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Wine in Portfolio Management.

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Preface and Acknowledgements

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Abstract

This master thesis demonstrates that wine can be a major add-on to the portfolios of investors. Depending on the model and the investor profile, wine will be more or less used as investors have different expected returns. An investor using the Markowitz framework will invest on average 21% of his portfolio in wine. On the other hand, an investor using the LPM framework will invest on average 13%, however, the LPM framework has a wider range of allocation from 5% to 58% which does not make it a suitable model for investment. In terms of investor profiles, all investors can benefit from wine, but, overall, the moderate profile is the one allocating the most towards wine with 23% of his portfolio. A crucial information that is demonstrated in this thesis is the relevance and importance of selecting an accurate data range. As explained, the portfolios constructed using the data from 2001 to 2021 and the portfolios constructed using data from 2010 to 2021 are very different and the allocation of funds changes a lot. Thus, a wealth manager should make sure to select an appropriate time horizon when constructing the portfolios of its clients interested in wines.

Keywords:

Investments, Portfolio Management, Markowitz, Wine, Equities, Fixed Income

JEL classification: G11, G15, G23, L66.

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1. Introduction

Wealth Managers have the goal to find the best investment solutions for their clients. Traditional investment solutions include equities, bonds, funds, ETFs, hedge funds or real estate. However, clients are also looking for interesting returns outside financial markets offered by assets uncorrelated with the former. Such assets are regrouped under the denomination of alternative investments. Alternative investments are investments that do not fit into the classical equity/cash categories of income. Wine, watches, arts, commodities or cryptocurrencies can be considered alternative investments (Chen, Scott , & Clarine, 2021).

Previous research by (Jureviciene & Jakavonyte, 2015) proved that a portfolio composed of equities, bonds and wine would yield a higher return than a composition of only two of these assets. The diversification benefits brought by wine also allow to perform decently, even during crises. However, wine should not be used in the portfolio of every investor, since it has some drawbacks. As Marc Ricardo notes, wine must be able to age for at least 10 to 25 years (Ricardo, 2013). Furthermore, a report from Baird Private Wealth Management explains that wine is less liquid as well as more complex (Baird Private Wealth Management, 2013). All of these researches agree on the benefits as well as the drawbacks of wine, however, none of these actually treat the question of how much should wine be used as an alternative investment in a portfolio. This thesis aims at creating several investor profiles and analyzing which of them would benefit from using wine within their portfolios. Ideally, this research would help wealth managers when it comes to offering the right assets to the right client.

2. Literature Review

Many researches have been conducted on the field of alternative investments. Plenty hedge funds were created with the aim to offer returns on assets uncorrelated with financial markets; these assets can take various forms and are often called alternative investments. The goal of alternative investments is to increase diversification, while reducing the investor's portfolio volatility (Baird Private Wealth Management, 2013). In their studies on wine as an alternative investment, Sanning et al showed that wine outperformed the returns predicted using the Fama-French three-factor model, thus, they demonstrated that wine have a low exposure to market risk factors and can improve the portfolio of investors as they will lower the overall risk. (Sanning, Shaffer, & Sharratt, *Alternative Investments: The Case of Wine*, 2012). This results explain why hedge funds such as the Ascot Wine Management Fine Wine Fund were created, the latest has exhibited annual returns between 10.9% to 13% (Sanning, Shaffer, & Sharratt, *Alternative Investments: The Case of Wine*, 2012). However, alternative investments' investors need to realize that these investments are also risky; they tend to be less liquid, more costly in management fees, less transparent and some such as wine need a longer time horizon (Jureviciene & Jakavonyte, 2015). Moreover, most alternative investments do not pay a dividend, thus, the only way to generate a return is through the value of the investment going up.

Previous studies on alternative investments discussed how paintings, stamps, old cars or bags can be used as a way to diversify a portfolio and improve its Sharpe ratio (Stephen S. , 2009). For instance, researches on paintings showed that the general art index has generated an annual return of 6.5% between 1980 and 2006, however, such assets have specific fees such as storage management or the selling/purchasing fees that can be quite high, however, once spread out over 25 years these fees become less relevant (Stephen S. , 2009). Thanks to its low correlation with financial markets, art has been an area in which wealthy investors diversify some of their portfolios.

Such researches often compare the return of the alternative investments to equities or fixed income and demonstrate that the former outperforms the latter or at least complement it. However, out of all the research done of such topics (especially about wine), there hasn't been any research that actually analyze how portfolio managers should take the findings into consideration when making their portfolio allocation. Thus, there are opportunities to work on the implementation of wines, bags, stamps or old cars in portfolio management and how these assets can benefit investors. Eventually, researches have showed that lack of regulation, storage cost, and, the lack of transparency can be drawbacks to invest in alternative investments and might explain why despite offering interesting returns such investments aren't used as much as they should be (Baird Private Wealth Management, 2013).

As it has been pointed out, investors that wish to hold alternative investments must take into account their characteristics & risks to invest in the most suitable asset. Therefore, wealth managers that wish to invest on behalf of their clients into this category must assess certain

points (Stephen S. , 2009). Satchell identified a crucial point which is the time-horizon of the client. Wine, stamps, cars, bags -and other type of alternative investments- need time to age and grow their value. Thus, a client that is looking for short-term or medium-term assets should not invest in these assets as he needs assets that are more liquid and have a lower period of retention. However, we should expect from these assets a higher return as they have higher risks.

As Jureviciene & Jakavonyty showed, wine needs a long time horizon to mature and reach its peak value at which an investor could profit from selling. Researchers do agree on the benefits of using wine as an alternative investment in portfolios but emphasize on the necessity of having a long-term horizon (Jureviciene & Jakavonyte, 2015).

Many articles were written on the topic of wine, starting with Krasker and his paper *The Rate of Return to Storing Wines*, he finds that there is no risk premium for storing wine from California & Bordeaux produced since 1950 over the period 1973 to 1977 (Krasker, 1979). A couple years later, Jaeger found a premium of 12% over the same wine, however, he used a lower storage cost and extended the sample to eight years, starting with 1969 (Jaeger, 1981). His motivation for lowering the storage cost is that Krasker used an implausibly large value which did not accurately represent the annual cost of storage of a bottle of wine. Weil, in his paper from 1993 found that a portfolio only composed of wine over the period 1980 to 1992 would have returned 9.5% annually and 11% if it was composed of only Bordeaux wine. Furthermore, Weil took into account sales tax, storage costs, auction house costs, transactions costs and possible income tax rates. He concludes that even if this return is lower than rates of return to NYSE stocks, wine are still interesting and have a lower volatility. In 2001, Burton and Jacobsen estimated the rate of return for red Bordeaux wine and found an annual rate of return of 7.9% for a portfolio composed of different wine vintage (Burton & Jacobsen, 2001).

In 2010, Philippe Masset and Caroline Henderson analyzed wine transactions price from the Chicago Wine Company and found out that over the period 1996 to 2007, the best wine (according to vintage and ratings) earned higher returns while having a lower variance than wine of a lower quality (Masset & Henderson, 2010). Masset and Henderson justified their findings by explaining that at some point there are no good opportunities of financial markets (when firms become too highly-valued), thus, investors should fly to another asset class of quality which can be wine for instance. Following this, Masset and Henderson analyzed how hedge funds are performing and whether investors should invest directly into such funds. They found that hedge funds in the wine industry are very illiquid as they hold large positions, thus, they do recommend investors to buy wine themselves and hold it rather than using such a fund that can increase the riskiness of wine investing (Masset & Henderson, 2010).

Following the paper of Burton and Jacobsen, Dimson et al published a paper in 2013 on the returns of Bordeaux Premiers Crus. Within this paper, the authors found a net annual return of 4.1% over a period of 1900 to 2012 (Dimson, Rousseau, & Spaenjers, 2013). This annual return is lower than what was found by Weil, Burton & Jacobsen or Jaeger and shows that analyzing wine return is not a simple task as many qualified researchers find very different results (obviously, the time horizon of their data not being the same might explain the difference in findings). However, all researchers end up finding that wine can be a very good add-on to the

portfolio of an investor as wine aren't correlated or highly correlated to financial markets and therefore can improve the diversification of the portfolio and reduce its overall risk. In my opinion, this explains why it is crucial to analyze the holding of wine within portfolio management and how wealth managers can take advantage of this asset to improve the returns of their clients.

Eventually, more recently, Marc Ricardo found that the Liv-Ex index (which is an index representing the price of investable wine) generated a return of 13.47% from 1993 to 2012 compared to a 6.05% for the S&P 500. Also, the Sharpe ratio for wine is 1.11 versus 0.46 for the S&P 500 and since it has little correlation with equities, it is a very interesting asset to hold (Baird Private Wealth Management, 2013).

Wine can be seen as an very interesting alternative investment as it is a scarce resource by nature. Indeed, a specific amount of wine is produced each year and the amount of bottles available will decrease year after year as people will consume it. However, despite its low correlation with financial markets, wine still is a risky asset. The latest does not pay dividend, it comes with high storage cost as it needs to be stored at a certain temperature for optimal preservation and the shipment of wine is delicate (Ricardo, Investment Grade Wine - An Alternative Asset Class, 2013). Also, even if the liquidity of wine is increasing annually, it is not an asset that is easily and quickly disposed of (Meltzer, Global Wine Auctions Exceed \$479 Million in 2018, 2019). The goal of this thesis is to use findings from previous researches on wine and complement them with data analysis to make them applicable to portfolio management.

3. Drivers of the Liv-ex Index Fine Wine 100

To understand how wine can be used as an alternative investment, it is necessary to find out what drives its return. One index that can be used to track the performance of wine is the Liv-ex Fine Wine 100 Index. This index was created by the London International Vintners Exchange and is the leading industry benchmark. It represents the price movement of the 100 most sought-after fine wine. The precise list of the components of the index can be found in the appendix.

Livex Index 100 Components Region

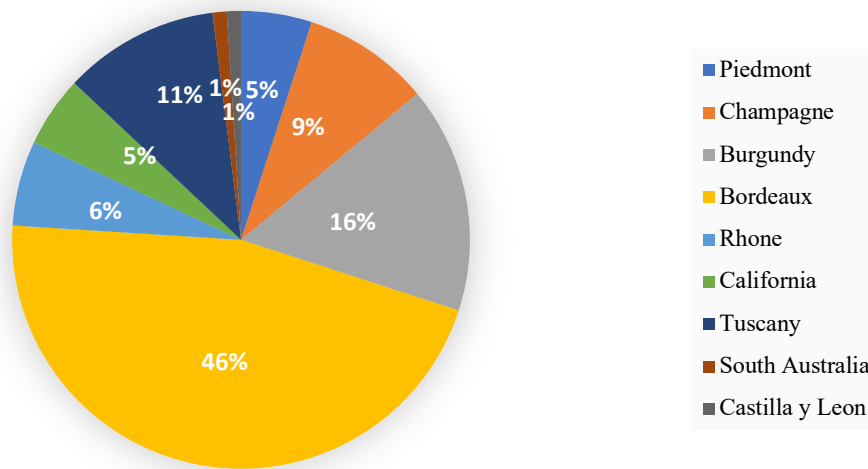


Figure 1: The composition of the Liv-ex Fine Wine 100 index by region as of 2022. Data retrieved from the London International Vintners Exchange.

The region that is the most represented is Bordeaux; this makes sense as the oldest castles and most reputable wine makers are based in this area. However, it is interesting to note that over the past years, Burgundy has been growing and is now 16% of the 100 Fine Wine Index.

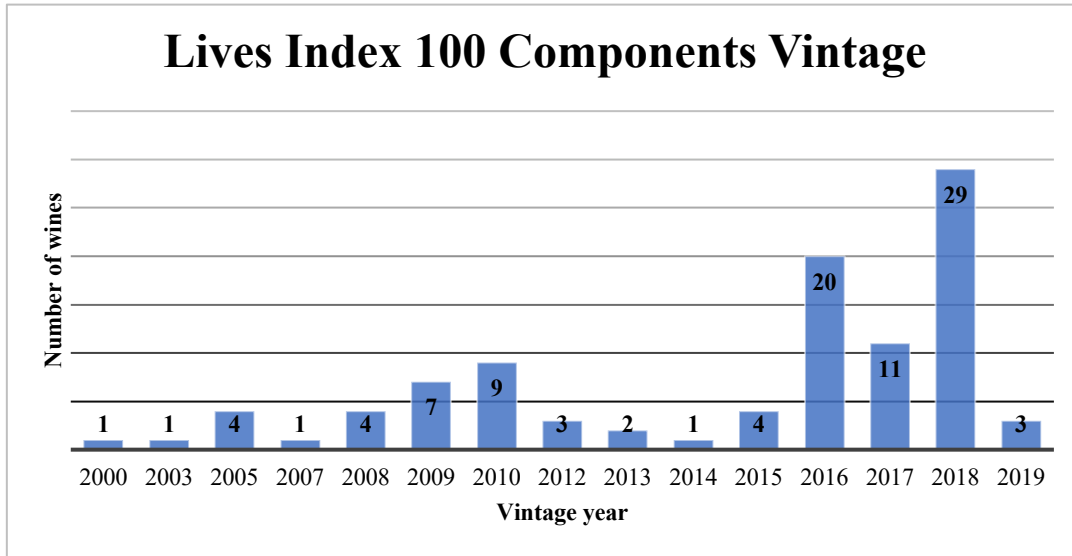


Figure 2: The composition of the Liv-ex Fine Wine 100 index by vintage as of 2022. Data retrieved from the London International Vintners Exchange.

In terms of vintage the horizon is large but most wine come from recent vintage. This is explained as recent wine tend to be cheaper than oldest ones. As they are more affordable, investors want to purchase them with the goal of selling or consuming them years later.

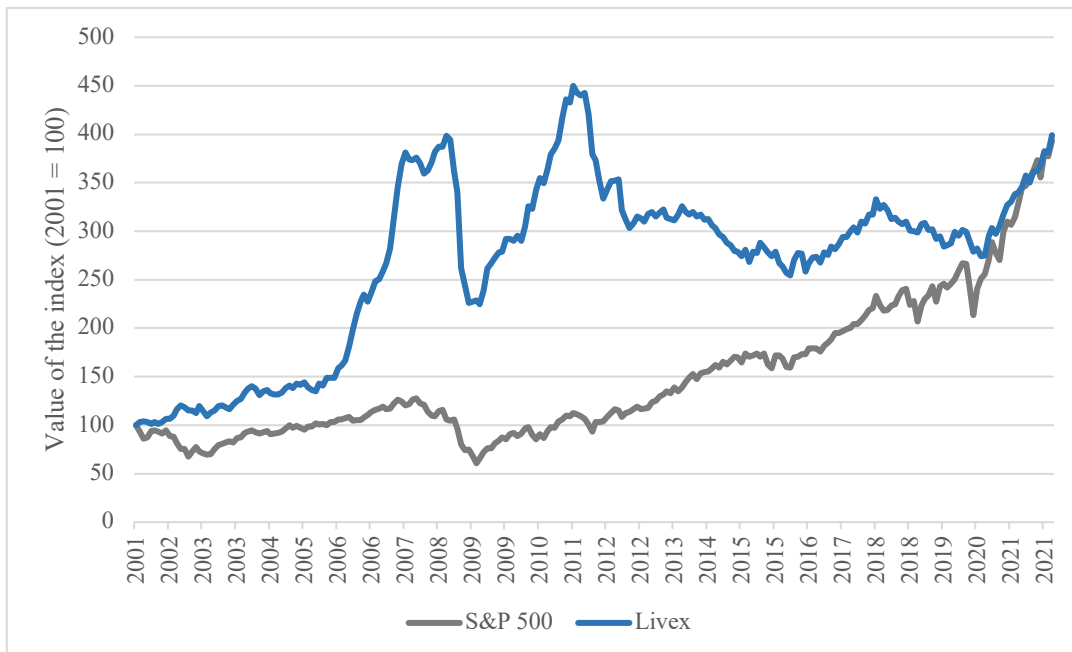


Figure 3: The return of the Liv-ex Fine Wine 100 index & the S&P 500 from 2001 to 2021. Data retrieved from Bloomberg.

This graph shows that the Liv-ex Fine Wine 100 index has been performing quite well on the long run, even if it suffered a few drawbacks during crises.

There are several key points driving the wine market and most importantly the Livex Fine Wine 100 Index.

The first key driver is the demand. As in any market, wine price is driven by bids of people willing to purchase the wine. Thus, when the Chinese economy is booming, it is generally very beneficial for wine. For instance, in 2007, Hong Kong cut duties from 80% to 40% and then to 0% (Liv-ex, s.d.). As can be seen on the upper graph, this corresponds to a rise in the Liv-ex index. In 2011, the prices of multiple wine were at an all-time high and once this small “bubble” burst, prices decreased, which explained the drop (Liv-ex, s.d.). After this downturn, in 2012, the Chinese government removed a program towards luxury goods which lowered once again the demand for wine and their prices. Eventually, the accumulation of savings during the Covid-19 pandemic can explain the rise of the Liv-ex index between 2020 and 2021, as investors and wine aficionados purchased wine (Robinson, 2022). Adam Bilbey, who is the global head of wine and spirits at Christie’s, explained that due to the global quarantine, wine drinking at home is at an all-time high, which drives the prices of wine up (Robinson, 2022).

Another driver is the weather. Depending on weather, wine produced for a particular year will have less or more sugar, will be more or less acid, and will have a more pronounced taste. These particularities will impact their ratings and the demand for the wine in the end. A model created by Jones & Storchmann shows that certain characteristics will change the price of the wine. The characteristics of the models are impacted mostly by the weather and are the following:

- The grape composition.
- The effects of age of the wine on market prices.
- The ratings of the wine.

Since the weather directly impacts grape composition, which will itself impact how the wine ages, we can say that the weather is a strong driver of wine prices (Jones & Storchmann, 2001).

Eventually, one driver that is key is wine critics. A few wine critics are very prominent and therefore can impact the price of wine. The key role attributed to wine experts, tasters and judges is justified as wine is a very specific good. It is difficult to assess the quality of a wine before its consumption, thus, it is why critics are important. For most consumers wine is indeed an experience and a luxury good, thus, a critic’s recommendation is a way to reinforce the desire of buying a specific bottle (Giraud-heraud & Pichery, 2013).

As we have seen so far, several key drivers can explain the return of wine and why the latter can be an investment. In the next section, the goal is to use different variables and assess their predicting power on the Livex index. As the most prominent consumers of wine are Chinese and Americans, macro-economic data of the two countries will be used. Also, wealthy people are the ones that can purchase wine, thus, a variable representing the evolution of wealth will be used. However, factors such as the weather, critics or ratings will not be used as the composition of the Livex index change frequently and it would not be practical to implement such factors into the regressions.

To visualize and actually understand which quantitative data can be used to predict the return of wine and the Liv-ex index, several regressions have been made. For the first regression, I test whether the GDP of China, its import volume, and, the GDP of the USA are significant.

The rationale behind this is that as the GDP of these countries increase, we would expect the price of wine to increase since Americans and Chinese are consumers of wine.

	Coefficients	Standard error
Intercept	-50.65	743.0215
Import volume of China	0.49***	0.1648
GDP of China	-0.015	0.0152
GDP of the USA	0.005	0.0148
# of Obs.	20	
Adj. R ²	0.56	

Table 1: Regression composed of Import volume, GDP of China and the GDP of the USA. Data retrieved from Bloomberg.

As we can see, only the import volume is significant as the p-value is below 0.01, the GDP of China and of the USA aren't significant which makes sense as people investing in wine belong to the most wealthiest people and the GDP does not grow as quickly as their wealth.

For the second regression, we will be especially testing the Wealth of the top 10% and 1% in China and in the USA. These variables come from the World Inequality Database and represent the total value of the wealth owned by these percentages within each country. The motivation behind this regression is that as the wealthiest people are those having the highest buying power, therefore, an increase in their wealth is likely to drive the price of wine up since they will be able to purchase more wine at a higher price.

	Coefficients	Standard error
Intercept	1886.68**	659.7560
China's wealth of the top 10%	-0.21**	0.0897
China's wealth of the top 1%	0.91***	0.2579
USA's wealth of the top 10%	-0.22***	0.0738
USA's wealth of the top 1%	0.35***	0.1155
# of Obs.	20	
Adj. R ²	0.74	

Table 2: Regression composed of China's wealth of the top 10% and 1% as well as USA's wealth of the top 10% and 1%. Data retrieved from the World inequality database.

As we can see on this table, the regression using the top wealthiest people from China and the USA yield significant coefficients for each variable. Thus, we can conclude that the amount of assets of the wealthiest people can be a driver of the Liv-ex index as the highest their assets are, the most they are likely to invest in wine and drive prices up.

Eventually, I will now be testing the variables used prior with controlling variables which are the other indexes such as the MSCI World, the MSCI China, the S&P 500 and High Yield US Bonds. The idea is to test whether the variables truly have an explanatory power.

	Coefficients	Standard error
Intercept	317,45	757,36
China's wealth of the top 10%	0,04	0,16
China's wealth of the top 1%	-0,03	0,35
USA's wealth of the top 10%	-0,02	0,08
USA's wealth of the top 1%	0.02	0,11
Control 1	YES	
# of Obs.	20	
Adj. R ²	0.94	

Table 3: Regression composed of China's wealth of the top 10% and 1% as well as USA's wealth of the top 10% and 1% and Controlling variables. Data retrieved from the World inequality database & Bloomberg.

We can see that by adding controlling variables, the tested factors lose all of their explanatory powers.

	Coefficients	Standard error
Intercept	232,03	584,27
Import volume of China	0,10	0,11
GDP of China	0,01	0.03
GDP of the USA	-0,01	0,01
Control 1	YES	
# of Obs.	20	
Adj. R ²	0.95	

Table 4: Regression composed of Import volume of China, the GDP of China, and, the GDP of the USA with Controlling Variables. Data retrieved from Bloomberg.

We can see that by adding controlling variables, the tested factors lose all of their explanatory powers.

For this last regression, we will be combining all the tested factors with the controlling variables.

	Coefficients	Standard error
Intercept	-758,02	979,23
Import Volume of China	0,17	0,21
GDP of China	-0,14	0,11
GDP of the USA	-0,05	0,03
China's wealth of the top 10%	0,04	0,38
China's wealth of the top 1%	0,28	0,55
USA's wealth of the top 10%	0,30	0,18
USA's wealth of the top 1%	-0.32	0,20
Control 1	YES	
# of Obs.	20	
Adj. R ²	0.91	

Table 5: Regression composed of China's wealth of the top 10% and 1% as well as USA's wealth of the top 10% and 1%, Import volume of China, the GDP of China and the GDP of the USA Controlling variables. Data retrieved from the World inequality database & Bloomberg.

We can see that by adding controlling variables, the tested factors lose all of their explanatory powers.

In this part we have explored several drivers of the Liv-ex index. The most important driver is the demand for wine, since this is what will determine the price, and, therefore the return that an investor can get by investing in them. Demand is mainly driven by the wealth of the investors as it was shown with the regressions performed. However, these factors aren't significant anymore once they have been tested with controlling variables. Another aspect that wasn't mentioned is the reputation; French castles are ancient and benefit from a global recognition. Since wine is considered a luxury good, the higher the reputation, the higher the demand & return of the wine. The demand is itself impacted by the quality of the wine, which is determined by both the weather/climate of the vintage and the critics given by judges and wine professionals. All these drivers are significant and they explain why Bordeaux, Burgundy and Champagne are the most represented within the Liv-ex Fine Wine 100 index.

4. Research Question, Hypotheses and Data source.

As this thesis will involve stocks, fixed income and wine, data on these three sources is to be found. For stocks, the data used are US stocks indices through MSCI ETFs, Canadian stocks indices through MSCI ETFs, European stocks indices through MSCI ETFs; Japan stocks indices through MSCI ETFs, Asian stocks indices through MSCI ETFs and emerging markets indices through MSCI ETFs.

It is essential to note that it would be possible to expand the selection if needed, but data would become too preponderant and irrelevant due to the correlation between equities. Thus, I will be using only these three sources to conduct my analysis.

For fixed income, indices from the US, the Eurozone and Japan will be used.

For wine, the Liv-ex Fine Wine 100 index will be used.

Stocks, bonds and the Liv-ex Fine Wine 100 index data come from Bloomberg.

The horizon in terms of data would be from 2001 to 2021, as 20 years is a fair horizon for wine and it will be interesting to see how crisis can impact the portfolios.

The idea is to create 3 investor profiles and analyze them:

- One defensive investor (low risk, low return (Around 3-4%))
- One moderate investor (medium risk, medium return (Around 6%))
- One aggressive investor (high risk, high return (Around 8%))

For each investor profile, I will analyze what should be the weights of the portfolio in US stocks, in Canadian stocks, in European stocks, in Japan stocks, in emerging markets stocks in fixed income and in wine.

The majority of the data analysis is conducted on excel. The idea is to use the solver to find the best proportion to the optimization problem (minimum variance for a given return for the Markowitz framework, and the minimum LPM for the Lower Partial Moment model).

The main research question is:

How do portfolios of investors change when they can invest in wine as a complement of equities and fixed income?

The goal is to see how portfolios of investors originally are through an optimization, ie, for a given return what are the weights of the portfolio in each asset so that it yields the lowest variance). Then, how these weights change when the investor has the opportunity to invest in wine through the Liv-ex Fine Wine 100 index, which is my proxy for wine returns.

Several sub-research questions were developed:

- How can different investors' profiles benefit from the opportunity to invest in wine?

I will analyze how 3 investors differently benefit from the opportunity to invest in wine.

The investors will have different strategies; one that is defensive (a return of 3-4% annually), one that is moderate (a return of 5-6% annually), and one that is aggressive (a return of 8-9% annually).

- How do timeframes impact portfolios?

I will start by using 20 years of data (Starting with the creation of the Livex index, from 2001 to 2021) and analyze to answer the previous questions. Then, I will use the 11 most recent years of data (from 2010 to 2021) to answer the previous questions and I will then compare the results.

- How do weights of the portfolio in each asset change if we use the LPM model instead of the mean-variance framework of Markowitz?

There, I will redo the previous analyses using the LPM model and using the 20 years of data.

5. Analysis of the Correlation & Summary Statistics

In this second part of this thesis, I will be presenting and analyzing the results obtained from my data and the models used. First of all, correlation matrixes and summary statistics for both periods used will be presented and analyzed, then, the portfolios constructed using the various models will be displayed and evaluated.

5.1 Correlation & Summary Statistics over the 2001–2021 period

In this first part of the results presentation, firstly will be covered the correlation matrix and summary statistics of the data over the period 2001-2021. Then, the same will be covered for the period 2010-2021. Eventually, I will analyze and present the main differences in summary statistics & correlations.

5.1.1 Correlation Matrix

[Figure 4 is in the Appendix at the end]

The Livex index offers a very low correlation with each asset, from -0.25 with EUR Government bonds to 0.44 for the MSCI Asia Pacific. This shows that this asset can be used to diversify portfolios quite effectively.

In terms of general findings, equities are correlated among each other, the average correlation is at 0.63. Developed countries tend to be more correlated together and developing countries tend to be more correlated among themselves. On the other hand, bonds have a lower correlation among themselves, the average correlation at 0.4, except for high yield corporate bonds that have an inter-correlation of 0.9.

Now that correlations between financial assets have been presented, I will move on to the summary statistics for each type of assets.

5.1.2 Summary Statistics

[Figure 5 is in the Appendix at the end]

The highest monthly return is delivered by the MSCI India and the lowest is delivered by the MSCI Asia Pacific. The most volatile region is Brazil as it has the highest standard deviation & range. I created a proxy for the Sharpe ratio which is calculated as the mean return of the asset divided by its standard deviation. The goal of this proxy is to analyze which regions offer the best return adjusted for volatility. India and South Africa offer the highest Sharpe ratio. On the other side, Latin America, Brazil and Asia Pacific are the less interesting.

[Figure 6 is in the Appendix at the end]

The highest monthly return is delivered by the MSCI USA and the lowest is delivered by the MSCI Europe. The most volatile region is Japan as it has the highest standard deviation & range. For the proxy of the Sharpe ratio, the USA is leading and Europe is the less interesting.

[Figure 7 is in the Appendix at the end]

The highest monthly return is delivered by the EUR Corporate High Yield bonds and the lowest is delivered by the Japan Corporate. The most volatile asset is the EUR Corporate High Yield bonds. For the proxy of the Sharpe ratio, US Government bonds are leading, on the other side, EUR Corporate High Yield bonds and Japan Corporate High Yield bonds are the less interesting.

Statistics	Liv-ex Fine Wine 100
Mean	0.63
Standard Deviation	3.7
Sharpe Ratio	0.17
Range	34.3
Minimum	-23.3
Maximum	11.1

Figure 4: Summary statistics for the Livex Index

The Livex Index has a monthly return of 0.63% with a standard deviation of 3.65%, a maximum drawdown of -23.28% and a maximum up of 11.05%. Its Sharpe ratio's proxy is 0.17.

As seen, over the period 2001-2021, wine and equities from developing countries have been performing quite well. Equities from developed countries did not perform as well and it is mostly due to the 2000's crisis. We will now analyze the results over the period 2010-2021.

Now that the correlations between financial assets and the summary statistics of each asset have been presented, I will perform the same analysis for the 2010 to 2021 period.

5.2 *Correlation & Summary Statistics over the 2010–2021 period*

5.2.1 Correlation Matrix

[Figure 9 is in the Appendix at the end]

The Livex index offers a very low correlation with each asset, from -0.27 with EUR Government bonds to 0.5 for the MSCI Asia Pacific. This shows that this asset can be used to diversify portfolios quite effectively.

In terms of general findings, equities are correlated among each other; the average correlation is at 0.59. Developed countries tend to be more correlated together and developing countries tend to be more correlated among themselves. On the other hand, bonds have a lower correlation among themselves, the average correlation at 0.5. The correlations for high yield corporate bonds have an average of 0.92.

Now that the correlations between financial assets have been presented, I will move on to the summary statistics for each type of assets.

5.2.2 Summary Statistics

[Figure 10 is in the Appendix at the end]

The highest monthly return is delivered by the MSCI India and the lowest is delivered by the MSCI Brazil. The most volatile region is Brazil. For the Sharpe ratio proxy, India is leading, quickly followed by South Africa. On the other hand, Latin America and Brazil are the least interesting.

[Figure 11 is in the Appendix at the end]

The highest monthly return is delivered by the MSCI USA and the lowest is delivered by the MSCI Canada. The most volatile region is Japan. For the proxy of the Sharpe ratio, the USA is leading and Europe is the least interesting.

[Figure 12 is in the Appendix at the end]

The highest monthly return is delivered by the EUR Corporate High Yield bonds and the lowest is delivered by the Japan Corporate bonds. The most volatile asset is the EUR Corporate High Yield bonds. For the proxy of the Sharpe ratio, Japan Corporate bonds are leading and Japan Government bonds are the least interesting.

Statistics	Liv-ex Fine Wine 100
Mean	0.26
Standard Deviation	2.9
Sharpe Ratio	0.09
Range	17.4
Minimum	-9.9
Maximum	7.4

Figure 5: Summary statistics for the Livex Index

The Livex Index has a monthly return of 0.26% with a standard deviation of 2.9%, a maximum drawdown of -9.96%, and a maximum up of 7.4%. Its Sharpe ratio's proxy is 0.09.

As explored, over the period 2010-2021, wine and equities from developing countries have not been performing well. On the other hand, equities from developed countries did perform fairly well. The main findings and differences for both periods will now be analyzed.

5.3 Main findings & differences between periods

For the correlation matrixes, there are no meaningful differences between correlations of returns from 2001 to 2021 and returns from 2010 to 2021. The greatest difference in correlation is 0.15. On the other hand, there are several differences for the descriptive statistics.

All developing countries suffered a strong decrease in their average monthly return when comparing data from 2001 to 2021 and data from 2010 to 2021. The greatest decrease is 1.09% for Brazil, decreasing from an average monthly return of 0.91% to -0.19%. The smallest decrease is 0.26% for South Africa, decreasing from an average monthly return of 0.86% to 0.60%. On average, the monthly return for developing countries drops by 0.64% per month when using data from 2010 to 2021 instead of 2001 to 2021.

On the other hand, all developed countries (except Canada) benefited from the change of data range. On average, developed countries saw an increase in their monthly return by 0.32%, except for Canada which suffered from a slight drop of 0.04% per month. The fact that the data range from 2010 to 2021 does not include the burst of the Internet bubble, as well as the 2008 crisis, substantially benefited developed countries.

For Government bonds, the change is minimal, on average they lost 0.04% of monthly return. Same goes for Corporate bonds, they lost 0.02% of monthly return. Eventually, High Yield Corporate bonds suffered a decrease of 0.04% of monthly return. These results show that bonds are less affected by the time horizon of the data than equities.

Finally, the Livex index suffered a lot from the change in time horizon, as it lost 0.37% of monthly return, dropping from 0.63% to 0.26%. This can be explained by the fact that the index boomed after its creation and also because it is during bubbles that investors actively look for alternatives. Nonetheless, wine remain an interesting asset as they are not heavily correlated with financial markets.

Thus, there are no differences in correlations due to the time horizon change of the data. However, there are some differences in terms of the average monthly return. Developing countries suffered from the change as they have been earning less between 2010 and 2021 than between 2001 to 2021. On the contrary, developed countries benefited from the change as the period 2010 to 2021 does not contain the burst of the Internet bubble and the Subprime crisis. Eventually, the Livex index's returns dropped due to the change mostly because between 2001 to 2010, wine appreciated a lot thanks to both crisis and the creation of the index.

In this part, we covered the correlations matrixes, the descriptive statistics for each period, and, the main differences over them. I will now move on to the presentation of the portfolios.

6. Model 1, Markowitz Framework using data from 2001 to 2021

First, the methodology used to construct the portfolios will be explained; then, the different portfolios and the weight of wine within each one will be presented. Eventually, an analysis of the results will be conducted.

6.1 Methodology

To find the best portfolios -the ones yielding the minimum variance for a given return-, I will conduct an optimization problem on Excel using the solver. 14 situations will be created and in each one of them will be performed the optimization problem, which will give the best portfolios for each returned defined.

The 14 situations are:

- A portfolio composed of Equities from Developed countries
- A portfolio composed of Equities from Developing countries
- A portfolio composed of Fixed income from Developed countries
- A portfolio composed of Equities from Developed countries and Equities from Developing countries
- A portfolio composed of Equities from Developed countries and of Fixed income from the same countries
- A portfolio composed of Equities from Developing countries and Fixed income of Developed countries
- A portfolio composed of Equities from Developing countries, Equities from Developed Countries and Fixed income of them.
- A portfolio composed of Equities from Developed countries and the Livex Index
- A portfolio composed of Equities from Developing countries and the Livex Index
- A portfolio composed of Equities from Fixed income and the Livex Index
- A portfolio composed of Equities from Developed countries, Developing countries and the Livex Index
- A portfolio composed of Equities from Developed countries, Fixed income and the Livex Index
- A portfolio composed of Equities from Developing countries, Fixed income and the Livex Index
- A portfolio composed of Equities from Developed countries, Developing countries, Fixed income and the Livex Index.

The monthly returns investigated are the following:

- 0.25% (Defensive Investor)
- 0.30%
- 0.40% (Moderate Investor)
- 0.50% (Moderate Investor)

- 0.60% (Moderate Investor)
- 0.70%
- 0.75% (Aggressive Investor)

The goal of investigating these different monthly returns has the aim to analyze how different investors' profile will allocate their funds to minimize their risk based on the return they aim to achieve.

Now that the methodology has been described, I will present the results for each portfolio.

6.2 Results

As we can expect, all portfolios that have the opportunity to invest in wine benefit from it, as their variance is always lower than the mimicking portfolio that could not allocate funds into the Livex index.

[Figure 14 is in the Appendix at the end]

The picture above shows each possible portfolio both in its version without the possibility to invest in wine and with the version with the opportunity to invest in wine.

6.2.1 Portfolio composed of Equities from Developed countries

For the first portfolio composed of the equities from developed countries, the average variance of the portfolio drops from 17 to 14. An investor with the same risk profile can get a monthly return of 0.5% with a variance of 14.21 in the first state. Once the investor obtains the possibility to invest in wine, he can obtain a monthly return of 0.7% with a variance of 12.19. On an annual period, it is a difference of 2.4% which is substantial.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

	MSCI Japan	MSCI Europe	MSCI Canada	MSCI USA	Livex
0,25%	6%	93%	0%	0%	1%
0,40%	6%	55%	1%	0%	38%
0,50%	4%	22%	24%	0%	50%
0,60%	1%	0%	31%	12%	56%
0,75%	0%	0%	0%	100%	0%

Figure 6: Portfolio weights for the portfolio composed of Equities from Developed countries.

As we can see, for a defensive investor, the use of wine might not be very beneficial as they tend to be more volatile than equities from Japan and Europe. For the aggressive investor, wine might not be very beneficial as well as this investor wants a high return and wine won't be able

to help him obtain it. On the other hand, for a moderate investor, investing in wine is interesting. For an investor targeting a monthly return of 0.40% (or 4.8% annually), he should invest 38% in wine. For an investor targeting a monthly return of 0.50% (or 6% annually), he should invest 50% in wine. For an investor targeting a monthly return of 0.60% (or 7.2% annually), he should invest 56% in wine.

6.2.2 Portfolio composed of Equities from Developed & Developing countries

For the second portfolio composed of the equities from developed countries & developing countries, the average variance of the portfolio drops from 15.5 to 12.5. An investor with the same risk profile can get a monthly return of 0.5% with a variance of 13.47 in the first state. Once the investor obtains the possibility to invest in wine, he can obtain a monthly return of 0.75% with a variance of 10.16. On an annual period, it is a difference of 3% which is substantial.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 16 is in the Appendix at the end]

As we can see, for a defensive investor, the use of wine might not be very beneficial, as they tend to be more volatile than equities from Japan and Europe. On the other hand, for a moderate investor, investing in wine is really interesting. For an investor targeting a monthly return of 0.40% (or 4.8% annually), he should invest 38% in wine. For an investor targeting a monthly return of 0.50% (or 6% annually), he should invest 48% in wine. For an investor targeting a monthly return of 0.60% (or 7.2% annually), he should invest 52% in wine. An aggressive investor will benefit from wine as well as wine compose 55% of the portfolio yielding a monthly return of 0.75% (or 9% annually).

6.2.3 Portfolio composed of Equities from Developed countries & Fixed income

For the third portfolio composed of the equities of developed countries & fixed income. The average variance of the portfolio drops from 6 to 5.5. When an investor is exposed to fixed income, wine becomes less interesting compared to situations where fixed income is not offered.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 17 is in the Appendix at the end]

As we can see, for a defensive investor, the use of wine might be a bit beneficial, as the optimum portfolio requires an investment of 5% in wine. Also, a moderate investor, can benefit from investing in wine. For an investor targeting a monthly return of 0.40% (or 4.8% annually), he should invest 9% in wine. For an investor targeting a monthly return of 0.50% (or 6% annually),

he should invest 15% in wine. For an investor targeting a monthly return of 0.60% (or 7.2% annually), and an aggressive investor, the opportunity to invest in wine is not beneficial.

6.2.4 Portfolio composed of Equities from Developed & Developing countries and Fixed income

For the fourth portfolio composed of the equities from developed countries, developing countries and fixed income, the average variance of the portfolio drops from 2.6 to 2.3.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

	Nifty 50	MSCI South Africa	MSCI USA	US Gov Bond	US Corp HY	Eur Gov Bond	Japan Gov Bonds	Japan Corp Bonds	Livex
0,25%	1%	1%	1%	13%	3%	22%	0%	55%	5%
0,40%	2%	2%	2%	24%	6%	43%	12%	0%	9%
0,50%	7%	3%	0%	14%	11%	53%	0%	0%	12%
0,60%	15%	5%	0%	0%	14%	52%	0%	0%	15%
0,75%	28%	7%	0%	0%	16%	31%	0%	0%	18%

Figure 7: Portfolio weights for the portfolio composed of Equities from Developed, Developing countries and Fixed income.

As we can see, all investors can benefit from the opportunity to invest in wine. A defensive investor should invest 5% of his portfolio in them. A moderate investor should invest between 9% to 15% depending on his targeted return. Eventually, an aggressive investor should invest 18% in wine.

6.2.5 Portfolio composed of Equities from Developing countries and Fixed income

For the fifth portfolio composed of the equities from developing countries and fixed income, the average variance of the portfolio drops from 2.6 to 2.4.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 19 is in the Appendix at the end]

As we can see, all investors can benefit from the opportunity to invest in wine. A defensive investor should invest 5% of his portfolio in them. A moderate investor should invest between 9% to 15% depending on his targeted return. Eventually, an aggressive investor should invest 18% in wine.

6.2.6 Portfolio composed of Equities from Developing countries

For the sixth portfolio composed of the equities from developing countries, the average variance of the portfolio drops from 19.2 to 12.7.

An investor with the same risk profile can get a monthly return of 0.75% with a variance of 18.72 in the first state. Once the investor obtains the possibility to invest in wine, he can obtain a monthly return of 1% with a variance of 17.59. On an annual period, it is a difference of 3%, which is substantial.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 20 is in the Appendix at the end]

As can be seen, all investors can benefit from the opportunity to invest in wine. The defensive investor should not invest in this situation as he can't get a low return with a small variance. A moderate investor should invest between 11% to 62% depending on his targeted return. Eventually, an aggressive investor should invest 62% in wine.

6.2.7 Portfolio composed of Fixed income

For the seventh portfolio composed of fixed income, the average variance of the portfolio drops from 1.42 to 1.24.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 21 is in the Appendix at the end]

As we can see, all investors can benefit from the opportunity to invest in wine. The defensive investor can benefit from wine by investing 5% of his funds. A moderate investor should invest between 10% to 21% depending on his targeted return. Eventually, an aggressive investor shouldn't invest there, as he wouldn't reach his targeted return.

Now that the portfolios constructed have been described, an analysis of the allocation of wine will be conducted.

6.3 *Analysis*

As we saw, all investors benefit from the opportunity to invest in wine since it can lower the variance of the portfolio for a given return. Based on the three investors' profiles that we investigate; it appears that the moderate investor is the one benefiting most from it since he invests more often in wine than the other profiles. The results found in this optimization problem are consistent with what can be expected, and allow me to validate my hypothesis regarding the importance of having wine in portfolios. I will now perform the same steps using data from 2010 to 2021.

7. Model 2, Markowitz Framework using data from 2010 to 2021

First, the methodology & differences with the data from 2001-2021 will be covered; secondly, the different portfolios and the weights of wine within each one will be presented; then, an analysis of the results will be done. Eventually, the differences between the portfolios constructed using data from 2001-2021 and portfolios constructed using data from 2010-2021 will be highlighted.

7.1 Methodology

In this part, we will use the same methodology as for the portfolios composed with data from 2001-2021. The main differences come from the summary statistics of the financial assets over the horizon time.

Developing countries suffered from the change as they have been earning less between 2010 and 2021 than between 2001 to 2021. On the contrary, developed countries benefited from the change, as the period 2010 to 2021 does not contain the burst of the Internet bubble and the Subprime crisis. Eventually, the Livex index's returns dropped due to the change mostly because between 2001 to 2010, wine appreciated a lot thanks to both crisis and the creation of the index. We will now move on to the portfolios that were created.

7.2 Results

As we can expect, most of the portfolios that have the opportunity to invest in wine benefit from it as their variance is always higher than the mimicking portfolio that could not allocate funds into the Livex index. However, due to the change in the average monthly return and volatility of the Livex Index, not all portfolios actually invest in it. This is an interesting finding, as it clearly shows that the horizon of the data range can impact portfolios' weights a lot.

[Figure 22 is in the Appendix at the end]

The picture above shows each possible portfolio both in its version without the possibility to invest in wine and with the version with the opportunity to invest in wine.

7.2.1 Portfolio composed of Equities from Developed countries

For the first portfolio composed of the equities from developed countries, the average variance of the portfolio drops from 11.4 to 8.7. An investor with the same risk profile can get a monthly return of 0.5% with a variance of 10.67 in the first state. Once the investor obtains the possibility to invest in wine, he can obtain a monthly return of 0.75% with a variance of 9.72. On an annual period, it is a difference of 3%, which is substantial.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

	MSCI Japan	MSCI Europe	MSCI Canada	MSCI USA	MSCI Livex
0,25%	0%	0%	0%	0%	100%
0,40%	3%	5%	29%	7%	56%
0,50%	3%	0%	23%	21%	53%
0,60%	1%	0%	14%	35%	50%
0,75%	0%	0%	0%	56%	44%

Figure 8: Portfolio weights for the portfolio composed of Equities from Developed countries.

As we can see, for a defensive investor, the use of wine is beneficial as the return on Equities is too high to achieve a monthly return of 0.25%. However, since a defensive investor would be fully invested in wine, the portfolio is not efficient. For the aggressive & moderate investors, wine will be very beneficial as well, these investors will be able to obtain a higher return with a lower variance. A moderate investor would invest between 50% and 56% within wine, depending on his targeted return and an aggressive investor will invest 44%.

7.2.2 Portfolio composed of Equities from Developed & Developing countries

For the second portfolio composed of equities from developed & developing countries, the average variance of the portfolio drops from 12.5 to 7.9. An investor with the same risk profile can get a monthly return of 0.5% with a variance of 9.92 in the first state. Once the investor obtains the possibility to invest in wine, he can obtain a monthly return of 0.75% with a variance of 9.36. On an annual period, it is a difference of 3%, which is substantial.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 24 is in the Appendix at the end]

As we can see, for a defensive investor, the use of wine is beneficial as the return on Equities is too high to achieve a monthly return of 0.25%. However, since a defensive investor would be invested in wine at 82%, the portfolio is not efficient. For the aggressive & moderate investors, wine will be very beneficial as well these investors will be able to obtain a higher return with a lower variance. A moderate investor would invest between 46% and 53% within wine depending on his targeted return and an aggressive investor will invest 35%.

7.2.3 Portfolio composed of Equities from Developed countries and Fixed income

For the third portfolio composed of the equities from developed countries & fixed income countries. The average variance of the portfolio does not change. When an investor is exposed to fixed income, wine become less interesting as the return of them over the period 2010-2021 is low and fixed income yields a higher return for a lower volatility.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 25 is in the Appendix at the end]

As we can see, no investors benefit from wine, this is mainly due to the low return and the volatility of the latter.

7.2.4 Portfolio composed of Equities from Developed & Developing countries and Fixed income

For the fourth portfolio composed of the equities from developed countries, developing countries & fixed income. The average variance of the portfolio does not change. When an investor is exposed to fixed income, wine become less interesting as the return of them over the period 2010-2021 is low and fixed income yields a higher return for a lower volatility.

	MSCI Japan	MSCI USA	US Gov Bond	US Corp Bonds	US Corp HY	Eur Gov Bond	Japan Gov Bonds	Japan Corp Bonds	Livex
0,25%	1%	8%	22%	0%	1%	11%	11%	45%	0%
0,40%	1%	14%	35%	0%	5%	26%	18%	0%	0%
0,50%	0%	20%	25%	7%	8%	39%	0%	0%	0%
0,60%	0%	30%	0%	33%	1%	36%	0%	0%	0%
0,75%	0%	46%	0%	45%	0%	9%	0%	0%	0%

Figure 9: Portfolio weights for the portfolio composed of Equities from Developed & Developing countries as well as Fixed income.

As we can see, no investors benefit from wine, this is mainly due to the low return and the volatility of the latter. Also, an investor will not invest in developing countries as the return is low over the period 2010-2021.

7.2.5 Portfolio composed of Equities from Developing countries and Fixed income

For the fifth portfolio composed of the equities from developing countries & fixed income. The average variance of the portfolio does not change. When an investor is exposed to fixed income, wine become less interesting as the return of them over the period 2010-2021 is low and fixed income yields a higher return for a lower volatility.

[Figure 27 is in the Appendix at the end]

As we can see, no investors benefit from wine (the defensive investor should invest 1% of his portfolio which is fairly low), this is mainly due to the low return and the volatility of the latter. Also, an investor will not invest in developing countries as the return is low over the period 2010-2021.

7.2.6 Portfolio composed of Equities from Developing countries

For the sixth portfolio composed of the equities from developing countries, the average variance of the portfolio drops from 16.5 to 10.2.

An investor with the same risk profile can get a monthly return of 0.5% with a variance of 13.26 in the first state. Once the investor obtains the possibility to invest in wine, he can obtain a monthly return of 0,7% with a variance of 14.05. On an annual period, it is a difference of 2.4% which is substantial.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 28 is in the Appendix at the end]

As we can see, all investors can benefit from the opportunity to invest in wine. The defensive investor would invest in this situation 89% of his portfolio in wine. A moderate investor should invest between 31% to 66% depending on his targeted return. Eventually, an aggressive investor should invest 4% in wine.

7.2.7 Portfolio composed of Fixed income

For the seventh portfolio composed of fixed income, the average variance of the portfolio does not change. Due to the low return of the Livex Index, fixed income appears to always perform better. Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 29 is in the Appendix at the end]

As can be witnessed, no investors benefit from wine (the defensive investor should invest 1% of his portfolio which is fairly low). This is mainly due to the low return and the volatility of the latter. Also, an investor will not invest in developing countries as the return is low over the period 2010-2021.

Now that the portfolios constructed have been described, an analysis of the allocation of wine will be done.

7.3 *Analysis*

As we saw, not all investors benefit from the opportunity to invest in wine, since the return of wine over the period 2010-2021 is low and the proxy of the Sharpe ratio is only 0.09. Over this period, fixed income replaces the role of wine, in the sense that bonds offer a higher return for a lower volatility. Based on the three investors' profiles that we investigate; it appears that the moderate investor is the one that benefits most from it since he invests more in wine than the other profiles. The results found in this optimization problem are consistent with what we can expect for portfolios that do not have the opportunity to invest in fixed income. However, when

investors have the opportunity to invest in fixed income, investing in wine become less interesting. After analyzing the results for this period, I will demonstrate the importance of selecting an accurate data range as there are many differences between the two models.

7.4 Differences between the portfolios constructed using data from 2001-2021 and portfolios constructed using data from 2010-2021

There are several differences in the portfolio allocation when the time horizon changes. As it was described in the first part, a majority of the assets encountered a change in their returns. The portfolio that is yielding the lowest variance is the one composed of every asset, and which was constructed using data from 2010 to 2021, this portfolio has an average variance of 2.06. To compare how both models change the allocation of wine within the portfolio, I will compare the difference in the weight of wine between the portfolios computed with data from 2001 to 2021 and data from 2010-2021.

For the first portfolio, composed of equities from developed countries and the Livex index, the difference is -32%. This difference comes from the fact that for portfolios constructed using 2010 to 2021 data, the Livex Index is much more used by all investors and therefore the difference is huge. This difference can come from the fact that Equities from Developed countries have a higher return over the 2010-2021 period than for the 2001-2021 period.

For the second portfolio, composed of equities and the Livex index, the difference is -14%. This difference comes from the fact that for portfolios constructed using 2010 to 2021 data, the Livex Index is much more used by all investors and therefore the difference is huge. However, one interesting observation is that the aggressive investor will invest more in wine when using 2001-2021 data than when using the 2010-2021 data.

For the third portfolio, composed of equities from developed countries, fixed income and the Livex index, the difference is 6%. This difference comes from the fact that for portfolios constructed using 2010 to 2021 data, the Livex Index is not used as Fixed Income offers a better alternative than wine when using this data.

For the fourth portfolio, composed of equities, fixed income, and the Livex index, the difference is 12%. This difference comes from the fact that for portfolios constructed using 2010 to 2021 data, the Livex Index is not used as fixed income offers a better alternative than wine when using this data.

For the fifth portfolio, composed of equities from developing countries, fixed income, and the Livex index, the difference is 12%. This difference comes from the fact that for portfolios constructed using 2010 to 2021 data, the Livex Index is not used as Fixed income offers a better alternative than wine when using this data.

For the sixth portfolio, composed of equities from developing countries and the Livex index, the difference is -3%. This difference is very small as both portfolios invest on average 45% and 48% in wine.

For the last portfolio, composed of fixed income and the Livex index, the difference is 12%. This difference comes from the fact that, for portfolios constructed using 2010 to 2021 data, the Livex Index is not used as Fixed income, offers a better alternative than wine when using this data.

Overall, we can see that the change in the data selection can impact the construction of portfolios a lot. As it was described, the return on the Livex index, the proxy of wine over the period 2001-2021, is twice as much as its return for the period 2010-2021. Thus, it explains why wine aren't as present when constructing portfolios using the latter time horizon. This finding shows how selective wealth managers and portfolio managers should be when they have to perform analyses on which horizon to use to construct the optimal portfolios.

In this part we saw the methodology & differences with the data from 2001-2021; secondly, the different portfolios and the weights of wine within each one were presented; then, an analysis of the results was performed. Eventually, differences between the portfolios constructed using data from 2001-2021 and portfolios constructed using data from 2010-2021 were highlighted. I will now construct portfolios using the lower partial moment model.

8. Model 3, Lower Partial Moment model, using data from 2001 to 2021.

First of all, the methodology of the LPM Model will be explained, secondly, the different portfolios and the weights of wine within each one will be presented, then, an analysis of the results will be done, eventually, the differences between the portfolios constructed using the Markowitz framework with data from 2001-2021 and portfolios constructed using the LPM model will be highlighted.

8.1 Methodology

The Lower Partial Moment (LPM) model is a measure of portfolio risk. This measure is computed based on portfolios returns that fall below a certain threshold. The main advantage of this model is that it allows to focus on returns that investors do not want to achieve. For instance, returns equally distributed between +5% and +15% have the same volatility as returns equally distributed between -5% and +5%. The Markowitz Framework would be indifferent in terms of volatility, however, the LPM model would not give the same result, since with a threshold of 0, the 2nd option would not be selected. This makes sense since every investor would prefer the 1st option since it is sure to obtain an equal or higher return.

In this part, I will look again at the 14 situations and in each one of them I will perform the optimization problem which will give the best portfolios for each returned defined. The data used is from 2001 to 2021. The thresholds for the different investors type and required return are the following:

- 0.25% - Threshold = -2%
- 0.30% - Threshold = -2%
- 0.40% - Threshold = -2.5%
- 0.50% - Threshold = -3%
- 0.60% - Threshold = -3.5%
- 0.70% - Threshold = -5%
- 0.75% - Threshold = -5%

Thresholds are different based on the required return, as I consider that investors wanting to obtain a higher return are also agreeing to more risk and downturn.

Now that the methodology has been explained, I will present the results of this model.

8.2 Results

As we can expect, all portfolios having the opportunity to invest in wine benefit from it, as the LPM is always lower than the mimicking portfolio that could not allocate funds into the Livex index. The variance, however, can sometimes go up as the goal is to get the lowest LPM as possible.

[Figure 30 is in the Appendix at the end]

The picture above shows each possible portfolio; both in its version without the possibility to invest in wine and with the version with the opportunity to invest in wine.

8.2.1 Portfolio composed of Equities from Developed countries

For the first portfolio composed of the equities from developed countries, the average variance of the portfolio drops from 18.7 to 15. An investor with the same risk profile can get a monthly return of 0.5% with a variance of 17.54 in the first state. Once the investor obtains the possibility to invest in wine, he can obtain a monthly return of 0.7% with a variance of 12.67. On an annual period, it is a difference of 2.4%, which is substantial.

Also, the average LPM in the first state is 901 whereas it drops to 722 when the investor can invest in wine. This clearly shows that being able to invest in wine will reduce the volatility and the risk of the portfolio.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

	MSCI Japan	MSCI Europe	MSCI Canada	MSCI USA	Livex
0,25%	5%	94%	0%	0%	1%
0,40%	21%	46%	4%	11%	18%
0,50%	25%	19%	5%	18%	33%
0,60%	9%	7%	4%	22%	58%
0,75%	0%	0%	0%	100%	0%

Figure 10: Portfolio weights for the portfolio composed of Equities from Developed countries.

As we can see, for a defensive investor, the use of wine is not very beneficial. For the aggressive investor, wine might not be very beneficial as well as this investor wants a high return and wine won't be able to help him obtain it. On the other hand, for a moderate investor, investing in wine is really interesting. For an investor targeting a monthly return of 0.40% (or 4.8% annually), he should invest 18% in wine. For an investor targeting a monthly return of 0.50% (or 6% annually), he should invest 33% in wine. For an investor targeting a monthly return of 0.60% (or 7.2% annually), he should invest 58% in wine.

8.2.2 Portfolio composed of Equities from Developed & Developing countries

For the second portfolio composed of the equities from developed countries & developing countries, the average variance of the portfolio drops from 20.5 to 14.5. An investor with the same risk profile can get a monthly return of 0.5% with a variance of 19.72 in the first state. Once the investor obtains the possibility to invest in wine, he can obtain a monthly return of 0.75% with a variance of 16.14. On an annual period, it is a difference of 3%, which is substantial.

Also, the average LPM in the first state is 1086, whereas it drops to 719 when the investor can invest in wine. This clearly shows that being able to invest in wine will reduce the volatility and the risk of the portfolio.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 32 is in the Appendix at the end]

As can be seen, for a defensive investor, the use of wine is not very beneficial. For the aggressive investor, wine can be very beneficial as well, as this investor wants a high return and wine will be able to help him obtain it; thus this investor should invest 21% in wine. For a moderate investor, investing in wine is really interesting as well. For an investor targeting a monthly return of 0.40% (or 4.8% annually), he should invest 20% in wine. For an investor targeting a monthly return of 0.50% (or 6% annually), he should invest 32% in wine. For an investor targeting a monthly return of 0.60% (or 7.2% annually), he should invest 32% in wine.

8.2.3 Portfolio composed of Equities from Developed countries and Fixed income.

For the third portfolio composed of the equities from developed countries & fixed income countries, the average variance of the portfolio drops from 9 to 6.

Also, the average LPM in the first state is 202 whereas it drops to 147 when the investor can invest in wine. This clearly shows that being able to invest in wine will reduce the volatility and the risk of the portfolio.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 33 is in the Appendix at the end]

As we can see, for a defensive investor, the use of wine might be a bit beneficial as the optimum portfolio requires an investment of 5% in wine. Also, a moderate investor can benefit from investing in wine. For an investor targeting a monthly return of 0.40% (or 4.8% annually), he should invest 8% in wine. For an investor targeting a monthly return of 0.50% (or 6% annually), he should invest 19% in wine. For an investor targeting a monthly return of 0.60% (or 7.2% annually), he should invest 38% in wine. On the other hand, an aggressive investor will not benefit from the opportunity to invest in wine.

8.2.4 Portfolio composed of Equities from Developed & Developing countries and Fixed income.

For the fourth portfolio composed of the equities from developed countries, developing countries and fixed income, the average variance of the portfolio drops from 4.5 to 3.5.

Also, the average LPM in the first state is 119, whereas it drops to 43 when the investor can invest in wine. This clearly shows that being able to invest in wine will reduce the volatility and the risk of the portfolio.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

	Nifty 50	US Gov Bond	US Corp Bonds	Eur Gov Bond	Eur Corp Bonds	Japan Gov Bonds	Japan Corp Bonds	Livex
0,25%	0%	20%	6%	22%	11%	20%	21%	0%
0,40%	11%	16%	6%	17%	10%	17%	18%	5%
0,50%	18%	19%	6%	20%	11%	17%	3%	5%
0,60%	38%	15%	6%	11%	9%	12%	3%	5%
0,75%	42%	13%	6%	10%	9%	11%	3%	5%

Figure 11: Portfolio weights for the portfolio composed of Equities from Developed & Developing countries and Fixed income.

As we can see, all investors except the defensive can benefit from the opportunity to invest in wine. Both a moderate investor, and an aggressive investor, should invest 5% in wine.

8.2.5 Portfolio composed of Equities from Developing countries and Fixed income.

For the fifth portfolio composed of the equities from developing countries and fixed income, the average variance of the portfolio drops from 4.1 to 3.5.

Also, the average LPM in the first state is 136 whereas it drops to 67 when the investor can invest in wine. This clearly shows that being able to invest in wine will reduce the volatility and the risk of the portfolio.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 35 is in the Appendix at the end]

There, all investors, except for the defensive one, can benefit from the opportunity to invest in wine. A moderate investor should invest between 8% to 17% depending on his targeted return. Eventually, an aggressive investor should invest 10% in wine.

8.2.6 Portfolio composed of Equities from Developing countries.

For the sixth portfolio composed of the equities from developing countries, the average variance of the portfolio drops from 23.2 to 20.

Also, the average LPM in the first state is 886, whereas it drops to 752 when the investor can invest in wine. This clearly shows that being able to invest in wine will reduce the volatility and the risk of the portfolio.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 36 is in the Appendix at the end]

As we can see, all investors can benefit from the opportunity to invest in wine. The defensive investor should not invest in this situation as he can't get a low return with a small variance. A moderate investor should invest 11%. Eventually, an aggressive investor should invest 17% in wine.

8.2.7 Portfolio composed of Fixed income.

For the seventh portfolio composed of fixed income, the average variance of the portfolio drops from 1.9 to 1.7.

Also, the average LPM in the first state is 53, whereas it drops to 50 when the investor can invest in wine. This clearly shows that being able to invest in wine will reduce the volatility and the risk of the portfolio.

Below are presented the portfolio weights for the three investors for the portfolio with exposure to wine.

[Figure 37 is in the Appendix at the end]

As we can see, not all investors can benefit from the opportunity to invest in wine. The defensive investor and the aggressive investor do not benefit from wine. On the other hand, a moderate investor should invest between 6% to 17% depending on his targeted return.

Now that the portfolios constructed have been described, an analysis of the allocation of wine will be done.

8.3 *Analysis*

As we saw, wine is used in all portfolios and the moderate investor is the one that is mostly taking advantage of it. The fact that wine are used in all portfolios is consistent with what I was expecting, as this asset is able to lower the lower partial moment and therefore meets more accurately the needs of the investors. The results are consistent as the portfolio with the lowest Lower Partial Moment is portfolio 10, which is composed of all possible assets (Equities, Fixed income, Wine). The volatility of the portfolio is usually correlated with the LPM, meaning that portfolios with a low LPM also have a low variance. Eventually, the portfolios that offer the lowest LPM are those that have both Fixed income and Wine as these assets tend to have a lower volatility and drawdown than Equities. I will now analyze the main differences between the LPM model and the Markowitz framework.

8.4 Differences between the lower partial moment model and the Markowitz framework

There are several differences between the portfolio allocation with the Markowitz Framework and the LPM model. First of all and as expected, the Markowitz Framework which aims to obtain the lowest volatility for a given return, yields portfolios that have a lower volatility than the LPM model. To compare how both models change the allocation of wine within the portfolio, I will compare the difference in the weight of wine between the portfolios computed with the Markowitz Framework and the ones computed with the LPM model.

For the first portfolio, composed of equities from developed countries and the Livex index, the difference is 7%. This difference comes from the fact that a moderate investor using the Markowitz Framework will allocate between 38% and 56% of his funds towards wine, whereas an investor using the LPM framework will have a more volatile allocation, ranging from 18% to 58%.

For the second portfolio, composed of equities and of the Livex index, the difference is 18%. This difference comes from the fact that within the LPM model, investors should invest in wine less than within the Markowitz Framework. In both models, the defensive investor will not use wine, but moderate & aggressive investors will rely heavily on them. The Markowitz framework has an average use of wine of 49% and the LPM model has an average of 26%.

For the third portfolio, composed of equities from developed countries, fixed income and the Livex index, the difference is -8%. This difference comes from the fact that a moderate investor using the Markowitz Framework will allocate between 9% and 15% of his funds towards wine whereas an investor using the LPM framework will have a more volatile allocation, ranging from 8% to 38%.

For the fourth portfolio, composed of equities, fixed income, and the Livex index, the difference is 8%. This difference comes from the fact that for the Markowitz Framework, investors should allocate between 5% and 18% whereas for the LPM Model, all investors except the defensive should allocate 5% of their portfolios towards wine.

For the fifth portfolio, composed of equities from developing countries, fixed income, and the Livex index, the difference is 3%. This small difference comes from the aggressive investor who would allocate 18% towards wine in the Markowitz Framework and only 10% with the LPM Model.

For the sixth portfolio, composed of equities from developing countries and the Livex index, the difference is 32%. This difference is driven by the fact that the aggressive investor in the Markowitz Framework will invest 62% in wine, whereas he will invest only 17% when using the LPM Model.

For the last portfolio, composed of fixed income and the Livex index, the difference is 5%. This small difference comes from the fact that the moderate investor will invest 15% towards wine with the Markowitz Framework and only 10% when using the LPM Model.

Overall, we can see that the LPM model gives wider range when it comes to investing in wine, therefore, it probably is not as easy to implement in practice as the Markowitz framework which is more consistent in terms of weights. Also, the Markowitz Framework tends to invest more in wine than the LPM Model. This demonstrates that the Markowitz Framework takes a consequent advantage of the low correlation of wine with other financial assets to lower the overall volatility of the portfolio.

9. Conclusion

As we have seen in this thesis, wine can be a major add-on to the portfolios of investors. Depending on the model and the investor profile, wine will be more or less used as investors have different expected returns. An investor using the Markowitz framework will invest more in wine than an investor using the LPM model. The lower partial moment model offers a wide range of allocation when it comes to wine investing (depending on the targeted return), therefore, this model would be trickier to implement for wealth managers and would not be recommended. In terms of investor profiles, all investors can benefit from wine, but, overall, the moderate profile is the one allocating the most towards wine. A crucial information that demonstrated in this thesis is the relevance and importance of selecting an accurate data range. As explained, the portfolios constructed using the data from 2001 to 2021 and the portfolios constructed using data from 2010 to 2021 are very different and the allocation of funds changes a lot. However, it is imperative to note that past performances do not predict future performances. For instance, wine have not been doing spectacular over the period from 2010 to 2020. However, it has been doing great in 2022 so far. (Robinson, 2022).

10. References

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11. Appendix

	MSCI AC Asia Pacific Index	MSCI China	MSCI India	MSCI Russia	MSCI Brazil	MSCI South Africa	MSCI Latin America	MSCI Japan	MSCI Europe	MSCI Canada	MSCI USA	US Gov Bond	US Corp Bonds	US Corp HY	Eur Gov Bond	Eur Corp Bonds	Eur Corp HY	Japan Gov Bonds	Japan Corp Bonds	Japan Corp HY	Livex	
MSCI AC Asia Pacific Index	1.00																					
MSCI China	0.78	1.00																				
MSCI India	0.72	0.99	1.00																			
MSCI Russia	0.69	0.50	0.50	1.00																		
MSCI Brazil	0.66	0.58	0.56	0.66	1.00																	
MSCI South Africa	0.64	0.94	0.60	0.50	0.55	1.00																
MSCI Latin America	0.75	0.62	0.63	0.73	0.98	0.60	1.00															
MSCI Japan	0.76	0.50	0.51	0.51	0.38	0.43	0.46	1.00														
MSCI Europe	0.72	0.53	0.59	0.58	0.57	0.55	0.64	0.67	1.00													
MSCI Canada	0.74	0.61	0.63	0.67	0.65	0.65	0.73	0.56	0.77	1.00												
MSCI USA	0.78	0.62	0.61	0.60	0.61	0.57	0.69	0.63	0.85	0.81	1.00											
US Gov Bond	0.05	0.01	0.06	0.05	0.06	0.05	0.08	-0.20	-0.16	-0.05	-0.10	1.00										
US Corp Bonds	0.42	0.28	0.28	0.28	0.31	0.30	0.37	0.14	0.28	0.34	0.28	0.77	1.00									
US Corp HY	0.71	0.49	0.59	0.60	0.61	0.45	0.68	0.51	0.65	0.67	0.71	0.33	0.58	1.00								
Eur Gov Bond	-0.08	-0.08	-0.01	-0.16	-0.10	-0.01	-0.10	-0.17	-0.14	-0.12	-0.16	0.68	0.51	-0.03	1.00							
Eur Corp Bonds	0.42	0.28	0.29	0.28	0.30	0.31	0.36	0.29	0.34	0.37	0.32	0.54	0.80	0.55	0.63	1.00						
Eur Corp HY	0.64	0.46	0.57	0.57	0.53	0.41	0.60	0.50	0.67	0.64	0.66	0.00	0.48	0.87	0.62	0.61	1.00					
Japan Gov Bonds	-0.17	-0.12	-0.11	-0.16	-0.01	-0.01	-0.03	-0.34	-0.15	-0.10	-0.12	0.46	0.35	-0.01	0.44	0.27	-0.08	1.00				
Japan Corp Bonds	-0.07	-0.05	-0.04	-0.06	0.03	0.02	0.04	-0.22	-0.04	0.02	-0.01	0.40	0.39	0.10	0.39	0.39	0.09	0.80	1.00			
Japan Corp HY	0.73	0.50	0.60	0.63	0.66	0.48	0.73	0.51	0.67	0.68	0.71	0.18	0.62	0.98	0.62	0.61	0.87	0.01	0.14	1.00		
Livex	0.44	0.37	0.26	0.43	0.37	0.23	0.42	0.31	0.28	0.39	0.34	-0.02	0.17	0.38	-0.25	0.14	0.39	-0.15	-0.01	0.37	1	

Figure 12: Correlation Matrix of the Financial Assets over the period 2001-2021

There are a few high correlations (≥ 0.8) between financial assets:

- Correlation of 0.96 between the MSCI Brazil and the MSCI Latin America
- Correlation of 0.85 and 0.81 between the MSCI USA and the MSCI Europe and MSCI Canada respectively
- Correlation of 0.87 and 0.98 between the Bloomberg USA Corporate High Yield Bonds and the Bloomberg EUR Corporate High Yield Bonds and Bloomberg JPY Corporate High Yield Bonds respectively
- Correlation of 0.87 between the Bloomberg EUR Corporate High Yield Bonds and the Bloomberg JPY Corporate High Yield Bonds
- Correlation of 0.80 between Japan Gov Bonds & Japan Corporate bonds.

On the other hand, some assets have low correlations (≤ 0.3):

- US Government bonds have a very low correlation with Equities (MSCIs). Correlations ranging from -0.20 (Japan) to 0.08 (MSCI Latin America)
- US Corporate bonds have a very low correlation with MSCI China, India, Japan and Europe
- US High Yield corporate bonds only have a low correlation with US Government bonds (0.13)
- EUR Government bonds have a very low correlation with Equities (MSCIs). Correlations ranging from -0.27 (Japan) to -0.01 (MSCI India).
- EUR Corporate bonds have a low correlation with China, Russia, Japan ranging from 0.23 to 0.28.
- EUR High Yield corporate bonds have no correlation with US Government bonds (0.00) and EUR Government bonds
- Japan Government bonds have a very low correlation with Equities (MSCIs). Correlations ranging from -0.27 (Japan) to -0.01 (Brazil). The bonds also have a very low correlation of 0.27 with EUR Corporate bonds.
- Japan Corporate bonds have a very low correlation with Equities (MSCIs). Correlations ranging from -0.22 (Japan) to -0.03 (Brazil). The bonds also have a very low correlation of 0.1 with US Corporate HY bonds.
- Japan HY Corporate bonds have a very low correlation with Government Bonds, respectively 0.18, 0.02, 0.01 for US, EUR and Japan

- The Livex index offers a very low correlation with each asset, from -0.25 with EUR Government bonds to 0.44 for the MSCI Asia Pacific. This shows that this asset can be used to diversify portfolios quite effectively.

Statistics	MSCI Asia Pacific	MSCI China	MSCI India	MSCI Russia	MSCI Brazil	MSCI South Africa	MSCI Latin America
Mean	0.48	0.85	1.31	0.99	0.91	0.86	0.69
Standard Deviation	4.66	7.11	6.46	9.13	10.34	4.75	7.98
Sharpe Ratio	0.1	0.12	0.2	0.11	0.09	0.18	0.09
Range	32.1	41.8	53.4	65.7	68.6	31.5	56.2
Minimum	-19.7	-22.9	-24.8	-35.3	-38.3	-16.5	-34.6
Maximum	12.4	18.9	28.7	30.4	30.3	14.9	21.6

Figure 13: Summary statistics for Developing countries

The highest monthly return is delivered by the MSCI India with an average monthly return of 1.31%, the lowest is delivered by the MSCI Asia Pacific with an average monthly return of 0.48%. The most volatile region is Brazil with a standard deviation of 10.34%. Brazil is the region with the highest range, with a maximum drawdown of -38.27% and a maximum up of 30.33%. I created a proxy for the Sharpe Ratio which is calculated as the mean return of the asset divided by its standard deviation. The goal of this proxy is to analyze which regions offer the best return adjusted for volatility. India is leading with a ratio of 0.2, quickly followed by South Africa with a ratio of 0.18. On the other side, Latin America, Brazil and Asia Pacific are the less interesting with ratios of 0.09, 0.09 and 0.10 respectively.

Statistics	MSCI Japan	MSCI Europe	MSCI Canada	MSCI USA
Mean	0.33	0.24	0.49	0.75
Standard Deviation	5.1	4.4	3.8	4.6
Sharpe Ratio	0.07	0.06	0.13	0.16
Range	33.7	28.5	28.6	30.4
Minimum	-21.1	-14.6	-17.1	-17.6
Maximum	12.7	13.8	11.6	12.8

Figure 14: Summary statistics for Developed countries

The highest monthly return is delivered by the MSCI USA with an average monthly return of 0.75%, the lowest is delivered by the MSCI Europe with an average monthly return of 0.24% which is mainly due to the burst of the Internet bubble. The most volatile region is Japan with a standard deviation of 5.05%. Japan is the region with the highest range, with a maximum drawdown of -21.06% and a maximum up of 12.66%. For the proxy of the Sharpe Ratio, the

USA is leading with a ratio of 0.16. On the other side, Europe is the less interesting with a ratio of 0.06.

Statistics	US Government Bond	US Corporate Bonds	US Corporate High-yield Bonds
Mean	0.35	0.46	0.65
Standard Deviation	1.1	1.7	2.7
Sharpe Ratio	0.35	0.28	0.25
Range	7.4	14.6	28.1
Minimum	-3.7	-7.8	-15.9
Maximum	3.7	6.8	12.1

Statistics	Europe Government Bond	Europe Corporate Bonds	Europe Corporate High-yield Bonds
Mean	0.35	0.34	0.66
Standard Deviation	1.1	1.1	3.1
Sharpe Ratio	0.32	0.31	0.21
Range	6.3	10.6	30.4
Minimum	-2.6	-6.9	-16.1
Maximum	3.7	3.7	14.3

Statistics	Japan Government Bond	Japan Corporate Bonds	Japan Corporate High-yield Bonds
Mean	0.13	0.09	0.55
Standard Deviation	0.6	0.3	2.7
Sharpe Ratio	0.22	0.29	0.21
Range	4.1	2.6	27.4
Minimum	-2.1	-1.4	-16.6
Maximum	2.0	1.2	10.7

Figure 15: Summary statistics for Fixed income

The highest monthly return is delivered by the EUR Corporate High Yield bonds with an average monthly return of 0.66%, the lowest is delivered by the Japan Corporate bonds with an average monthly return of 0.09%. The most volatile region is the EUR Corporate High Yield bonds with a standard deviation of 3.08%. The same region has the highest range, with a maximum drawdown of -16.08% and a maximum up of 14.34%. For the proxy of the Sharpe ratio, US Government bonds are leading with a ratio of 0.35. On the other side, EUR Corporate High Yield bonds and Japan Corporate High Yield bonds are the less interesting with ratios of 0.21.

Statistics	Liv-ex Fine Wine 100
Mean	0.63
Standard Deviation	3.7
Sharpe Ratio	0.17
Range	34.3
Minimum	-23.3
Maximum	11.1

Figure 16: Summary statistics for the Livex Index

The Livex Index has a monthly return of 0.63% with a standard deviation of 3.65%, a maximum drawdown of -23.28% and a maximum up of 11.05%. Its Sharpe Ratio's proxy is 0.17.

	MSCI AC Asia Pacific Index	MSCI China	MSCI India	MSCI Russia	MSCI Brazil	MSCI South Africa	MSCI Latin America	MSCI Japan	MSCI Europe	MSCI Canada	MSCI USA	US Gov Bond	US Corp Bonds	US Corp HY	Eur Gov Bond	Eur Corp Bonds	Eur Corp HY	Japan Gov Bonds	Japan Corp Bonds	Japan Corp HY	Livex	
MSCI AC Asia Pacific Index	1.00																					
MSCI China	0.81	1.00																				
MSCI India	0.66	0.45	1.00																			
MSCI Russia	0.68	0.50	0.43	1.00																		
MSCI Brazil	0.67	0.53	0.48	0.66	1.00																	
MSCI South Africa	0.61	0.48	0.39	0.45	0.50	1.00																
MSCI Latin America	0.74	0.57	0.56	0.71	0.97	0.56	1.00															
MSCI Japan	0.68	0.41	0.38	0.48	0.29	0.30	0.36	1.00														
MSCI Europe	0.73	0.48	0.53	0.61	0.46	0.51	0.55	0.69	1.00													
MSCI Canada	0.68	0.51	0.54	0.62	0.56	0.61	0.64	0.50	0.77	1.00												
MSCI USA	0.83	0.62	0.58	0.64	0.55	0.59	0.84	0.64	0.82	0.81	1.00											
US Gov Bond	0.14	0.10	0.22	0.04	0.24	0.18	0.24	-0.21	0.08	0.13	0.06	1.00										
US Corp Bonds	0.38	0.27	0.41	0.22	0.40	0.35	0.42	-0.01	0.33	0.38	0.31	0.87	1.00									
US Corp HY	0.77	0.58	0.57	0.65	0.67	0.55	0.73	0.47	0.72	0.72	0.76	0.97	0.83	1.00								
Eur Gov Bond	-0.04	-0.06	0.06	-0.17	0.03	0.08	0.02	-0.13	0.04	0.02	-0.07	0.64	0.56	0.11	1.00							
Eur Corp Bonds	0.46	0.32	0.46	0.28	0.41	0.41	0.45	0.21	0.49	0.47	0.43	0.58	0.69	0.63	0.80	1.00						
Eur Corp HY	0.70	0.50	0.57	0.57	0.51	0.51	0.60	0.51	0.75	0.65	0.68	0.99	0.88	0.72	0.90	0.80	1.00					
Japan Gov Bonds	-0.10	-0.11	0.02	-0.10	0.26	0.08	0.08	-0.14	-0.13	-0.03	-0.13	0.51	0.46	0.08	0.49	0.16	0.06	1.00				
Japan Corp Bonds	0.00	-0.06	0.11	-0.03	0.13	0.12	0.13	-0.20	-0.01	0.12	-0.03	0.53	0.48	0.21	0.47	0.23	0.75	0.09	1.00			
Japan Corp HY	0.77	0.57	0.58	0.68	0.70	0.51	0.77	0.47	0.73	0.71	0.74	0.99	0.83	0.97	0.16	0.73	0.90	0.09	0.25	1.00		
Livex	0.55	0.44	0.30	0.49	0.38	0.30	0.43	0.38	0.36	0.43	0.47	0.07	0.30	0.47	0.27	0.32	0.44	-0.15	-0.03	0.44	1.00	

Figure 17: Correlation Matrix of the Financial Assets over the period 2010-2021

There are a few high correlations (≥ 0.8) between financial assets:

- Correlation of 0.97 between the MSCI Brazil and the MSCI Latin America
- Correlation of 0.82 and 0.81 between the MSCI USA and the MSCI Europe and MSCI Canada respectively
- Correlation of 0.88 and 0.97 between the Bloomberg USA Corporate High Yield Bonds and the Bloomberg EUR Corporate High Yield Bonds and Bloomberg JPY Corporate High Yield Bonds respectively
- Correlation of 0.90 between the Bloomberg EUR Corporate High Yield Bonds and the Bloomberg JPY Corporate High Yield Bonds
- The MSCI Asia Pacific is highly correlated with the MSCI China (0.81) and the MSCI USA (0.83)

On the other hand, some assets have low correlations (≤ 0.3):

- MSCI Japan has a low correlation of 0.29 with the MSCI Brazil and 0.30 with the MSCI South Africa
- US Government bonds have a very low correlation with Equities (MSCIs). Correlations ranging from -0.21 (Japan) to 0.24 (MSCI Latin America & Brazil).
- US Corporate bonds have a very low correlation with MSCI China, Russia and Japan.
- EUR Government bonds have a very low correlation with Equities (MSCIs). Correlations ranging from -0.17 (Russia) to 0.08 (MSCI South Africa).
- EUR Corporate bonds have a low correlation with Russia and Japan with 0.28 and 0.21 respectively.

- EUR High Yield corporate bonds have a small correlation with US Government bonds (0.29) and EUR Government bonds (0.22).
- Japan Government bonds have a very low correlation with Equities (MSCIs). Correlations ranging from -0.34 (Japan) to 0.10 (Brazil). The bonds also have a very low correlation of 0.06 with EUR High Yield Corporate bonds and 0.08 with US High Yield Corporate bonds.
- Japan Corporate bonds have a very low correlation with Equities (MSCIs). Correlations ranging from -0.20 (Japan) to 0.13 (Brazil). The bonds also have a very low correlation of 0.21 with US High Yield Corporate bonds and 0.23 with EUR High Yield Corporate Bonds.
- Japan HY Corporate bonds have a very low correlation with Government Bonds, respectively 0.16 and 0.25 for EUR and Japan
- The Livex index offers a very low correlation with each asset, from -0.27 with EUR Government bonds to 0.55 for the MSCI Asia Pacific. This shows that this asset can be used to diversify portfolios quite effectively.

Statistics	MSCI Asia Pacific	MSCI China	MSCI India	MSCI Russia	MSCI Brazil	MSCI South Africa	MSCI Latin America
Mean	0.41	0.35	0.86	0.28	-0.19	0.60	-0.17
Standard Deviation	4.1	5.8	4.9	7.9	9.5	3.9	7.5
Sharpe Ratio	0.1	0.06	0.18	0.04	-0.02	0.15	-0.02
Range	22.2	33.9	37.1	46.8	68.6	29.9	56.2
Minimum	-12.1	-17.3	-21.8	-23.9	-38.3	-14.9	-34.6
Maximum	10.2	16.6	15.3	22.8	30.3	14.9	21.6

Figure 18: Summary statistics for Developing countries

The highest monthly return is delivered by the MSCI India with an average monthly return of 0.86%, the lowest is delivered by the MSCI Brazil with an average monthly return of -0.19%. The most volatile region is Brazil with a standard deviation of 9.48%. Brazil is the region with the highest range, with a maximum drawdown of -38.27% and a maximum up of 30.33%. For the Sharpe ratio proxy, India is leading with a ratio of 0.18, quickly followed by South Africa with a ratio of 0.15. On the other hand, Latin America and Brazil are the least interesting with ratios of -0.02.

Statistics	MSCI Japan	MSCI Europe	MSCI Canada	MSCI USA
Mean	0.65	0.49	0.45	1.14
Standard Deviation	4.8	3.9	3.3	4.1
Sharpe Ratio	0.14	0.13	0.13	0.28
Range	23.7	28.5	27.4	25.1
Minimum	-10.9	-14.6	-17.1	-12.3
Maximum	12.7	13.8	10.4	12.8

Figure 19: Summary statistics for Developed countries

The highest monthly return is delivered by the MSCI USA with an average monthly return of 1.14%, the lowest is delivered by the MSCI Canada with an average monthly return of 0.45%. The most volatile region is Japan with a standard deviation of 4.8%. Japan is the region with the highest range, with a maximum drawdown of -11% and a maximum up of 12.66%. For the proxy of the Sharpe Ratio, the USA is leading with a ratio of 0.28. On the other hand, Europe is the least interesting with a ratio of 0.13.

Statistics	US Government Bond	US Corporate Bonds	US Corporate High-yield Bonds
Mean	0.28	0.44	0.61
Standard Deviation	0.9	1.4	1.9
Sharpe Ratio	0.31	0.31	0.31
Range	5.9	12.3	17.5
Minimum	-3.1	-7.1	-11.5
Maximum	2.9	5.2	5.9

Statistics	Europe Government Bond	Europe Corporate Bonds	Europe Corporate High-yield Bonds
Mean	0.29	0.30	0.60
Standard Deviation	1.2	1.1	2.3
Sharpe Ratio	0.26	0.27	0.27
Range	6.2	10.6	20.3
Minimum	-2.6	-6.9	-13.6
Maximum	3.7	3.7	6.7

Statistics	Japan Government Bond	Japan Corporate Bonds	Japan Corporate High-yield Bonds
Mean	0.14	0.08	0.53
Standard Deviation	0.6	0.2	2.1
Sharpe Ratio	0.23	0.34	0.25
Range	3.9	1.9	19.7
Minimum	-1.9	-1.3	-13.6
Maximum	2.0	0.7	6.1

Figure 20: Summary statistics for Fixed income

The highest monthly return is delivered by the EUR Corporate High Yield bonds with an average monthly return of 0.61%, the lowest is delivered by the Japan Corporate bonds with an average monthly return of 0.08%. The most volatile region is the EUR Corporate High Yield bonds with a standard deviation of 2.27%. The same region has the highest range, with a maximum drawdown of -13.60% and a maximum up of 6.7%. For the proxy of the Sharpe ratio, Japan Corporate bonds are leading with a ratio of 0.34. On the other hand, Japan Government bonds are the least interesting with a ratio of 0.23.

Statistics	Liv-ex Fine Wine 100
Mean	0.26
Standard Deviation	2.9
Sharpe Ratio	0.09
Range	17.4
Minimum	-9.9
Maximum	7.4

Figure 21: Summary statistics for the Livex Index

The Livex Index has a monthly return of 0.26% with a standard deviation of 2.9%, a maximum drawdown of -9.96%, and a maximum up of 7.4%. Its Sharpe Ratio's proxy is 0.09.

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Portfolio 1 - Developed Return Variance 0,25 18,53 0,3 16,32 0,4 14,03 0,5 14,21 0,6 15,78 0,7 19,08 0,75 21,52	Portfolio 8 - Developed + Livex Return Variance 0,25 18,52 0,3 15,28 0,4 11,09 0,5 9,49 0,6 9,79 0,7 12,19 0,75 21,49	Portfolio 2 - Developed + Developing Return Variance 0,25 18,53 0,3 16,32 0,4 14,02 0,5 13,47 0,6 13,87 0,7 14,9 0,75 15,59 0,9 18,44	Portfolio 11 - Developed + Developing + Livex Return Variance 0,25 18,53 0,3 15,28 0,4 11,09 0,5 9,47 0,6 9,2 0,7 9,71 0,75 10,16 1 17,59
Portfolio 3 - Developed + FI Return Variance 0,25 0,3 0,3 0,44 0,4 0,84 0,5 1,96 0,6 4,79 0,7 11,29 0,75 21,49	Portfolio 9 - Developed + FI + Livex Return Variance 0,25 0,27 0,3 0,4 0,4 0,74 0,5 1,68 0,6 4,77 0,7 11,02 0,75 21,49	Portfolio 4 - Developed + Developing + FI Return Variance 0,25 0,29 0,3 0,43 0,4 0,82 0,5 1,51 0,6 3,02 0,7 5,41 0,75 6,94	Portfolio 10 - Developed + Developing + FI + Livex Return Variance 0,25 0,27 0,3 0,39 0,4 0,73 0,5 1,34 0,6 2,75 0,7 5,04 0,75 6,52
Portfolio 5 - Developing + FI Return Variance 0,25 0,3 0,3 0,46 0,4 0,82 0,5 1,51 0,6 3,03 0,7 5,41 0,75 6,94 1 18,02	Portfolio 13 - Developing + FI + Livex Return Variance 0,25 0,27 0,3 0,41 0,4 0,73 0,5 1,34 0,6 2,75 0,7 5,04 0,75 6,52	Portfolio 6 - Developing Return Variance 0,25 0,3 0,4 0,5 21,13 0,6 18,61 0,7 18,35 0,75 18,72 1 22,65	Portfolio 12 - Developing + Livex Return Variance 0,25 0,3 0,4 0,5 18,91 0,6 11,21 0,7 10,18 0,75 10,36 1 17,59
Portfolio 7 - FI Return Variance 0,15 0,13 0,25 0,31 0,3 0,46 0,4 0,86 0,5 1,99 0,6 4,82 0,75 /	Portfolio 14 - FI + Livex Return Variance 0,15 0,12 0,25 0,28 0,3 0,4 0,4 0,75 0,5 1,69 0,6 4,28 0,75 /		

Figure 22: Portfolios' results constructed using the Markowitz Framework and Data from 2001-2021.

	Nifty 50	MSCI South Africa	MSCI Japan	MSCI Europe	MSCI Canada	MSCI USA	Livex
0,25%	0%	0%	4%	95%	0%	0%	1%
0,40%	0%	0%	6%	55%	1%	0%	38%
0,50%	0%	3%	4%	25%	20%	0%	48%
0,60%	0%	17%	2%	10%	19%	0%	52%
0,75%	7%	26%	0%	0%	0%	12%	55%

Figure 23: Portfolio weights for the portfolio composed of Equities from Developed & Developing countries.

	MSCI USA	US Gov Bond	US Corp HY	Eur Gov Bond	Japan Gov Bonds	Japan Corp Bonds	Livex
0,25%	2%	14%	4%	23%	0%	52%	5%
0,40%	4%	27%	8%	45%	7%	0%	9%
0,50%	3%	0%	31%	51%	0%	0%	15%
0,60%	5%	0%	74%	19%	0%	0%	0%
0,75%	100%	0%	0%	0%	0%	0%	0%

Figure 24: Portfolio weights for the portfolio composed of Equities from Developed countries and Fixed income.

	Nifty 50	MSCI South Africa	US Gov Bond	US Corp HY	Eur Gov Bond	Japan Gov Bonds	Japan Corp Bonds	Livex
0,25%	1%	1%	12%	4%	22%	0%	55%	5%
0,40%	2%	2%	23%	8%	43%	13%	0%	9%
0,50%	7%	3%	14%	11%	53%	0%	0%	12%
0,60%	15%	5%	0%	14%	52%	0%	0%	15%
0,75%	28%	7%	0%	16%	31%	0%	0%	18%

Figure 25: Portfolio weights for the portfolio composed of Equities from Developing countries and Fixed income.

	MSCI AC Asia Pacific Index	MSCI China	Nifty 50	MSCI Russia	MSCI Brazil	MSCI South Africa	MSCI Latin America	Livex
0,25%								
0,40%								
0,50%	89%	0%	0%	0%	0%	0%	0%	11%
0,60%	32%	0%	0%	0%	0%	6%	0%	62%
0,75%	0%	0%	7%	0%	0%	31%	0%	62%

Figure 26: Portfolio weights for the portfolio composed of Equities from Developing countries.

	US Gov Bond	US Corp HY	Eur Gov Bond	Japan Gov Bonds	Japan Corp Bonds	Livex
0,25%	12%	6%	24%	0%	52%	5%
0,40%	24%	13%	46%	8%	0%	10%
0,50%	0%	35%	50%	0%	0%	15%
0,60%	0%	63%	16%	0%	0%	21%
0,75%						

Figure 27: Portfolio weights for the portfolio composed of Fixed income.

Figure 28 displays 14 small tables, each representing a different portfolio configuration. Each table shows the Return and Variance for various weightings (0.25, 0.3, 0.4, 0.5, 0.6, 0.7, 0.75) for a specific portfolio. The portfolios are:

- Portfolio 1 - Developed
- Portfolio 2 - Developed + Developing
- Portfolio 3 - Developed + FI
- Portfolio 4 - Developed + Developing + FI
- Portfolio 5 - Developing + FI
- Portfolio 6 - Developing
- Portfolio 7 - FI
- Portfolio 8 - Developed + Livex
- Portfolio 9 - Developed + FI + Livex
- Portfolio 10 - Developed + Developing + FI + Livex
- Portfolio 11 - Developed + Developing + Livex
- Portfolio 12 - Developing + Livex
- Portfolio 13 - Developing + FI + Livex
- Portfolio 14 - FI + Livex

Figure 28: Portfolios' results constructed using the Markowitz Framework and Data from 2010-2021.

	Nifty 50	MSCI South Africa	MSCI Latin America	MSCI Japan	MSCI Europe	MSCI Canada	MSCI USA	Livex
0,25%	0%	0%	8%	0%	0%	10%	0%	82%
0,40%	4%	16%	0%	4%	3%	20%	0%	53%
0,50%	6%	16%	0%	4%	0%	12%	13%	49%
0,60%	7%	15%	0%	2%	0%	3%	27%	46%
0,75%	8%	11%	0%	0%	0%	0%	46%	35%

Figure 29: Portfolio weights for the portfolio composed of Equities from Developed and Developing countries.

	MSCI Japan	MSCI USA	US Gov Bond	US Corp Bonds	US Corp HY	Eur Gov Bond	Japan Gov Bonds	Japan Corp Bonds	Livex
0,25%	1%	8%	22%	0%	1%	11%	11%	45%	0%
0,40%	1%	14%	35%	0%	5%	26%	18%	0%	0%
0,50%	0%	20%	25%	7%	8%	39%	0%	0%	0%
0,60%	0%	30%	0%	33%	1%	36%	0%	0%	0%
0,75%	0%	46%	0%	45%	0%	9%	0%	0%	0%

Figure 30: Portfolio weights for the portfolio composed of Equities from Developed countries and Fixed income.

	Nifty 50	US Gov Bond	US Corp Bonds	US Corp HY	Eur Gov Bond	Japan Gov Bonds	Japan Corp Bonds	Livex
0,25%	0%	14%	0%	19%	16%	7%	43%	1%
0,40%	0%	22%	0%	37%	34%	7%	0%	0%
0,50%	2%	0%	9%	56%	32%	0%	0%	0%
0,60%	6%	0%	16%	78%	0%	0%	0%	0%
0,75%	56%	0%	0%	44%	0%	0%	0%	0%

Figure 31: Portfolio weights for the portfolio composed of Equities from Developing countries and Fixed income.

	Nifty 50	MSCI South Africa	MSCI Latin America	Livex
0,25%	0%	4%	6%	89%
0,40%	9%	25%	0%	66%
0,50%	25%	27%	0%	48%
0,60%	40%	29%	0%	31%
0,75%	64%	31%	0%	4%

Figure 32: Portfolio weights for the portfolio composed of Equities from Developing countries.

	US Gov Bond	US Corp Bonds	US Corp HY	Eur Gov Bond	Japan Gov Bonds	Japan Corp Bonds	Livex
0,25%	13%	0%	19%	17%	7%	43%	1%
0,40%	22%	0%	37%	34%	6%	0%	0%
0,50%	0%	11%	59%	30%	0%	0%	0%
0,60%	0%	7%	93%	0%	0%	0%	0%
0,75%							

Figure 33: Portfolio weights for the portfolio composed of Fixed income.



Figure 34: Portfolios' results using the LPM model and data from 2001 to 2021.

	MSCI AC Asia Pacific Index	Nifty 50	MSCI Brazil	MSCI Japan	MSCI Europe	MSCI Canada	MSCI USA	Livex
0,25%	0%	0%	0%	9%	91%	0%	0%	0%
0,40%	4%	0%	0%	21%	39%	12%	4%	20%
0,50%	0%	0%	0%	6%	37%	0%	25%	32%
0,60%	3%	5%	5%	6%	22%	1%	25%	32%
0,75%	3%	6%	8%	3%	1%	1%	56%	21%

Figure 35: Portfolio weights for the portfolio composed of Equities from Developed & Developing countries.

	MSCI Canada	MSCI USA	US Gov Bond	US Corp Bonds	US Corp HY	Eur Gov Bond	Eur Corp HY	Japan Corp Bonds	Japan Corp HY	Livex
0,25%	0%	2%	15%	0%	4%	20%	0%	54%	0%	5%
0,40%	4%	3%	23%	2%	6%	37%	4%	10%	3%	8%
0,50%	5%	5%	24%	2%	14%	20%	6%	0%	4%	19%
0,60%	5%	7%	0%	3%	24%	10%	9%	0%	4%	38%
0,75%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%

Figure 36: Portfolio weights for the portfolio composed of Equities from Developed countries and Fixed income.

	MSCI AC Asia Pacific Index	Nifty 50	MSCI Russia	MSCI South Africa	US Gov Bond	US Corp HY	Japan Gov Bonds	Japan Corp Bonds	Japan Corp HY	Livex
0,25%	0%	3%	0%	3%	18%	7%	19%	50%	0%	0%
0,40%	2%	4%	3%	4%	25%	12%	22%	20%	1%	8%
0,50%	2%	6%	3%	5%	40%	16%	9%	9%	1%	10%
0,60%	2%	13%	2%	13%	20%	12%	11%	10%	1%	17%
0,75%	0%	26%	4%	19%	11%	13%	9%	8%	0%	10%

Figure 37: Portfolio weights for the portfolio composed of Equities from Developing countries and Fixed income.

	MSCI AC Pacific Index	MSCI Asia China	Nifty 50	MSCI Russia	MSCI Brazil	MSCI South Africa	MSCI Latin America	Livex
0,25%								
0,40%								
0,50%	89%	0%	0%	0%	0%	0%	0%	11%
0,60%	70%	3%	6%	4%	3%	3%	1%	11%
0,75%	44%	3%	20%	6%	4%	4%	2%	17%

Figure 38: Portfolio weights for the portfolio composed of Equities from Developing countries.

	US Gov Bond	US Corp HY	Eur Gov Bond	Japan Corp Bonds	Livex
0,25%	22%	0%	40%	39%	0%
0,40%	24%	0%	59%	0%	17%
0,50%	20%	50%	16%	8%	6%
0,60%	6%	77%	6%	3%	9%
0,75%					

Figure 39: Portfolio weights for the portfolio composed of Fixed income.

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Wine	Vintage	Region
Chateau Angelus Premier Grand Cru Classe A, Saint-Emilion Grand Cru	2016	Bordeaux
Chateau Beausejour Duffau-Lagarrosse Premier Grand Cru Classe B, Saint-Emilion Grand Cru	2016	Bordeaux
Chateau Beychevelle 4eme Cru Classe, Saint-Julien	2018	Bordeaux
Chateau Cheval Blanc Premier Grand Cru Classe A, Saint-Emilion Grand Cru	2018	Bordeaux
Chateau Cheval Blanc Premier Grand Cru Classe A, Saint-Emilion Grand Cru	2015	Bordeaux
Chateau Cheval Blanc Premier Grand Cru Classe A, Saint-Emilion Grand Cru	2010	Bordeaux
Chateau Figeac Premier Grand Cru Classe B, Saint-Emilion Grand Cru	2015	Bordeaux
Chateau Haut-Brion Premier Cru Classe, Pessac-Leognan	2018	Bordeaux
Chateau Haut-Brion Premier Cru Classe, Pessac-Leognan	2016	Bordeaux
Chateau Haut-Brion Premier Cru Classe, Pessac-Leognan	2009	Bordeaux
Chateau Haut-Brion Premier Cru Classe, Pessac-Leognan	2005	Bordeaux
Chateau La Mission Haut-Brion Cru Classe, Pessac-Leognan	2009	Bordeaux
Chateau La Mission Haut-Brion Cru Classe, Pessac-Leognan	2005	Bordeaux
Chateau Lafite Rothschild Premier Cru Classe, Pauillac	2018	Bordeaux
Chateau Lafite Rothschild Premier Cru Classe, Pauillac	2017	Bordeaux
Chateau Lafite Rothschild Premier Cru Classe, Pauillac	2016	Bordeaux
Chateau Lafite Rothschild Premier Cru Classe, Pauillac	2015	Bordeaux
Chateau Lafite Rothschild Premier Cru Classe, Pauillac	2010	Bordeaux
Chateau Lafite Rothschild Premier Cru Classe, Pauillac	2009	Bordeaux
Chateau Lafleur, Pomerol	2018	Bordeaux
Chateau Latour Premier Cru Classe, Pauillac	2005	Bordeaux
Chateau Latour Premier Cru Classe, Pauillac	2003	Bordeaux
Chateau Leoville Barton 2eme Cru Classe, Saint-Julien	2016	Bordeaux
Chateau Leoville Las Cases 2eme Cru Classe, Saint-Julien	2016	Bordeaux
Chateau Leoville Poyferre 2eme Cru Classe, Saint-Julien	2009	Bordeaux
Chateau Lynch-Bages 5eme Cru Classe, Pauillac	2010	Bordeaux
Chateau Margaux Premier Cru Classe, Margaux	2018	Bordeaux
Chateau Margaux Premier Cru Classe, Margaux	2016	Bordeaux
Chateau Margaux Premier Cru Classe, Margaux	2010	Bordeaux
Chateau Margaux Premier Cru Classe, Margaux	2005	Bordeaux
Chateau Montrose 2eme Cru Classe, Saint-Estephe	2010	Bordeaux
Chateau Mouton Rothschild Premier Cru Classe, Pauillac	2018	Bordeaux
Chateau Mouton Rothschild Premier Cru Classe, Pauillac	2016	Bordeaux
Chateau Mouton Rothschild Premier Cru Classe, Pauillac	2009	Bordeaux
Chateau Mouton Rothschild Premier Cru Classe, Pauillac	2008	Bordeaux
Chateau Mouton Rothschild Premier Cru Classe, Pauillac	2000	Bordeaux
Chateau Palmer 3eme Cru Classe, Margaux	2018	Bordeaux
Chateau Pavie Premier Grand Cru Classe A, Saint-Emilion Grand Cru	2017	Bordeaux
Chateau Pichon Baron 2eme Cru Classe, Pauillac	2018	Bordeaux
Chateau Pontet-Canet 5eme Cru Classe, Pauillac	2010	Bordeaux
Chateau Pontet-Canet 5eme Cru Classe, Pauillac	2009	Bordeaux
Chateau d'Yquem Premier Cru Superieur, Sauternes	2015	Bordeaux
Cos d'Estournel 2eme Cru Classe, Saint-Estephe	2016	Bordeaux
Ducru-Beaucaillou 2eme Cru Classe, Saint-Julien	2009	Bordeaux
Petrus, Pomerol	2016	Bordeaux
Petrus, Pomerol	2010	Bordeaux
Bouchard Pere et Fils, Montrachet Grand Cru	2018	Burgundy
Clos de Tart, Clos de Tart Grand Cru	2018	Burgundy
Domaine Armand Rousseau, Chambertin Grand Cru	2018	Burgundy
Domaine Armand Rousseau, Chambertin-Clos de Beze Grand Cru	2018	Burgundy
Domaine Comte Georges de Vogue, Bonnes Mares Grand Cru	2018	Burgundy
Domaine Comte Georges de Vogue, Musigny Grand Cru, Cuvee Vieilles Vignes	2018	Burgundy
Domaine Faiveley, Corton Grand Cru, Clos des Cortons Faiveley	2019	Burgundy
Domaine Leflaive, Bienvenues-Batard-Montrachet Grand Cru	2018	Burgundy
Domaine Ponsot, Clos de la Roche Grand Cru, Cuvee Vieilles Vignes	2018	Burgundy
Domaine de la Romanee-Conti, La Tache Grand Cru	2017	Burgundy
Domaine de la Romanee-Conti, Richebourg Grand Cru	2017	Burgundy
Domaine de la Romanee-Conti, Romanee-Conti Grand Cru	2017	Burgundy
Domaine des Lambrays, Clos des Lambrays Grand Cru	2018	Burgundy
Joseph Drouhin, Montrachet Grand Cru, Marquis de Laguiche	2018	Burgundy
Robert Groffier, Chambolle-Musigny Premier Cru, Les Amoureuses	2018	Burgundy
Trapet Pere et Fils, Chambertin Grand Cru	2018	Burgundy
Dominus, Napa Valley	2018	California
Harlan Estate, Napa Valley	2017	California
Opus One, Napa Valley	2017	California
Screaming Eagle, Cabernet Sauvignon, Oakville	2018	California
Screaming Eagle, Cabernet Sauvignon, Oakville	2016	California
Vega Sicilia, Unico, Ribera del Duero	2010	Castilla y Leon
Bollinger, La Grande Annee	2012	Champagne
Dom Perignon	2010	Champagne
Dom Perignon	2008	Champagne
Krug, Vintage Brut	2008	Champagne
Louis Roederer, Cristal	2013	Champagne
Louis Roederer, Cristal Rose	2012	Champagne
Pol Roger, Sir Winston Churchill	2012	Champagne
Taittinger, Comtes de Champagne Blanc de Blancs	2008	Champagne
Taittinger, Comtes de Champagne Rose	2007	Champagne
Bartolo Mascarello, Barolo	2016	Piedmont
Comm. G.B. Burlotto, Barolo, Monvigliero	2016	Piedmont
Gaja, Barbaresco	2018	Piedmont
Giacomo Conterno, Barolo, Monfortino Riserva	2014	Piedmont
Giacomo Conterno, Barolo, Monfortino Riserva	2013	Piedmont
Chateau de Beaucastel Hommage a Jacques Perrin, Chateauf-neuf-du-Pape	2019	Rhone
Clos des Papes, Chateauf-neuf-du-Pape, Rouge	2019	Rhone
Domaine Jean Louis Chave, Hermitage, Rouge	2017	Rhone
E. Guigal, Cote Rotie, La Turque	2017	Rhone
E. Guigal, Cote Rotie, La Turque	2016	Rhone
Paul Jaboulet Aine, Hermitage, La Chapelle Rouge	2018	Rhone
Penfolds, Grange, South Australia	2016	South Australia
Masseto, Toscana	2017	Tuscany
Masseto, Toscana	2016	Tuscany
Ornellaia, Bolgheri	2018	Tuscany
Poggio di Sotto, Brunello di Montalcino	2016	Tuscany
Sassicaia, Tenuta San Guido, Bolgheri	2018	Tuscany
Sassicaia, Tenuta San Guido, Bolgheri	2017	Tuscany
Sassicaia, Tenuta San Guido, Bolgheri	2016	Tuscany
Solaia, Toscana	2018	Tuscany
Soldera Case Basse, 100% Sangiovese, Toscana	2016	Tuscany
Tignanello, Toscana	2018	Tuscany
Tignanello, Toscana	2016	Tuscany

Figure 40: Components of the Liv-ex Fine Wine 100