Can Alternative Investments Benefit Diversification?

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Abstract

The present study is designed to empirically test portfolio diversification benefits in alternative investments, such as private equity, venture capital, hedge funds, real assets, and private placement debt. This paper seeks to horizontally evaluate the risk performance in mixed portfolios consisting of traditional and alternative investments for a given level of return. We assess the individual of portfolio diversification benefits by decomposing traditional and alternative risk measures in optimal portfolios. Using quarterly data from Preqin, Liv-Ex, Eurekahedge, and Artprice database, this article investigates a comprehensive picture in alternative and traditional investments statistically. By analyzing the empirical result from alternative risk measures, we validate diversification benefits from alternative investments. We find that a portfolio with alternative assets tends to have a lower risk for a given level of return than the benchmark portfolio only consisting of stocks and bonds. Furthermore, incorporating alternative assets, such as hedge funds, private equity, and private placement debt, into traditional portfolios improves the benefits of diversification. Several assets, however, may not help investors improve the benefits of diversification, like the artwork investment and natural resources.

Introduction

Diversification plays an indispensable role in a portfolio's construction. It helps investors allocate capital in a way that is limiting the exposure to a single asset's risk, unsystematic risk. The rationale behind this risk management strategy is that a well-diversified portfolio consisting of low-correlated multifarious assets, such as ETFs (Exchange-traded fund), stocks, bonds, and CCE (cash and short-term cash equivalents), will generate a long-term higher return with mitigating unsystematic risk. In general, low-correlated assets in a portfolio is an efficient way to hedge again market volatility and provides a higher return in the long term.

Investors initially utilized low-correlated traditional assets, like stocks and bonds, to diversify unsystematic risk. However, the investor's confidence in capital markets decreased dramatically after the financial crisis of 2007 – 2008. Stock Market Confidence Indices[1] from the International Center for Finance in Yale school of management show that investor's confidence in the stock market from U.S. individual and institutional investors decreased more than 12% points from 2006 to 2009 on average. On the contrary, investors tend to focus on alternative investments to hedge the capital market risk because it has a low-correlated relationship with traditional financial assets and macroeconomic factors. McKinsey&Company reports that global alternative assets under management nearly doubled from $2.9 trillion to $6.2 trillion between 2005 to 2010 (Erzan, 2012). Institution investors and endowments have invested partial capital on alternative investments, such as real estate, hedge funds, and private equity. Endowments from Yale University achieved an extraordinary return in their portfolio over the past 30 years. The portfolio's assets managed by the Yale Investments Office has been reduced the dependence

[1] Reference Database: U.S. one-year confidence index: https://som.yale.edu/faculty-research-centers/centers-initiatives/international-center-for-finance/data/stock-market-confidence-indices/united-states-stock-market-confidence-indices

on domestic marketable securities by reallocating their capital to alternative investments. According to the portfolio in Yale Endowments[2], more than 50% of assets are alternative assets, such as venture capital, real estate, and natural resources.

An industry report provided by a financial service company in 2013, Baird, indicates that the performance of a portfolio consisting of alternative investments and traditional investments is better than a portfolio with only traditional investments (Baird Private Wealth Management, 2013). More specifically, a portfolio composed of alternative investments moves the Markowitz efficient frontier (a method to describe the relationship between risk and return) up and to the left. It implies that the portfolio with alternative investment is less risky than a portfolio consisting of traditional financial assets for a given level of return. Figure 1 is a time-series to show an index performance between artworks investments and stock investments. It is clear that the art market's performance is better than the S&P 500 from 2000 to 2016. Besides, other alternative assets, like private equity, significantly outperform traditional investments in the U.S market.

In academia, an increasing number of researchers also focus on the potential role of alternative investment in the portfolio's construction. Edwin and Susanne (2010) examine the performance and diversification of several alternative assets and find that portfolios that add alternative investments to a traditional global portfolio outperforms the basic portfolio with traditional financial assets (Fischer, 2010). This is the first literature to show the benefits of diversification of incorporating multiple alternative assets into a traditional portfolio, but it does not indicate which assets contributed to the performance. Andreas, Frode, and Tom in 2018 investigate the role of hedge funds in a traditional portfolio. They find that there is no significant

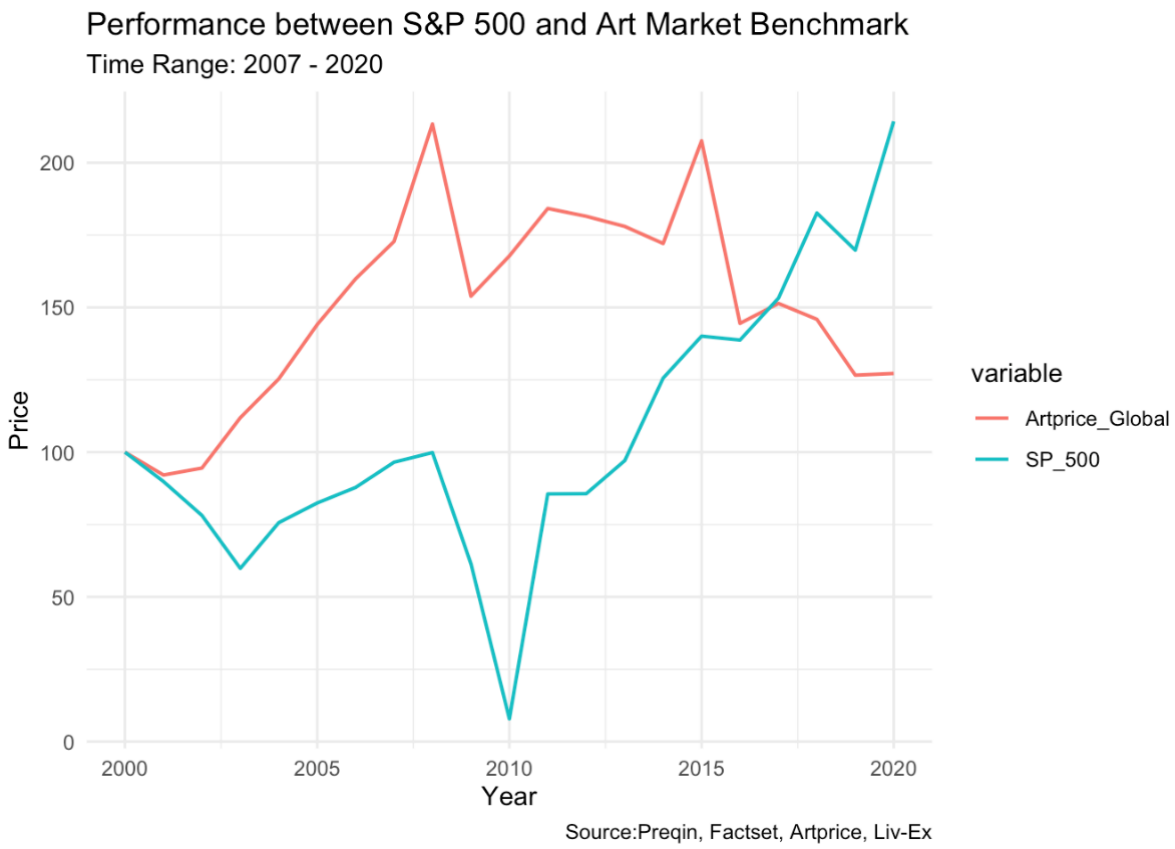
[2] The information is provided by Yale Investments Office: https://investments.yale.edu/

increase in performance when incorporating hedge funds into a well-diversified portfolio with traditional financial assets regardless of the portfolio allocation strategy and types of hedge funds they used (Mikkelsen, 2019). Even though their findings help investors identify hedge funds' potential roles in portfolio diversification, it does not examine individual effects of other possible alternative assets, like venture capital, private debt, and real assets and so on.

This study will fill gaps from previous studies by investigating the individual effect of alternative investments on the benefits of diversification from 2007 to 2020. It will decouple the universe of alternative investments by identifying the individual effect of the inclusion of more comprehensive alternative investment in a portfolio on risk-adjusted-performance. To show the benefit of diversification, the author is able to investigate various measures of risk among portfolios for a given level of target return, such as volatility, downside risk, drawdown effect, and value at risk (VaR), and conditional value at risk (CVaR). In general, there are five major categories in terms of alternative investment: Private Equity, Venture Capital, Real Assets, Hedge funds, and Private Placement Debt. The study will scrutinize each of them to validate the benefits of alternative investments in the portfolio’s diversification.

The rest of this article is organized as follows. The next section introduces the background of alternative assets and relevant literature on alternative investments. Section 3 presents the data used in this study and the descriptive statistics. The subsequent section described the empirical model. Section 5 will carefully examine the empirical result and findings. The last section will describe limitations and potential paths for future researchers.

Figure 1: Performance between S&P 500 and Art market (Quarterly data from 2007 to 2020. Red Line: Artworks investment, Blue line: S&P 500)



Background and Literature Review

An alternative investment is the opposite side of traditional financial investment. CAIA Association, Chartered Alternative Investment Analyst, defines "alternative investments as an investment that is not simply a long position in traditional investments" (Chambers, 2015). Alternative investments have a lesser regulation, a lower transparency, and higher fees as compared to traditional investments. Liquidity, in fact, is one of the most obvious difference between traditional and alternative investments. Liquidity is a measure to identify which assets can be quickly brought and sold in the market. Some measures, like current ratio, quick ratio, and cash ratio, can be used to calculate the liquidity for investors. Traditional investments, like stocks

and bonds, tend to have higher liquidity than alternative assets because it is easier for investors to trade assets in the secondary market. Obviously, cash is the most liquid asset. In empirical finance, there are five major categories in terms of alternative financial assets: private equity, venture capital, real assets, hedge fund, private placement debt.

Private equity is a type of alternative investment funds that buy and reconstruct non-public companies. Private equity funds' main goal is to reconstruct the acquired firms and resell them at a higher value, providing a higher return for investors. Private equity funds tend to reform firms by cutting operational costs, which generates higher profit in the short term. The return in the private equity fund is higher than in traditional investments, but the liquidity is relatively low. Venture capital also belongs to the subcategories of alternative investment. Venture capital funds are a type of investment that provided capital to startups, early-stage, and emerging companies that have demonstrated potential growth. Investors usually regard venture capital as a form of private equity, but their investment target is different, which explains that venture capital belongs to a separate category in alternative investments.

Moreover, the CAIA association defines real assets as a subcategory in alternative investments, such as precious coins, commodities, real estate, fine wine, artwork, watches, and natural resources. Real assets are tangible assets that have an intrinsic value due to their properties, but the liquidity in terms of real assets is lower than traditional financial assets because the market volume is relatively small. Each tangible asset has different markets to buy and sell relevant goods. The fine wine market has outperformed most stocks and ETFs, according to the data from the wine trading platform (Lix-Ev.com). The spread between the S&P 500 index and the fine wine benchmark index keeps increasing since 1988. The annualized returns in the fine wine market are about 13.6% over the past 15 years (Lix-Ev.com).

Furthermore, the common sense is that real assets are appropriate complementary for portfolio's construction since it has a low correlation with traditional financial assets and macroeconomic factors.

Hedge funds are alternative investment vehicles that use a variety of strategies to generate an active return for their accredited investor clients. Hedge funds are able to take advantage of sophisticated investment techniques, such as short selling, leverage, and financial derivatives, to distinguish them from regulated mutual funds. Common strategies in hedge funds are event-driven strategy, global macro strategy, long and short equity strategy, etc. In most cases, the cost of hedge funds is higher as compared to a traditional investment instrument.

The last section in alternative investments is private placement debt, which belongs to non-public bond investments. There are several advantages of investing in private placement debt, such as confidentiality and higher yield. A financial report from a business consultancy, Strategy Insights, indicates that the liquidity premium in investing private placement debt ranges between 25 – 45 basis points from 2003 to 2012 on average (Mendel, 2013). Namely, the return of investing in private placement debt is higher than public bonds.

Based on the previous introduction in alternative investments, it is obvious to understand why people in the real-life invest in alternative assets. Even though the liquidity in alternative investments is relatively lower than traditional investments due to limited markets, alternative assets tend to provide higher returns for investors as compared to traditional assets. For example, Investors might usually use the strategic weighted strategy to allocate their capital in alternative assets. Norges Bank Investment Management have used 70%/25%/5% ratio to invest in alternative and traditional assets due to attractive returns. In addition to investors, it still attracts an increasing number of researchers and scholars to investigate alternative investments

academically. There are several pieces of literature with respect to diversification and alternative investments. The fundamental milestone in empirical finance is the modern portfolio theory provided by Markowitz (1952). He studied the benefits of diversification in traditional investments by investigating a portfolio's return and risk. He utilizes geometry to visualize efficient portfolios consisting of two or three financial assets. Markowitz concludes that the adequacy of diversification should not depend solely on the number of different securities. General diversification should use various stocks from different industries because it is more likely for firms from a similar industry to do poorly than for firms in dissimilar industries (Markowitz, 1952). In other words, investors should invest their capital in securities with low covariance (various industries) among themselves, which may eliminate variance and increase return.

Markowitz (1952) explicitly indicates why diversification is important in traditional investments. Can alternative investments benefits diversification? There is some evidence that validates diversification from alternative investments. Edwin and Susanne (2010) integrate hedge funds, managed futures, real estate, private equities, and commodities into traditional portfolios consisting of stocks and bonds. They used two optimization strategies (Maximizing Sharpe Ratio and Minimizing Portfolio Variance) to obtain optimal weights for a portfolio composed of alternative investments and traditional investments. By comparing VaR (value at risk) and modified Sharpe ratio, they conclude that mixed portfolios with alternative investments and traditional investments outperform a portfolio only consisting of stocks and bonds (Fischer, 2010). In other words, it is appropriate and profitable for investors to add alternative investments into their traditional portfolios. Even though this study considers a collective effect in mixed portfolios, it does not examine an individual impact of single alternative assets on a portfolio.

Their findings, in other words, advised investors to incorporate alternative investments into their portfolios, but it does not display which alternative assets are valuable and practical to select.

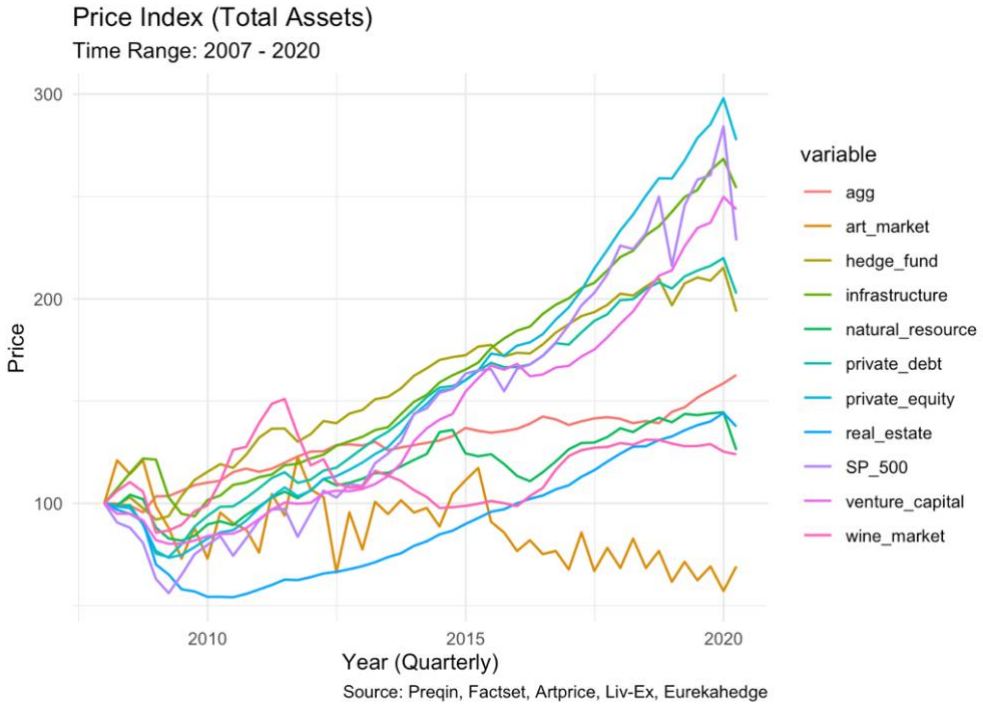
Andreas, Frode, and Tom (2018) investigate the benefits of diversification by incorporating various types of hedge funds into a traditional portfolio consisting of global stocks and bonds in order to validate individual effects of hedge funds in diversification. This literature's central question is to identify the possible role of hedge funds in a traditional financial portfolio. They initially construct nine portfolios that consist of stocks, bonds, and nine different hedge funds (the global hedge funds index, the equity hedge index, the event-driven index, the macro index, and the relative value index) by using an optimization strategy. The strategy they used is to maximize the Sharpe ratio, which is a ratio to compare the portfolio performance and the rate of return on a risk-free investment. They conclude that adding hedge funds in a portfolio shows no significant increase in performance, on average, when comparing a well-diversified portfolio as a benchmark, regardless of optimization strategies and types of hedge funds (Mikkelsen, 2019). In other words, the role of hedge funds in a portfolio may be unnecessary because normal diversification in stocks and bonds can still help investors achieve target performance. However, even though this literature investigates individual effects of hedge funds in diversification, it does not elaborate on the potential benefits of diversification from other alternative assets such as real assets, private equity, and private placement debt and so on.

Data and Descriptive Statistics

We use diverse datasets to investigate individual effects of diversification from alternative investments on mixed portfolios comprehensively. A mixed portfolio is defined as a combination between traditional and alternative assets. In terms of traditional investments, we

use the S&P 500 index as a benchmark in the stock market and iShares Core US Aggregate Bond EFT (AGG) in the bond market. Alternative investment in this article can be decomposed into five main categories: private equity, venture capital, real assets, hedge funds, and private placement debt. Figure 2 provides a time-series graph covering the performance in traditional and alternative investments from 2007 to 2020. The frequency of sample datasets is quarterly from December 2007 to March 2020 because investment holding periods in alternative assets is likely to be more extended than traditional investments. Preqin is a leading data vendor that provides financial data and information in alternative investments. We used Private Equity Quarterly Index, Venture Capital Quarterly Index, Real Estate Quarterly Index, Infrastructure Quarterly Index, Natural Resources Quarterly Index, Private Debt Quarterly Index from 2007 to 2020 in the Preqin database.

Figure 2: Price index from 2007 to 2020 (Quarterly data)



In terms of other possible real assets, we use an industry-leading benchmark, Liv-Ex Fine Wine 100, to represent the wine market. Liv-Ex Fine Wine 100 index sponsored by Liv-Ex, a global marketplace for the wine trade, represents the performance movement of 100 of the most sought-after fine wines on the financial market by tracking the price of the most traded wines. Art investment also plays an essential role in alternative investments because of its properties and intrinsic values. We collected an industry benchmark, Art Price Global Index, to define the artwork market from the Artprice database. This index is to monitor and quantify the art market's value accretion by focusing on its most stable elements, which is a stable and effective index to represent the artwork market. The last category in alternative investment is hedge funds. Rather than investigating different types of hedge funds, this study focuses on the overall performance in the hedge funds industry in North America. We used a North American hedge funds index from the Eurekahedge database to define the average market performance in hedge funds. Table 1 provides a database summary of the assets we used in this study.

Table 1: Data source summary in traditional and alternative investments

<table>
<tr><th colspan="4">Investment Universe</th></tr>
<tr><th colspan="2">Traditional Investments</th><th colspan="2">Alternative Investments</th></tr>
<tr><td>Assets</td><td>Database</td><td>Assets</td><td>Database</td></tr>
<tr><td>Stocks</td><td>S&P 500 index</td><td>Private Equity</td><td rowspan="6">Preqin Quarterly Index</td></tr>
<tr><td>Bonds</td><td>AGG</td><td>Venture Capital</td></tr>
<tr><td rowspan="4"></td><td rowspan="4"></td><td>Real Estate</td></tr>
<tr><td>Infrastructure</td></tr>
<tr><td>Natural Resources</td></tr>
<tr><td>Private Debt</td></tr>
<tr><td></td><td></td><td>Fine Wine</td><td>Liv-Ex Fine Wine 100</td></tr>
<tr><td></td><td></td><td>Global Artworks</td><td>Art Price Global Index</td></tr>
<tr><td></td><td></td><td>Hedge Funds</td><td>Eurekahedge North American Hedge Fund</td></tr>
</table>

The descriptive statistics for different asset classes are presented in Table 2. Private equity has the highest average return, while natural resource has the lowest average return. A higher standard deviation, in general, means higher risk in a certain asset. In terms of average risk performance, it is clear that the standard deviation in private equity is about 4%, but the bond market has approximately 1.95% that is the lowest value in the market. It means that the bond is the least risky asset as expected. The stock market has larger volatility than most assets, including alternative assets. By comparing risk and return, private equity is risker than the bond even though it has a higher return. The artworks investment has the highest standard deviation about 18.21%, which means that the art market is the most volatile asset among all investments. The higher range in return is another potential indicator to show the volatility in an asset. The range in the art investment is about 80%, which is the most volatile asset among investments. Table 3 provides the percentile of assets' return from 2007 to 2020. The artwork market has the largest loss and gains in quarterly returns. In the 1% percentile, the artwork market has -29.37% return loss, but it has 41% return gains in the 99% percentile, which emphasizes that the artwork is the most unstable asset in alternative investments. From the statistical distribution, the artwork market has a relative balance in distribution since it has a big swing in the left and a big swing in the right. The unusual point is that the bond market, stock market, wine, and natural resource has a negative return in the 25% percentile, but only the artwork market has a negative loss in the 50% percentile.

The third moment suggests that normal distribution in return tends to have a zero skewness. Real estate has the smallest skewness about -3.31, which means that it has a longer or fatter tail on the left side of the distribution. A negative skewness implies that an investor may experience frequent small gains and a few large losses. The art investment is the only asset with

positive skewness, which means that an investment may expect frequent small losses and a few extreme gains. The fourth moment, kurtosis, is to determine the heaviness of the return distribution tails. In descriptive statistics, the real estate has a higher kurtosis which means that it may have a high probability of extremely large and extremely small returns when investing in the real estate market. The art investment has a platykurtic distribution (a negative excess kurtosis). It means that investors could have a lower chance of expecting an extreme return. In terms of normality, the S&P 500 index and the fine wine market have a normal distribution in return, but the rest of the assets, such as AGG, private equity, and venture capital, do have a nonnormal distribution. Table 2 describes whether each asset's return is normally distributed from a statistical perspective by using Jarque-Bera test overall.

Table 2: Descriptive statistics of the quarterly returns in traditional assets and alternative assets from 2007 to 2020 (Quarterly data)

Asset	Mean	Median	SD	Range	Mini	Maxi	Kurtosis	Skewness	Normality
AGG	1.02%	1.00%	1.95%	11.43%	-3.30%	8.13%	2.85	0.58	No
S&P 500	2.08%	3.93%	8.62%	37.80%	-21.93%	15.86%	0.72	-0.93	Yes
Private Equity	2.19%	3.30%	4.00%	21.98%	-14.97%	7.01%	6.80	-2.32	No
Private Debt	1.54%	2.49%	4.23%	26.50%	-15.75%	10.75%	6.06	-1.82	No
Venture Capital	1.89%	2.09%	3.35%	19.70%	-10.58%	9.12%	3.14	-1.12	No
Global Artworks	0.82%	-5.51%	18.21%	80.08%	-35.77%	44.32%	-0.50	0.49	No
Fine Wine	0.61%	0.69%	5.79%	32.94%	-19.00%	13.94%	2.42	-0.73	Yes
Real Estate	0.77%	2.24%	4.69%	27.81%	-23.05%	4.76%	13.87	-3.31	No
Natural Resource	0.57%	1.67%	4.40%	22.25%	-13.63%	8.62%	2.55	-1.32	No
Hedge Funds	1.42%	2.11%	3.59%	20.52%	-9.96%	10.55%	2.04	-0.74	No
Infrastructure	1.99%	2.20%	3.63%	23.79%	-15.24%	8.55%	10.97	-2.62	No

Table 3: Percentile of the quarterly returns in traditional assets and alternative assets from 2007 to 2020 (Quarterly data)

Percentile	1%	5%	10%	25%	50%	75%	90%	95%	99%
AGG	-3.27%	-1.76%	-1.10%	-0.11%	1.00%	2.37%	2.74%	3.55%	6.13%
S&P 500	-20.81%	-13.74%	-11.05%	-0.64%	3.93%	6.65%	11.37%	13.64%	15.71%
Private Equity	-11.42%	-5.85%	-2.00%	1.28%	3.30%	4.38%	5.30%	5.55%	6.95%
Private Debt	-12.84%	-6.55%	-1.81%	0.45%	2.49%	3.70%	4.66%	5.46%	9.69%
Venture Capital	-7.95%	-3.52%	-2.24%	0.40%	2.09%	3.94%	5.07%	5.50%	8.38%
Global Artworks	-29.37%	-21.00%	-18.69%	-12.63%	-5.51%	15.85%	27.35%	30.72%	41.10%
Fine Wine	-15.41%	-10.63%	-4.42%	-1.40%	0.69%	3.17%	7.33%	8.80%	12.87%
Real Estate	-17.29%	-6.05%	-4.04%	0.16%	2.24%	3.00%	3.82%	4.09%	4.55%
Natural Resource	-13.23%	-7.48%	-4.07%	-1.39%	1.67%	2.97%	4.93%	5.43%	7.68%
Hedge Funds	-8.17%	-5.50%	-3.45%	0.03%	2.11%	3.25%	4.89%	6.24%	9.10%
Infrastructure	-11.66%	-3.74%	0.39%	1.41%	2.20%	3.36%	4.73%	6.67%	7.95%

Data visualization is an effective way for readers to see the performance in the asset's return. Figures 3 and 4 indicate that the art investment is the most volatile market in alternative investments because of the dramatic variation in time-series data. At the same time, the bond is the least risky asset in traditional investments compared to the stock market. A common aspect in all assets is that all investments experience a relatively huge loss in return from 2008 to 2009. It means that investors in the 2008 financial crisis not only face a considerable loss in the real estate market but also a loss in other alternative and traditional investments. Figure 5 visualizes the correlation relationship between assets. A blue value represents that two assets have a higher positive correlation, while red color indicates a negative relationship among assets. Private equity has the highest correlation with private placement debt about 0.89. A higher correlation between assets means that both of them are likely moving in the same direction. The art investment tends to have a low correlation with other alternative and traditional investments, which is an appropriate way to hedge the risk in the capital market. The red color in the bond market shows that AGG tends to have a negative relationship with all assets. In general, we can

see that the stock market has a positive relationship with alternative investment, but the bond market has a reverse effect based on the correlation matrix. According to portfolio diversification, the best value in correlation among assets is -1 because it will minimize the portfolio's risk. The negative correlations, in other words, provide diversification benefits.

Figure 3: Quarterly Return in Alternative Investments from 2007 to 2020

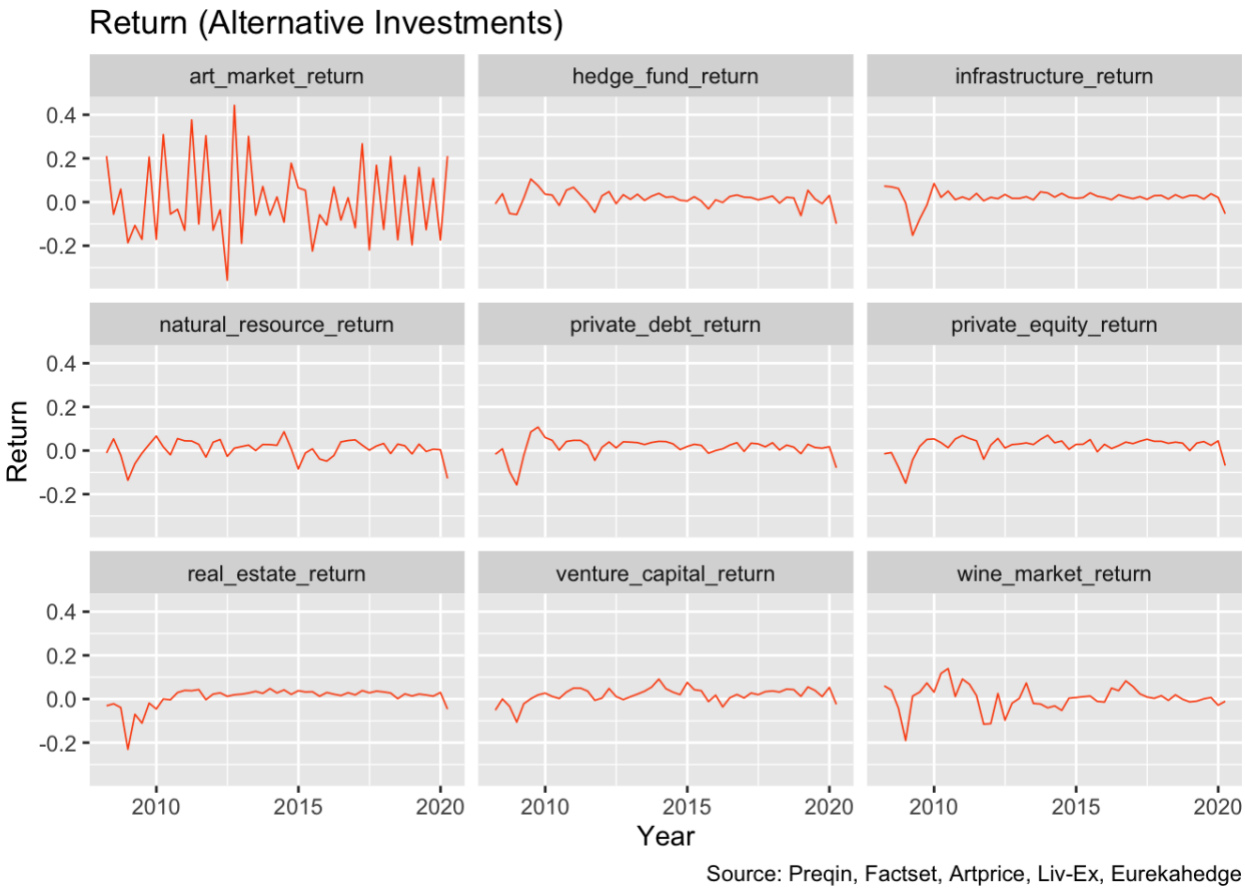


Figure 4: Quarterly Return in Traditional Investments from 2007 to 2020

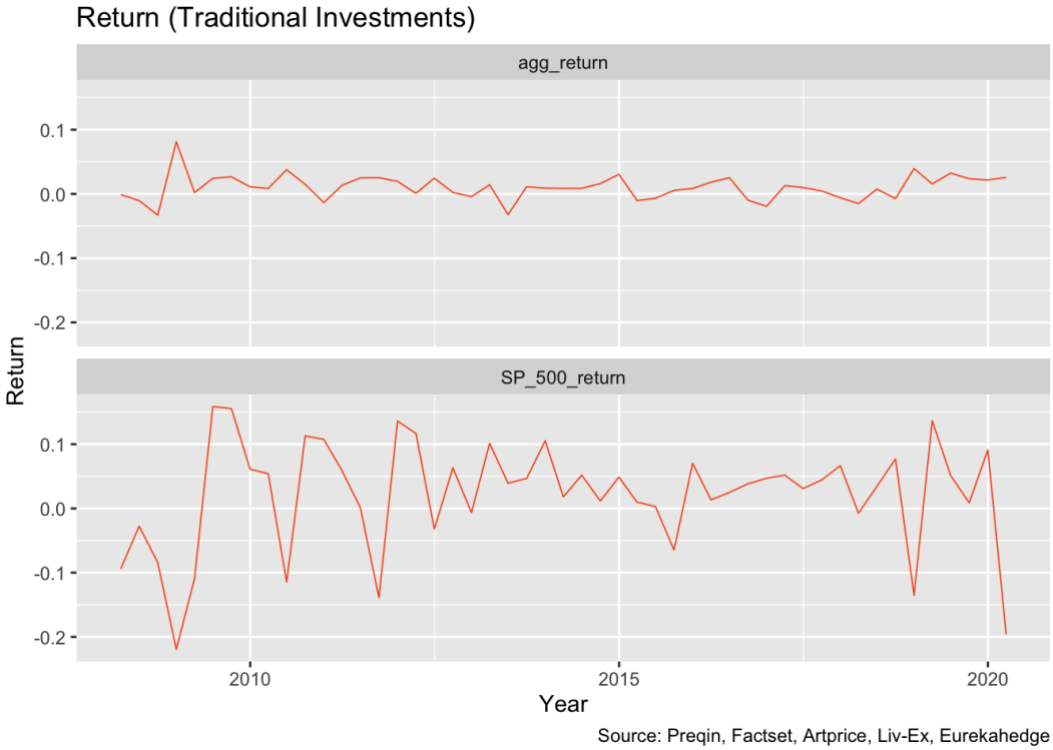
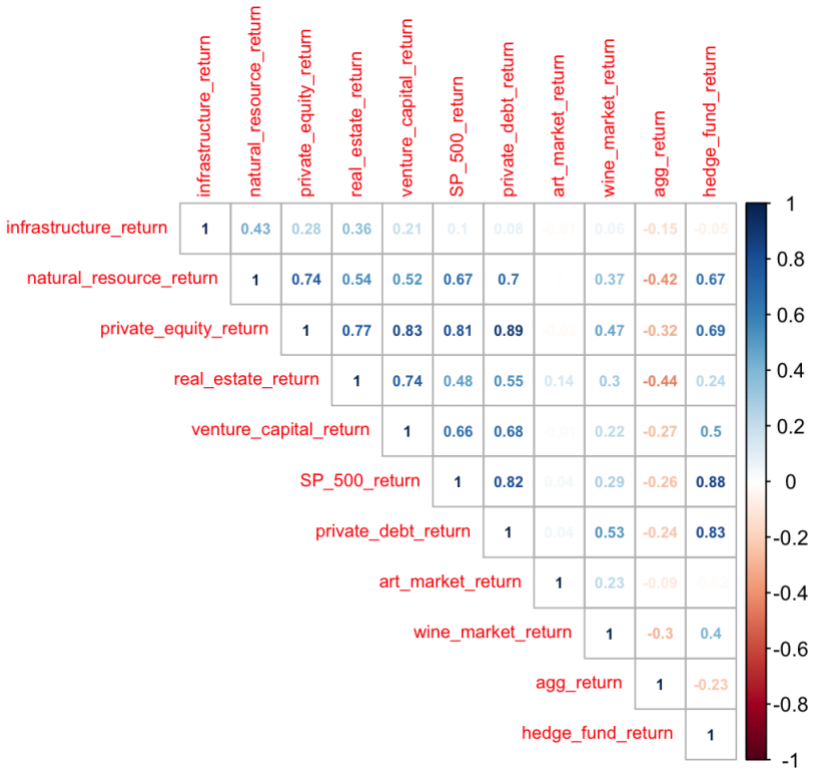


Figure 5: Correlation (numerical value) among Traditional and Alternative Investments



Methodology

In this section, we provide an explanation of allocation strategies and the performance measure among mixed portfolios with alternative investments. The main goal in our portfolio's construction is to reduce the risk by keeping the target return because we need to identify individual effects of diversification from alternative assets. More specifically, diversification means that a portfolio composed of different assets tend to produce higher long-term returns with mitigating the unsymmetric risk in individual assets. We are trying to analyze whether adding alternative assets in traditional portfolios only consisting of stocks and bonds benefits diversification? In other words, we would answer whether adding alternative investment reduce the portfolio's risk (traditional and alternative risk measures) for a given level of return overall. We use the index values to calculate the return and risk of assets. Equation 1 presents a formula for calculating the simple net return of an asset. The numerator represents an asset's index value in the current period (t), and the denominator represents the index value in the previous period (t-1).

$$(1)\ Return\colon R_t = \frac{P_t}{P_{t-1}} - 1$$

$$P_t\colon price\ at\ t$$

$$P_{t-1}\colon price\ at\ t-1$$

Before introducing optimal portfolios, it is necessary for us to understand how investors in real-life construct mixed portfolios composed of alternative and traditional assets since we want to compare the ideal and actual situation. Investors might use the strategic weighted strategy to allocate their capital in various assets. For example, the allocation strategy in Norges

Bank Investment Management uses a 70%/25%/5% ratio to invest in the stock, bond, and real estate. Andreas, Frode, and Tom (2018) replace the 5% ratio in real estate to hedge funds to analyze the individual effect of hedge funds in portfolio performance. In this paper, we will use a similar ratio for stocks and bonds but replace 5% weight for each alternative asset. By doing so, we would simulate what mixed portfolios with alternative assets performs

The fundamental milestone in empirical finance is the modern portfolio theory provided by Markowitz (1952). The goal of modern portfolio theory is to help the risk-averse investment achieve a maximum tradeoff between return and risk. This study will utilize Maximizing the Sharpe Ratio Strategy in the benchmark portfolio only consisting of stocks and bonds to calculate the target return for alternative portfolios. Equation 2 presents the objective function and constraints for this optimization strategy. To be more specific, the objective function in the first optimization strategy is to maximize the Sharpe ratio. The Sharpe ratio is a ratio to compare the portfolio performance and the rate of return on a risk-free investment. It indicates how well the portfolio performs. Namely, the Sharpe ratio could tell investors how much excess return they could obtain for the extra volatility in portfolios. A higher Sharpe ratio means that the portfolio performance is better than risk-free investment. Variables indicates that investors tend to have a higher expected return of portfolios or lower standard variance of portfolios in order to obtain a higher Sharpe ratio. Besides, investors could usually use the yield from U.S Treasury bond to calculate risk-free rate. This study would use the U.S treasury bill rate provided by Fama-French data library to estimate the risk-free rate. In terms of other constraints, the total weight in portfolio should be one because we assume that investors would like to invest entire capital in the market. Even though it is possible to have short selling in

stocks and bonds, we require that the benchmark portfolio is long-only because we need to be consistent with alternative portfolios.

$$(2)\ Objective\ Function: Maximizing\ Sharpe\ Ratio = \frac{E(r_p) - r}{\sigma(r_p)}$$

$$Subject\ to:$$

$$E(r_{target}) = E(r_p) = \sum_{j=1}^{N} E(r_j) * x_j$$

$$r = risk\ free\ rate = 0.005625$$

$$\sigma(r_p) = \sqrt{\sum_{i=1}^{N}\sum_{j=1}^{N} x_i x_j \sigma_{ij}}$$

$$\sum_{j=1}^{N} x_j = 1$$

$$x_j \geq 0$$

$$E(r_p) = expected\ portfolio\ return$$

$$E(r_j) = expected\ return\ of\ an\ asset\ class$$

The previous strategy is to calculate the target return for portfolios composed of traditional and alternative assets. In terms of the allocation strategy in portfolios with alternative investments, we will use the optimization strategy (Minimizing Variance strategy) to construct nine alternative portfolios by targeting the given return from the benchmark portfolio, which allows us to compare mixed portfolios horizontally. This research aims to measure the benefit of diversification by comparing differences and similarities in terms of risk. Equation 3 presents the objective function and constraints in Minimizing Variance Strategy. The objective function in

the optimization equation is to minimize portfolios' variance for a target return. In terms of constraints, a portfolio's return should be equal to the target return driving from a benchmark portfolio, which allows us to measure the risk among alternative portfolios for a consistent level of return. In constructing alternative portfolios, we also assume that investors tend to invest entire capital. We don't allow the short selling in alternative investments because it is impossible to conduct this kind of trading strategy in some alternative assets, such as artworks, wine, and infrastructure. It implies that x_i is always positive.

$$(3)\ Objective\ Function: Minimizing\ Variance: \sigma(r_p) = \sqrt{\sum_{i=1}^{N}\sum_{j=1}^{N} x_i x_j \sigma_{ij}}$$

$$Subject\ to:$$

$$E(r_p) = \sum_{j=1}^{N} E(r_j) * x_j = E(r_{target})$$

$$\sum_{j=1}^{N} x_j = 1$$

$$x_j \geq 0$$

$$E(r_p) = expected\ portfolio\ return$$

$$E(r_j) = expected\ return\ of\ a\ single\ asset$$

$$E(r_{target}) = a\ target\ return$$

$$\sigma(r_p) = portfolio\ variance$$

$$\sigma_{ij} = covariance\ of\ two\ assets\ (i, j)$$

$$x_i\ or\ x_j = weights\ proportions$$

$$N = the\ number\ of\ assets$$

The purpose of an optimization strategy is to help investors find an optimal weight for each asset in a portfolio. After that, we could use optimal weights to conduct performance measure, especially portfolio's risk and return. There are totally three main assets consisting of traditional investments and alternative investments in an individual portfolio. The traditional investment is composed of the S&P 500 Index in the stock market and AGG in the bond market. We will use private equity, venture capital, private placement debt, hedge funds, and real assets to define alternative assets in terms of alternative investments. Since this study aims to identify the role of each alternative asset in traditional portfolios, we will construct nine portfolios consisting of three assets by running the Minimizing Variance Strategy. Equation 4 represents the risk and return of an individual portfolio. w_i represent the weight for i asset in one portfolio. The portfolio is composed of stocks, bonds, and the type of alternative investments so that we will have three weights for each of them. w_a represents the weight in stocks. w_b represents the weight of the bond. w_c is the weight for types of alternative investment. $E(R_i)$ will be the expected return of each asset by calculating its historical price. The second formula in Equation 4 is to measure the portfolio's risk. In empirical finance, investors have a tendency to use the portfolio's standard deviation as a measure of risk. σ_i^2 represents the individual asset's risk and ρ_{ij} represent the correlation between asset i and asset j.

(4) $Portfolio\ return$:

$$E(R_p) = w_a E(R_a) + w_b E(R_b) + w_c E(R_c)$$

$Portfolio\ risk$:

$$\sigma_p^2 = w_a^2\sigma_a^2 + w_b^2\sigma_b^2 + w_c^2\sigma_c^2 + 2w_a w_b \sigma_a \sigma_b \rho_{ab} + 2w_a w_c \sigma_a \sigma_c \rho_{ac} + 2w_b w_c \sigma_b \sigma_c \rho_{bc}$$

Portfolio's volatility is a usual way to describe risk, but it provides the average risk, which is not useful because investors care more about the downside risk. Therefore, we still need to use other alternative risk measures, such as semi-variance, VaR, CVaR and maximum drawdown, to analyze portfolios. Semi-variance is a way to measure the downside risk of investment portfolios which is better than average risk. It is measured by calculating the dispersion of observations that fall below the mean. Equation 5 is a mathematical formula to describe the semi-variance. Value at Risk (VaR) is an alternative risk measure in the financial industry. It measures the risk of loss for portfolio investments with a given probability. Conditional value at risk (CVaR) is calculated by considering a weighted average of the extreme losses in the tail of the distribution beyond the VaR cutoff point. In this study, we are going to assume that the portfolio's return is normally distributed. We will use a 1% level to calculate the normal VaR and CVaR. Equations 6 and 7 describe the value at risk and conditional value at risk mathematically (Favre and Galeano, 2002).

$$(5): semivariance = \frac{1}{n}\sum_{r_t<E}^{n}(E - r_t)^2$$

$$n = observations\ below\ the\ mean$$

$$r_t = the\ observed\ value$$

$$E = the\ average\ value\ in\ dataset$$

$$(6): VaR(r_j) = E(r_j) + z_\alpha * \sigma(r_j)$$

$$z_\alpha = quantile\ of\ the\ standard\ normal\ distribution$$

$$(7): CVaR = -(E(r_j) + \frac{\varphi(\sigma)}{\alpha} * \sigma(r_j))$$

$$\varphi(*) = density\ function\ of\ the\ standard\ normal\ distribution$$

Alternative risk measures are to analyze the risk in the overall portfolio, but it is hard to identify the specific contribution from alternative assets. Thus, we need to decompose risk since it could tell us where/how these assets impact risk, which would eventually answer whether adding alternative investments benefits diversification. This section will introduce methods to calculate the diversification benefits contributed by alternative investments by decomposing value at risk and volatility. Equation 8 is a casual way to calculate the risk benefits of alternative assets in terms of value at risk. There are two formal methods to identify the diversification benefits from alternative investment by decomposing the volatility since the volatility is additive. Equation 9 is a general way to calculate the marginal contribution at risk for a particular asset (i) to the portfolio variance (asset i, asset j, asset z). The numerator in the equation is the portfolio's variance, and the denominator is composed of any terms related to a specific asset. This formula will be an efficient method to identify how much risk an asset contributes to the portfolio's volatility. Equations 10 and 11 are formal methods to emphasize portfolio diversification by decomposing the portfolio's volatility. Equation 10 is a method to calculate the diversification benefits from traditional assets and alternative assets, but Equation 11 only measures the diversification benefits from the alternative investment.

$$(8): risk\ benefits\ at\ VaR = VaR(P) - VaR(S) - VaR(B) - VaR(A_i)$$

$$VaR: historical\ value\ at\ risk$$

$$VaR(P): value\ at\ risk\ for\ portfolio$$

$$VaR(B): value\ at\ risk\ for\ AGG$$

$$VaR(S): value\ at\ risk\ for\ S\&P\ 500$$

$$VaR(A_i): value\ at\ risk\ for\ alternative\ asset\ i$$

$$(9): Marginal\ Contribution\ at\ risk\ for\ asset\ i: \frac{w_i^2\sigma_i^2 + 2w_iw_j\sigma_i\sigma_j\rho_{ij} + 2w_iw_z\sigma_i\sigma_z\rho_{iz}}{\sigma_p^2}$$

$$(10): Diversification\ Benefits\ in\ general\ portfolio: \frac{2w_iw_j\sigma_i\sigma_j\rho_{ij} + 2w_iw_z\sigma_i\sigma_z\rho_{iz} + 2w_jw_z\sigma_j\sigma_z\rho_{jz}}{\sigma_p^2}$$

$$(11): Diversification\ Benefits\ from\ alternative\ assets: \frac{2w_iw_j\sigma_i\sigma_j\rho_{ij} + 2w_iw_z\sigma_i\sigma_z\rho_{iz}}{\sigma_p^2}$$

$$Assumption: asset\ i = alternative\ asset$$

$$asset\ j = S\&P\ 500$$

$$asset\ z = AGG$$

Empirical Result

It is clear that alternative investments are much more popular than they used to be. Because of the lack of perfect information, we found that real-life investors usually invest 5% in alternative assets. Therefore, we calculate the annualized risk, annualized return, and Sharpe ratio in real-life portfolios to analyze what investors actually do before introducing the optimal portfolio. In Table 4, the portfolio with private equity has the highest annualized return. However, it is surprising that the portfolio with the artwork asset has the highest annualized risk with the lowest return, which means that this portfolio is less superior than the rest of the

portfolios. The portfolio with infrastructure is more superior to the benchmark portfolio because it has a lower risk and higher return than the benchmark portfolio, which may be worth investing in. From the risk and return tradeoff aspect, most of the portfolios with alternative assets tend to have a higher return than the benchmark portfolio, but the corresponding volatility is also higher. Sharpe ratio is a popular indicator to describe the average return in excess of the risk-free ratio per unit of annualized volatility. From table 4, we see that the portfolio with infrastructure has the highest Sharpe ratio, which may be the most attractive for investors caring about the return/risk tradeoff. A portfolio with the art investment has the lowest ratio.

Table 4: Annualized Variance, Annualized Return, Sharpe Ratio for real-life portfolios (Benchmark Portfolio: 77.5% in stock, 22.5% in bond, Alternative Portfolio: 70% in stock, 25% in bond, 5% in alternative assets)

Real-life Portfolio	Annualized Return	Annualized Risk	Sharpe Ratio
Benchmark	**6.19%**	**13.16%**	**0.43**
Real Estate	7.07%	14.60%	0.45
Natural Resource	6.71%	15.08%	0.41
Wine	6.64%	14.53%	0.42
Venture Capital	9.47%	14.25%	0.62
Hedge Funds	8.49%	15.09%	0.53
Infrastructure	9.65%	12.69%	0.72
Private Equity	10.03%	15.22%	0.62
Private Debt	8.68%	15.49%	0.52
Arts	4.32%	22.05%	0.17

Real-life portfolios are not optimal portfolios because of the strategic weighted allocation strategy. If we use the optimization strategy to reallocate assets, we receive a different picture of

the portfolio's performance. In table 5, we used the Maximizing Sharpe Ratio strategy to calculate the weight for the benchmark portfolio, but we utilized the Minimizing Variance strategy to calculate portfolios with alternative assets for a target return from the benchmark. After comparing the Sharpe ratio between real-life portfolios and optimal portfolios, it is clear that all of the optimal portfolios have a higher Sharpe ratio than the real-life portfolio, which means that portfolios constructed by the optimization strategy may be more attractive for investors. A portfolio with hedge funds achieves the highest Sharpe ratio, but portfolios with wine and natural resources have the same ratio as the benchmark portfolio. We see that optimal portfolios give more than 75% of capital in the bond market and only about 12% in the stock market, which is totally different from real-life portfolios.

Furthermore, we have same return in all optimal portfolios, which means that optimization strategies are right and consistent. Because we are trying to minimize the volatility, we see that a portfolio with hedge funds has the lowest volatility for a target return. It implicitly indicates that adding hedge funds in traditional portfolios could, on average, help investor achieves a better risk/return tradeoff. The result is consistent with the paper published in 2010. Mikael Haglund finds that "risk benefits can be obtained by including hedge funds in the portfolio." (Haglund, 2010). However, it is not consistent with the focal paper in 2018. We find that adding hedge funds on average could decrease the risk in portfolios.

The benchmark portfolio and the portfolio with an artwork asset have the same volatility, return, and Sharpe ratio since they have the same weight in all of the assets. Even though the artwork belongs to alternative assets, the art asset has a higher risk and lower return than S&P 500. Because the optimization strategy is to minimize the variance for a given return, the strategy gives a zero for the art asset. The optimization strategy in optimal portfolios shows a small

weight in wine, natural resources, and artworks. However, investors in financial markets did hold these assets in real life. Why would our optimization strategy show that investors should not hold the fine wine, natural resource, and artwork assets? We provide four possible reasons to explain this contradiction. Investors who are investing in these assets may have a different utility function. Investor may have different attitude with respect to risk, like risk-neutral, risk-loving, and risk-averse. Besides, the optimization strategy could have a wrong objective function and incomplete constraints, which means that optimal weights from the optimization strategy may not be the optimal case for these assets. The unreliable data source could also be a possible reason because of the selection bias from the data vendor. Last but not least, the limited sample period in our dataset may not cover the longer holding periods in wine, natural resources, and artworks investment. In other words, investors who are investing in fine wine, natural resource, and artworks may have a tendency to hold more than 20 years in these assets so as to increase the intrinsic and collection value. In the current model, we implicitly assume that all assets are held at the same, quarterly, horizon. The trouble is that there might be mixed holding period horizons, which is difficult to include inside of a standard optimizer. Therefore, these reasons mentioned above explain contradictory results from our optimization strategy.

Table 5: Annualized risk, return, Sharpe ratio, and weights for Various Assets for optimal portfolios (Benchmark portfolio: Maximizing Sharpe Ratio Strategy, Alternative Portfolios: Minimizing Variance Strategy)

Portfolio Types	Annualized Volatility	Annualized Return	Sharpe Ratio	Stocks Weight	Bonds Weight	Alternative Assets Weight
Benchmark	**3.52%**	**4.32%**	**1.07**	**12.08%**	**87.92%**	**N/A**
Hedge Funds	3.06%	4.32%	1.23	0.00%	76.34%	23.66%
Private Debt	3.18%	4.32%	1.18	0.00%	81.16%	18.84%
Venture Capital	3.33%	4.32%	1.13	4.17%	89.20%	6.63%
Infrastructure	3.34%	4.32%	1.12	5.83%	89.43%	4.73%
Private Equity	3.38%	4.32%	1.11	5.08%	90.51%	4.41%
Real Estate	3.46%	4.32%	1.09	13.71%	82.93%	3.36%
Wine	3.50%	4.32%	1.07	13.32%	85.09%	1.59%
Natural Resource	3.51%	4.32%	1.07	12.73%	86.37%	0.89%
Arts	3.52%	4.32%	1.07	12.08%	87.92%	0.00%

Besides, both hedge funds portfolio and private debt portfolio have a zero ratio in stock weight, which may implicitly show the diversification benefits by adding alternative assets. In fact, hedges funds and S&P 500 have a strong positive correlation about 0.88. Private debt and S&P 500 also have a strong positive relationship about 0.82. Thus, hedge funds and private debt are a superior substitute of stock because of a better risk-return tradeoff. Most portfolios have the largest weight in bonds, which is consistent with our optimization strategy. In general, table 5 shows that a higher weight in alternative assets could lead to lower volatility in portfolios. Nothing in alternative asset's weight indicates the highest volatility in the portfolio's performance. The F-test in portfolio volatility in table 6 implies that the volatility in the benchmark portfolio is equal to the volatility in portfolios with alternative assets because the p-value is bigger than 5% and 10%. The result may be reasonable because alternative portfolios

have bigger weights in traditional assets, which is consistent with the benchmark portfolio only consisting of traditional investments

Table 6: F-test for volatility in portfolios (Significant Level: 5%)

F-test in portfolio volatility	Benchmark	P-value (5%)
Real Estate	equal	0.46
Natural Resource	equal	0.50
Wine	equal	0.48
Venture Capital	equal	0.35
Hedge Funds	equal	0.17
Infrastructure	equal	0.36
Private Equity	equal	0.39
Private Debt	equal	0.25
Arts	equal	0.50

Volatility is a common method to measure the average risk in portfolio performance. Semi-variance is a better way to measure the downside risk. From table 7, we see that the value from semi-variance is consistent with volatility (their ranking is consistently similar). The similar result from volatility and semi-variance implicitly shows that adding alternative assets can satisfy a better risk-return tradeoff since portfolios with alternative investments have a lower downside risk than the benchmark portfolio. Diversification benefits of adding alternative assets in portfolios could be achieved. In terms of VaR (value at risk), the portfolio with infrastructure has the largest VaR (it is closed to zero). Most alternative portfolios have a larger VaR than the benchmark portfolio, except for the private debt portfolio and the private equity portfolio. Even though the result is not exactly consistent with volatility and semi-variance, most portfolios with alternative assets have a better risk performance than the benchmark portfolio. It is also implicit

to show that adding alternative assets in traditional portfolios could achieve a risk reduction in VaR. In conditional value at risk (CVaR), investors are looking for smaller CVaR. Table 7 clearly shows that most portfolios with alternative assets have a smaller CVaR than the benchmark portfolio, except for the real estate portfolio. The value from CVaR is consistent with volatility and semi-variance, except for several portfolios mentioned above. By comparing conditional value at risk among portfolios, we see that adding alternative assets would have a better risk performance than the benchmark portfolio consisting of stocks and bonds.

A maximum drawdown, an alternative measure in downside risk, is the maximum observed loss from a peak. By simulating the portfolio's performance during the investment holding period, a portfolio with hedge funds would have the smallest drawdown value than most alternative and benchmark portfolios. Most portfolios with alternative assets have a smaller drawdown value than the benchmark, except for portfolios with fine wine, real estate, and private placement debt. In general, if an investor can add alternative assets in portfolios, the maximum observed loss could be smaller from 2008 to 2020 than the traditional portfolio. Because of the 2008 financial crisis, all of the portfolios have a maximum drawdown in 2008. The portfolio with real estate has the largest drawdown. The 2008 financial crisis is mainly about the issue from the real estate market. The result from the maximum drawdown is consistent with the observed fact.

Table 7: Alternative risk measures in portfolios

Portfolio Types	Volatility	Downside Risk (Semi-variance)	VaR (1%)	CVaR (1%)	Maximum Drawdown	Period
Benchmark	**0.0352**	**0.0174**	**-0.0317**	**-0.0077**	**-5.11%**	**2008-09**
Hedge Funds	0.0306	0.0151	-0.0304	-0.0090	-3.75%	2008-09
Private Debt	0.0318	0.0157	-0.0335	-0.0094	-5.16%	2008-09
Venture Capital	0.0333	0.0165	-0.0302	-0.0082	-4.52%	2008-09
Infrastructure	0.0334	0.0165	-0.0289	-0.0083	-3.88%	2008-09
Private Equity	0.0338	0.0167	-0.0320	-0.0093	-4.83%	2008-09
Real Estate	0.0346	0.0171	-0.0306	-0.0076	-5.28%	2008-09
Wine	0.0350	0.0173	-0.0316	-0.0079	-5.13%	2008-09
Natural Resource	0.0351	0.0174	-0.0315	-0.0078	-5.09%	2008-09
Arts	0.0352	0.0174	-0.0317	-0.0077	-5.11%	2008-09

By far, we have finished investigating the risk measure in the overall portfolio, but we are still unsure about the specific contribution from alternative assets. In this section, we are going to use two methods to decompose the risk measure in order to identify the role of alternative assets. Table 8 describes the relationship between marginal contribution in the portfolio's risk and asset weights. It is clear that the marginal contribution for portfolio volatility in alternative assets is smaller than the corresponding portfolio's weights in alternative assets. It means that adding alternative assets would not equally increase the portfolio volatility by the same percentage. In terms of traditional assets, S&P 500 contributes a lot to the portfolio's risk. The weight in the stock is smaller than the marginal contribution in portfolio volatility. The overall result shows that adding alternative assets could decrease the risk by decomposing the marginal contribution in portfolio volatility. Furthermore, we also find that there is a negative sign in several alternative assets such as the fine wine, venture capital, infrastructure, and private equity in terms of marginal contribution at risk. Thus, adding alternative assets in the traditional portfolios might

decrease the portfolio's volatility, which implicitly displays the diversification benefits of adding alternative assets in traditional portfolios.

Table 8: Marginal contribution in portfolio's risk (W: asset's weight in the portfolio, MCR: marginal contribution in risk)

Portfolio Types	Stocks (W)	Bonds (W)	Alternative Asset (W)	Stocks (MCR)	Bonds (MCR)	Alternative Asset (MCR)
Benchmark	**12.08%**	**87.92%**	**N/A**	**20.13%**	**79.87%**	**N/A**
Real Estate	13.71%	82.93%	3.36%	33.15%	66.79%	0.06%
Natural Resource	12.73%	86.37%	0.89%	24.53%	75.38%	0.09%
Wine	13.32%	85.09%	1.59%	28.01%	72.20%	-0.21%
Venture Capital	4.17%	89.20%	6.63%	0.72%	99.32%	-0.04%
Hedge Funds	0.00%	76.34%	23.66%	0.00%	81.79%	18.21%
Infrastructure	5.83%	89.43%	4.73%	1.24%	99.03%	-0.27%
Private Equity	5.08%	90.51%	4.41%	1.90%	98.30%	-0.20%
Private Debt	0.00%	81.16%	18.84%	0.00%	86.76%	13.24%
Arts	12.08%	87.92%	0.00%	20.13%	79.87%	0.00%

Table 9: Diversification Benefits from Value at Risk and Volatility (*: informal method, DB: diversification benefits)

Portfolio	DB in VaR*	DB in Volatility	DB in Volatility (Only Alternative Asset)
Benchmark	**20.900%**	**-1.050%**	**0.000%**
Real Estate	38.300%	-1.196%	-0.053%
Natural Resource	34.200%	-1.087%	0.003%
Wine	36.300%	-1.162%	-0.034%
Venture Capital	29.000%	-0.510%	-0.121%
Hedge Funds	29.200%	-0.767%	-0.767%
Infrastructure	32.800%	-0.632%	-0.088%
Private Equity	32.300%	-0.560%	-0.087%
Private Debt	33.600%	-0.756%	-0.756%
Arts	50.300%	-1.050%	0.000%

After analyzing the marginal contribution at risk, adding alternative assets in traditional portfolios did achieve the risk reduction. Table 9 provides methods to calculate the diversification benefits from traditional assets and alternative assets. In value at risk (VaR), we use a casual approach to decompose this alternative risk measure. By calculating absolute difference in VaR between corresponding portfolios and individual assets, we find that adding alternative assets will mitigate value at risk from individual assets because of the negative correlation among assets. Even though it is hard to draw a precise conclusion by comparing the scale, its direction could tell investors that adding alternative assets would achieve risk reduction. The bigger value is better because it can show the diversification benefits from the value at risk. By comparing values, we see that all portfolios with alternative assets have a bigger value than the benchmark portfolio. It means that adding alternative assets in portfolios could increase the diversification benefits. Even though this is an approximate value to show the diversification benefits, it can still help us show the direction as compared to the benchmark portfolio. In terms of volatility, we use a formal way to decompose the risk in order to show the diversification benefits. First, a negative value means an increase in diversification benefits because it decreases the portfolio risk. The general trend shows that all portfolios would achieve diversification benefits deriving from traditional assets and alternative assets. To identify the specific role of alternative assets, we only select any terms related to alternative assets. The artworks in alternative portfolios have zero diversification benefits because there is a zero in asset's weight for the art investment. Most portfolios with alternative assets have a negative value, which means that adding alternative assets could decrease the portfolio risk. It emphasizes the diversification benefits contributed by alternative assets. More importantly, adding natural resource increases the portfolio risk because the value is positive (0.003%). From the value of diversification

benefits in the whole portfolio, the value is negative (-1.087%), but the value of diversification benefits from alternative assets is positive (0.003%). It implies that the diversification benefits in the portfolio with natural resources come from traditional investments (stocks and bonds) rather than alternative assets. We, therefore, find that some alternative assets would increase the diversification benefits in portfolios, but there are still several assets, such as the artwork and natural resource, that could not help investors to gain diversification benefits.

By analyzing and decomposing multiple dimensions of risk, adding alternative assets into traditional portfolios could help investor achieve diversification benefits. There are several possible rationales to explain these conclusions. Different assets in alternative and traditional investment have different liquidity, which could generate diversification. Besides, a negative correlation between alternative and traditional investments mitigates the unsystematic risk from individual assets. Macroeconomic factors, such as inflation, GDP, national income, and unemployment level, play an indispensable role in traditional investments. These factors may not have a strong correlation in alternative assets, which could potentially decrease portfolios' risk under economic downturn. These potential reasons mentioned above may explain why we find these results. The aim in this paper is to validate the diversification benefits from alternative investment. We will not find the specific rationale that causes the diversification benefits in alternative portfolio, so this question is left for future researchers.

Conclusion

In conclusion, this study may be the first literature to examine the individual of a comprehensive alternative investment with respect to the benefits of diversification. We use a complete dataset in alternative investments to measure their performance from 2007 to 2020. By analyzing various risk measures and decomposing VaR and volatility, we find that adding alternative investments in traditional portfolios would generally improve the benefits of diversification at an individual level because a portfolio with alternative assets tends to have a lower risk for a given level of return than the benchmark portfolio consisting of stocks and bonds. However, there are several alternative assets that would not improve the portfolio, such as the artwork investment and natural resources. Our findings are consistent with the previous literature offered by Haglund (2010), but it is contrary to the focal paper from Mikkelsen (2018). In fact, we validate diversification benefits from alternative investments. Alternative assets with different liquidity have a weak relationship with traditional investments, which explain why we have diversification benefits in mixed portfolios.

In this study, there are several places that it can be improved potentially for future researchers. Even though we use more than 10 years dataset to investigate alternative investments, but it may not be enough because investors may expect a longer holding periods in some assets, like artworks. Different length of holding periods among alternative and traditional investments could also be a problem when constructing alternative portfolios. I would suggest that future research could use more extended period to delve into characteristics of alternative investments. Researchers, besides, could examine a more comprehensive dataset by including more alternative assets, especially in real assets. This study only covers five real assets, so it may be a good idea to incorporate more assets in mixed portfolios, such as watches, stamps, and

luxury cars and so on. Last but not least, we decompose the value at risk and volatility to show diversification from alternative assets, but future researchers could also decompose other downside risk, such as conditional value at risk, semi-variance, and maximum drawdown.

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Bibliography

Baird Private Wealth Management, “The Role of Alternative Investments in a Diversified Investment Portfolio.” *Baird Private Wealth Management*, Baird, 2013, www.bairdfinancialadvisor.com/schmidtvanderleestwenzelgroup/mediahandler/media/163794/The_role_of_alternative_invst.pdf.

Chambers, D. R., Anson, M. J., Black, K. H., & Anson, M. J. (2015). Chapter 1: What is an Alternative Investment? In *Alternative investments: CAIA level I* (pp. 1-22). Hoboken, NJ: Wiley.

Erzan, Onur, et al. “The Mainstreaming of Alternative Investments: Fueling the Next Wave of Growth in Asset Management.” *Financial Services Practice*, McKinsey & Company, 2012,www.mckinsey.com/~/media/mckinsey/dotcom/client_service/financial%20services/latest%20thinking/reports/the_mainstreaming_of_alternative_investments.pdf.

Favre, Laurent, and José-Antonio Galeano. “Mean-Modified Value-at-Risk Optimization with Hedge Funds.” *The Journal of Alternative Investments*, vol. 5, no. 2, 2002, pp. 21–25., doi:10.3905/jai.2002.319052.

Fischer, Edwin O., and Susanne Lind-Braucher. “Optimal Portfolios with Traditional and Alternative Investments: An Empirical Investigation.” *The Journal of Alternative Investments*, vol. 13, no. 2, 2010, pp. 58–77., doi:10.3905/jai.2010.13.2.058.

Haglund, Mikael. "Higher Moment Diversification Benefits of Hedge Fund Strategy Allocation." *Journal of Derivatives & Hedge Funds*, vol. 16, no. 1, 2010, pp. 53–69., doi:10.1057/jdhf.2010.2.

Markowitz, Harry. "Portfolio Selection." *The Journal of Finance*, vol. 7, no. 1, 1952, pp. 77–91. *JSTOR*, www.jstor.org/stable/2975974. Accessed 3 Nov. 2020.

Mendel, Ron. "Private Placement Debt: Diversification, Yield Potential in a Complementary IG Asset." *STRATEGY INSIGHTS*, STRATEGY INSIGHTS, Nov. 2013, conferences.pionline.com/uploads/conference_admin/HIMCO_Private_Placement.pdf.

Mikkelsen, Andreas, et al. "Hedge Funds as a Diversification Vehicle." *The Journal of Investing*, vol. 28, no. 6, 2019, pp. 55–72., doi:10.3905/joi.2019.1.099.