pricing data is used, the data is collected from three different sources. The most recent data from 2001 to 2014 is from the Liv-ex Fine Wine Investables index, which consists of the 250 most traded Bordeaux wines from 24 different chateaus. The data from 1988 until 2001 is also calculated by Liv-ex. However, this index is based on historical prices collected from leading fine wine merchants. The data from July 1978 until December 1987 is collected through historical auctions prices from the major auctions in the UK, US, Asia, and Europe excluding sales taxes and communions. The data is based on the price development of the 5 first growths in Bordeaux in selected vintages. The observations from the three different sources are calculated into an index, referred to as the wine index. The technicalities can be found in Appendix C.

The data from Liv-ex is chosen hence Liv-ex is the world's largest and most influential fine wine exchange with more than 440 members in 35 countries. Liv-ex operates 5 different indices where Lix-ex Fine Wine Investables has the longest track record. Therefore Lix-ex Fine Wine Investables is chosen to represent the investment opportunity in wine in the period from 1988 to 2014.

4.3. The financial return of fine wine

The following chapter analyzes the return of investing in the actual wine bottles; the price development of selected IGW is tracked back to July 1978 and is shown in real and nominal value in the following graph.

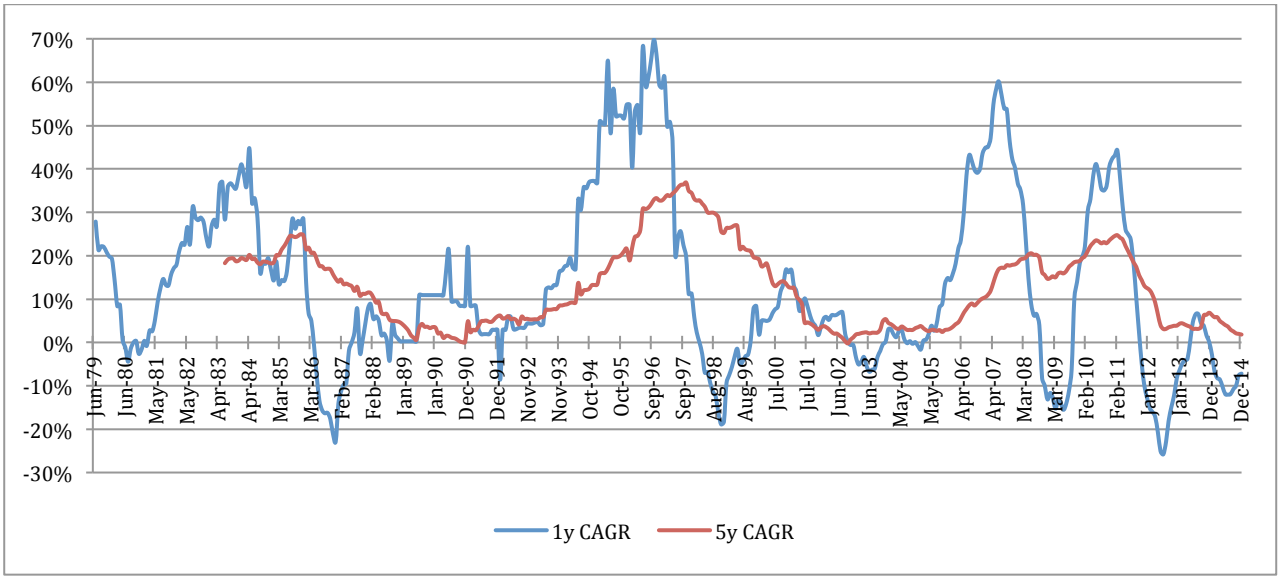
Figure 4-1 Wine price index nominal and real values (July 1978=100) (own creation)



The figure shows that the price IGW rose with 4789% in nominal terms from July 1978 to December 2014, and peaked in 2011 at index 7090. In real US inflation adjusted terms the price rose 1251%. This is equal to a nominal annual return of 10.67% or a real annual return of 7.19% throughout the 36.5-years analysis period. The data table of the graph can be seen in Appendix C.

The figure shows four strong bull periods, the first from February 1981 to November 1985, where the nominal price increased 202% in nominal value or 25.91% pro anno, then from May 1991 to October 1997 where it surged 410% or 28.51% a year. In the third it increased 152% from October 2004 to June 2008, equal to 27.91% a year and finally the last period from December 2008 to June 2011 where it increased 86% or 27.29% pro anno. Likewise the wine price had four bear periods, typical shorter corrections. The first was from the peak in November 1985 to January 1987, where the price decreased 23%. The second correction was a 24% decline from the peak in October 1997 to December 1998. The third was a 20% price drop during 5 months form August 2008 to December 2008. The fourth was the longest from the peak in June 2011 the price declined 31% during 37 months. The price fluctuation is illustrated in the following graph, though the 1-year CAGR and 5-years CAGR, and the following paragraphs will describe the macroeconomic and wine related factors that have influenced the price movements of fine wine.

Figure 4-2 1-year and 5-years CAGR on fine wine (own creation)



The power of Robert Parker is often discussed in the wine world, some loves him other hates him. Independently of the individual opinion, then there is no doubt about that his 100 points can move demand like no one else. Parker stated his career as a wine critic in 1975 and his newsletter gained popularity up through the following years. He got the world's attention when he opposed the major critics at the time and rated the 1982 Bordeaux vintage as "superb", today the 1982 vintage is still considered one of the greatest and traded at a premium price (WSJ, 2015). His influence, particularly in the US, is one of the factors that increased the demand for wine on the American market. The American wine consumption more than doubled from 1950 to 1980. Along with the new wine drinking trend population growth also contributed to increasing American demand (Anderson, 2004). The Yuppies used wine as a luxury product to show prestige at fancy restaurants and trendy wine bars. This made the American market the main export market outside Europe in the 1980s, thus the strong American economy had an influence on the rising price of IGW, which rose 204% between 1981 and 1985. The weakening of the economy in the late 1980s led to a drop of the dollar exchange rate and to a crash of the stock market on Black Monday, October 1987, thus a drop in consumption and imported goods, which weaken the demand for expensive European fine wine. This influence can be spotted on the correlation between the exchange rate on the American dollar to the British pound and the wine index. On a two-year return basis, between January 1981 and December 1989, the correlation was 0.821.

The slowdown of the American economy opened up for new markets. In the 1990s the interest for Bordeaux grew on the Asian market, particularly in Japan, Hong Kong, and Singapore. The Japanese wine consumption grew from 1 liter per capita in 1993 to 3 liter per capita in 1999 (Anderson, 2004), and the Japanese sommelier, Shinya Tasaki's, world championship in 1995 further increased the interest for wine.

This increased Asian demand can be spotted in the wine price, which rose 410% between 1991 and 1997. However, the weakening of the Japanese Yen between 1995 and 1999 and the Asian financial crisis in 1997 damped the demand. This was one of the main factors of the wine price correction between October 1997 and December 1998. The correlation between the wine index and the main Japanese stock index Nikkei 225 was 0.671 on a two-year return basis between January 1991 and December 1998.

In the mid-2000s the wine market started to show strength again, this time led by another Asian market, namely China. China made its big entrance on the 2005 *En Primeur* market. 2005 was a stunning 100 points vintage and by many compared to the 1982 vintage. The *En Primeur* prices skyrocketed to an all-time high, about three times higher than the 2004 vintage. The mid 00s was also a booming period for new technologies, which made wine investment more liquid. Further the establishment of new wine funds boomed in 2006 and 2007 where the fast growth on the global stock markets led to a growing investor appetite for alternative investments. The investment in wine was further stimulated by the new legislation in Hong Kong, which removed all duties on wine, making Hong Kong a free wine port. These factors lead to and 151% increase on IGW between 2004 and 2008.

In October 2008 the 1-year CAGR on wine turned red, this was the time of the crash of the Lehman Brother and the meltdown of the global stock markets, investors liquidated their holdings and the appetite for fine wine consumption dropped. Differently from the stock market the wine index rebounded fast, already 14 months after the bottom in 2008 the index was at a new all-time high, the growth was led by Chinese demand. When the 2008 vintage was released China was the largest buyer of Bordeaux, the "above average vintage" was highly demanded due to the luck associated with the number 8 in the Chinese culture. *Lafite Rothschild*[6] added an engraved a red image of the Chinese symbol for number eight on the bottle, making the bottle a rare collection item and the price rose to more than double of the other first growths. The 2008 vintage was followed by the two extraordinary vintages, 2009 and 2010, where the *En Primeur* price almost quadrupled from the 2008 level. The market boomed again and peaked in June 2011, where the high prices release prices form the procurers slowed down the world demand. Prices started to decline and it was enforced by the new Chinese regulation, which banned public gift giving, this in particular hit the luxury industry, and the fine wine price has declined 31% since the peak in 2011.

To sum up, an investment in fine wine has provided the investor with a nominal financial return of 10.67% per year, and a yearly inflation adjusted return of 7.19%. The returns has been relatively volatile through the

[6] One of the five first growths in Bordeaux. Consistently one of the most expensive wines in the world (Robinson, 2002)

analysis period with for main bull periods and four corrections or bear periods, currently fine wine is trading about 31% lower than its peak in 2011. However, a long-term nominal annual return above 10% is a good return compared to other asset classes. This will be further analyzed in chapter 6.

4.4. Costs of trading and storing wine

This section will estimate the costs of trading and storing wine. As described earlier, the costs associated with trading and storing wine are remarkably higher than the costs of trading and storing financial assets like bonds, stocks, and contracts on commodities. The following section will divide the costs into two categories. First the trading costs, which includes transactions fees and membership fees. Second, the importance of storage and the cost associated will be analyzed. The costs might vary from one investor to another, thus the results are not used in the general calculations of the paper, however, they are important to highlight.

Transaction costs on wine are higher than on traditional assets. Traditional auction houses charge approximately a 15% sales commission for both buyer and seller. However, the development of different online auctions has lowered the price. The worlds leading market place, Liv-ex, charges a 2% commission for both buyer and seller. In addition to the commission, Liv-ex further charges a £3.5 settlement fee per unit for the buyer, meaning a case of 12 bottles costs £42. This is approximately 1% of the value of a case of first growth Bordeaux and 2% on the average Bordeaux. This leads to total transaction costs for buying and selling of approximately 5% for a case of first growth and 6% for the average Bordeaux. Finally, Liv-ex charges a yearly membership fee of £1,500. Depending on portfolio size the investor can be better of going through a broker in order to trade on Liv-ex. In this paper it is assumed that the investor has a wine portfolio larger than £150,000, meaning that the subscription fee is less than 1% annually.

Wine needs perfect storage conditions in order to mature correctly. It is important to underline that not all wines are made for storage, a large majority of wines are made for consumption within one to three years and will not develop more delicate flavors through bottle ageing. The small fraction of wine made for storage is broadly the wines discussed in this paper, fine wines that can be used for collections, investment, and showing prestige. Wine should always be store horizontal and under good storage conditions including stable temperature, humidity, no light, no vibration, and no smell. These factors will briefly be highlighted in the following paragraphs.

Storage temperature is very important. Wine can both be stored too hot or too cold. It is recommended to store wine at a constant temperature between 10 and 15 degrees Celsius, if the wine is stored to hot during longer periods, it will develop “cooked” flavors like raisins and cocked fruit. If it is stored too cold (negative 4 to 8 degrees Celsius) the liquid can freeze and the bottles crack. During cooler storage (10-15 degrees Celsius) the wine develops slower resulting in more complex flavors (Dominé, 2004). Temperature

fluctuations are more damaging than a too high constant temperature, thus a stable temperature is important. When the temperature increases the liquid expands and when it drops it contracts, leading to over and under pressure that may draw oxygen into the bottle (Robinson, 2002).

Light is damaging the wine through the ultraviolet radiation, which can damage smell, taste, and color. The dark bottles filter the radiation, however it is not fully protected, thus storage at dark places is recommended. Humidity is important in order to protect the cork, if the wine is stored in dry conditions for years, the cork will dry leading to a leaking sealing to the wine, oxygen will thereby enter the bottle. Further it is believe that vibration will contribute to an acceleration of the storage. Finally, storage should take place in a "smell neutral" environment (Dominé, 2004; Robinson, 2002).

In addition to the storage requirements, insurance is also preferable due to the physical delivery. Hence most investors do not have access to the required storage conditions at home the most rational is to select a professional storage house. There exist several different storage options; the UK prices vary between £7.4 and £24 per case including insurance (jancisrobinson.com, 2014). Several storage houses additionally offer in bond storage, meaning that the stock is held free from duties and VAT, applicable for trading and international shipment. £9.00 annually per a case (12 bottles), leads to a yearly fee of 0.22% on average of the first growth price and 0.43% on average of the investment graded Bordeaux price (Appendix D).

The total costs of trading and holding wine are summarized in the table below and the calculations can be found in Appendix D. It is assumed that the storage and insurance costs as well as the membership fee will follow the development of the wine prices throughout the period, meaning that the same percentage rate can be used. The costs may vary from one investor to another; therefore an investor should calculate personal costs in order to achieve more precise conclusions. Due to the rough estimates and the aim to reach general conclusion, the costs will only be used in chapter 6.3.

Table 4-1 Costs of trading and storing wine

Annual fees	**First growth**	**Average Bordeaux**
Storage and insurance	0.22%	0.43%
Membership fee	1.00%	1.00%
Transaction costs		
Commission	4.00%	4.00%
Settlement fee	1.04%	2.00%

4.5. Performance of wine compared to stocks in wine related companies

This section compares the performance of the wine price with the performance of the public listed stocks having almost 100% of the operating activities in the wine industry. The aim is to determine whether the listed wine stocks can be used a proxy for the development of the fine wine prices, as discussed in chapter 3.6.6.

For the analysis the following four firms have been selected: Vina Concha y Toro (VCO) is Latin Americas largest wine producer and among the largest in the world, the firm is based in Chile but has activities in Argentina and California as well. Laurent Perrier (LPE) is a French company operating in the Champagne region. Vranken-Pommery Monopole (VCO) is a merger between two Champagne producers, with additional activities in Douro, Portugal and in the Mediterranean region. Willamette Valley Vineyards Inc. (WVVI) is one of the leading Point Noir producers in Oregon.

Table 4-2 Selected wine related stocks (Source: Bloomberg, own creation)

Name	Origin	Listed	Market cap ultimo 2014
Vina Concha y Toro (VCO)	Chile	NYSE	$1.4 billion
Laurent Perrier (LPE)	France	EN Paris	€370 million
Vranken-Pommery Monopole (VRAP)	France	EN Paris	€208 million
Willamette Valley Vineyards Inc. (WVVI)	Oregon, USA	NASDAQ	$28 million

The data used for the analyses consist of monthly observations between June 1999 and December 2014, meaning a total of 187 observations per asset. Monthly observations are chosen since the Fine Wine Investable index is reported monthly, further June 1999 is selected as cut off hence it is the first observation of LPE. In addition to the monthly observations the correlation matrix is also calculated on annual basis, under the assumption that fine wine is less liquid and responds to macroeconomic movements with a lag, further the volatility is calculated on an annual basis due to the illiquidity of the wine index. Along with the four individual stocks the Fine Wine Investable index (LIVEX) and the Dow Jones Industrial Average (DJIA) are included, in order to determine the individual wine stocks performance and correlations with fine wine and with the general America stock market. All data is downloaded from Bloomberg.

Figure 4-3 Performance of selected wine stocks and indices (Source: Bloomberg, own creation)

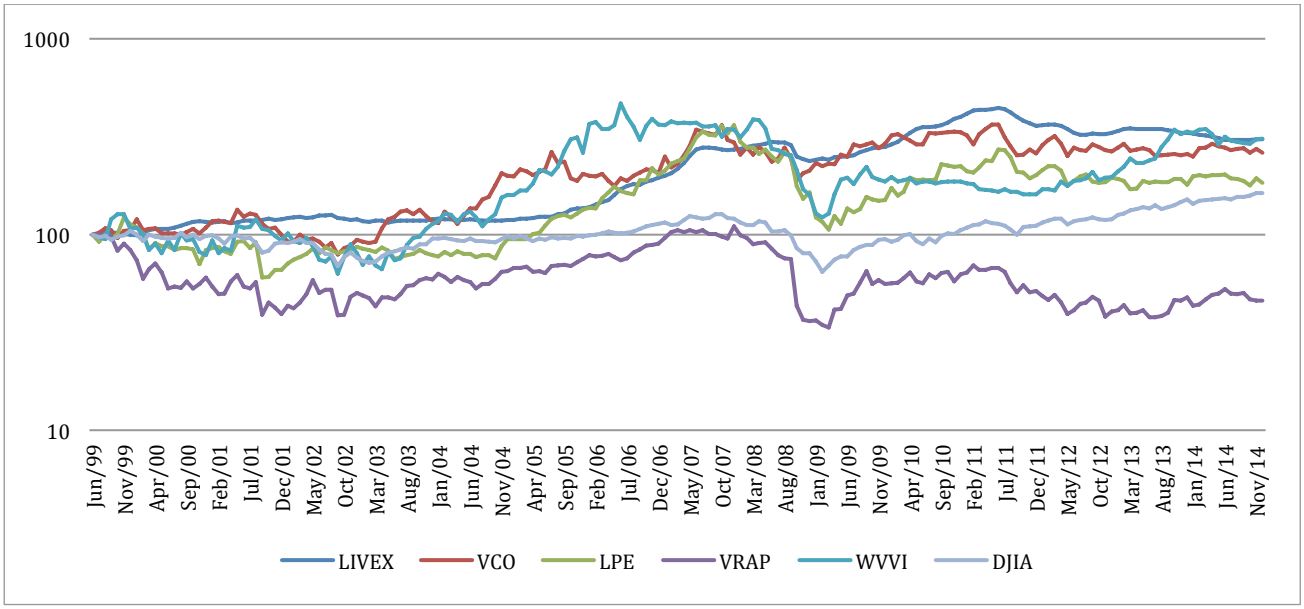


Table 4-3 Monthly and yearly correlation matrix of selected wine stocks and indices

Monthly	LIVEX	VCO	LPE	VRAP	WVVI	DJIA
LIVEX	1.0000					
VCO	0.1573	1.0000				
LPE	0.2430	0.3033	1.0000			
VRAP	0.2159	0.2951	0.4815	1.0000		
WVVI	0.1188	0.1114	0.2375	0.2639	1.0000	
DJIA	0.1484	0.3980	0.3420	0.4946	0.2872	1.0000

Yearly	LIVEX	VCO	LPE	VRAP	WVVI	DJIA
LIVEX	1.0000					
VCO	0.2786	1.0000				
LPE	0.7542	0.4479	1.0000			
VRAP	0.4751	0.5378	0.7058	1.0000		
WVVI	0.0705	0.2468	0.3752	0.4949	1.0000	
DJIA	0.2775	0.3959	0.4673	0.6759	0.5419	1.0000

Table 4-4 Risk and return of selected wine stocks and indices

	LIVEX	VCO	LPE	VRAP	WVVI	DJIA
Return yearly	7.19%	6.19%	3.92%	-5.00%	7.25%	3.11%
Volatility yearly	17.42%	24.30%	32.94%	31.10%	35.52%	16.05%
Dividends	0.00	8.45	11.73	13.31	0.00	0.00
HPR	206.56%	220.99%	116.90%	-28.27%	209.33%	62.46%
Return y incl. Div.	7.19%	7.48%	4.97%	-2.13%	7.25%	3.11%
Return per risk	0.413	0.308	0.151	-0.069	0.204	0.194

The calculations show that VCO had the highest holding period return (HPR) followed by WVVI and LIVEX. Fine wine had a lower return in this analysis period, compared to the period analyzed in previous chapter. The rest of the investment opportunities performed significantly poorer throughout the analysis period. VRAP had the worst performance with an annual loss of almost 5% (2.13% after dividends) throughout the 187 months. The DJIA had the second lowest return (3.11%). The annual standard deviation is used to determine risk. Fine wine and the DJIA had a significantly lower standard deviation than the individual assets, this might be the consequence of the diversification advantage hence both are indices containing more assets. The illiquid stock WVVI had the highest. The return per risk, which is the ratio of return over risk, shows that wine outperforms all other securities.

The correlation coefficient provides information about how two assets move compared to each other. The coefficient obtains values between 1 and -1, where 1 is perfect positive correlations and -1 represent a perfect negative correlation. A high correlation means that the investment moves together, therefore a security with a high correlation to fine wine will be a good alternative. On a monthly basis fine wine is uncorrelated with all other investment opportunities likewise any correlation between the other securities is relatively low, with the correlation between VRAP and DJIA as the highest (0.4946). On a yearly basis all correlations coefficients are higher (except LIVEX/WVVI) meaning that on a yearly basis the movements are more aligned than on a monthly. The highest correlated assets are LIVEX and LPE with a correlation on 0.7542 meaning that LPE is the best public traded security in the sample to substitute fine wine. LPE's product portfolio contains high-end Champagne.

The low correlation between fine wine and the stock listed wine firms, and the different performance patterns make the listed wine firms unusable to use as a proxy for the performance of fine wine, therefore the following paper will use the pricing of the actual bottles bought in the secondary market for the further analysis.

4.6. Summery of the price development of wine

This chapter has analyzed the return of fine wine between July 1978 and December 2014. During this period IGW returned 4789% in nominal prices and 1251% in inflation adjusted prices. This is equivalent to a nominal yearly return of 10.67% or 7.19% in real terms. The fine wine prices have been relatively volatile, with strong bull periods and rapid corrections.

The main driver behind the price increases has been greater wealth, increasing number of HNWI and the development of new markets. In the 80s the American wine consumption rose likewise did the demand for fine European wine; this was supported by a strong economy and a strong dollar. In the 90s the new Asian economies, led by Japan, started to consume wine and the consumption per capita increased rapidly, helped

by the strong currencies and rising wealth. In the 00s the Chinese economy grew significantly and the rising number of HNWI started to demand western luxury products to show success and social status. Hong Kong became a wine free port and a leading hub for the global fine wine industry. The symbolic luck associated with 8 in 2008 and the two following extraordinary vintages made fine wine reach new all time highs.

The declines in wine prices have mainly been driven by weak economics, falling currencies, and regulation. The American economic and US dollar weakened in the end 80s, the Yuppies lost money and had to cut down the spending on luxury. Likewise the Asian financial crisis in 1997 resulted in weaker currencies and lost wealth for the HNWI. The story was repeated in 2008 during the global financial crisis the demand for luxury slowdown. Finally, the Chinese anti corruption law that was passed in 2011 hit the whole luxury industry, further the fine wine producers' greed has led to rapid growing prices which has dampen the interest for fine wine.

The chapter has argued for the importance of good storage conditions in order to preserve the wine. It is estimated that storage and insurance costs to between 0.2% and 0.5% annually, depending on the value of the wine. Further, the transactions costs are estimated to an annual 1% membership fee and 5-6% commission per trade. The costs are omitted in the further calculations, both because of the rough estimations that differ depending on the individual investors profile, trading frequency, portfolio size, and trading value, but also but due to the theoretical generalization of the paper.

Finally, the chapter has determined that the public listed wine firms are not a good proxy for an investment in fine wine. The correlation is relatively low between fine wine and the firms and the volatility of the actual bottles is lower then the volatility on the stocks. Further, the stocks do not outperform wine fine, meaning that the return per risk of IGW is higher than any of the individual stocks as well as the stock index. In conclusion, fine wine has been an attractive investment throughout the analysis period, compared to individual stocks and the stock index. However, the results do not take annual transactions costs and storage costs into account, meaning the individual investor has to adjust the annual returns of fine wine.

5. Analysis of price development

This chapter will dig deeper into the economic factors that influence the price development of wine. First, it will highlight some general global trends followed by a regression analysis, which include several macroeconomic variables effect on the wine price. Finally, it will highlight the future perspective for the price development of wine by building on the conclusions from the previous chapters.

5.1. Number of High-Net-Worth-Individuals

Fine wines' status as a luxury product and a collectible gives it an exposure to the global number of HNWI. According to Barclay's survey (2012) 28% of High-Net-Worth-individuals own a wine collection, which is higher than five years ago (21%). This makes it interesting to study the number of wealthy individuals worldwide, under the assumption that more wealthy people also leads to higher demand for fine wine.

The world is getting richer, and the number of Ultra-High-Net-Worth-Individuals (UHNWI) is increasing. UHNWI, individuals worth more than 30$ million US dollars, is reported yearly by Wealth-X, the number has increased from 186,345 worldwide in 2011 to 211,275 in 2014 and is estimated to exceed 250,000 by 2019. Looking into the main wine markets then North America has the largest concentration of UHNWI with 74,865 individuals up from 58,030 in 2011 and the population is expected to surpass 90,000 by 2019. Europe has the second largest population with 61,820 individuals in 2014 and is expected to exceed 70,000 by 2019. Finally, Asia had 46,635 UHNWIs in 2014 and is expected to have more than 60,000 by 2019. The numbers are expected to grow with 4% annually worldwide. The Asian region is growing with 5.9% a year and is estimated to have more UHNWIs than Europe by 2027 (Wealth-X, 2011, 2012, 2013, 2014). Due to Forbes' list of billionaires, which shows the number of US dollar billionaires worldwide, the world had 470 US dollar billionaires in 2000. Since then the number has increased with 250% to 1645. The trend in number of wealthy people creates a basis for an increased demand for wine and other luxury products in the coming years.

5.2. Global interest for fine wine

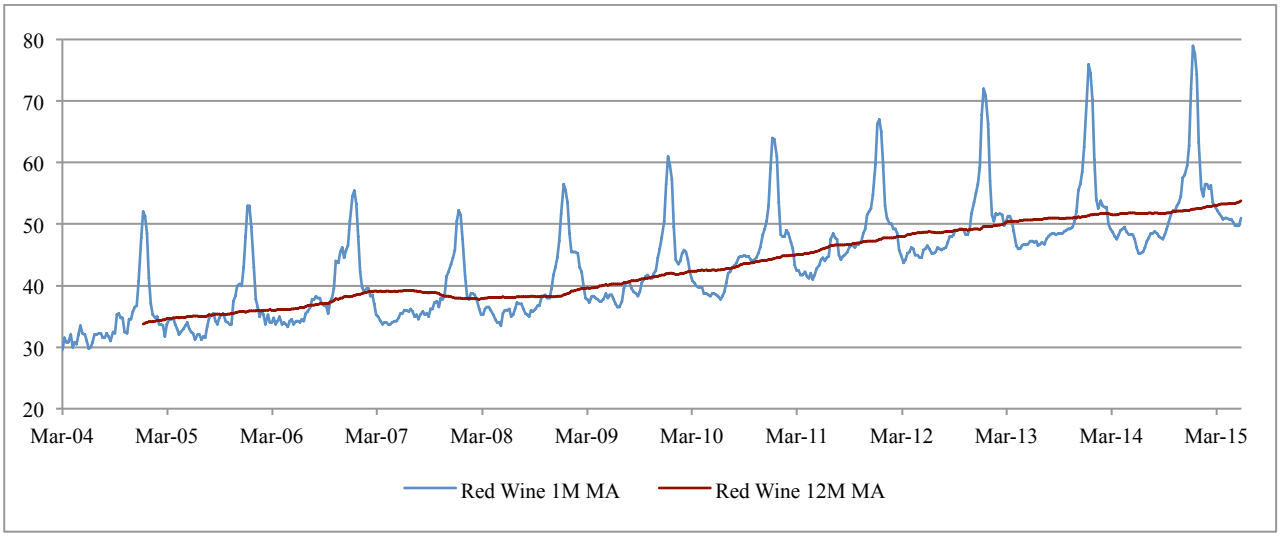
Fine wine does no only depend on wealthy individuals it also depends on the interest for fine wine. The aim of this section is to estimate the current trends for wine and fine wine, by using search data from Google Trends.

Google Trends shows the relative popularity of a search term in a value between 0 and 100. Meaning that it shows the terms strength compared to the total number of searches done on Google, at the same time it compares the search terms to the historical activity. Therefore the results show relative strength, not absolute, meaning that the declining trends can be increasing in absolute terms and visa versa. It is assumes that the results from Google can be used to generalize for the whole market since Google has a market share around 67% on the search engine industry. Other search engines, Baidu, Bing, and Yahoo, has below 10% each (Searchenginewatch.com, 2014).

The search term "Red Wine" had an increasing interest throughout the last 11 years. Which indicates that more people search for red wine, either for getting knowledge or shopping. Figure 5-1 shows the 1-month

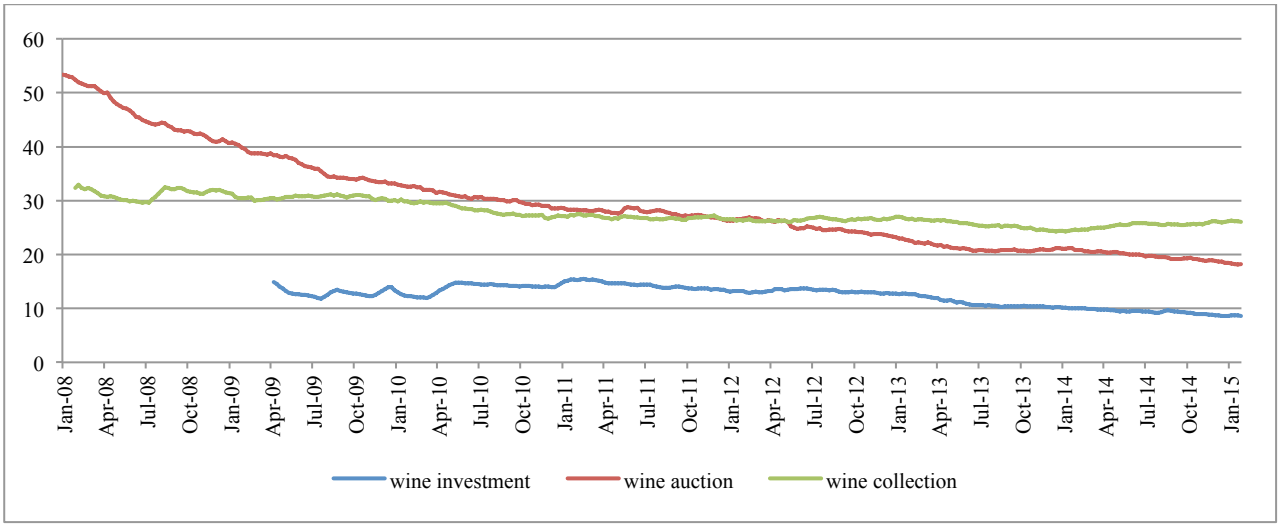
moving average is peaking every December, assumable because of gift giving and consumption for the Christmas holidays and the New Year, which makes December the busiest month in the wine retail industry. Likewise the 12-month moving average has been increasing every year except between 2007 and 2008. The data includes the words for "red wine" from the following languages: English, Danish/Norwegian, Portuguese, Spanish, French, and Chinese.

Figure 5-1 Google search for "Red Wine" 1M MA and 12M MA



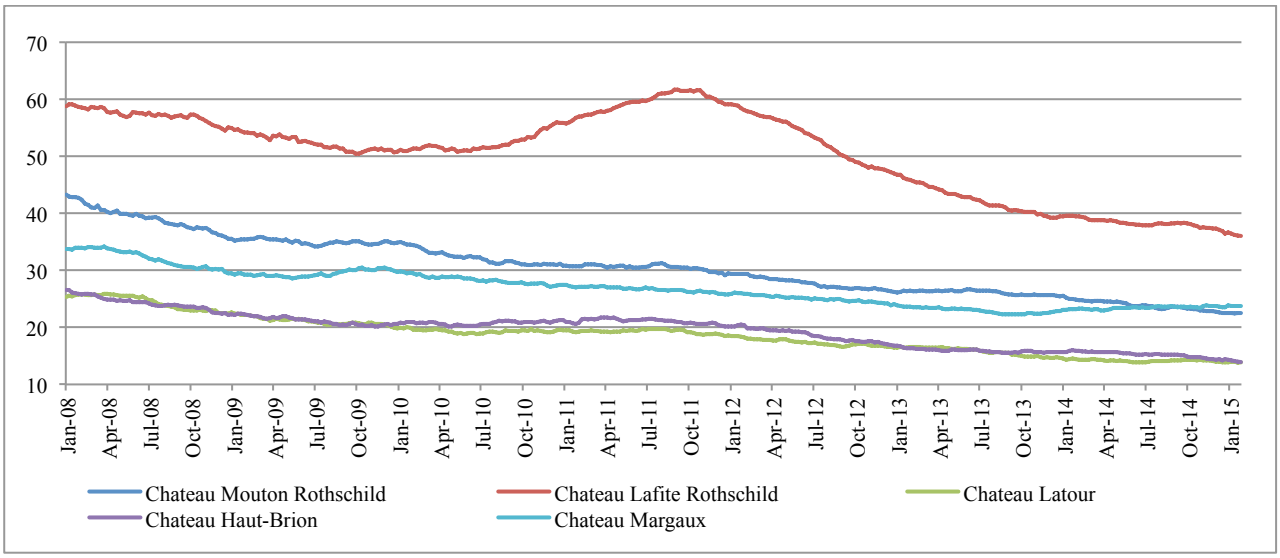
The search term "red wine" does not give significant information about how the market for investment in wine has emerged, like the search term "car" would not give an indication of the market for luxury cars. Therefore the trend of several other fine wine related search terms is analyzed. The first figure compares the 12-month moving average for the search terms "wine investment", "wine auction", and "wine collection". Due to lack of data the graph for "wine investment" and "wine collections" starts later than "wine auction". The graph shows a significant declining trend in the search for "wine auction" is felt from around 53 in primo 2008 to 18 in end 2014, this is surprising since wine auctions broke several records during the period, however the public seems to loose interest in the topic. The term "wine collection" has been relatively stable throughout the period, with a steady declining trend, the highlighted news flow about "wine collection" has mostly contained both the term "wine collection" and "wine auction", however their trends are very different. Finally, the volume for the term "wine investment" is lower than the two others, it peaked in 2011, where the Lix-ex also peaked. From there on it declined from approximately 15.5 to 8.5, meaning that "wine investment" is losing relative strength on the search engine.

Figure 5-2 12M MA for ”wine investment”, ”wine auction”, and ”wine collection”



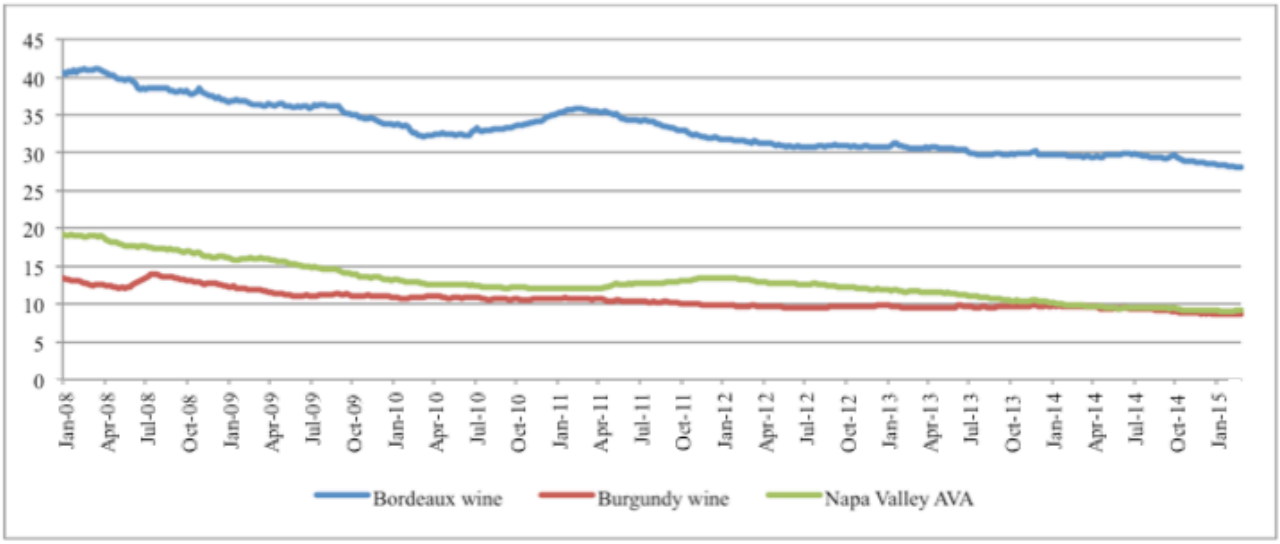
The trend of the five first growth producers obtains information about the relative popularity for the fine wines from Bordeaux. The graph below shows the search development on a 12-month moving average. All five producers are in a downwards-sloping trend, however Chateau Lafite Rothschild had a significant spike at the end of 2010, when it was published that the 2008 edition would have the Chinese symbol for eight on the label. Chateau Lafite Rothschild is the most popular compared to the four others, with a significant higher search volume throughout the whole period, followed by Chateau Mouton Rothschild and Chateau Margaux, the latter surpassed Chateau Mouton Rothschild at the end of the period. The least popular are Chateau Haut-Brion and Chateau Latour.

Figure 5-3 12M MA for the five first growth



The final graph in this section compares the search results for different regions, in order to obtain information about the trending areas. It compares "Bordeaux wine", "Burgundy wine", and "Napa Valley AVA". It shows that all three areas are in a downtrend and that "Bordeaux wine" is considerably more popular that the two other regions. This confirms the previous assumption about Bordeaux is the main market for fine wine due to size and volatility.

Figure 5-4 3M MA for "Bordeaux wine", "Burgundy wine", and "Napa Valley AVA"



The Google Search data shows that term "Red wine" is rising in popularity due to the upwards-going trend. However, all search terms related to fine wine and investment in wine are in a downwards-going trend indicating that the relative interest for investment in wine and fine wine is declining. The search term "red wine" is very fluctuating, with high peak in every December, demonstrating that it is driven by consumption and gift giving for the December holidays. Investment in wine should not have seasonal peaks hence it is a long-term investment, if any, the peaks should be in the spring when the tasting and the pricing of the *En Primeur* takes place. The 1-month moving average for the five first growths shows peaks in December, likewise does the 1-month moving average for "wine collection", however the 1-month moving average for "wine investment" does not show any seasonality (Appendix E). In conclusion, the search terms indicates a relative decreasing interest for fine wines and investment in wine although the term red wine is in a relative rising trend.

5.3. Linear regression explaining the movement in wine prices

The aim of the section is to create a model that explains the macroeconomic factors' influence on the price of fine wine. The model is created from the factors discussed in the previous section. However, some factors are either hard to measure, such as change in consumption patterns or regulations, or are lacking data, such as the country specific demand for wine (data from 1999) or the number of HNWI, as a consequence this

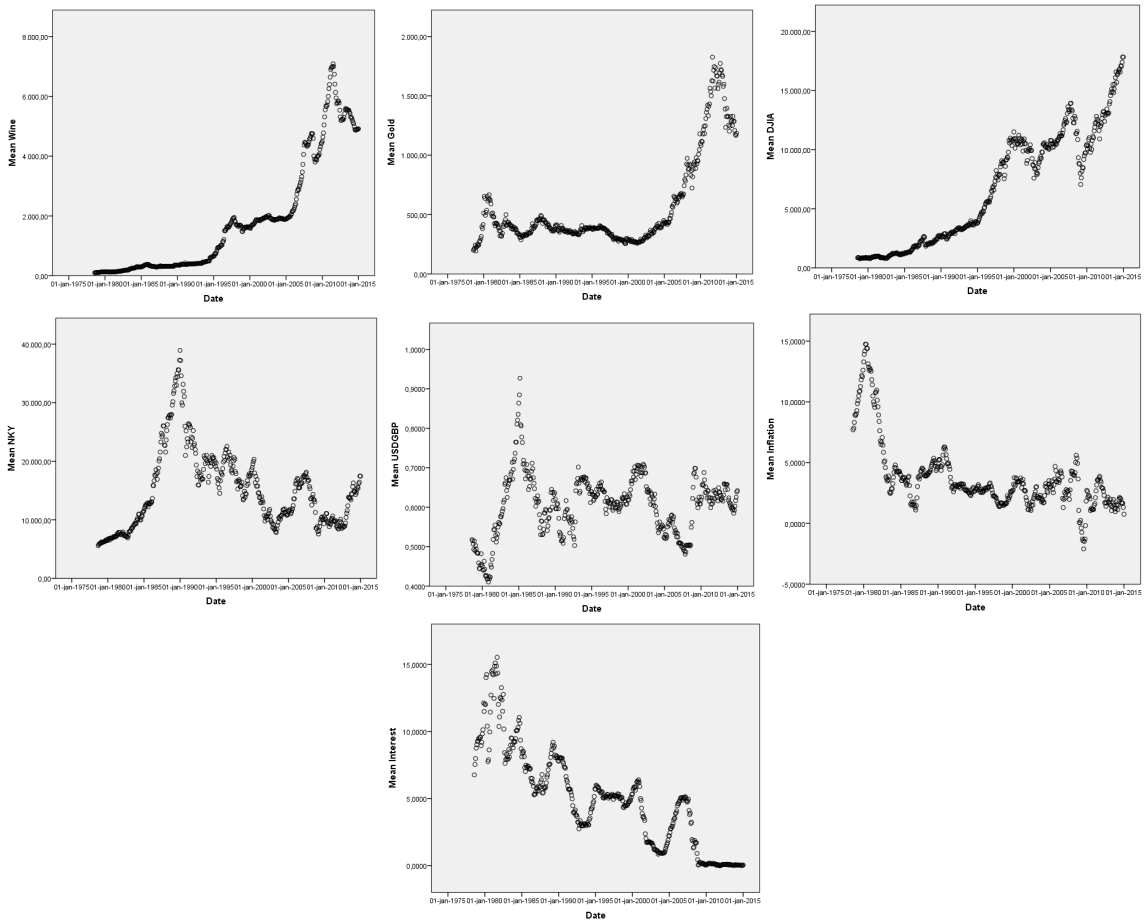
data will not be included in the model. Further the supply of wine has been relatively stable and will be omitted from the model. This means that the selected variables for the model are following general macroeconomic factors:

Wine = price of wine, represented by the wine index created for this paper.
Gold = price of a troy ounce of gold quoted in US dollars.
DJIA = American stock market, showed through the Dow Jones Industrial Average, which is a major index and good indicator of the movements in the stock market and economy.
NKY = Japanese stock market, represented through the leading index Nikkei 225.
USD = spot rate between American US dollars and the British Pound Sterling, as the amount of GBP per USD.
Inf = Inflation rate, represented by the U.S. Consumer Price Index (CPI) – All urban samples.
Int = Interest rate, represented by the U.S. 3-Month Treasury bill.

The data for all variables is reported in monthly observations between July 1978 and December 2014, since the wine index starts in July 1978 and is reported monthly. The data is time-series, which makes it necessary to check if the data is stationary before constructing the model. The main reasons are: First, that non-stationary time-series will cause autocorrelation, which leads to a wrong conclusion. Second, both sides of the equation consists of time-series, therefore the model will obtain a high R-square despite any meaningful relationship. Third, the random walk phenomenon can appear on financial time-series, meaning that the value at time "t" is equal to time "t-1" plus a stochastic component, which does not make sense to base a forecast on. There exist various models to test if the data is stationary or not, in this paper graphical analysis and the Autocorrelation Function (ACF) and Correlogram will be applied.

The study of the graphical analysis is conducted by studying the scatterplots of the data against the time. Of the data is stationary the mean will be around zero and the data is without trends, cycles, or random walks. The graphic below shows that this is not applicable for any of the data, meaning that the probability of non-stationary data is high.

Figure 5-5 Scatter plot of data series

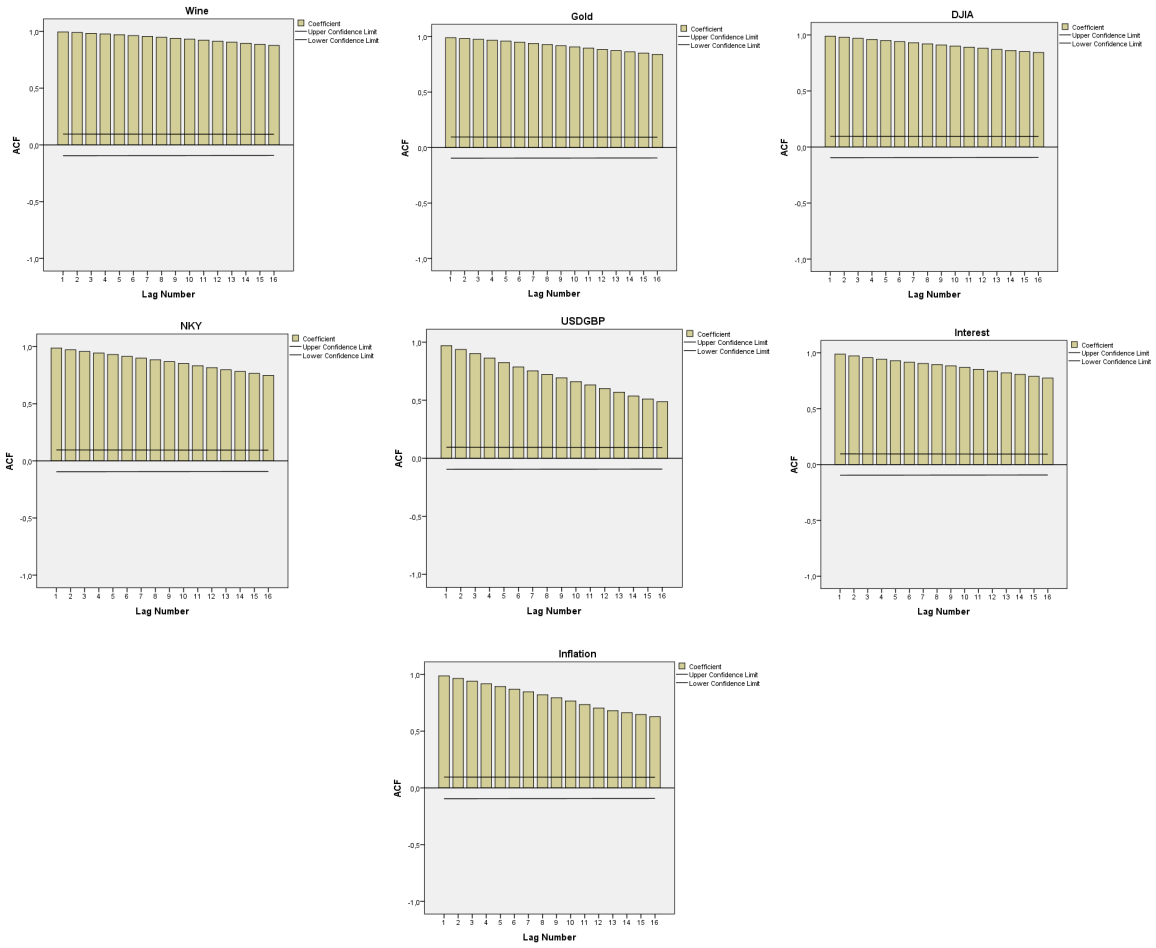


To confirm the suspicion, a graphical Autocorrelation Function (ACF) is performed. ACF test for stationary under the condition that the lag, denoted by ρ_k, is defined as

$$\rho_k = \frac{covariance\ at\ lag\ K}{variance}$$ (Gujarati and Porter, 2009)

ρ_k is a number between -1 and +1 and when plotted against the lag, the ACF graph will be obtained. The ACF graph for non-time-series will obtain autocorrelation values that drift around zero. This is not applicable for any of the variables in the model, which all shows a slow decline per lag. It can therefore be concluded that the data is non-stationary, thus a transformation is needed.

Figure 5-6 Graphical ACF of data series



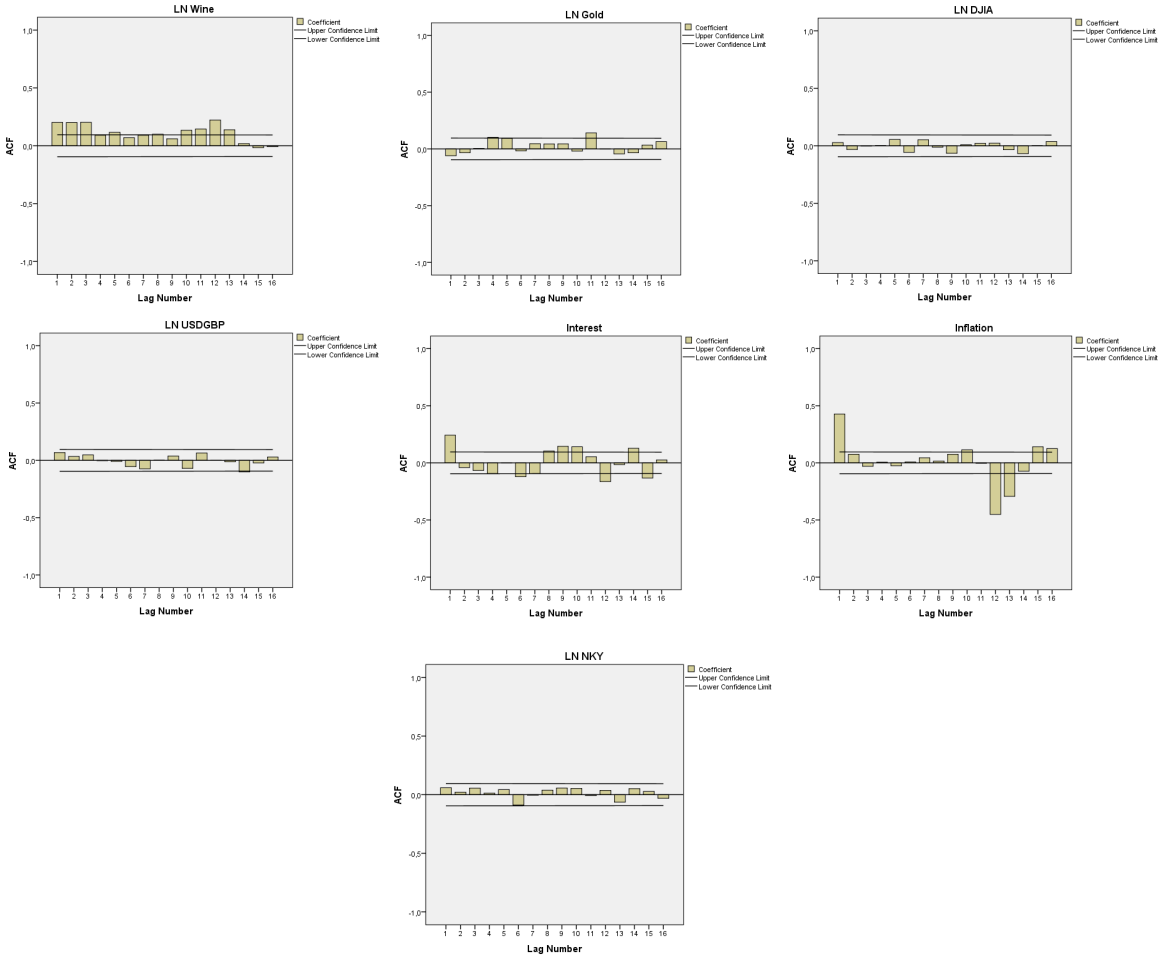
In econometrics, a common transformation of times-series is by using the natural logarithm. However, this will not make that data stationary, thus the data needs to be differentiated to become stationary. Meaning that the data will be transformed as following:

$$\text{Return of } Y_t \text{ (Wine, Gold, DJIA, NKY, and USD)} = LN\left(\frac{Y_t}{Y_{t-1}}\right)$$

$$\text{Delta of } Y_t \text{ (Inf and Int)} = Y_t - Y_{t-1}$$

The inflation rate and interest rate are already mentioned in percentage, thus only the delta is transformed. The rest of the data is transformed with the logarithm of the monthly return. After the transformation a new ACF test is conducted, and the results are illustrated in the graphs below. The graph shows that the coefficient is randomly distributed around zero, wine has only positive coefficients and inflation has some outliers, however the data is accepted as stationary.

Figure 5-7 Graphical ACF of transformed data



A multiple regression is a tool to estimate the value of the dependent variable (Wine) from a range of independent variables (Gold, DJIA, NKY, USD, Inf, and Int). The model can have a single depend variable but one or more independent variables in order to estimate the affect of more variables simultaneously. In this case the regression model will estimate how the movements of Gold, DJIA, NKY, USD, Inf, and Int affects the price of wine. The intuition is that the stock markets and gold are alternative investments to wine, however they are also indications about the general economy. The stock markets reflect the movements in the global economy, where gold on the other hand is used as a safe harbor when there is a threat of global recession or war. Thus the use of these variable makes it possible to see how the price on fine wine is influenced by different macroeconomic factors, and thereby determine whether fine wine is a supplement to the stock market or an alternative investment to the traditional markets and more related to gold. The last option is that fine wine is unrelated to both factors, meaning no direct link between the movements in the global economy and wine. In addition the exchange rate on the US dollar to the British Pound is included, due to the assumption that the American demand for IGW will decrease when the dollar weakens against the

British Pound. Finally, the inflation rate and the interest rate are included to test the linkage between the price of wine and the change of the interest rate and inflation rate.

Since the price development of wine is a financial time-series reported monthly, it is likely that the price at time t is influenced at the price at time t-1. Therefore the first lag of the wine price, Wine_{t-1}, is included in the regression. The other time-series variables can be alternative investments to wine, thus the switch of investment or rebalancing of a portfolio takes time and therefore the first lag of the stock markets and gold are included in the regression. This can be represented in following model:

$$Wine = f(Wine_{t-1}, Gold_t, Gold_{t-1}, DJIA_t, DJIA_{t-1}, NKY_t, NKY_{t-1}, USD, Inf, Int)$$

The rewritten equation is:

$$Wine_t = \beta_0 + \beta_1 * Wine_{t-1} + \beta_2 * Gold_t + \beta_3 * Gold_{t-1} + \beta_4 * DJIA_t + \beta_5 * DJIA_{t-1} + \beta_6 * NKY_t + \beta_7 * NKY_{t-1} + \beta_8 * USD_t + \beta_9 * deltaInf_t + \beta_{10} * deltaInt_t + \epsilon$$

Where β_0 is the intercept and $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}$ are the parameters connected to $Wine_{t-1}$, $Gold_t$, $Gold_{t-1}$, $DJIA_t$, $DJIA_{t-1}$, NKY_t,NKY_{t-1}, USD_t, $deltaInf_t$, $deltaInt_t$ respectively, ϵ is the error term that cannot be explained for the model.

In order to make the model data stationary the model is differentiated, thus the variables used in the model are following:

$$return\ of\ Wine_t = \beta_0 + \beta_1 * return\ of\ Wine_{t-1} + \beta_2 * return\ of\ Gold_t + \beta_3 * return\ of\ Gold_{t-1} + \beta_4 * return\ of\ DJIA_t + \beta_5 * return\ of\ DJIA_{t-1} + \beta_6 * return\ of\ NKY_t + \beta_7 * return\ of\ NKY_{t-1} + \beta_8 * return\ of\ USD_t + \beta_9 * deltaInf_t\% + \beta_{10} * deltaInt_t\% + \epsilon$$

The linear regression gives following output:

Regression Statistics	
Multiple R	0.25986049
R Square	0.06752747
Adjusted R Square	0.04553520
Standard Error	0.02974890
Observations	435

ANOVA

	df	SS	MS	F	Significance F
Regression	10	0.02717392	0.00271739	3.07050857	0.00088231
Residual	424	0.37523882	0.00088500		
Total	434	0.40241274			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.00700329	0.00153615	4.55897645	0.00000673	0.00398387	0.01002272
LN Gold	-0.03523967	0.02737251	-1.28741122	0.19865328	-0.08904238	0.01856304
LN DJIA	-0.00982785	0.03723933	-0.26391058	0.79197704	-0.08302455	0.06336884
LN NKY	-0.00419031	0.02859389	-0.14654582	0.88356017	-0.06039374	0.05201311
LN USD	-0.10996207	0.05142883	-2.13814049	0.03307640	-0.21104929	-0.00887486
Delta Interest	-0.00175506	0.00301542	-0.58202988	0.56085589	-0.00768209	0.00417197
Delta Inflation	0.00221970	0.00368699	0.60203645	0.54747167	-0.00502735	0.00946676
LAG LN Wine	0.19714261	0.04743499	4.15605877	0.00003919	0.10390559	0.29037962
LAG LN Gold	0.02322365	0.02627711	0.88379781	0.37730622	-0.02842597	0.07487327
LAG LN DJIA	0.03250635	0.03712807	0.87551955	0.38178698	-0.04047165	0.10548435
LAG LN NKY	0.03771600	0.02844206	1.32606428	0.18553231	-0.01818900	0.09362100

The regression output shows that the P-value of all parameters, except LN USD and LAG LN Wine, are above the chosen critical value of 0.05. This means that the null hypothesis cannot be rejected. The null hypothesis in this case is that the correlation coefficient for the tested parameter is equal to zero, $\beta_1 = 0$, $\beta_2 = 0$, $\beta_3 = 0, \beta_4 = 0, \beta_5 = 0, \beta_6 = 0, \beta_7 = 0, \beta_8 = 0, \beta_9 = 0, \beta_{10} = 0$. Thus all parameters, except LN USD and LAG LN Wine, do not have any significant influence on the price of wine. In addition the R-square of the model is rather low, indicating that the model just explains a very small proportion of the variation on the wine price. However, the F-value in the ANOVA test is below 0.05, meaning that the null hypothesis can be rejected. The hull hypothesis is that all coefficients are equal to zero ($\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = 0$). This means that the explanatory power of the model is strong.

5.3.1. Test of the assumptions of the classical linear regression model

To support the results from the model in the section above the assumptions of the classical linear regression model are tested. The assumptions are:

- No multicollinearity
- No heteroskedasticity
- Normally distributed errors

The reason behind the test is that if the assumptions are violated, the OLS estimators may not be legitimate, resulting in the findings do not reflect the real case.

Multicollinearity occurs when numerous independent variables are closely correlated. This can lead to wrong conclusions in the regressions analysis and can cause wide confidence intervals and odd P-values for the explanatory variables. One of the symptoms of multicollinearity is a high R-square value, without having significant regression coefficient. However, the results from the linear regression show that this is not the case in this model (Newbold et al., 2010).

Testing for multicollinearity can be done is different ways. In this paper the collinearity diagnostics and a correlation matrix will be used to determine whether multicollinearity occurs in the dataset. In the collinearity diagnostics it is assumed that if the conditional index is above 10, then a moderate to strong degree of multicollinearity is detected. In this dataset the condition index of 1.879 indicates no collinearity (Appendix F).

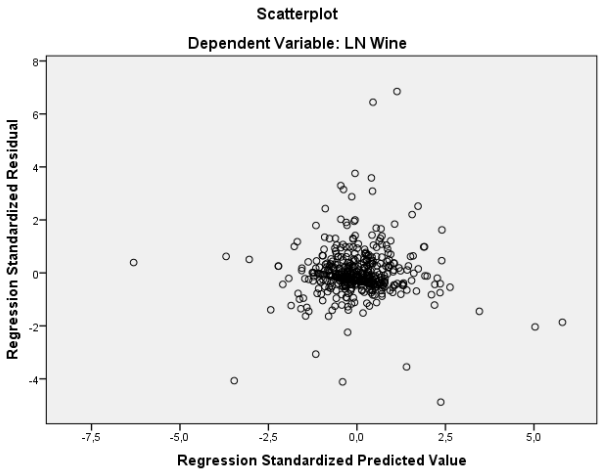
Before concluding, a correlation matrix of all variables is constructed and can be seen in Appendix F. It shows that the highest correlation occurs between DJIA / NKY and LAG DJIA / LAG NKY both are having a correlation coefficient of 0.46, meaning a moderate degree of correlation. The correlation makes sense hence the variables are two main stocks markets and the first lag of the same markets and it is assumed that both markets follow the trends on the global economy.

Even though the results do not indicate multicollinearity a regression analysis without one of the independent variables is generated, in order to compare the results. By omitting Japan (LN NKY and LAG NKY) the P-value on LAG DJIA falls to 0.098, meaning it is still insignificant. The R-square of the model decrease marginally to 0.0636 and the adjusted R-square increase marginally to 0.04604, driven by fewer degrees of freedom. The results can be seen in Appendix G. Another regression model is created without the American stock market (LN DJIA and LAG DJIA) the P-value on LAG NKY falls to 0.0532, which is very close to the significance level of 0.05. The coefficient has a positive effect on 0.049 on the dependent variable however 0 is still in the 95% confidence interval. The results can be seen in Appendix H.

Heteroscedasticity means non-constant error variance and occurs when the variability in the random variables differs. Autocorrelation means that the errors are mutually correlated. Homoscedasticity is the absence, where the errors have uniformed variance and are uncorrelated. Both Heteroscedasticity and Autocorrelation can lead to inefficient coefficient estimations and biased P-values in the OLS, thus it is relevant to test for these assumptions before concluding on the model (Newbold et al., 2010).

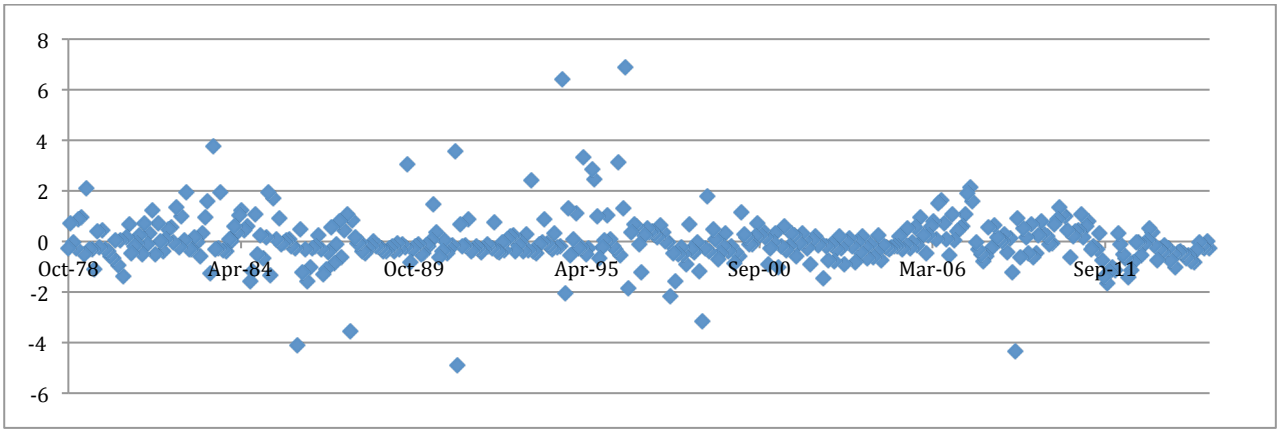
The assumption of Heteroscedasticity can be checked visually by plotting the standardized residuals against the regression standardized predicted value. In the ideal situation the residuals are randomly scattered around zero, like a "birds nest". Below the standardized residual and the standardized predicted values for the regression model are visualized. The residuals are nicely distributed around zero, indicating that the hypothesis of Heteroscedasticity in the dataset can be rejected.

Figure 5-8 Scatterplot testing for Heteroscedasticity



Likewise Autocorrelation can be detected visually, by plotting the standardized residuals against time, where the residuals should be scattered randomly around zero throughout the whole period. The figure below shows the standardized residuals from the dataset, which are nicely distributed around zero without any significant change in variation over time. There is less variation in the period from the end 1980s to the start 1990s due to very few observations.

Figure 5-9 Scatterplot testing for Autocorrelation



According to these tests and visualizations no of the assumptions for classic linear regression model are violated. This means that the results from the model are unbiased and the coefficients are efficient, indicating

that the model can be used to determine how the different independent variables influence the pricing of fine wine.

5.4. Summary of the multiple regression

The following model is used to estimate the retune on wine:

$$return\ of\ Wine_t = \beta_0 + \beta_1 * return\ of\ Wine_{t-1} + \beta_2 * return\ of\ Gold_t + \beta_3 * return\ of\ Gold_{t-1} + \beta_4 * return\ of\ DJIA_t + \beta_5 * return\ of\ DJIA_{t-1} + \beta_6 * return\ of\ NKY_t + \beta_7 * return\ of\ NKY_{t-1} + \beta_8 * return\ of\ USD_t + \beta_9 * deltaInf_t\% + \beta_{10} * deltaInt_t\% + \epsilon$$

The tests conducted in the section conclude that the model serves the assumptions for classic linear regression model, meaning that the model does not have multicollinearity among the regressions either heteroscedasticity or autocorrelation among the residuals. This means that the model can be used to estimate how the independent variables influence the price on the dependent variable: fine wine. According to the model the return on wine is determined by the return on the American and Japanese stock market, the return on gold, the return on the US dollar spot rate with the British Pound, the first lagged return of wine, the first lagged return of the American and Japanese stock markets, the first lagged return of gold, and the delta of the inflation rate and the interest rate.

The results show that the first lagged return of wine and the return of the USDGBP spot rate are proven to be significant. The first lagged return of wine has a positive effect on the return of wine meaning that wine had a positive return in period t-1 it has a positive effect on the return at time t. The return of USDGBP spot rate has a negative effect on the return of wine, meaning that when the US dollar increase to the British pound the price of wine will decrease, which is rather surprising hence it them becomes relatively cheaper for the American market to buy European wine through the London brokers.

The rest of the independent variables in the model: return of gold, lagged return of gold, return of the stock markets, lagged return of the stock markets, delta inflation, and delta interest rate are proven not to be significant, meaning the return on the independent variables do not influences the return on the dependent variable. The change on the stock markets, the gold price, inflation rate and interest rate should not lead to a change in the wine price.

To sum up, the empirical study in the section shows that wine is unrelated to movements on the world's stock markets and gold market, thus fine wine should be a good hedge against the fluctuations on the global financial markets, and thereby suitable for portfolio diversification.

5.5. Future perspectives

The final section of the chapter will use the findings from the paper to highlight some future perspectives for investment in wine. Meaning that the future perspectives for the wine industry and the global economy will be discussed.

The wine industry has survived several threats throughout the history, in recent centuries the largest threats has been the different vine related diseases that ravage the European wine regions in the middle of the 19th century. Grape Phylloxere from 1883 is still the most damaging disease in the wine history, there exist no cure against it, but grafting of Phylloxere resistant American rootstocks saved the European wine industry. Other diseases like downy mildew, powdery mildew, and black rot among others are still a threat against the wine industry. It is hard to predict whether new deceases will emerge in the future, however the technological and biological development has created cures to prevent the major threats. Global warming and more extreme weather conditions is another threat, California is already suffering from drought and the producers in Europe have in recent years reported about rare weather conditions which is a danger to the wine production, in the future this can cause disruption in the wine industry, where new wine regions will emerge and other disappear, however it is not possible to control nor predict the weather. Along with vine diseases and the changing climate the outbreak of wars taking place in wine regions is a threat against wine production. This is not considered a great threat, due to the political stability in the main wine producing countries.

In regard to the pricing of wine, fraud and greed from the producers seems to be the largest threats. Fraud has always been a risk against the luxury industry. A large number of replicated bags, watches, glasses, and clothes are on the market. Assumable the consumer is aware of the origin of the replicated luxury items. Fraud of luxury wine is harder for the consumer to detect, and if detected nothing can be done against it. No one knows exactly how an old bottle should taste, and the consumer cannot proof it was a counterfeited bottle when it is consumed. The rising number of counterfeited wine bottles has increased the risk of investing in wine, and might keep potential investors out of the market. Liv-ex reports that they check more than 30,000 cases a year to verify the content. The greed from the producers is an increasing problem. The rising *En Primeur* prices and release prices throughout the recent years have cooled down the investors' interest, which is one of the factors of the falling prices since 2011. In history this scenario has happened several times and there is a great chance that it will happen over and over again, just like bubbles on the stock market.

Economic growth and distribution of wealth is a main driver behind the demand for luxury products, such as wine. The number of HNWI individual is increasing in all regions and is estimated to continue in the future.

Particularly the economic development and urbanization of the Asian region is leading to a rising number of HNWI and a significant increasing demand for luxury items. China is still growing fast, but also new markets as India and South East Asia have a rising number of HNWI. India does not have a strong wine tradition, and wine is still considered as a niche in India, both in the beverage and in the luxury category. However, wine consumption is growing, and is among subgroups preferred over other spirits due to its health benefits, further is shows prestige and success to be seen with a bottle of Champagne (Euromonitor, 2014a).

Finally, the fashion of collection and consuming fine wine is essential. Trends of collections change over time, whether it is collection of football cards in the elementary school or more sophisticated collections of coins or stamps, then collection trends are cyclical. Stamp collectors have been around since the invention of the stamps in the middle of 17th century. However, the fashion of collecting stamps seems to have peaked. The technological replacement of stamps is one reason, but also the many entertainment alternatives have resulted to little interest from the young generation. The members of the American Philatelic Society (Stamps.org) has decreased from 57,815 members in 1988 to 32,030 members in 2014, likewise the average age of stamp collectors is increasing.

It is hard to estimate the number of wine collectors worldwide hence it is unknown whether the wine is purchased for consumption, collection, or pure investment. The wine collectors do not have a registered association, but are typically organized in smaller wine clubs or societies. According to the Google trend analysis the relative numbers of wine collectors and the number of searches for IGW producers have been decreasing through the recent years, however the analysis is short and imprecise to draw any conclusions. In terms of consumption the demand for red wine is increasing, particularly in the Asian markets, likewise the Google trend analysis shows an increasing interest for red wine.
The economic development of new markets is estimated to become the main driver behind the future demand for wine, both in the low price segment and the higher price segment. The supply of the low price segment is estimated to increase along with the development of the new market, just like China is becoming the world's largest wine producer. However the premium wines are harder to replicate, due to the history and prestige, which makes them a luxury and provide the show-off effect. Thus IGW, like other luxury goods, will experience increasing demand on the long-term. On the short-term fine wines from Bordeaux have reached a peak, the producers have increased prices excessively during the symbolic 2008 and the extraordinary 2009 and 2010 vintages. The quality of the 2011, 2012, and 2013 vintage has not been remarkable, and the producers have been reluctant to reduce prices to an appropriate level. Further, the market has sufficient supply after a remarkable decade with four extraordinary vintages. A consolidation is taking place after the 2011 peak, as it did after the 1985 peak and the 1997 peak, if wine is following its own cyclic trend then the

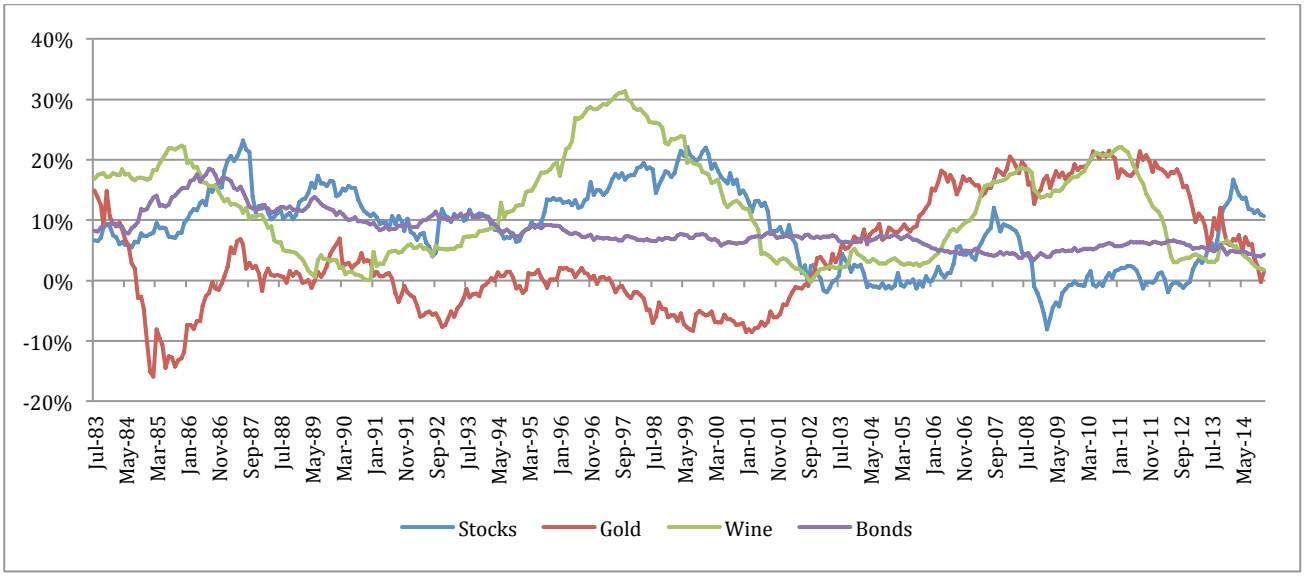
next peak takes place 12-14 years from 2011. However, *"prediction is very difficult, especially if it's about the future"* - *Niels Bohr.*

6. Fine wine in a portfolio with bonds, stocks, and gold

The focus of this section is to determine whether fine wine can contribute to portfolio diversification. The results from the regression model in previous chapter concluded that fine wine is unaffected from movements of the stock indices and the gold price, thus wine should be an suitable asset to combine with these assets in a portfolio, in order to minimize risk and maximize return. To test this hypothesis modern portfolio theory will be applied, where wine will be combined with stocks, bonds, and gold in a portfolio build on monthly observations from July 1978 to December 2014.

In addition to the main portfolio build on the entire period, four other portfolios will be created to compare the results. The first will be a similar portfolio with monthly observations from July 1978 to December 2014; the only difference is that transaction and storage costs of wine will be included in the model. The three other portfolios are built on the theory of no transactions costs and are based on three different economic cycles. The first is the 12.5-year period from July 1978 to December 1990. The second is based on the 12 year period between January 1991 and December 2002 and the third is the last 12 years between January 2003 and December 2014. All observations are monthly, since the wine index is reported monthly, meaning that the full period has 438 observations and the three cycles has 150, 144, and 144 observations respectably. The reason behind creating three sub periods is to determine how wine performs compared to the other assets under different economic environments. The first period is characterized by high interest rates and thereby high bond return, the second by high return on the stock market and on wine, and the third by financial turmoil illustrated by a high gold return and volatile stock market performance. The comparison of the different results helps to determine how an investor should include wine in the portfolio diversification during different economic cycles. The trends on a 5Y CAGR of the different securities are illustrated in figure 6-1.

Figure 6-1 Annual Return during 5 year periods



6.1. Modern portfolio theory

Modern portfolio theory (MPT) is commonly used investment theory developed by Harry Markowitz in 1952. The idea behind the theory is that the risk-averse investor can construct portfolios to maximize the expected return and minimizing the risk, by combining two or more assets. The optimal portfolios will create an efficient frontier, which will maximize the expected return at a given risk. Intuitively uncorrelated or negative correlated assets provide a better diversification benefit. However, even positively correlated assets can contribute to diversification and thereby lower the risk (Bodie et al, 2011). In the previous regressions analysis, it was concluded that wine, gold, and stocks were uncorrelated, meaning that a combination of them will provide a better risk and return ratio than either of them individual. To find the optimal portfolios following mathematical formulas are used:

Return on assets: There are two ways to calculate the return on assets. The normal discrete compounding $R_t = (P_t - P_{t-1})/P_{t-1}$ or the continuously compounding $R_t = \log(\frac{P_t}{P_{t-1}})$. The difference between the two methods is often small, however the continuously compounding is simpler to work with when covert monthly returns to annual returns, thus it is used in the calculations in this section (Bodie et al, 2011)

Return on portfolio: $E(r_x) = \Sigma_{i=1}^{N} x_i E(r_i)$ (Benninga, 2008)

Standard deviation: $\sigma = \sqrt{\frac{1}{N}\Sigma_{i=1}^{N}(x_i - \mu)^2}$ (Benninga, 2008)

Variance: $Var(r_x) = \Sigma_{i=1}^{N}(x_i)^2 Var(r_i) + 2\Sigma_{i=1}^{N}\Sigma_{j=i+1}^{N} x_i x_j COV(r_i, r_j)$ (Benninga, 2008)

Sharpe ratio: $S = \frac{E(r_x - r_f)}{\sqrt{Var}(r_x - r_f)}$ (Benninga, 2008)

A range of different assumes are made in modern portfolio theory, including (Bodie et al, 2011):

- Investors are small and price takers.
- Investors have identical holding periods.
- Investors are rational mean-variance optimizers and risk-averse.
- Investors analyze securities in the same way, they access new information at the same time, and they use the same assets and covariance to generate the efficient frontier.
- Investments are limited to public traded financial assets. Borrowing and lending in the risk free asset is possible.
- No taxes and no transaction costs.
- Correlations between assets are fixed and constant forever.

Several of the assumptions can be criticizes, in this paper particularly the last one about constant correlations is proven not to be true, hence the correlation between the assets vary in the different analysis periods. Likewise the no transaction costs was discussed in chapter 4.4. Further IGW is not a public traded asset, but an alternative investment, but it will be treated like a public traded asset.

6.1.1. Assumptions

In addition to the assumptions made in the previous chapter and the assumptions in chapter 4.1, then following is assumed for the following analysis.

Barclays U.S Aggregate Bond Index (previously Lehman Aggregated Bond Index) is assumes to represent the investment opportunity in Bonds. It is a market capitalization-weighted index consisting of the most traded U.S investment grade bonds.

The gold to dollar spot rate (XAU/USD) is used to represent the investment opportunity in gold.

The US 3 month government bond is used to represent the investment opportunity in the risk free rate.

It is assumed that the investor is risk neutral investor hence the investor has the option to invest in the risk free asset.

6.1.2. Adjustment of standard deviations

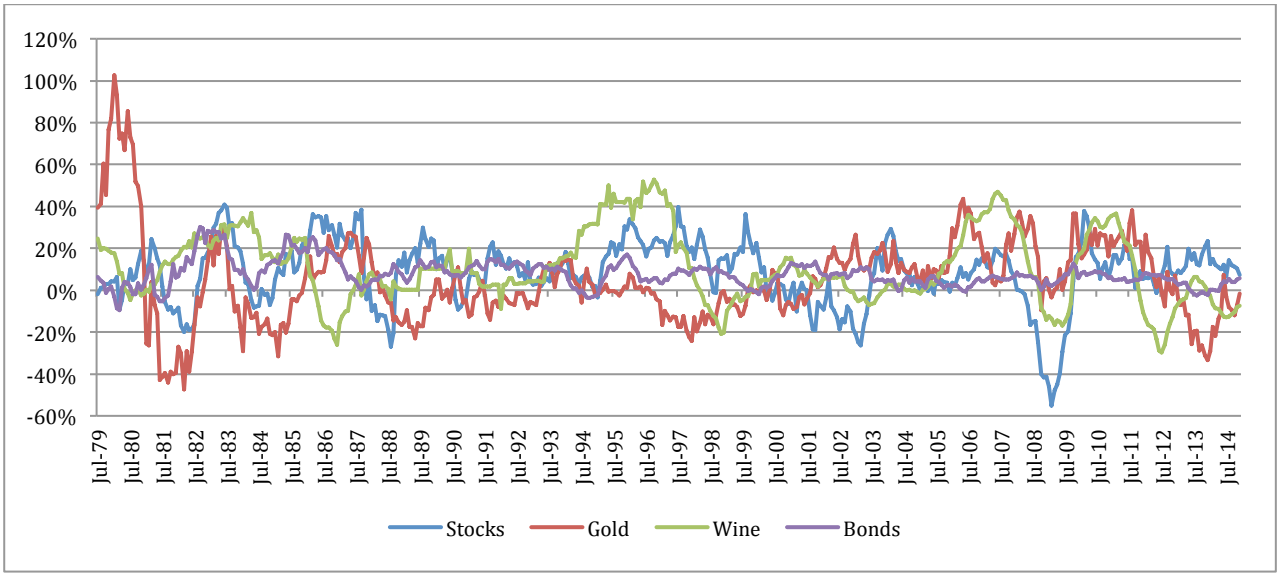
In the following calculations the standard deviation will be calculated on a yearly basis. According to the theory the standard deviations are calculated on return between period t and period t_{-1}, in this case monthly basis, and then annualized. However, due to the relatively low volume of transactions on IGW, the price movement can be based on few observation a year, this gives a good price indication for the index however it does not capture monthly volatility. This is in particularly applicable on the data between January 1988 and December 1992 where 48 monthly observations out of 60 had a zero return. On the other hand stocks, bonds, and gold are traded for billions of dollars every day, which thereby capture the daily and monthly volatility. The consequence is that the annualized monthly volatility on wine is a poor estimation of the actual annual volatility; hence it underestimates the real volatility of IGW.

A way to correct that issue is using yearly observations, meaning one observation per year, however that would reduce the sample to 36 observations, further it would not detect the volatility occurring during the year. If for example an asset loses 50% of the value during the first 2 months of the year and gain 100% during the last 10, then the start value and the end value would be equal and no volatility would be detected. This analysis will therefore calculate the yearly return for every month, meaning that the return between t and t_{-12} is calculated monthly hence the monthly volatility hereby will be captured in the model. The annualized standard deviation on the different methods and periods are compared in table 6-1. The 1Y sample is the model with just one annual observation, the rest are based on monthly observations. The numbers show that the annualized monthly observations, the one observation per year, and the t - t_{-12} method have relatively identical value for stocks, gold, and bonds. However on IGW there is a significant difference between the monthly estimation on 10.57% and the yearly on 17.00% and 17.38%. The annual volatility of each of the assets is illustrated in figure 6-2.

Table 6-1 Annual standard deviations on different basis periods

Annualized	Stocks	Gold	Wine	Bonds
1M	15.08%	18.57%	10.57%	5.56%
1Y	15.26%	20.76%	17.00%	6.29%
2Y	10.34%	14.32%	13.89%	4.63%
5Y	6.64%	9.03%	8.20%	3.14%
10Y	4.52%	6.94%	3.29%	2.42%
1Y Sample	14.24%	21.00%	17.38%	6.16%

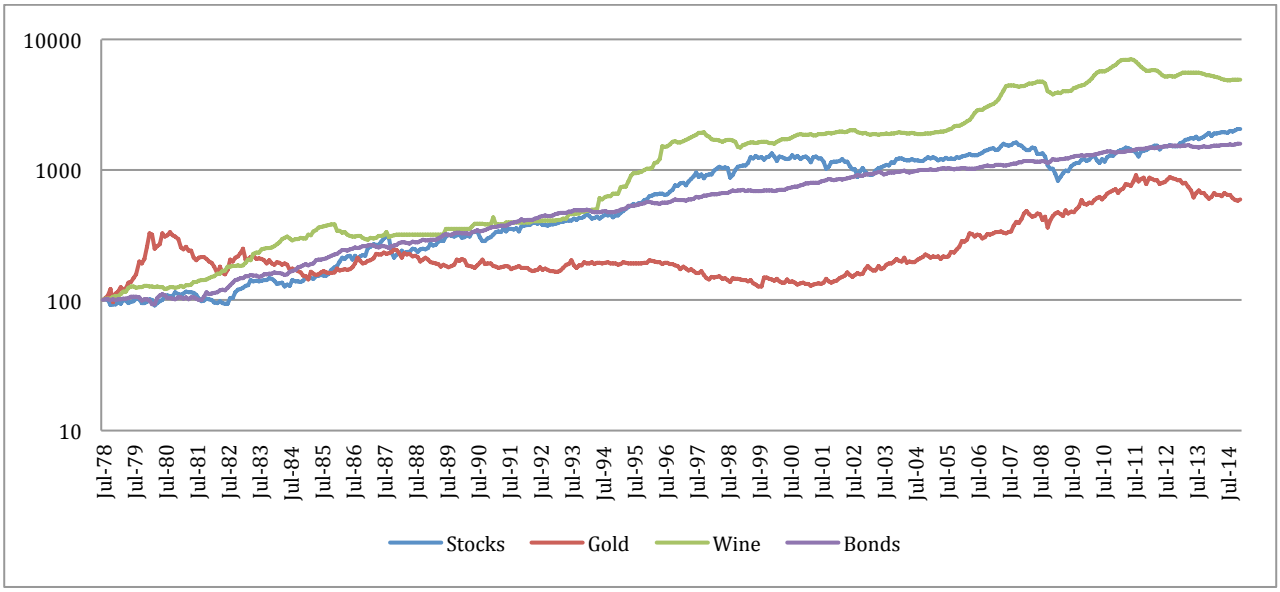
Figure 6-2 Annual volatility on stocks, gold, wine, and bonds



6.2. Portfolio with wine, stocks, bonds, and gold from July 1978 to December 2014

The focus of the section is to compare the risk and return of the selected assets throughout a period of 36.5 years from July 1978 until December 2014. The results will further be used to the creations of the minimum variance and the tangent portfolio under the conditions that all assets have no transaction costs or storage costs.

Figure 6-3 Return of wine, stocks, bonds, and gold (July 1978=100) (Source: Bloomberg, own creation)



The graph shows the performance of the four selected assets throughout the analysis period, Wine has outperformed the other assets with an increase of 4816% (10.74% annually) stocks is the second best

performing with a total return of 1967% (8.46% annually) followed by bonds 1487% (7.77% annually), and gold 491% (4.74% annually). The average annual risk free rate throughout the analysis period is calculated to 4.68%. The risk is measured in annual standard deviation and is presented together with the Sharpe ratio of the individual assets in the table below. Gold has the highest risk, followed by wine and stocks. Bonds are the most secure assets after the risk free rate. The Sharpe ratio measures the ratio between the excess return and the standard deviation, meaning that it identifies the return the investor gains from accepting another unit of risk. A higher Sharpe ratio gives higher return per unit of risk. Bonds have the highest Sharpe ratio of 0.48 followed by wine with 0.36. Stocks retune 0.25 where gold just return 0.003 per extra unit of risk.

Table 6-2 Return, standard deviation and Sharpe ratio of stocks, gold, wine, and bonds

	Stocks	Gold	Wine	Bonds
Annual return	8.46%	4.74%	10.74%	7.67%
Annual standard deviation	15.26%	20.76%	17.00%	6.29%
Sharpe ratio	0.24760	0.00253	0.35640	0.47536

The correlation matrix presented below shows that all four assets have a low correlation. The highest correlated assets are stocks and wine (0.2335) followed by stocks and bonds (0.2303) all other correlations are close to zero. Bonds and gold further have a negative correlation, thus negative co-movements. The low correlation indicates that the four assets are well suited for portfolio diversification.

Table 6-3 Correlation matrix of stocks, gold, wine, and bonds from the overall testing period

	Stocks	Gold	Wine	Bonds
Stocks	1.0000			
Gold	0.0106	1.0000		
Wine	0.2335	0.0497	1.0000	
Bonds	0.2303	-0.1430	0.0615	1.0000

Next the tangency portfolio and the minimum variance portfolio are calculated. The tangency portfolio is the portfolio on the Capital Market Line (CML), which is a tangent on the efficient frontier. Where the slope of the CML is the Sharpe ratio. The efficient frontier consists of the possible combinations of asset allocation, where the investor maximizes the return and minimizes the risk. Points below the efficient frontier are inefficient because it is possible to achieve a better return at the same level of risk. The theory of the efficient frontier is based under the assumption that unsystematic risk can be fully diversified. The minimum variance portfolio is the portfolio that maximizes the diversification benefit and minimizes the risk regardless of the risk free rate. It is located on the efficient frontier as the point with the lowest standard deviation (Bodie et al., 2011).

The composition of the tangent portfolio and the minimum variance portfolio is presented in table 6-4. According to the theory 73.71% of the tangent portfolio should be placed in bonds, 18.89% in wine, 4.88% in stocks and 2.51% in gold. This combination of assets would return 8.22% annually at a risk of 6.054%. The expected return of the portfolio is higher than an investment in just bonds (7.67%) or gold (4.88%), but slightly lower than stocks (8.46%) and wine (10.74%). The portfolio risk is lower than an investment in any of the individual assets. Further the Sharpe ratio of 0.58 is higher than any of the individual assets.

The minimum variance portfolio consists of 78.85% bonds, 10.17% gold, 7.42% wine, and 3.56% stocks. The expected return is 7.63%. The risk of 5.52% is lower than any of the individual assets. The Sharpe ratio of 0.53 is likewise higher than any individual assets, which shows the diversification benefit. Gold holds a relatively high percentage of the minimum variance, even though gold is the poorest performing asset in the analysis period both in terms of return, risk, and Sharpe ratio, however the negative correlation with bonds makes it an attractive hedge on the minimum variance portfolio. The efficient frontier, the CML, the two portfolios, and the individual assets are illustrated in the figure below.

Figure 6-4 illustration of the efficient frontier, CML, Tangency portfolio, minimum-variance portfolio and the individual assets

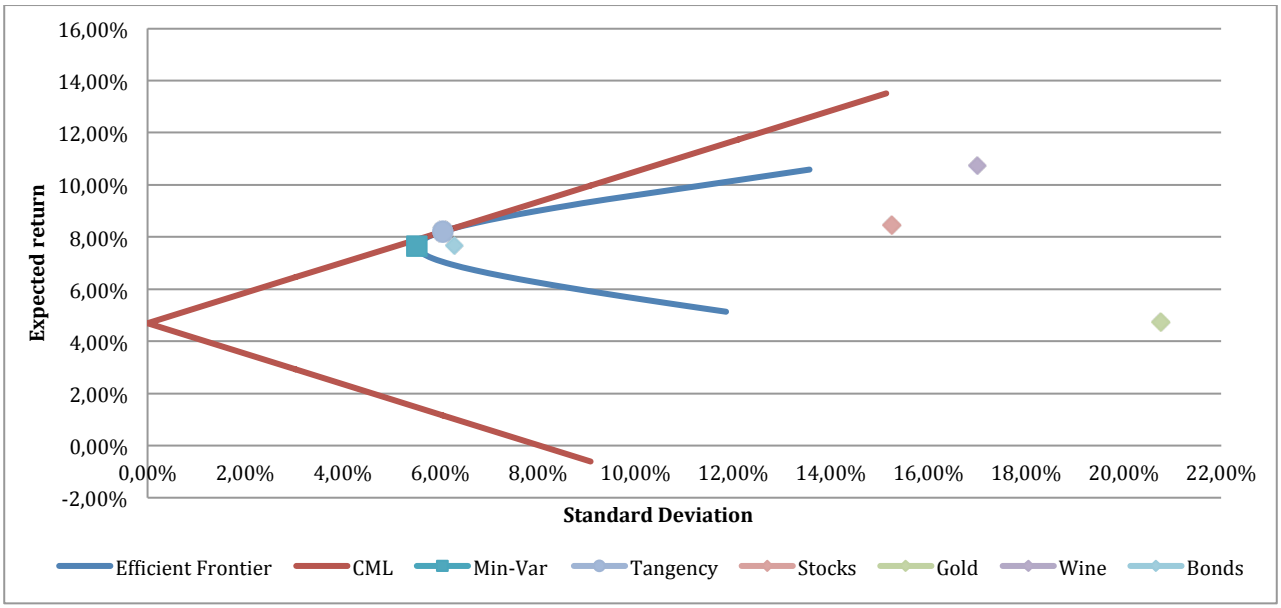


Table 6-4 Tangency portfolio and Minimum variance portfolio from the overall testing period

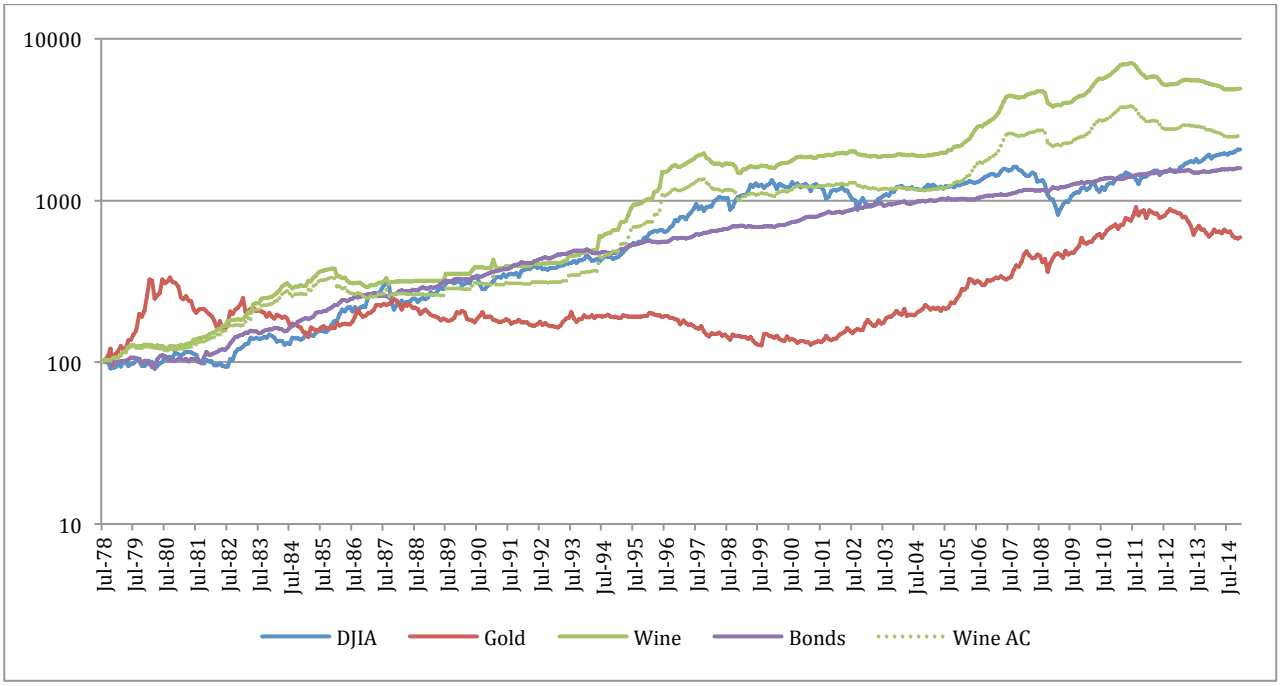
Portfolio	Tangency	Minimum Variance
Stocks	4.8807%	3.5616%
Gold	2.5130%	10.1739%
Wine	18.8933%	7.4184%
Bonds	73.7130%	78.8461%
Sum	100.0000%	100.0000%
Expected return	8.2179%	7.6304%
Standard deviation	6.0540%	5.5280%
Sharpe ratio	0.58372	0.53300

6.3. Portfolio of wine, stocks, bonds, and gold including storage costs 1978-2014

The following section will compare the risk and return on the same selected assets, throughout the same period from July 1978 to December 2014. However, the wine data will include storage costs and transaction costs equivalent to the costs associated with trading wine estimated in chapter 4.4. It is assumed that the wine is held for a ten years period, meaning a yearly transaction cost of 0.5% for first growth and 0.6% for average Bordeaux. The total annual costs (annual fees + annual transaction costs) are estimated to 1.73% for first growth and 2.03% for average Bordeaux. Under the assumption that a wine portfolio is diversified and consists of both first growth and average Bordeaux an annual cost of 1.88% (monthly 0.16%) for storing and trading wine is used (Appendix D).

Figure 6-5 shows the performance of bonds, stocks, wine, and gold between July 1978 and December 2014, the only difference from figure 6-3 is the scattered green line, which shows the performance of wine after annual storage and transaction costs. Wine after costs (AC) rose 2396% (8.88% annually) that is significant lower that wine with no transaction costs (4816%), however it is still more than stocks (1967%), bonds (1487%), and gold (491%).

Figure 6-5 Performance of selected assets after wine after monthly costs (July 1978=100)



The risk of wine is unchanged hence the monthly costs does not affect the volatility of the asset, thus the standard deviation is 16.997%. The lower return for the same risk leads to a decrease of the Sharpe ratio from 0.35640 to 0.24689.

Table 6-5 Return, standard deviation and Sharpe ratio of stocks, gold, wine AC, and bonds 1978-2014

	Stocks	Gold	Wine AC	Bonds
Annual return	8.4628%	4.7365%	8.8805%	7.6735%
Annual standard deviation	15.2612%	20.7644%	16.9973%	6.2889%
Sharpe ratio	0.24760	0.00253	0.24689	0.47536

The correlation matrix is unchanged hence the volatility is unchanged. This furthermore means that the composition of the minimum variance portfolio is unchanged, just the expected return felt from 7.63% to 7.49% and the Sharpe ratio felt from 0.5330 to 0.5080. The asset allocation of the tangent portfolio changed, thus the new tangent portfolio consists of 77.65% bonds, 12.39% wine, 7.02% stocks, and 2.94% gold. The share of wine decreased with 6.51 percentage points, the proportion invested in stocks and bonds grew most in absolute terms. The expected return of the tangent portfolio AC fell to 7.79%, the standard deviation fell to 58.16%, and the Sharpe ratio to 0.5344. Unsurprisingly the portfolio without transaction and storage costs is preferred.

Table 6-6 Tangency portfolio and minimum variance portfolio including storage and transactions costs

Portfolio	Tangency	Minimum variance
Stocks	7.0199%	3.5616%
Gold	2.9381%	10.1739%
Wine AC	12.3882%	7.4184%
Bonds	77.6538%	78.8461%
Sum	100.0000%	100.0000%
Expected return	7.7921%	7.4923%
Standard deviation	5.8155%	5.5280%
Sharpe ratio	0.53445	0.50802

In order to achieve a general conclusion without including individual investors transaction and storage costs, the rest of the portfolios are constructed under the assumption of zero transaction costs. Subtracting the costs would change the portfolio weights and returns.

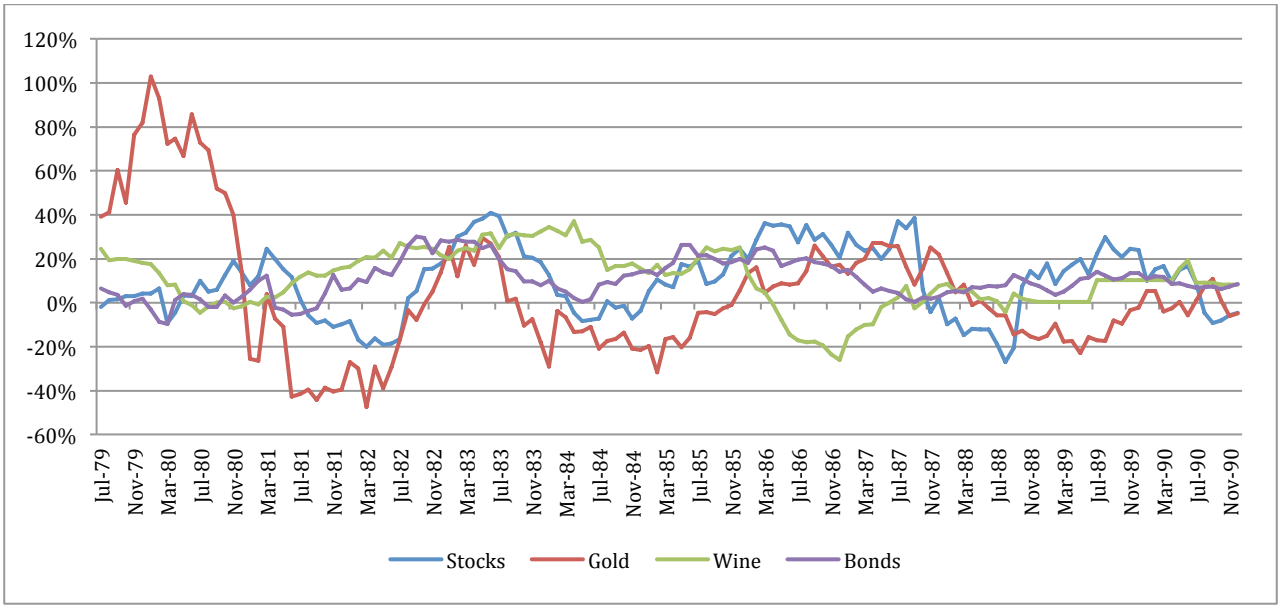
6.4. Portfolio of wine, stocks, bonds, and gold during 12 years economic cycles

This section will split the analysis into three different periods, with the aims of identifying the behavior of fine wine in different macroeconomic cycles. The three periods are July 1978-December 1990, January 1991-December 2002, and January 2003-December 2014. First the general economic environment for the periods will be describe, then the assets performance, volatility, and correlations will be calculated, followed by the creation of the tangency and minimum variance portfolio. Finally the results between the difference cycles will be compared.

6.4.1. Optimal portfolios between 1978-1990

The first period begins in the aftermath of the oil crisis of 1973 and the 1979 energy crisis. The American inflation was double digit and the unemployment high. Both in the US and in the UK the interest rates were above 10% in the last years of the 70s and the first in the 80s. The financial institutions were in a crisis and several American banks failed. The combination of high inflation, rising oil prices, and the soviet invasion of Afghanistan made investors seek to gold as a safe investment, leading to a spike in the gold price. The economy started to recover in 1983 where the inflation rate fell to about 3%, the gold price declined and the stock market started to boom, it increased with almost 100% between August 1985 and August 1987. OPEC collapsed in 1986, which led to a drop in the oil prices, further the financial markets started to show weakness in 1987. The tension in Iran, where American supertankers were attacked exaggerated the fear on the financial markets, which started the crash on October 19, first in East Asian then followed by the other markets. DJIA dropped 22.61% on a single day. The stock market recovered in the following years and reached a new peak in July 1990.

Figure 6-6 Annual return of selected assets between 1978 and 1990



The returns from the period shows that stocks rose 205% (10.07% annually), bonds 259% (10.41% annually), and wine 282% (10.59% annually). Despite the rapid increase in the beginning of the period gold only rose 91% (4.31% annually). The average risk free rate was 8.36% and the average American inflation 6.11%. The high volatility on gold is measured at an annual standard deviation of 29.64%, which is significantly higher than the stocks and wine. Bonds had a relatively high volatility 8.64% in the analysis period. Due to the high riskless rate, gold had a negative Sharpe ratio. Bonds had the highest reward per unit of risk followed by fine wine.

Table 6-7 Return, standard deviation, Sharpe ratio on selected assets between 1978 and 1990

1978-1990	Stocks	Gold	Wine	Bonds
Annual return	10.0645%	4.3066%	10.5895%	10.4133%
Annual standard deviation	15.8704%	29.6379%	13.0303%	8.6375%
Sharpe ratio	0.10761	-0.13665	0.17135	0.23809

The correlation between the assets was relatively low throughout the period except between stocks and bonds. Gold had a negative correlation with both wine and bonds, likewise had wine and stocks. This indicates that the assets are suitable for portfolio diversification.

Table 6-8 Correlation matrix of selected assets between 1979 and 1990

1978-1990	Stocks	Gold	Wine	Bonds
Stocks	1.0000			
Gold	0.1969	1.0000		
Wine	-0.1964	-0.1937	1.0000	
Bonds	0.4105	-0.2039	0.1771	1.0000

The asset composition of the tangency portfolio and the minimum variance portfolio are showed in table 6-9. The tangency portfolio consist of negative 10.14% gold, hence the gold had a significantly lower return that the rest of the assets and a negative Sharpe ratio. The other assets all have a relatively high weight, with bonds as the largest followed by fine wine and stocks. The return on the tangency portfolio is 11.03% with a standard deviation of 9.20%. The Sharpe ratio of 0.2905 is significantly higher than any of the individual assets. The minimum variance portfolio contains almost the same proportion of bonds, 10.28% gold, and a lower proportion of stocks and wine. The expected return was 9.81% and the standard deviation 6.79%.

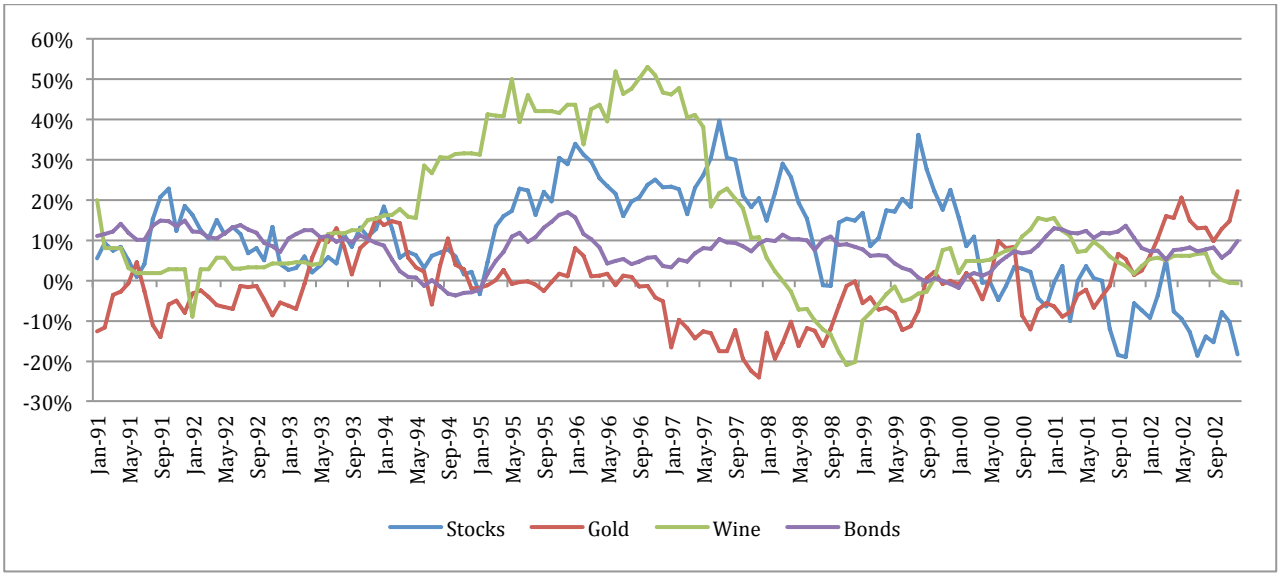
Table 6-9 Tangency portfolio and minimum variance portfolio between 1978 and 1990

Portfolio 1978-1990	Tangency	Minimum variance
Stocks	17.9981%	5.9321%
Gold	-10.1352%	10.2782%
Wine	34.7633%	26.3450%
Bonds	57.3738%	57.4446%
Sum	100.0000%	100.0000%
Expected return	11.0307%	9.8114%
Standard deviation	9.2039%	6.7884%
Sharpe ratio	0.29052	0.21427

6.4.2.Optimal portfolios between 1991-2002

The second period from 1991 to 2002 started with a recession and rising inflation rates, mainly led by the tensions in the gulf region and the spiked in the gas price at the end of the 1980s. The world's second largest economy at the time, Japan, experienced an asset bubble at the end of the 1989s and the Nikkei 225 continues to drop throughout the decade, which is referred to as the lost decade. On the contrary the American economy experienced on of the strongest decades, the economic boom started in the beginning of 1994, many jobs were created and the American unemployment rate fell below 5% in 1997, the GDP grew rapidly, the stock markets boomed, even a rising interest rate to around 5% could not slow down the economy. High investments in new technologies and a belief of the "New economy" led to booming prices on Internet companies. Meanwhile in Asia the rapid growth in new tiger economies Hong Kong, Singapore, South Korea, and Taiwan stopped. The Asian financial crisis hit and the Asian stock markets (and wine), however the recovery was fast, already in 1999 the economies were back on track. The global boom during the period sent the gold prices down and stock (and wine) prices up. This ended at the end of the analysis period, where the new millennium started with the burst of the dot-com bubble, followed by the 9/11 terror attacks which sent the stock markets down and gold price up.

Figure 6-7 Annual return on selected assets between 1991 and 2002



Wine was the best performing asset in the period with a 344% return, stocks retuned 205%, and bonds 154%, gold investors lost 4.90% during the period, the risk free rate was 4.43%. The volatility on wine was the highest followed by stocks. Gold and bonds both had a standard deviation below 10%. The low risk on bonds and the above risk free return give bonds the best Sharpe ratio followed by wine and stocks. The negative return on gold led to a negative Sharpe ratio, meaning that the risk free asset is a better investment than gold. All results are presented in the table below.

Table 6-10 Return, standard deviation, Sharpe ratio on selected assets between 1991 and 2002

1991-2002	Stocks	Gold	Wine	Bonds
Annual return	10.2939%	-1.6736%	13.8413%	7.9493%
Annual standard deviation	12.3915%	9.0874%	17.6376%	4.5825%
Sharpe ratio	0.47300	-0.67195	0.53344	0.76741

The correlations between the assets show that gold has a significantly negative correlation with stocks it is further negatively correlated with bonds and has nearly a zero correlation with wine. This makes gold an attractive hedge, even though the return in the analysis period was negative. Wine is positively correlated with stocks and negatively correlated with bonds. Bonds and stocks are close to a zero correlation.

Table 6-11 Correlation matrix of selected assets between 1991 and 2002

1991-2002	Stocks	Gold	Wine	Bonds
Stocks	1.0000			
Gold	-0.4556	1.0000		
Wine	0.3628	0.0468	1.0000	
Bonds	0.0224	-0.1337	-0.1610	1.0000

The negative return on gold makes it an attractive short for the tangency portfolio, which consist of 127.96% bonds, 30.33% wine and a 6.19% short in stocks and 52.11% short in gold. This combination would return 14.60% at a standard deviation of 8.63% leading to a Sharpe ratio of 1.1787. The minimum variance portfolio is composed of long positions in all assets with bonds and gold as the largest weights. Though wine looks like an attractive investment, then the minimum variance portfolio would just consist of 1.65% wine due to its high volatility. The portfolio would return 5.91% at a standard deviation of 3.28%. The Sharpe ratio of 0.44858 is below the individual assets.

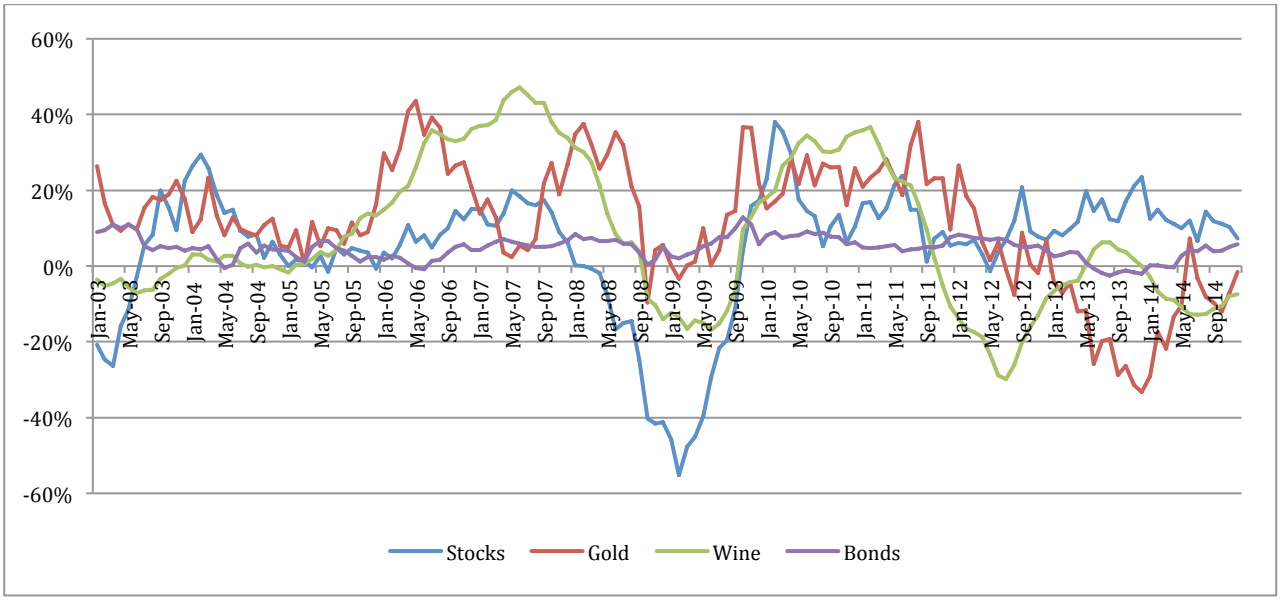
Table 6-12 Tangency portfolio and minimum variance portfolio between 1991 and 2002

Portfolio 1991-2002	Tangency	Minimum variance
Stocks	-6.1864%	14.2853%
Gold	-52.1077%	25.7224%
Wine	30.3299%	1.6467%
Bonds	127.9642%	58.3456%
Sum	100.0000%	100.0000%
Expected return	14.6056%	5.9060%
Standard deviation	8.6304%	3.2844%
Sharpe ratio	1.17873	0.44858

6.4.3.Optimal portfolios between 2003-2014

The last period also started with a recession due to the aftermath of the dot-com crisis and the 9/11. However, the economy recovered during mid-00s where stock markets and housing prices reached new highs. The commodity prices boomed and China showed double digit GDP growth. In the summer 2007 the curve switched, the stock markets started to decline, and collapsed when Lehman Brothers filed for chapter 11 in 2008. The global economy entered into the global financial crisis, which was the worst recession since the great depression in the 1930s. Meanwhile the wine and gold price reached new highs in 2011, before entering a downturn until the end of the analysis period.

Figure 6-8 Annual return on selected assets between 2003 and 2014



Gold was by far the best performing asset in the period with a return of 319.17%, meanwhile fine wine increased 151.86%, bonds and stocks just returned 88.20% and 79.67% respectively. The annual risk free rate was 1.35%. Wine was the most volatile asset in the period followed by stocks and gold. Bonds had a low standard deviation of 2.97%. Due to the low volatility bonds had the highest Sharpe ratio followed by gold. Wine and stocks had a significantly lower.

Table 6-13 Return, standard deviation, Sharpe ratio on selected assets between 2003 and 2014

2003-2014	Stocks	Gold	Wine	Bonds
Annual return	5.0966%	11.5585%	7.7882%	4.7720%
Annual standard deviation	16.6415%	16.2272%	19.0402%	2.9694%
Sharpe ratio	0.22484	0.62880	0.33788	1.15081

The correlations matrix shows that gold and fine wine and gold and bonds had a fairly high correlation. The only asset that stocks were correlated with was wine. Stocks additionally had a low negative correlation with bonds and close to zero correlation with gold.

Table 6-14 Correlation matrix of selected assets between 2003 and 2014

2003-2014	Stocks	Gold	Wine	Bonds
Stocks	1.0000			
Gold	0.0288	1.0000		
Wine	0.3896	0.5051	1.0000	
Bonds	-0.0866	0.4778	0.0766	1.0000

The tangent and the minimum variance portfolio consist of large proportions of bonds, due to the high Sharpe ratio. The tangency portfolio returns 4.83% at a standard deviation of 2.89%, which is slightly better than a 100% investment in bonds. The minimum variance portfolio consist of a negative proportion of gold, even though it had the highest return, however the high Sharpe ratio on bonds leads to a 102.06% proportion in bonds and marginal share in wine and stocks. The low risk free rate contributes to the high Sharpe ratios for the portfolios.

Table 6-15 Tangency portfolio and minimum variance portfolio between 2003 and 2014

Portfolio 2003-2014	Tangency	Minimum variance
Stocks	3.8584%	2.8992%
Gold	-0.2016%	-8.2723%
Wine	1.9020%	3.3172%
Bonds	94.4412%	102.0558%
Sum	100.0000%	100.0000%
Expected return	4.8282%	4.3201%
Standard deviation	2.8866%	2.6671%
Sharpe ratio	1.20327	1.11177

6.5. Summary of the portfolio of wine, stocks, bonds, and gold

This section has analyzed wines performance compared to stocks, bonds, and gold. It shows that wine had the highest annual return (10.74%) throughout the analysis period, followed by stocks (8.46%), bonds (7.67%) and gold (4.47%). Even after subtracting the estimated costs of storing and trading wine, IGW is still performing slightly better than the other assets, with an annual return of 8.88%. In the sub periods wine outperformed the other assets in both the first (1978-1990) and second (1991-2002) and it outperformed stocks and bonds in the third (2003-2014). In the first period wine returned 10.59% annually, with is very close to stocks (10.06%) and bonds (10.41%) but significantly higher than gold (4.31%). In the second period wine returned 13.84%, compared to a 10.29% return on stocks, 7.95% on bonds, and a -1.67% on gold. The third period wine returned (7.79%), which was better than stocks (5.10%) and bonds (4.77%), but lower than gold (11.56%).

The volatility of wine was 17.00% during the full testing period, compared to 20.76% on gold, 15.26% on stocks, and 6.29% on bonds. The volatility of wine has been increasing throughout the period; in the first cycle wine had a volatility of 13.03%, which was lower than both stocks (15.87%) and gold (29.63%). In the second period wine had a volatility of 17.64%, which was higher than both stocks (12.39%) and gold (9.09%). And in the third period the volatility rose to 19.04% on wine, compared to 16.64% volatility on stocks and 16.23% on gold. This can be a consequence of the emergence of new players and technologies, which have created new ways of investing and speculating in IGW and increased the liquidity in the market.

In terms of reward to risk (the Sharpe ratio) wine outperformed the risky assets (stocks and gold) in each of the analysis periods, except in the last period where gold performed better than wine. Only in the transaction cost adjusted portfolio stocks and wine had the same risk to reward. These findings indicate that IGW is an attractive investment, both in terms of risk to reward as well as portfolio diversification.

According to the analysis wine is an attractive asset for portfolio diversification in combination with the other financial securities. All of the 10 different portfolios consist of a positive asset allocation in wine. The tangent portfolio between 1978 and 1990 consists of the highest share (34.76%). On the contrary the minimum-variance portfolio between 1991-2002 consists of the lowest share (1.65%).

7. Conclusion

Throughout the history fine wine has been mentioned and admired as a status symbol for the noble and successful. During the recent decades the number of successful and rich people has been rising, likewise has price of fine wine. The hype for wine reached new all time highs at the same time as the global economy suffered the worst recession since the great depression. Wealthy individuals paid as much as $39,500 for a single bottle of wine. This paper is an academic paper analyzing the fine wine market and the risk and return of holding fine wine, further it treats wine as an investment asset which is compared to stocks, bonds, and gold. In the conclusion, the findings from the different chapters will be presented to construct a comprehensive investment recommendation.

An investor can obtain exposure to wine directly by purchasing in the bottles and store them or indirectly by investing in funds, which invest in the bottles. Alternatively, an investor can invest in companies that produce wine to obtain exposure to the wine industry. This paper uses the direct investment method, by tracking the price development of the tangible fine wines. The wines made for storage and investment is a small fraction of the total wine market, only the best producers in the best vintages produce wine of a quality that can be stored for decades. The primary area for wine investment is Bordeaux, due to the history, quality, quantity, and investment liquidity. Thus, the wine index made for this paper is based on the price development of the best wines from the Bordeaux region.

The price of fine wine is determined by the theory of supply and demand. The supply of fine wine is relatively static due to the geographical limitations. The grapes have to originate from specific regions in order to be sold under a specific brand. The historical wine regions have been defined and unchanged for centuries, thus the yearly supply of grapes for IGW is fixed. However, during the recent decades the number of great vintages has been increasing, either due to technological improvements and/or changing climate, which has increased the global production of fine wine slightly. The demand for fine wine has increased

significantly during the recent decades. There is a rising number of global HNWI that demand fine wine as a luxury to show social status and prestige. Particularly the "new rich" demand more luxury than the "old rich", which has lead to a shift in the main Bordeaux export markets. The USA was the largest importer outside Europe in 1980s, Japan grew significantly in the 1990s, and China became the largest in the 2000s. It is further estimated that the Asian region will continue to demand more luxury products, including fine wine, in the coming decades.

The paper has constructed a regression model to determine how macroeconomic factors influence the price of fine wine. The model is constructed on data consisting of monthly observations between July 1978 and December 2014. The model concludes that the variation wine price cannot be predicted from the variation in the macroeconomic data, hence only the variation in the USDGBP spot and the first lagged return of wine were proven significant. The variation in gold, the American and Japanese stock market, the first lag of gold, the first lag of the American and Japanese stock markets, as well as the delta of the inflation rate, and the interest rate were insignificant. The variation in the USDGBP spot had a negative correlation with the variation in the wine price, meaning that when the USD is appreciating to the GBP the fine wine is depreciation, which is rather surprising hence it them becomes cheaper for the American market to buy European fine wine. The main conclusion of the model is that the wine price is uncorrelated to the selected macroeconomic factors, indicating that fine wine is a good hedge against the traditional investment assists as stocks, gold, and fixed income.

The return of wine is calculated on a 36.5-years period time-series data consisting of monthly observations. The data is based on the price development of selected Bordeaux wines. The wine prices index rose 4789% in nominal terms during the period, equitant to 10.67% annually. The inflation adjusted real annual return is determined to 7.19%. A yearly nominal return of 10.67% is fairly good, however the return is volatile and fine wine is currently trading 31% below the peak in June 2011. In addition to the volatility, investing in wine is carrying out higher transactions costs than traditional investment assets as well as storage costs due to the physical delivery. The new technologies have lowered the costs, yet this paper has estimated the transactions costs (buy+sell) to 5% and the yearly storage, insurance, and membership fee to 1.22%. The costs differs from one investor to another, due to trade size, portfolio size, and the frequency of trading, thus the costs are omitted for the generalization of the paper, however for the investment recommendation investors need to include personal costs to optimize the return.

The final analysis of the paper is based on the modern portfolio theory, where wine is compared to stocks, bonds, and gold. The analysis is based on the 36.5-year period, as well and three 12-years sub periods. The model concludes that return on wine outperformed the other assets in three out of four periods, only gold

performed better in the last period. In terms of volatility wine had an increasing volatility throughout the analysis, which can be explained by the entrance of new players and the development of technologies that have made wine trading more liquid. The diversification benefit of wine is analyzed by the construction of 5 minimum variance portfolios, which are minimizing the volatility, and 5 tangent portfolios, which are maximizing the Sharpe ratio. The model concludes that fine wine has a positive weight in all constructed portfolios, meaning that is an attractive asset for portfolio diversification, due to the reward to risk profile and the low correlation with the traditional investment assets.

The recommendation for investors is that fine wine, as an alternative asset class, historically has provided an attractive return to the relative risk. It is further an asset that provides a diversification benefit to a portfolio consisting of stocks, gold, and bonds, due to the low correlation with the traditional asset classes. However, it is important to know which wines to invest in, hence wine is not a standardized commodity. Further, investment in wine is carrying higher costs and less liquidity than traditional assets, which decrease the return and increase the risk. The market for wine investment is relatively small both in comparison to the whole wine industry as well as the global investment assets. The global IGW market is estimated to $4 billion a year compared to the global wine trade of $318 billion in 2013 and the market capitalization of the global stock markets of $55 trillion in 2012, which makes IGW a niche investment class. Finally, an investor has the keep in mind that many players on the fine wine market invest for a social return rather than a financial return, meaning that not all players makes economic rational decisions.

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Appendix A – The Médoc Classification of 1885

Premier Crus Classés (First Growths)

Château Lafite-Rothschild, Pauillac
Château Latour, Pauillac
Château Margaux, Margaux
Château Haut-Brion, Pessac, Graves
Château Mouton-Rothschild, Pauillac (since 1973)

Deuxièmes Crus Classés (Second Growths)

Château Rauzan-Ségla, Margaux
Château Rauzan-Gassies, Margaux
Château Léoville-Las-Cases, St. Julien
Château Léoville-Poyferré, St. Julien
Château Léoville-Barton, St. Julien
Château Durfort-Vivens, Margaux
Château Lascombes, Margaux
Château Gruaud-Larose, St. Julien
Château Brane-Cantenac, Cantenac-Margaux
Château Pichon-Longueville Baron, Pauillac
Château Pichon Lalande, Pauillac
Château Ducru-Beaucaillou, St. Julien
Château Cos d'Estournel, St. Estèphe
Château Montrose, St. Estèphe

Troisièmes Crus Classés (Third Growths)

Château Giscours, Labarde-Margaux
Château Kirwan, Cantenac-Margaux
Château d'Issan, Cantenac-Margaux
Château Lagrange, St. Julien
Château Langoa-Barton, St. Julien
Château Malescot St. Exupéry, Margaux
Château Cantenac-Brown, Cantenac-Margaux
Château Palmer, Cantenac-Margaux
Château La Lagune, Ludon-Haut-Médoc
Château Desmirail, Margaux
Château Calon-Ségur, St. Estèphe
Château Ferrière, Margaux
Château Marquis d'Alesme-Beker, Margaux
Château Boyd-Cantenac, Cantenac-Margaux

Quatrièmes Crus Classés (Fourth Growths)

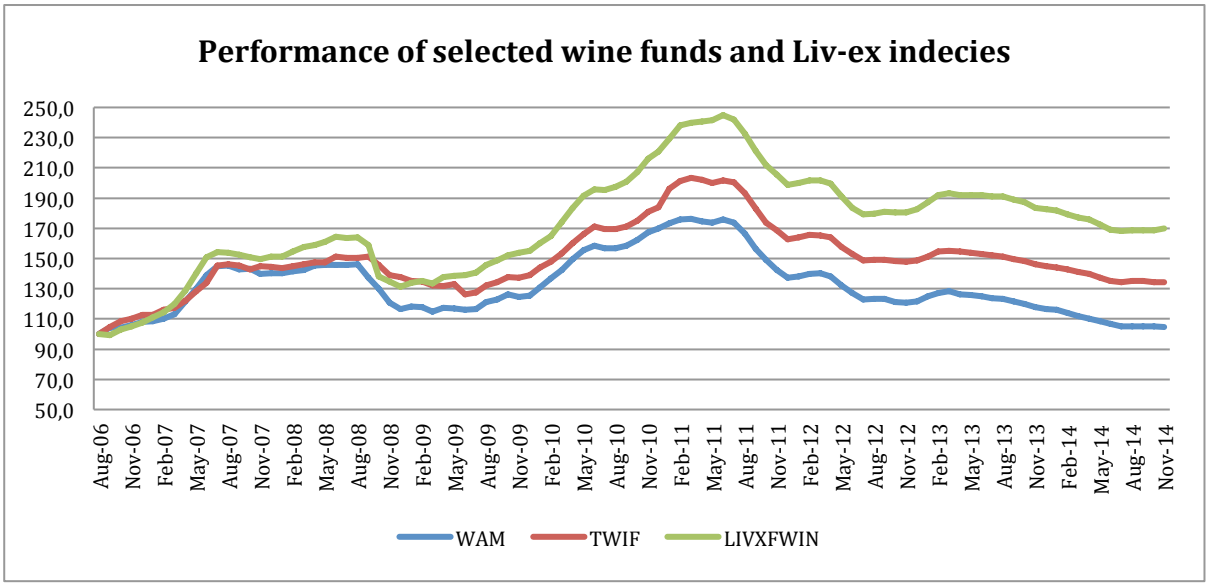
Château St.Pierre, St. Julien
Château Branaire, St. Julien
Château Talbot, St. Julien
Château Duhart-Milon, Pauillac
Château Pouget, Cantenac-Margaux
Château La Tour-Carnet, St. Laurent-Haut-Médoc
Château Lafon-Rochet, St. Estèphe
Château Beychevelle, St. Julien
Château Prieuré-Lichine, Cantenac-Margaux
Château Marquis-de-Terme, Margaux

Cinquièmes Crus Classés (Fifth Growths)

Château Pontet-Canet, Pauillac
Château Batailley, Pauillac
Château Grand-Puy-Lacoste, Pauillac
Château Grand-Puy-Ducasse, Pauillac
Château Haut-Batailley, Pauillac
Château Lynch-Bages, Pauillac
Château Lynch-Moussas, Pauillac
Château Dauzac, Labarde-Margaux
Château Cantemerle, Macau-Haut-Médoc
Château du Tertre, Arsac-Margaux
Château Haut-Bages-Libéral, Pauillac
Château Pédesclaux, Pauillac
Château Belgrave, St. Laurent-Haut-Médoc
Château de Camensac, St. Laurent-Haut-Médoc
Château Cos Labory, St. Estèphe
Château Clerc-Milon-Rothschild, Pauillac
Château Croizet-Bages, Pauillac
Château Mouton-Baronne-Philippe (now d'Armailhacq), Pauillac

Appendix B – Liv-ex and Wine funds

Name	Start date	Website
The Wine Investment Fund (TWIF)	March 2004	www.wineinvestmentfund.com
Find Wine Fund by Wine Asset Managers (WAM)	August 2006	www.wamllp.com



Correlation Matrix	WAM	TWIF	LIVXFWIN
WAM	1.000		
TWIF	0.836	1.000	
LIVXFWIN	0.878	0.773	1.000

Appendix C – The Wine Index

Time	Source	Name	Selection criteria and calculation
2001-2014	Liv-ex	Fine Wine Investable Index	200 most traded Bordeaux wines from 24 different producers. Need at least a 95 point score from a leading critic or 93 point for the top 8 producers (First Growth*, Ausone, Cheval Blanc, and Petrus). Needs to be available phsycally at the UK market - no En Primeur Weighted average, reported monthly
1988-2001	Liv-ex	Fine Wine Investable Index	Historical Bordeaux prices collected from leading fine wine merchants. Weighted average, reported monthly
1978-1988	Decanter (own calculations)	-	Historical auction prices excluding sales taxes and commissions, prices converted to GBP. Data set consists of the five first growths in following vintages: 1961, 1962, 1964, 1966, 1967, 1970, 1971, 1975, 1976, 1978, 1979, 1980, 1981, 1982, and 1983. Maximum duration in the index is 20 years Weighted average, reported monthly Containing 5040 observations

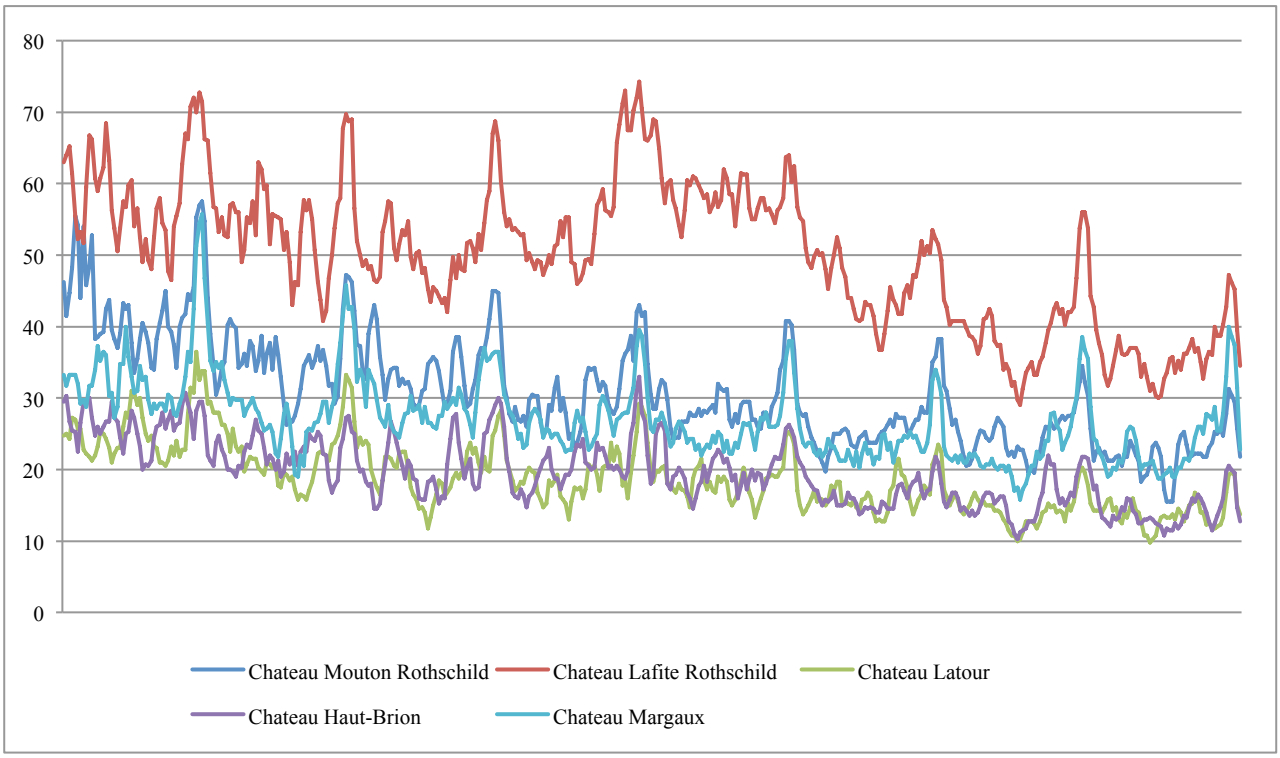
End year values with highs and lows

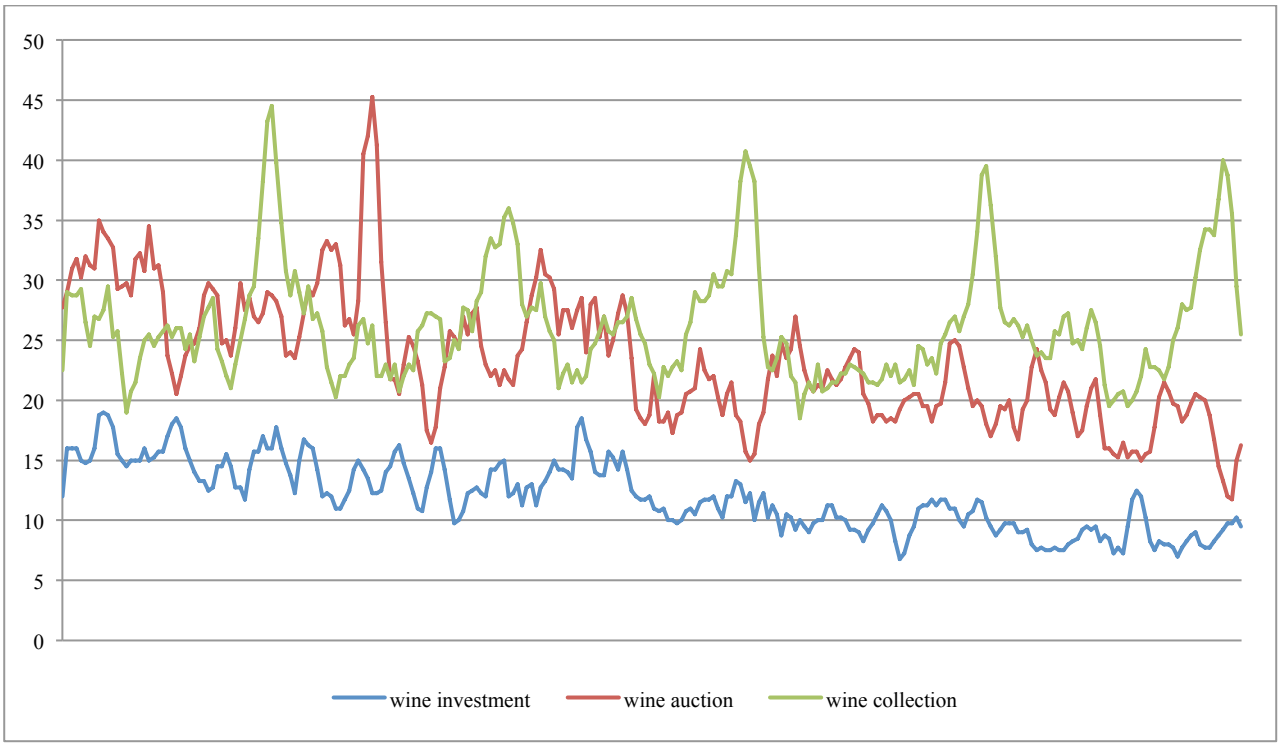
	Nominal	Real
31/07/78	100	100
31/12/78	107.13	103.07
31/12/79	128.35	108.44
31/12/80	126.34	95.48
28/02/81	126.34	93.97
31/12/81	148.05	103.35
31/12/82	183.82	123.73
31/12/83	254.11	164.01
31/12/84	296.46	184.83
30/11/85	381.35	229.51
31/12/85	381.01	228.47
31/12/86	293.86	173.83
31/01/87	291.25	171.67
31/12/87	317.10	180.14
31/12/88	317.92	172.86
31/12/89	352.63	182.26
31/12/90	382.48	187.12
31/05/91	382.48	185.33
31/12/91	393.49	187.50
31/12/92	410.61	189.49
31/12/93	478.85	215.69
31/12/94	657.03	287.70
31/12/95	1017.40	433.40
31/12/96	1622.00	670.57
31/10/97	1953.34	796.07
31/12/97	1804.95	734.24
31/12/98	1475.18	590.25
31/12/99	1598.64	622.27
31/12/00	1857.20	696.98
31/12/01	1924.83	713.82
31/12/02	1913.15	690.45
31/12/03	1917.39	678.24
31/10/04	1887.34	648.81
31/12/04	1900.57	653.69
31/12/05	2174.03	718.86
31/12/06	3121.36	1011.11
31/12/07	4376.71	1359.38
30/06/08	4761.32	1432.64
31/12/08	3801.76	1182.15
31/12/09	4497.04	1362.63
31/12/10	6400.63	1907.33
30/06/11	7090.77	2072.95
31/12/11	5758.88	1666.28
31/12/12	5290.46	1506.37
31/12/13	5294.29	1483.85
31/07/14	4869.78	1351.76
31/12/14	4916.19	1380.52

Appendix D – Estimation of transaction and storage costs

Absolut value	**First Growth**	**Average classified Bordeaux**
Average price £ per case	4050	2100
Storage and insurance per case £	9	9
Yearly membership fee £	1500	1500
Transaction costs		
Settlement fee per unit 3.5£	42	42
Settlement fee in percentage	1.04%	2.00%
Transaction cost of value buy+sell	4.00%	4.00%
Total transactions costs	5.04%	6.00%
Yearly fees		
Storage and insurance	0.222%	0.429%
Yearly membership fee <1%	1%	1%
Total	1.22%	1.43%
Annualized costs		
Annual transaction costs	0.50%	0.60%
Annual storage and subscription	1.22%	1.43%
Total Annual costs	1.73%	2.03%
Annual average		1.88%
Monthly Average		0.16%

Appendix E - Google trend 1M MA Graphs





Appendix F – Correlation matrix of variables in the regression analysis

Collinearity Diagnostics table

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions										
				(Constant)	LNGold	LNDJIA	LNNKY	LNUSDGBP	DeltaInterest	DeltaInflation	LAG Wine	LAG Gold	LAG DJIA	LAG NKY
1	1	1.756	1.000	.06	.01	.08	.08	.02	.01	.01	.05	.00	.08	.06
	2	1.487	1.087	.00	.08	.04	.03	.10	.10	.00	.01	.03	.08	.10
	3	1.381	1.128	.01	.14	.08	.06	.12	.00	.16	.00	.01	.01	.02
	4	1.187	1.216	.26	.00	.01	.07	.02	.00	.00	.26	.05	.01	.04
	5	1.149	1.236	.03	.00	.02	.05	.00	.20	.14	.00	.19	.08	.05
	6	.918	1.383	.03	.00	.00	.00	.01	.16	.05	.17	.58	.01	.00
	7	.774	1.506	.09	.47	.00	.00	.05	.28	.10	.14	.00	.00	.02
	8	.720	1.562	.03	.02	.06	.00	.44	.16	.42	.09	.01	.00	.00
	9	.603	1.706	.39	.27	.00	.01	.23	.06	.08	.28	.12	.00	.03
	10	.527	1.825	.01	.00	.21	.21	.00	.01	.01	.01	.00	.49	.51
	11	.498	1.879	.09	.00	.49	.50	.02	.02	.00	.00	.00	.25	.18

Correlation matrix between all variables

	LN Wine	LN Gold	LN DJIA	LN NKY	LN USD	Delta Int	Delta Inf	LAG Wine	LAG Gold	LAG DJIA	LAG NKY
LN Wine	1.00										
LN Gold	-0.03	1.00									
LN DJIA	0.00	0.01	1.00								
LN NKY	0.01	0.02	0.46	1.00							
LN USD	-0.11	-0.29	-0.06	-0.10	1.00						
Delta Int	-0.01	-0.10	-0.01	0.07	0.14	1.00					
Delta Inf	0.07	0.16	-0.03	-0.01	-0.15	0.11	1.00				
LAG Wine	0.20	0.02	0.08	0.04	-0.06	0.05	0.10	1.00			
LAG Gold	0.04	-0.06	-0.06	-0.02	0.01	0.12	0.13	-0.03	1.00		
LAG DJIA	0.08	0.00	0.03	0.08	0.00	0.09	0.06	0.00	0.01	1.00	
LAG NKY	0.10	-0.01	0.02	0.06	-0.02	0.11	0.11	0.01	0.02	0.46	1.00

Appendix G – Regression models without Japan

Regression Statistics	
Multiple R	0.25224370
R Square	0.06362688
Adjusted R Square	0.04604241
Standard Error	0.02974100
Observations	435

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	8	0.02560427	0.00320053	3.61835620	0.00043741
Residual	426	0.37680847	0.00088453		
Total	434	0.40241274			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.00697200	0.00153448	4.54356976	0.00000721	0.00395591	0.00998809
LN Gold	-0.03624516	0.02735481	-1.32500121	0.18588100	-0.09001236	0.01752204
LN DJIA	-0.01183992	0.03304579	-0.35828819	0.72030513	-0.07679301	0.05311318
LN USDGBP	-0.11084056	0.05116416	-2.16637101	0.03083672	-0.21140620	-0.01027493
Delta Interest	-0.00152557	0.00299314	-0.50968915	0.61053319	-0.00740874	0.00435760
Delta Inflation	0.00262342	0.00367252	0.71433821	0.47540930	-0.00459509	0.00984192
LAG Wine	0.19670214	0.04742120	4.14797860	0.00004050	0.10349347	0.28991081
LAG Gold	0.02318005	0.02626991	0.88238003	0.37806896	-0.02845474	0.07481483
LAG DJIA	0.05462048	0.03298254	1.65604255	0.09844957	-0.01020828	0.11944925

Appendix H – Regression model without USA

Regression Statistics	
Multiple R	0.25628995
R Square	0.06568454
Adjusted R Square	0.04813871
Standard Error	0.02970830
Observations	435

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	8	0.02643229	0.00330404	3.74359809	0.00029902
Residual	426	0.37598044	0.00088258		
Total	434	0.40241274			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.00714561	0.00150488	4.74829893	0.00000281	0.00418770	0.01010352
LN Gold	-0.03483467	0.02733158	-1.27452085	0.20317366	-0.08855620	0.01888687
LN NKY	-0.00640245	0.02530683	-0.25299295	0.80039570	-0.05614426	0.04333935
LN USDGBP	-0.10916183	0.05135085	-2.12580353	0.03409425	-0.21009441	-0.00822924
Delta Interest	-0.00162208	0.00300626	-0.53956692	0.58977764	-0.00753103	0.00428687
Delta Inflation	0.00227205	0.00368113	0.61721571	0.53742221	-0.00496339	0.00950750
LAG Wine	0.19608740	0.04725623	4.14945077	0.00004025	0.10320300	0.28897180
LAG Gold	0.02350380	0.02621511	0.89657460	0.37045233	-0.02802327	0.07503087
LAG NKY	0.04903804	0.02529643	1.93853625	0.05321804	-0.00068331	0.09875939