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**INVESTING IN FINE WINE FROM THE PERSPECTIVES OF  
DIVERSIFICATION AND COSTS**

# INVESTING IN FINE WINE FROM THE PERSPECTIVES OF DIVERSIFICATION AND COSTS

## ABSTRACT

This paper examines the meaningfulness of fine wine as an alternative investment, with particular focus on the costs of investing in fine wine. Is fine wine suitable for further diversifying and thus improving the risk-return profile of portfolios invested in global equities and bonds? This analysis takes place in an initial stage on an index basis and in a second stage on the basis of real investment opportunities. The reference currencies are the US dollar and the euro. In order to observe stock indexes, the MSCI World Index is used, and for bonds the JPM World Government-Bond Index is deployed. Regarding the data for investment in fine wine, the main focus is on the Liv-ex-50 Index. The time period is defined by the availability of the data. For the observation of indices, the period is from the beginning of 2004 to May 2018. For observation on the basis of a real investment the period is from March 2010 to May 2018. In the case of the real investment, index funds are used for the data analysis of equities and bonds. As there is no index fund for fine wine, the Liv-ex-50 index is used including all of the costs of a real investment.

Various portfolio compositions are used for the periods indicated. On the one hand, a portfolio of 50% equities and 50% bonds is compared to a portfolio of 45% equities, 45% bonds and 10% fine wine. On the other hand, a portfolio of 25% equities and 75% bonds is compared to a portfolio of 20% equities, 70% bonds and 10% fine wine. As benchmarks, the annualised return, the standard deviation and the Sharpe ratio of the respective portfolios are calculated.

The results for the periods indicated are sobering. The inclusion of fine wine leads - at an index level - to only a slight improvement of the annualised return, but to a marked increase in risk. When considering the real investment, the considerable costs of an investment in fine wine come to bear. The annualised return is lower and at the same time the risk is higher than that of portfolios which do not include fine wine. It is only when the index is viewed in euros that a slight improvement of the Sharpe ratio in one portfolio can be recorded. When costs are considered, the inclusion of fine wine leads to a worsening of the Sharpe ratio in all cases. This result is a significantly more critical verdict on this diversification opportunity than was noted in the previous studies by Masset and Weisskopf (2010), Masset and Henderson (2010), Bouri (2014), Bouri et al. (2016) and Aytac et al. (2016). By contrast, our results confirm the studies which point out the high costs of investment in fine wine and which reach largely negative findings when analysing real investments in wine investment funds (Burton and Jacobsen, 2001, Masset and Weisskopf, 2015).

**Keywords:** fine wine, alternative assets, portfolio diversification, Sharpe ratio

**JEL classification:** E47, F31, F37, G11, G15, G17, Q19.

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## 1. Introduction

Don't put all your eggs in one basket. One of the most important principles in investing is to hold a diversified portfolio. This means spreading one's capital between different investment forms in order to reduce dependency on one form of investment, because no matter how convinced one may be by an investment, things can turn out differently to how one imagined.

For centuries, investors have been practising the concept of spreading financial investments widely. By investing in securities of different geographical origins and from various issuers, the risk of a portfolio is reduced. The fundamental principles of portfolio diversification can be seen in the brochures of investment funds as early as 1870 (Rutterford and Sotiropoulos, 2016). The theoretical basis of portfolio theory was laid down by Harry Markowitz (Markowitz, 1952). Via the diversification of assets, the risk of a portfolio (as measured by the standard deviation) can be reduced while maintaining the same expected return, or the returns can be increased without also increasing the risk involved. In order to achieve this, one has to not only take the individual risk into account when selecting equities, but also the price trends of various forms of investments over the course of time. When one asset loses value, another can gain. So, if they are not completely correlated, portfolio risk can be reduced by mixing different forms of investment. Spreading one's investments is possible in various ways. It can be done via different asset classes, or also by investing internationally in a range of countries and currencies. The best-known asset classes are equities, bonds and money-market instruments. These are referred to as classical or traditional asset classes, while all other types are described as alternative asset classes.<sup>1</sup> The price movements of alternative asset classes are different from those of the classical asset classes, which is what makes them so interesting. This is also the reason why they are suitable for diversification and for reducing portfolio risk.

In the aftermath of the global financial crisis in the years 2008/2009, interest rates fell significantly worldwide. Due to the very low returns, the prices of many bonds were noticeably higher than their redemption value. Until the point in time when the bond is repaid, there will therefore be price losses, so other investment opportunities with a chance of price increases thus gain in attractiveness. This is also one of the reasons why there has been impressive growth in alternative investments (Kräussl, 2017). Alongside hedge funds, private equity and commodities, so-called exotics or collectables are also increasingly being viewed as investment opportunities.<sup>2</sup>

An issue which has been debated more frequently in recent years is investment in wine (Ashton, 2010), whereby the positive aspects of diversification are particularly emphasised. The foundation for this is the fact that the factors which influence wine prices differ significantly from those which influence the prices of classical asset classes. The main influences on wine prices are the weather and thus the quality of the wine, the origin and classification<sup>3</sup> of the wine, and their evaluation by independent experts (above all Robert Parker).<sup>4</sup> The great influence the weather has is indisputable: a lot of rain in winter, a growth period with warm temperatures and a dry phase towards the end of the growth period and during harvesting are ideal conditions for high-quality wines. The influence of expert evaluations is more limited, because the quality of the wine is initially determined by the weather and the know-how of the producer. The assessment by experts ultimately only confirms the quality determined by the above-mentioned factors (Lecocq, 2006). In addition, an IMF study also established economic growth in the emerging markets as an important influence on the development of wine prices (Cevik, 2011). The factors which influence wine prices thus differ

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<sup>1</sup> There is no standardised definition of the term 'alternative investments'. Everything which is not stocks or bonds should therefore be viewed as alternative investments (Fraser-Sampson, 2011).

<sup>2</sup> An overview of studies on the performance of collectables can be found in Burton (1999).

<sup>3</sup> The classification of wines in Bordeaux was first carried out at the time of the 1855 World Exhibition for wines from Medoc. The first growths (at that time there were four, since 1973 there have been five) were classed as Premier Grand Crus. These are the Chateaux Haut-Brion, Lafite-Rothschild, Latour, Margaux and Mouton-Rothschild.

<sup>4</sup> See Ashenfelter et al., 1995, Ali et al., 2010, Dubois and Nauges, 2010, Hay, 2010, Masset et al., 2015, Ashton, 2016.

considerably from the factors which determine the values of traditional asset classes. This is already a good indicator that wine could be suited towards improving the risk-return profile of securities portfolios.

For wine to be suitable as an investment, certain conditions must be fulfilled. The term fine wine investments is used when the following are in place: (1) There is a secondary market, (2) the wine has the potential to improve in the bottle, (3) the winery has a longer track record in the production of high-quality wines, and (4) there are positive evaluations by independent experts. The annual trading volume in the fine wine market is estimated to be around \$4-5bn (in 2004 this was only approx. \$ 1bn)<sup>5</sup>. Unlike other commodities such as gold or oil, fine wine is not traded on a standardised basis; there are too many different wines and too many trading places. The founding of the London International Vintners Exchange (Liv-ex) in 1999 was therefore a milestone in the professional trade with fine wine. Liv-ex is the world's most important electronic exchange for fine wine. It provides a weekday market for wine dealers, traders and brokers. The difference to auction houses is that only registered traders are allowed to trade here. In addition, the wines traded here are solely those which comply with the definition of fine wine, and not antique wines. Liv-ex calculates and publishes its own research and price index and follows strict transparency rules. The daily database of Liv-ex goes back as far as 2004 and thus provides sufficient history for the analysis in this study.<sup>6</sup>

Studies have been dealing with wine as an investment since the end of the 1970s. Krasker (1979) concluded that the returns from storing wine are no higher than from investing in no-risk investments. His database were the prices of wines from Bordeaux and California which were auctioned between 1973 and 1977 by Heublein, at the time a very well-known wine trader. Jaeger (1981) observed a longer period from 1969 to 1977 and reduced the assumed storage costs by using Freemark Abbey Winery as a basis for his calculations. He determined a performance above risk-free investments. In a long-term study covering the period 1900 to 2012, Dimson et al. (2015) came - on the basis of auction results and a 'value-weighted arithmetic repeat sales regression'<sup>7</sup> approach - to a geometrically-weighted average return of 5.3%. Taking storage and insurance costs into account, this is reduced to 4.1% (transaction costs can reduce the result further). For their study, the authors collected the prices of five wines. The wines are: Haut-Brion, Lafite-Rothschild, Latour, Margaux and Mouton-Rothschild. The majority of the prices originate from Christie's auction house in London. For an overview of the studies dealing with the issue of the performance of wine investments, see Storchmann (2012).

For this paper, studies which mainly focus on the diversification features of wine are of great relevance. These studies use time series of indices as their basis for calculations, and the majority of them come to positive results. According to them, the risk-return profile is significantly improved by including wine in a portfolio of traditional asset classes. In a study on the period from 1983 to 2002, Kumar (2010) compared the Fine Wine 50 index<sup>8</sup> with the FTSE 100 (UK equities), the Dow Jones Industrial Average (US equities), UK treasury bonds and US 30-year treasury bonds. His results show that investing in wine is more profitable than investing in stocks or bonds. Its volatility is higher than that of bonds, but lower than that of equities. The positive diversification effects in particular are emphasised. The portfolio with the highest return in Sterling and US dollars consisted entirely of wine. The minimum variance portfolio in Sterling consisted of 18% wine, 4% equities and 78% bonds. In US dollar it consisted of 1% wine, 1% equities and 98% bonds. It was shown that the Sharpe ratio<sup>9</sup> of the portfolio was higher with the inclusion of wine than without it.

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<sup>5</sup> Most of the trading volume of wine is accounted for by dealers, and approx. 10% by auctions of the Liv-ex wine exchange (source: liv-ex.com).

<sup>6</sup> Bouri (2013) argued the case for using Liv-ex index data: it can be viewed as a reference for the fine wine market.

<sup>7</sup> Price trends are calculated here on the basis of transactions for exactly the same wines over time.

<sup>8</sup> This is an index which was calculated on the basis of auction results. It contained wines from ten producers from five vintages. The vintages were from 1961-1990.

<sup>9</sup> The Sharpe ratio, also called the reward to variability ratio, measures the average return earned in excess of a risk-free interest rate per unit of volatility.

In an analysis covering the period 1996 to 2007, Masset and Henderson (2010) showed on the basis of data from the Chicago Wine Company<sup>10</sup> that investing in wine is advantageous. An attractive return was obtained and the correlation with equities was not significant. This means that investment in wine leads to a meaningful diversification of portfolios. The portfolio with the highest Sharpe ratio contains a higher proportion of wine than equities.

Masset and Weisskopf (2010) established that for the period 1996-2009 that the General Wine Index<sup>11</sup> and above all the Grand Crus from Bordeaux from the best vintages achieved a better return than stocks, and at the same time exhibited lower volatility. A look at other wine indices also confirms that higher returns and lower risks were obtained than in the Russell 3000 Index.

In another study, Bouri (2014) compared two portfolios over the period 1988-2013 against a benchmark portfolio of 100% US stocks (S&P 500). The first of these portfolios contained 50% fine wine (Liv-ex-Fine Wine Investables Index)<sup>12</sup> and 50% US stocks. The second portfolio was a minimum variance portfolio consisting of US stocks and fine wine. It comes to the conclusion that adding wine investments to an equities portfolio leads to a reduction of risk. Particularly in times in which equities are losing value, wine shows its positive diversification effects.

Aytac et al. (2016) considered the period 2007-2014 in their study. On the basis of Liv-ex indices<sup>13</sup> as well as WineDex indices<sup>14</sup>, gold, French equities (CAC indices), bonds (EMTX)<sup>15</sup> and a worldwide equities portfolio (MSCI World), they came to the conclusion that the inclusion of Bordeaux wines improved the efficiency in every case. Investors thus obtain a higher return for the same risk if they include wine in their portfolios. The results for the WineDex indices are clearly better than those of the London Liv-ex wine exchange. Both the Sharpe ratios and the modified Sharpe ratios<sup>16</sup> improved.

Bouri et al. (2016) analysed monthly data for the period 2001-2014 and focused on the advantages in terms of diversification of investing in wine at times in which traditional asset classes are doing poorly: they examined the function of wine as a hedge and safe haven. For investments in wine, the Liv-ex Fine Wine Investables Index was used. The UK stock market was represented by the FTSE 100 Index. In the periods indicated, a differentiation was made between bull markets (from 2004-2007 and 2009-2014) and bear markets. They came to the conclusion that the risk-return ratio of a portfolio is improved by adding wine to it. Fine wine is thus considered to function as a hedge in negative market periods.

The main issue in this study is whether fine wine as an alternative asset can make a positive contribution towards diversification in a portfolio which is already broadly diversified in terms of the traditional assets of stocks and bonds. A positive contribution towards diversification is an increase of the annualised return over the observation period with the same level of risk (as measured by standard deviation) or a reduction of risk with the same return. In order to consider return and risk, the Sharpe ratio is used. The Sharpe ratio measures the over-return (the return in excess of the risk-free interest rate) per unit of risk. The higher the Sharpe ratio, the more attractive is the portfolio. In the studies mentioned, the analysis is carried out on the basis of index data. Index figures do not contain any costs and are merely useful for a theoretical view, so in this study calculations on the basis of real investments are used in addition to calculations on the basis of index values.

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<sup>10</sup> The Chicago Wine Company (TCWC) was founded in 1974 and held its first wine auction in April 1977. It was thus the second company after Heublein to hold wine auctions in the USA.

<sup>11</sup> The index data is from the Chicago Wine Company and contains all auctions which took place from January 1996 to February 2007.

<sup>12</sup> The index of the Liv-ex fine wine market in London consists of Bordeaux wines from the 24 leading producers. The selection takes place on the basis of evaluations by the wine critic Robert Parker (at least 95 out of 100 points).

<sup>13</sup> The indices are entirely transparent and can be viewed on the web page <https://www.liv-ex.com/news-and-insights/indices/>.

<sup>14</sup> The indices are calculated on the basis of wine auctions in France. They consist of 40 representative wines of the region from the last ten vintages. No information is available on the weighting of the index components.

<sup>15</sup> The EMTX indices cover the whole of Europe and were developed in 2003 by EuroMTS and Euronext.

<sup>16</sup> The modified Sharpe ratio assumes a skewed rather than a normal distribution of returns.

A real investment can be carried out by purchasing investment funds. In the case of actively managed investment funds, investors delegate their investment decisions to experts who have specific expertise in this asset class. For this service, experts receive payment from their investors. In the case of fine wine, the delegation of investment decisions to experts appears particularly meaningful. This is because (1) there is no central market place and therefore there is no single price, (2) it is difficult to obtain access to market-relevant information due to a lack of regulation, and (3) high costs can be mitigated by economies of scale. In order to measure the success of funds which invest in fine wine, Masset and Weisskopf (2015) examined the performance of nine wine funds over the period 2000-2013. Only one of the nine funds considered<sup>17</sup> succeeded in achieving a higher Sharpe ratio than the benchmark index<sup>18</sup>. In their study, they also drew attention to the problem of liquidity in wine funds. In the years 2012 and 2013, for example, there were already two funds which had to close due to liquidity problems and contradictions in evaluations.<sup>19</sup> The reason for the closure of the funds was a high number of fund shares being returned by investors. If the contents of the fund cannot be liquidated quickly in such a case, the fund has to close.<sup>20</sup>

Alongside investing in actively managed investment funds, buying a passive index tracker is another way of investing in an asset class. Passive funds aim to replicate an index. Their performance is therefore very close to that of the underlying index. The advantage are the significantly lower fees compared to actively managed funds. In this study, real investments are therefore considered on the basis of index funds. In the traditional asset classes, there are suitable funds available, but for investments in fine wine there has been no index fund until now. An index is therefore calculated which takes into account all of the actual costs of the investment.

In order to determine whether including fine wine in a portfolio is meaningful, the underlying investment universes have to be established. This applies to the stocks, bonds and the investment in fine wine. The goal is to ensure a well-diversified portfolio. Sufficient and easily realisable liquidity should also be present. This means that it must be possible to invest in the markets represented by the indices, and that they are not only available as a calculated index. On the equities side, the MSCI World Index was therefore chosen, which is broadly diversified according to countries as well as sectors of industry. It represents the global stock markets. The bond side is represented by the J.P. Morgan Global Government Bond Index: this global index is composed of the bonds of the leading industrial nations and is broadly diversified according to countries as well as maturities. With regard to the selection of a wine index, the majority of recent studies concentrate on the indices of the London International Vintners Exchange (Liv-ex). In the case of an index for investment in fine wine, transparency, investability and liquidity are decisive for the analysis. Transparency means that all information about the index must be available. This includes the index components, the weighting of the components, and the time and extent of changes in the index. The question of the price at which the wines in the index are calculated also has to be transparent. Investability means that all of the wines in the index are available, and that the wines are traded regularly. The criterion of liquidity means that the bid-ask spread is not too large, and that the order book consists of a sufficient number of positions. Due to the criteria to be fulfilled, the use of an index of the Liv-ex wine exchange in London is absolutely necessary, because only these indices fulfil all of the criteria. Which Liv-ex index is selected depends on the criterion of the highest level of liquidity. For years now, the five most sought-after wines at the London wine exchange have been the five first growths from Medoc/Bordeaux. The proportion of Bordeaux wines in total Liv-ex trading is

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<sup>17</sup> This was the Nobles Cru Fund. However, it should be noted that the fund used a method to evaluate the wines in its fund which it has developed itself and which is not comparable with other funds.

<sup>18</sup> The benchmark index is the Liv-ex-Fine Wine Investables Index.

<sup>19</sup> In autumn 2012 the Nobles Cru Fund had to close. After doubts about the correctness of the evaluation method of the fund wines, a large number of investors returned their shares. The Nobles Cru Fund had by far the best results in the Masset and Weisskopf study. In June 2013 The Vintage Wine Fund also had to close due to poor performance and accelerated sales.

<sup>20</sup> Some open real estate funds in Germany suffered the same fate in 2010. After doubts arose in the press about the evaluations of properties in the fund, shareholders rushed to return their holdings. When the liquidity of the fund had been used up it had to close. In some cases, it took years for the properties to be sold and for the investors to be reimbursed. In cases where shares in the fund were sold in a hurry, some investors suffered losses of up to a third of their investment.

falling, but they still accounted for over 70% in 2017. The Liv-ex Fine Wine 50 Index consists of the last ten physically available vintages of all of the Premier Grand Crus from Bordeaux. The composition of the index is changed at the end of June every year. The five wines from the oldest vintages leave the index, and the five newly-available wines are included in the index (for the current composition of the index, see Appendix 1).<sup>21</sup> At this point, one could argue that in the last few years in particular, the wines from Burgundy have increased in value particularly, and that one should perhaps choose an index containing these wines. However, the decisive criterion is liquidity, and for an investment in the index components the majority of the wines of the index, or even all of the wines, should be sufficiently tradeable. That only applies to the Liv-ex-50 Index.

For the comparison of a real investment, suitable index funds for the mentioned index universes have to be selected. To this end, an adequate history going back to March 2010 is required, given that from that time the data for the calculation of the wine index including the costs is available. It is also important that at that point in time the index fund contained a certain amount of assets, thus signalling sufficient tradability. A higher level of assets in the fund additionally ensures that the fix cost components of the fund do not have any significant negative effects on its performance. On the basis of these criteria, the iShares MSCI World Ucits ETF<sup>22</sup> (fund launched on 28 October 2005) was chosen for the investment in stocks. On the bonds side, it is the iShares Global Government Bond Ucits ETF (fund launched on 6 March 2009). As all of the costs are included in the price of the fund, the fund price can be used as the basis for the calculation of performance. For the real investment in fine wine, the Liv-ex 50 Index including costs is used. The data required for the calculation was made available by Liv-ex. Until now there have been no studies in which bid-ask spread data from the Liv-ex wine exchange has been taken into account. A particularly interesting question here is whether the costs of the actual investment in wine are higher than those of the investment in the traditional asset classes. Burton and Jacobsen (2001) already highlighted the high costs of an investment in wine. When transaction, insurance and storage costs are considered, the annual return is reduced by up to 3.7 percentage points according to their calculations.

Two portfolios were established as a starting point which can be considered as representative for different risk preferences. On the one hand, a portfolio is used which consists of 50% each of stocks and bonds (portfolio A1), and on the other hand a portfolio consisting of 25% stocks and 75% bonds (Portfolio B1). 10% of fine wine is added to both of these portfolios (Portfolio A2 and Portfolio B2).<sup>23</sup> In the calculation, an annual rebalancing<sup>24</sup> at the start of the year is presumed.

Due to the results of the previous studies, the first hypothesis is as follows:

Hypothesis 1: In a broadly diversified portfolio of traditional asset classes, a positive diversification effect is achieved by including fine wine.

The first null hypothesis to be examined is therefore:

Null hypothesis 1: In a broadly diversified portfolio of traditional asset classes, no positive diversification effect is achieved by including fine wine.

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<sup>21</sup> Chateau Latour announced in 2012 that it was no longer going to sell any more wines *en primeur* (i.e. while they are still in the vats, as wine futures). In future, Latour will only put its wines on the market when it considers them ready to drink. For this reason, the last physically available vintage from Chateau Latour is 2011. For all other producers it is the 2015 vintage. The composition of the index with regard to Chateau Latour has had to adjust itself to the decision on the release of new vintages. This decision means that the 2011 vintage from Chateau Latour will remain in the index until a new vintage is sold. Until this point in time, the percentage proportion of the annual index adjustment (in relation to the entire index) will be reduced from 20% to 16% (8 out of 50 wines).

<sup>22</sup> iShares is the name of the index provider. It belongs to the investment company BlackRock. UCITS is the abbreviation of Undertakings for Collective Investments in Transferable Securities and is a term which refers to the EU regulations on investment funds. ETF stands for Exchange Traded Fund and means that this is an exchange-traded index fund.

<sup>23</sup> The portfolios then consist of 45% stocks, 45% bonds, 10% wine, and 70% bonds, 20% stocks and 10% wine.

<sup>24</sup> The index weightings which have changed due to price trends are reset to their initial levels.

The results of Burton and Jacobsen (2001) give grounds for the presumption that the positive diversification effect will disappear when taking the costs of an investment in fine wine into account. The second hypothesis is therefore as follows:

Hypothesis 2: Taking all cost components into account, the risk-return ratio of a portfolio consisting of traditional asset classes is not improved by adding fine wine.

The second null hypothesis to be examined is therefore:

Null hypothesis 2: Taking all cost components into account, adding fine wine leads to an improvement of the risk-return ratio of a portfolio consisting of traditional asset classes.

## **2. Data and methodology**

### **2.1. Data**

A calculation using historical data forms the basis of the analysis. The results of the calculations with historical data are considered to be an indication that they might also apply to the future. In a first step, a connection is made to the approaches used in the previous studies and a calculation is made using index figures (Aytac, 2016, Bouri, 2016). An index is composed of the price data of the index components and is normally calculated on a daily basis. It therefore represents a specific investment universe. Indices are benchmarks which supply a data basis for asset allocation and diversification decisions, as well as the calculation of key figures (Kumar, 2010). With regard to equities, the MSCI World Index was chosen for the calculation with index values. This global index is broadly diversified: It is composed of stocks from 23 countries, and the weighting is made according to market capitalisation. Due to the size of the US stock market, the focus is therefore on US companies (index weighting approx. 60%, followed by Japan with around 9%). The bond market is represented by the J.P.Morgan Global Government Bond Index. This global index is composed of government bonds of the 13 most important industrial nations and is broadly diversified in terms of countries (the index weighting of the USA is approx. 40% here, followed by Japan with around 20%). The index covers the entire range of maturities from one to up to ten years to maturity. The Liv-ex Fine Wine 50 Index was chosen to represent fine wine. It consists of the last ten physically available vintages of all of the Premier Grand Crus from Bordeaux. The calculation on the basis of the indices covers the period from the beginning of 2004 to the end of May 2018. This period of time was chosen because it corresponds to the maximum availability of the data for the Liv-ex 50 Index of the London wine exchange. The calculation is carried out on the basis of monthly index figures which were taken from Datastream.<sup>25</sup>

As the indices are calculated on the basis of gross prices, costs are not taken into account. In a second step, the calculation on the basis of an actual investment is carried out. Investors who invest their own funds are predominantly interested in real opportunities and risks. A calculation on the basis of an index is therefore not very meaningful. This analysis is thus much closer to reality than previous studies. Stocks and bonds are both represented by investment funds. Here, the costs of an actual investment are taken into account. Passively managed index funds in particular are suited to reflect the exposure in a chosen asset class, because they are not subject to the risk of a deviation from the index in terms of returns which is due to active management. Deviations from the performance of the index are only due to the moderate fees which are included in index funds. For the calculation on the basis of the actual investments, the performance data of the iShares MSCI World Ucits ETF are used for the equities and that of the iShares Global Government Bond Ucits ETF for bonds. An adequate data basis is available for both of these stock exchange-traded index funds. The data required was made available by the fund company iShares. In the case of fine wine, on the other hand, there is no index fund available, and the calculation is made on the basis of an index where all costs are inclusive. The basis of the calculation is the Liv-ex 50 Index. The costs for the investment in the wines of the index via the Liv-ex trading platform were made available for the period from March 2010 to May 2018.

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<sup>25</sup> Information on the composition of the index is in the appendix.



This period thus forms the starting point for a comparison on the basis of an actual investment. Figure 1 summarises the two perspectives.

**Table 1: Basic data**

	Period	Stocks	Bonds	Fine wine
Index comparison	01/2004-05/2018	MSCI World	JPM World	Liv-ex 50
Real investment	03/2010-05/2018	iShares MSCI World Ucits ETF	iShares Global-Government Bond Ucits ETF	Liv-ex 50 including costs

## 2.2. Methodology

In order to analyse the diversification properties of fine wine, the above-mentioned portfolio components must be combined into an overall portfolio. The composition of the portfolio is determined by the degree of risk aversion of the subjects. The higher the degree of risk aversion, the lower the proportion of the riskier asset. We oriented ourselves towards the system used in previous studies (Canner et al. 1997, Masset and Weiskopf, 2010, Aytac, 2015), which linked the proportion of equities in the portfolio with the willingness to take risks. We can use two portfolios as an example: they only differ in the size of the proportion of stocks and bonds in the portfolio. Portfolio A1 consists of 50% stocks and 50% bonds. Portfolio B1 consists of 75% bonds and 25% equities. Alternative investments or exotic asset classes are usually only included in small portions, as they are subject to special risks. Studies which have analysed the inclusion of alternative asset classes used between 5% and 15% (Bessler and Wolff, 2015). We followed this system and considered the inclusion of 10% fine wine to be appropriate. Portfolio A2 is thus composed of 45% stocks, 45% bonds and 10% fine wine. After the inclusion of fine wine, Portfolio B2 is structured as follows: 20% stocks, 70% bonds and 10% fine wine. Figure 2 summarises the portfolios.

**Table 2: Portfolio compositions**

	Portfolio A1	Portfolio B1	Portfolio A2	Portfolio B2
Stocks	50%	25%	45%	20%
Bonds	50%	75%	45%	70%
Fine wine	0%	0%	10%	10%

In the analysis, the portfolio is composed of up to three parts. Due to increases and decreases in values, the index weightings shift over the years. Indices which have a better performance than others present in the portfolio obtain a higher index weighting. In order to compensate for the shifting of the index weightings, rebalancing is carried out at the beginning of the year. The index weightings are thus reset to the initial level.

In order to judge performance, the annualised return of the respective portfolio is calculated over the observation period. For risk, the standard deviation is calculated. The standard deviation represents the overall risk of the portfolio; however, the simultaneous consideration of return and risk is decisive. The Sharpe ratio, also called the reward to variability ratio, is a suitable tool for this purpose. It measures the average return earned in excess of the risk-free rate per unit of volatility or total risk. The higher the figure, the better. The Sharpe ratio is calculated according to the following formula (Sharpe, 1964):

$$S(x) = (r_x - R_f) / \text{StdDev}(x),$$

whereby  $S(x)$  is the Sharpe ratio,  $r_x$  is the portfolio return,  $R_f$  the risk-free interest rate, and  $\text{StdDev}(x)$  is the standard deviation. In US dollars, the 3-Month US Treasury Bill rate<sup>26</sup> was used as the risk-free interest rate ( $R_f$ ). In euros it is the 3-month Libor rate<sup>27</sup>.

The calculation was carried out in the base currency of US dollars as well as in euros. The dollar is the world's most significant investment currency, with the highest trading volume of any currency. It can thus also be viewed as the most representative currency. The euro is the world's second most-important reserve currency. The data series of the stock and bond index are available in US dollars as well as euros. The wine index used is quoted in sterling and is changed into US dollars<sup>28</sup> and euros. Table 3 shows an overview of all the portfolios which were compared.

For the calculation on the basis of the actual investments, the performance data of the iShares MSCI World Ucits ETF are used for equities and that of the iShares Global Government Bond Ucits ETF for bonds. There is no index fund for the investment in the Liv-ex 50 wine index. The calculation of the Liv-ex 50 is carried out on the basis of traded prices or the mid-prices<sup>29</sup> of the index components. As is usual in index calculations, transactions fees, bid-ask spreads, and storage and insurance costs are not taken into account. Transaction costs are the fees which are charged for buying and selling. At the Liv-ex wine exchange they are a percentage of the transaction volume. Bid-ask spreads are the difference between the best buying price and the best selling price on the stock exchange. As the Liv-ex 50 wine index is calculated from the mid-prices between the bid and ask price, there is a price deviation when transactions are made. This price difference has to be taken into account in the calculation of the index including costs. The following costs are therefore included in the calculation of the index including costs: (1) The cost of the initial investment<sup>30</sup>, (2) the cost of the annual change of the composition of the index<sup>31</sup>, (3) the annual storage and insurance costs for the storage of the wines in the wine exchange's warehouse, and (4) the annual subscription fees for access to the stock exchange. An exact list of the costs can be viewed in Appendix 2<sup>32</sup>. An annual management fee, such as those contained in stock and bond funds, is ignored. The bid-ask daily data for the individual wines of the Liv-ex 50 Index are used to calculate the costs of an initial investment and the costs of the annual index adjustments.<sup>33</sup>

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<sup>26</sup> The data was taken from the website of the Federal Reserve Bank in St. Louis, <https://fred.stlouisfed.org>. For the period 01/2004 to 05/2018 the average interest rate was set at 1.22%, and for the period 03/2010 to 05/2018 it was set at 0.3%.

<sup>27</sup> The data is available from the website <https://de.global-rates.com>. For the period 01/2004 to 05/2018 the average interest rate was set at 1.36%, and for the period 03/2010 to 05/2018 it was set at 0.25%.

<sup>28</sup> The rate of the US dollar to the British pound is referred to as the cable. The reason for this is that a cable was laid on the bed of the Atlantic in the mid-19th century in order to enable messages to be transmitted.

<sup>29</sup> The mid-price method can be viewed at <https://www.liv-ex.com/news-and-insights/indices> using the link: [Mid Price logic here](#).

<sup>30</sup> One-off purchase of the portfolio at the ask price plus transaction costs.

<sup>31</sup> The five oldest vintages are sold, and the five new physically available vintages are bought (spread plus transaction costs, purchase at the ask price, sale at the bid price). The changeover of the vintages of Chateau Latour takes place on an irregular basis and is dependent on the release of new vintages.

<sup>32</sup> As some fees are volume-dependent, an investment amount of £10 million is assumed.

<sup>33</sup> Given that the index is calculated according to the mid-price method, the transactions at bid or ask prices (at half the spread) are included in the calculation of the index including costs.

**Table 3: Portfolio comparisons, hypotheses**

Index calculation	Hypothesis 1: Portfolios with a higher Sharpe ratio
Portfolio A1 in USD vs. Portfolio A2 in USD	A2
Portfolio B1 in USD vs. Portfolio B2 in USD	B2
Portfolio A1 in EUR vs. Portfolio A2 in EUR	A2
Portfolio B1 in EUR vs. Portfolio B2 in EUR	B2
Real investment	Hypothesis 2: portfolios with a higher Sharpe ratio
Portfolio A1 in USD vs. Portfolio A2 in USD	A1
Portfolio B1 in USD vs. Portfolio B2 in USD	B1
Portfolio A1 in EUR vs. Portfolio A2 in EUR	A1
Portfolio B1 in EUR vs. Portfolio B2 in EUR	B1

### 3. Results

The index data for the period between the beginning of 2004 and the end of Mai 2018 in USD shows a surprising picture regarding performance and standard deviation as well as the Sharpe ratio (see Table 4). The annualised return of the wine index at +6.96% is below that of the equities (+7.13%) and above that of the bonds (+3.80%). Risk as measured by the standard deviation is highest in the wine index by a clear margin. Its figure of 29.07% is significantly above that of the equities (16.35%) and bonds (5.29%). The Sharpe ratios reflect this relationship between return and risk. The wine index has the lowest Sharpe ratio at 0.2. The bonds have the highest Sharpe ratio at 0.49, while that of the equities is 0.36. In order to calculate the risk-free interest rate, the average interest rate of the 3-month Treasury Bill rate of 1.22% was determined over the period.

The results do not, however, reveal anything about possibly positive characteristics in terms of portfolio diversification, because the deciding factor are the correlations. The portfolio with 50% stocks and 50% bonds (A1) achieved an annualised return of 6.04% with a standard deviation of 7.54%. Adding 10% fine wine<sup>34</sup> (A2) increases the return to 6.31% while simultaneously increasing the standard deviation to 9.07%. The Sharpe ratio shows a clear picture. The inclusion of the wine index reduces the Sharpe ratio from 0.64 to 0.56. It must be noted that this result speaks against including fine wine in this portfolio. The results of the second portfolio consisting of 25% stocks and 75% bonds (B1) are just as clear. The return of the portfolio consisting of traditional asset classes can be increased from 5.04% to 5.35% by including fine wine (B2). However, at the same time, the risk in terms of the standard deviation also rises clearly from 4.44% to 6.18%. The Sharpe ratio of 0.86 is reduced to 0.67 by the inclusion of fine wine, while the return-risk profile thus worsens considerably.

Expectations regarding the improvement of the risk-return profile by including fine wine were not fulfilled. On the contrary, the Sharpe ratios worsened in both cases. One could possibly make the selection of the Liv-ex 50 wine index responsible for this: the index consists entirely of Bordeaux wines. Since 2015, wines from Burgundy have achieved significantly higher returns than those from Bordeaux. However, this argument can be countered by the fact that the Liv-ex 50 was among the best-performing indices over the entire observation period, while wines from Burgundy only started to increase in value considerably from 2015 onwards. On the other hand, a look at liquidity speaks against this: a broader index with a larger number of less 'liquid' wines would clearly lose when the return including all costs is calculated. The advantage of the gross price increases in Burgundy wines would soon be counteracted by the high costs.

<sup>34</sup> The composition of the portfolio is then: 45% stocks, 45% bonds and 10% fine wine.

**Table 4: Index comparison in US dollars (1/2004-5/2018)**

Period 2004-5/2018	100% stocks (MSCI World in USD)	100% bonds (JPM World in USD)	100% Fine wine (Liv-ex 50 in USD)	Portfolio A1 (50% stocks, 50% bonds)	Portfolio A2 (45% stocks, 45% bonds, 10% fine wine)	Portfolio B1 (25% stocks, 75% bonds)	Portfolio B2 (20% stocks, 70% bonds, 10% fine wine)
Return (annualised)	7.13%	3.80%	6.96%	6.04%	6.31%	5.04%	5.35%
Standard deviation	16.35%	5.29%	29.07%	7.54%	9.07%	4.44%	6.18%
Sharpe ratio	0.36	0.49	0.20	0.64	0.56	0.86	0.67

As long as equities are represented by the globally-diversified MSCI World Index, bonds by the globally diversified JPM World Index and fine wine by the Liv-ex-50 Index, no positive diversification effect can be attached to the inclusion of fine wine in two differently-weighted portfolios. On this basis, its inclusion cannot be recommended. The diverging results of previous studies can be traced back to a different data basis: they used different time period, different indices and a different base currency.

In order to address the issue of the different base currency, we also carried out a calculation with the euro as the base currency (see Table 5). Here one can see a change in the overall picture in favour of fine wine. When Portfolio A1 with 50% stocks and 50% bonds is considered from a risk-return perspective, it has a Sharpe ratio of 0.2. This figure is identical to that of Portfolio A2 which includes 10% wine. In the case of Portfolio B2 consisting of 25% stocks and 75% bonds, the inclusion of 10% wine creates a slightly positive diversification effect. The Sharpe ratio increased to 0.17 (previously 0.16) in the portfolio consisting of 20% stocks, 70% bonds and 10% wine.

**Table 5: Index comparison in euros (1/2004 - 5/2018)**

Period 2004-5/2018	100% stocks (MSCI World in EUR)	100% bonds (JPM World in EUR)	100% fine wine (Liv-ex 50 in EUR)	Portfolio A1 (50% stocks, 50% bonds)	Portfolio A2 (45% stocks, 50% bonds, 10% fine wine)	Portfolio B1 (25% stocks, 75% bonds)	Portfolio B2 (20% stocks, 70% bonds, 10% fine wine)
Return (annualised)	5.47%	2.19%	5.30%	4.40%	4.71%	3.41%	3.76%
Standard deviation	22.04%	12.03%	35.73%	15.12%	16.53%	12.79%	14.26%
Sharpe ratio	0.19	0.07	0.11	0.20	0.20	0.16	0.17

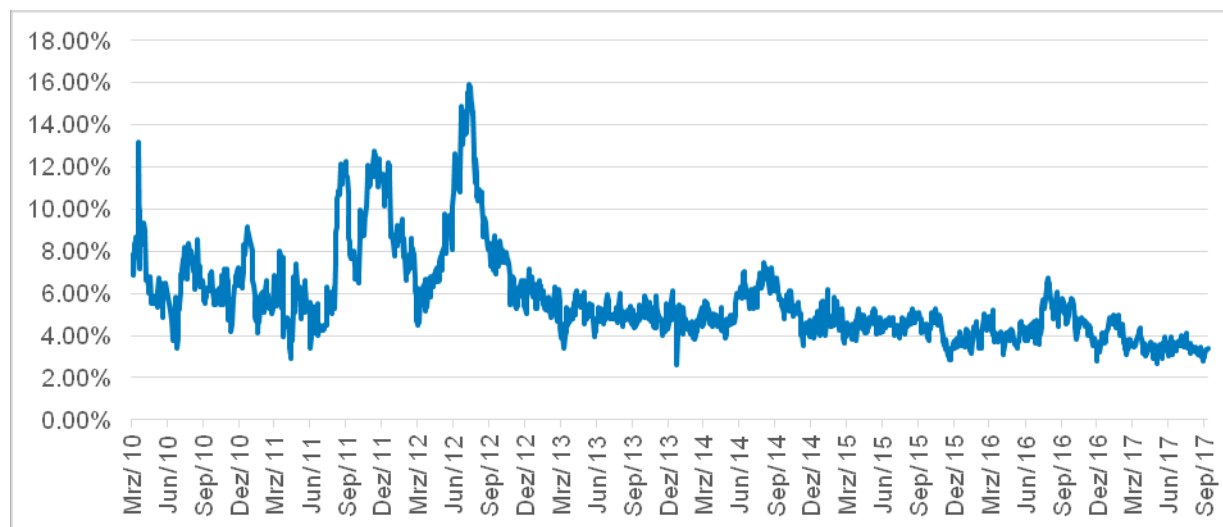
The index comparison can only provide a theoretical indication of diversification properties. The reason for this lies in the calculation of the index. Indices do not contain any costs, and it is therefore not possible to invest in them at the prices given. The cheapest way to invest in indices is via index funds. Index funds are

offered by a multitude of fund companies. They allow investors to invest in the index universe at low fees. Their performance is that of the index minus the costs. In the traditional asset classes, the availability of index funds is very high, and the costs are low. In the case of alternative asset classes, however, availability is very low, or non-existent as in the case of fine wine.

For the calculation of the Liv-ex 50 Index including costs, the spreads between the prices of the wines at which an immediate sale is possible (bid price) and the prices at which an immediate purchase is possible (ask price) play a decisive role. As the index is recomposed at the end of June every year, the buying and selling has to be done at exactly this point in time: wines which no longer form part of the index are sold at the current buying rate (bid price), and wines which are newly included in the index are bought at the selling rates (ask prices). Figure 1 shows the average spreads of all index figures over the period of analysis.<sup>35</sup>

Compared to the index data, the fund data for the period between March 2010 and May 2018 shows a strongly diverging picture regarding performance and standard deviation as well as the Sharpe ratio<sup>36</sup> (see Table 6). This is definitely also due to the changed time scale, but above all it is because this is now fund data which contains all the costs of an investment. The iShares MSCI World Ucits ETF USD exhibits an annualised performance of +9.69% with a standard deviation of 11.10%. The Sharpe ratio is 0.85. The iShares-FTSE-G7 Government Bond Ucits ETF USD only achieved an annualised return of +1.32% with a standard deviation of 5.69%. The Sharpe ratio is 0.18. The Liv-ex 50 Index including costs exhibits an annualised performance of 0.02% with a standard deviation of 17.42%. The Sharpe ratio is -0.02. Here one can already note the difference to the analysis of the index data: by looking at a real investment, all of the key figures are - as expected - worse. This is shown most clearly in the investment in fine wine.

**Figure 1: average bid-ask spreads of all index figures of the Liv-ex 50**



When the two portfolios including fine wine are compared, the annualised performance compared to the portfolios without fine wine is lower. For the portfolio with 50% stocks and 50% bonds, the annualised return over the period between March 2010 and May 2018 was 5.67% compared to 5.19% for the portfolio including 10% fine wine. At the same time, risk as shown by the standard deviation rose from 5.25% without wine to 5.91% with wine. The portfolio with 75% bonds and 25% stocks achieved a performance of 3.54% compared to only 3.06% for the portfolio with 10% wine. The standard deviation of the portfolio without wine was

<sup>35</sup> A glance at the Liv-ex trading page shows that during the changeover of the index the calculation of transactions at bid or ask prices is legitimate. A potential wine index fund with a fund volume of only £10 million would have to sell over forty 12 bottle cases of the current oldest vintage (2006) for the index changeover. Due to the need for a timely changeover, this would presumably only be possible at average prices below the bid price.

<sup>36</sup> The average risk-free interest rate was set at 0.3% for the period 03/2010-05/2018.

4.18%. Including 10% fine wine increased the risk to a figure of 5.13% for the standard deviation. In both portfolios, the inclusion of 10% fine wine leads to an even clearer worsening of the risk-return profile than the calculation on an index basis. The Sharpe ratios also fall accordingly, from 1.02 to 0.83, and from 0.78 to 0.54.

**Table 4: Index funds comparison in US dollars (3/2010 - 5/2018)**

Period 3/2010- 5/2018	100% stocks (MSCI World iShares ETF in USD)	100% bonds (FTSE G7 Governm. Bond iShares in USD)	100% fine wine (Liv- ex 50 in USD incl. costs)	Portfolio A1 (50% stocks, 50% bonds)	Portfolio A2 (45% stocks, 45% bonds, 10% fine wine)	Portfolio B1 (25% stocks, 75% bonds)	Portfolio B2 (20% stocks, 70% bonds, 10% fine wine)
Return (annualised)	9.69%	1.32%	0.03%	5.67%	5.19%	3.54%	3.06%
Standard deviation	11.10%	5.69%	17.42%	5.25%	5.91%	4.18%	5.13%
Sharpe ratio	0,85	0,18	-0,02	1,02	0,83	0,78	0,54

Here again, the funds are also considered in euros (see Table 7). The small diversification success of fine wine seen from the perspective of the index in euros cannot be repeated in a comparison of the index funds with the wine index in euros including costs. Both of the portfolios with the inclusion of 10% fine wine exhibit a poorer risk-return relationship than those without wine. The Sharpe ratios fall.

**Table 7: Index funds comparison in euros (2/2010 - 5/2018)**

Period 3/2010- 5/2018	100% stocks (MSCI World iShares ETF in EUR)	100% bonds (FTSE G7 Governm. Bond iShares in EUR)	100% fine wine (Liv- ex 50 in EUR incl. costs)	Portfolio A1 (50% stocks, 50% bonds)	Portfolio A2 (45% stocks, 45% bonds, 10% fine wine)	Portfolio B1 (25% stocks, 75% bonds)	Portfolio B2 (20% stocks, 70% bonds, 10% fine wine)
Return (annualised)	7.69%	-0.51%	-1.79%	3.75%	3.28%	1.66%	1.19%
Standard deviation	17.27%	9.39%	20.70%	12.50%	12.87%	10.63%	11.06%
Sharpe ratio	0.43	n.a. <sup>37</sup>	n.a.	0.28	0.24	0.13	0.08

The results reflect the high cost burden involved in a real investment in fine wine. The transaction costs in connection with the high bid-ask spreads lead - in comparison to the traditional asset classes - to a clear worsening of the figures. The Total cost of ownership is below 0.28% (TER<sup>38</sup> 0.5%) for the equity funds, and

<sup>37</sup> The higher the Sharpe ratio of a portfolio the better is only valid for positive figures of the excess return (McLeod and van Vuuren, 2004). All calculated portfolios do have a positive excess return.

<sup>38</sup> In the case of both index funds, the total cost of ownership is below the total expense ratio (TER) shown. The TER includes all annual administration fees. Transaction and trading fees are not taken into account. At the same time,

below 0.17% (TER 0.2%) for the bond index funds. The annual total expense ratio in the case of the wine index (without taking the initial investment into account) is 1.15%, and with the initial investment it is 1.77%). A management fee was not taken into account.<sup>39</sup> Studies which have not explicitly taken the aspect of costs into account cannot in good faith recommend an investment in fine wine in order to diversify a portfolio. Taking all cost components into account, the risk-return ratio of a portfolio consisting of traditional asset classes is worsened by adding fine wine. No positive diversification effects can be achieved.

The evaluation of the hypotheses takes place on the basis of a table of results (Table 8) in which the portfolios with the highest Sharpe ratios are shown. The portfolios with a higher proportion of equities are identified by the letter A, while those with a lower proportion of equities are identified by the letter B. The portfolios which do not include fine wine bear the number "1", while those which include 10% fine wine bear the number "2".

**Table 3: Portfolio comparisons, results of the hypotheses**

Index calculation	Results of hypothesis 1: Portfolios with a higher Sharpe ratio
Portfolio A1 in USD vs. Portfolio A2 in USD	A1
Portfolio B1 in USD vs. Portfolio B2 in USD	B1
Portfolio A1 in EUR vs. Portfolio A2 in EUR	A1=A2
Portfolio B1 in EUR vs. Portfolio B2 in EUR	B2
Real investment	Results of hypothesis 2: Portfolios with a higher Sharpe ratio
Portfolio A1 in USD vs. Portfolio A2 in USD	A1
Portfolio B1 in USD vs. Portfolio B2 in USD	B1
Portfolio A1 in EUR vs. Portfolio A2 in EUR	A1
Portfolio B1 in EUR vs. Portfolio B2 in EUR	B1

As can be seen from Table 3, hypothesis 1 must be discarded. The null hypothesis proved to be correct. Only in one of the four portfolios (Portfolio B2 in EUR consisting of 70% bonds, 20% stocks and 10% fine wine) does a slight increase of the Sharpe ratio occur due to the inclusion of fine wine. In the other three cases, the inclusion of wine does not lead to an improvement of the Sharpe ratio. When a real investment including costs is considered, hypothesis 2 is confirmed. Null hypothesis 2 has to be discarded. All of the portfolios in US dollars and euros have a higher Sharpe ratio without fine wine. No positive diversification effects can be established.<sup>40</sup> This study thus assesses the possibilities for diversification much more critically than the previous studies by Masset and Weisskopf (2010), Masset and Henderson (2010), Bouri (2014), Bouri et al. (2016) and Aytac et al. (2016). At the same time, those studies are confirmed which highlight the high costs involved in fine wine investment, and which come to predominantly negative conclusions about real investments in wine investment funds (Burton and Jacobsen, 2001, Masset and Weisskopf, 2015).

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returns from securities lending are also not included. These returns exceed other fees, so that the total cost of ownership (calculated as the difference between the performance of the index and the index fund's performance) is lower than the TER.

<sup>39</sup> Nevertheless, these costs are clearly below the 3.7% p.a. calculated by Burton and Jacobsen (2001). Due to the establishment of the Liv-ex wine market, investment in fine wine has become considerably cheaper.

<sup>40</sup> A calculation with a uniform moderate spread of 4% which diverges from the actual bid/ask spreads as could be observed in recent years does not lead to any diverging results with regard to the diversification properties of fine wine.

#### 4. Summary

In the search for alternative asset classes for portfolio diversification, the positive qualities of investment in fine wine have increasingly been reported on in the past 15 years. Whereas older studies had to fall back on data from wine auction houses, newer ones predominantly use index data from the London fine wine market Liv-ex, which was established in 1999.

However, making calculations on the basis of index data contains pitfalls. Index data differs from a real investment in that it does not take into account the costs which are incurred. This question is of particular relevance for investments in fine wine, as there have been no such index funds until now. Some wine investment funds do exist, but their strategies are neither transparent nor is the performance convincing (Masset and Weisskopf, 2015).

This study took into account the possible costs of a real investment in all of the asset classes considered. With this data, the diversification features of the inclusion of fine wine in a global portfolio which was already broadly diversified were examined and compared with an analysis on the basis of index data alone.

At an index level, the inclusion of fine wine merely leads to a slight improvement of the annualised return, but at the same time to an increase in risk. Only in the case of one portfolio in euros was the Sharpe ratio somewhat better after the inclusion of 10% fine wine. When considering an actual investment, the high costs of investing in fine wine play a role. In US dollars and euros, the annualised returns are lower in comparison to the portfolios without fine wine, and at the same time the risk levels are higher. The inclusion of wine always leads to a decrease in the Sharpe ratio.

The conclusion on the diversification properties of fine wine in a portfolio which is already broadly diversified in traditional asset classes can be - fittingly - described as sobering. Fine wine does not lead to any improvement of the Sharpe ratio from the index perspective in US dollars, and when the base currency is euros only a slight increase is achieved in one out of two portfolios. Viewed according to costs, there is not a single case where the risk-return profile was improved by adding fine wine. This finding is clearly contradictory to those of the previous studies. However, on the positive side it can be noted that the costs of an actual investment in fine wine have been noticeably reduced by the establishment of the Liv-ex Wine Exchange.



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## Appendix 1: Index compositions

### Equities, composition of the MSCI World Index

Country	Index weighting	Number of companies
USA	60.26%	631
Japan	8.99%	321
United Kingdom	6.53%	102
France	3.98%	79
Germany	3.46%	65
Canada	3.45%	90
Switzerland	2.72%	37
Australia	2.46%	67
Hong Kong	1.35%	48
Holland	1.29%	21
Spain	1.06%	22
Sweden	0.93%	31
Italy	0.85%	24
Denmark	0.62%	17
Singapore	0.49%	26
Finland	0.38%	12
Belgium	0.37%	10
Norway	0.25%	9
Israel	0.18%	11
Ireland	0.18%	6
Austria	0.09%	5
New Zealand	0.06%	7
Portugal	0.06%	3

### Bonds, composition of the JPM World Government Bond Index

Country	Index weighting
USA	40.25%
Japan	19.72%
France	8.17%
United Kingdom	7.15%
Italy	7.09%
Germany	5.46%
Spain	4.67%
Belgium	2.02%
Australia	1.68%
Holland	1.63%
Canada	1.33%
Denmark	0.50%
Sweden	0.31%
Term	
1-3 years	24.39%
3-5 years	19.28%
5-7 years	12.07%
7-10 years	12.56%
10+ years	31.69%

**Fine Wine, Liv-ex 50 Index, equally weighted according to producer and vintage**

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Chateau Haut-Brion				X	X	X	X	X	X	X	X	X	X
Chateau Margaux				X	X	X	X	X	X	X	X	X	X
Chateau Mouton Rothschild				X	X	X	X	X	X	X	X	X	X
Chateau Lafite Rothschild				X	X	X	X	X	X	X	X	X	X
Chateau Latour	X	X	X	X	X	X	X	X	X	X			

## **Appendix 2**

List of costs of the Liv-ex 50 Index. An investment of £10 million (pounds sterling) is presumed.

### Trading costs (bid-ask spread)

The Liv-ex 50 contains 50 wines. Every year at the end of June, the five oldest vintages are replaced by the five physically available new vintages. As the index is equally weighted, in this way 20% of the index is traded (currently 16%, until a new vintage of Chateau Latour is released). This index adjustment is carried out at the bid-ask spreads available at the end of June. The vintages to be sold are sold at bid prices, and the vintages to be bought are bought at ask prices. The first investment was made at the selling rates valid at that time (ask prices).

### Transaction costs

1% transaction costs per transaction. It is assumed that a transaction volume of £20,000 per year is reached. This is the condition for a transaction fee of 1%.

### Insurance

£10 per month plus 0.015%. This corresponds to 0.18% p.a.

### Storage

£0.55 per case and month. From a volume of £10 million and at an average bottle price of £500, the price for a 12-bottle case is £6,000s. At an investment of £10 million, this would be 1,666 cases.  $1,666 \times 0.55 \times 12 = 0.11\%$  p.a.

### Liv-ex subscription fee

Here, the Liv-ex 'gold' pricing package with direct market access is presumed. The fee amounts to £500 per month, £6000 per year. This is equivalent to 0.06% p.a.