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Investing in Collectibles

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ABSTRACT

This study focuses on investing in collectibles. We will investigate the benefits of investing in collectibles in several ways. Correlations with traditional asset classes are computed to look for diversification opportunities and possible hedging purposes. Ex ante MV optimal portfolios are constructed to see whether collectibles can improve the efficiency of a mixed asset portfolio. Last, cross asset correlations in different periods are investigated to see how collectibles behave in both a stable and a crisis period. Various indices are used as proxies for different asset classes. The total dataset contains 25 years of monthly prices. We conclude that collectibles inhibit financial characteristics that can be beneficial for investors in various ways. Diversifying and hedging risk, and good performance during recession are the most valuable. We found no proof for collectibles contributing to the efficiency of a globally diversified mixed asset portfolio. Major differences are found within the asset class collectibles.

Keywords:
Portfolio Choice, Investment Decisions, Alternative Investments, Collectibles, Diversification

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1 Introduction and objectives

1.1 Introduction

Portfolio diversification has been of interest to practically every investor. Both financial institutions and private investors are seeking for the highest returns per unit of risk. Since Markowitz (1952), people have been aware of the benefits of adding additional assets to their portfolio. This especially applies to assets that have low or negative correlations with the assets currently present in the portfolio. The search for additional alternative asset classes has led to increased attention and investment in commodities, real estate, hedge funds and international equity. These alternative assets have been widely explored and discussed in financial literature over the past 30 years. We can state that these alternative asset classes of the past have become traditional asset classes nowadays. Relatively new alternative asset classes have not been studied extensively. Trading co^2 emissions, or investments in collectible objects are good examples of new classes. In this thesis we will concentrate on investing in collectibles. Little research has been done on collectibles considered as financial assets.

In this thesis we will investigate the benefits of investing in collectibles. Our study is most similar to that of Campbell (2007). Campbell's paper (2007) looks at art as an alternative asset class. It mainly focuses on the diversification benefits of art during bear markets. It concludes that the low correlation of art with other classes offers diversification benefits to portfolios. Our thesis can be seen as an addition to this paper. In addition to art, we will look at other collectibles as a financial asset class. Not only art is included, but we also consider wine and stamps. We distinguish and study three possible benefits of investments in collectibles. Profit opportunities, diversification opportunities and hedging opportunities . Correlation coefficients are computed to evaluate diversification possibilities and hedging opportunities. A standard MV (MV) framework is used to construct ex-ante optimal portfolios. We compare ex ante optimal portfolios. The first portfolio includes collectibles. The second one does not include them. The last section will be dedicated to the behavior of collectibles during crisis. The most recent financial crisis is subject of this investigation.

1.2 Objectives

The objective of this thesis is to explore the benefits of investing in collectibles. We study the benefits of adding collectibles to an international mixed asset portfolio in particular. We can distinguish three different types of benefits, which lead to three questions. The first is the excess return opportunity. Do collectibles outperform traditional financial assets in terms of risk adjusted return? The second benefit is that of diversification.

To what extent are returns on collectibles correlated with traditional financial asset return? The last benefit is that of hedging. Can collectibles be used as an hedging instrument against particular risks or events? The latter 2 may seem similar, but they are not. The second objective focuses on an investor that holds a globally diversified portfolio and seeks for further diversification of that portfolio. The third objective focuses on the hedging opportunities against one particular exposure to risk, for example inflation risk.

Furthermore, we will look whether there are differences in benefits within the asset class Collectibles. All three questions will be answered in this thesis.

1.3 Relevance

The relevance of Portfolio diversification has long been acknowledged by investors worldwide. Both financial institutions and private investors seek for the highest returns per unit of risk. The awareness that adding additional assets to a portfolio brings diversification benefits leads to a quest for alternative investments. Major financial institutions including pension funds already apply investments strategies that include alternative investments. Our study contributes to the quest for alternative investments by exploring the financial characteristics of collectibles. Investing directly into collectibles can cause a couple of problems, such as transaction and storage costs. In this thesis we consider indirect investments through an investment vehicle. At this moment, that particular investment vehicle does not exist in real life. Therefore, the outcome of this thesis is mainly of theoretical relevance. We are confident that increased attention towards alternative investments will make practical use of similar studies possible in the future.

A study on investing in collectibles could be of practical use. In that case one would have to consider the prices of physical objects and account for different costs. Apart from costs, there are other problems that arise when one invests in collectibles. These issues are described in section 2.3. For all the problems, assumptions will have to be made in the research.

1.4 Structure

The remainder of this thesis is outlined as follows. In the section 2 we define and describe the terminology and perspectives used in this thesis. In section 3 we discuss the current literature including the results and methodologies. In section 4, we describe and define our research methodology. We elaborate on the data that we use in our investigation in section 5. The results are presented in section 6, in section 7 we give some concluding remarks.

2 Definitions, descriptions and perspective

2.1 Alternative assets

Portfolio diversification benefits and excess return opportunities have always attracted investors towards investing in assets other than the conventional asset classes. An alternative asset class can be defined as a group of assets that is not considered traditional. The views on whether an asset class is in fact traditional has been subject to change. A lot of assets that were initially seen as alternatives are nowadays part of almost every investment portfolio. Examples include real estate, commodities, derivatives and international stocks. Through the years many studies have focused on the characteristics and applications of these asset classes. Among others, today's alternative asset investments include trading in co^2 emissions, participating in limited partnerships, buying intellectual property and investing in collectibles. Little research has been done on these asset classes, since there is no high quality data available. In this study we will focus on the benefits of investing in collectibles, for which frequent high quality has become available.

2.2 Collectibles

Collectors can be described as individuals who passionately (even obsessively) search for and buy unique items of some sort, Belk(1995). Often, these items have low intrinsic value in relation to their selling price. Next to consumption value and objective characteristics, prices are driven by scarcity and emotional factors. Therefore, it is no surprise that collectibles are often referred to as emotional assets. The consumption value of collectibles provides the owner higher utility in terms of aesthetic value, Campbell, Koedijk & de Roon (2009). Although financial benefits may not always have been the primary purpose for acquiring collectibles, Burton and Jacobsen (1999) show that many collectors also hope for financial gains. There are innumerous objects that can be classified as collectibles. Therefore we have to set boundaries and make choices on which collectibles are viable for our study.

First, many transactions on collectibles take place on either the private market (auction websites, flea markets, etc.) or the dealer market. These transactions are not recorded which makes it very difficult to track price developments. Only collectibles that are frequently sold through auctions houses (that keep records) are of use to us.

Secondly, there has to be a substantial number of transactions on the collectible in order to track price developments. For example, one can collect space shuttles but there are simply not enough items nor transactions to keep good track of prices.

The group of collectibles that meet these criteria is still enormous. We choose to include three collectibles in our study, Wine, Stamps and Art. All three have an active trading market and are sold at auction houses. For these items, frequent high quality data are available.

We define wines as being red Bordeaux. Red Bordeaux are laid down for long storage, since they require many years to mature fully, Krasker (1979). This characteristic, distinguishes them from other wines. It is not surprising that some 90% of the wines bought for investment are red Bordeaux. The objective factors that drive wine prices are color, vintage, appellation and ranking. Sensory variables (bouquet, taste and finish) are found to be of less importance for the price, Combris, Lecocq & Visser (1999). The fine wine market is estimated to be worth $3 billion annually. 5 years ago, this number was $1 billion . The fine wine market was traditionally concentrated in Europe, but due to globally integrated markets it has spread to the US, Japan, Asia and recently to emerging economies like China and Russia. The auction market, account for only a tenth of the total US$300m . 60% of the auction sales are accounted for by the US market[1].

We define stamps as being US and UK stamps only. Many investors specialize in vintage stamps from the United Kingdom and the US. Data available on stamp prices are therefore only on (vintage) US and UK stamps. There are millions of collectors, who spend a total of $10 billion on stamps annually, Reuters (2006).

Art is a term used for many forms of artistic work, such as paintings, sculptures, photography and literature. We concentrate on paintings. Objects of art, such as paintings, can be possessed, valued and traded in. It is difficult to value and trade in literature or drama. On paintings there are frequent, high quality data available for various segments. This allows for an evaluation of different segments within a class. This aspect provides us with more detailed information and conclusions about this particular collectible. The worldwide turnover of fine art auction sales is $ 5 Billion. Before 2006 this was some $ 4 Billion annually, during the peak period 2006-2008 this was some $ 8 Billion[2].

2.3 Drawbacks of investment in collectibles

When investing in collectibles directly one can encounter a couple of difficulties. Some of these problems are harder to overcome than others.

Firstly, collectibles are not very liquid. Because there is no liquid market, it is hard to liquidate positions in collectibles instantly. In order to sell, one has to find a dealer, an auction house or a private buyer. It can take up to five months to liquidate a collection of wine, Sanning, Shaffer & Sharratt (2006). Illiquidity is likely to increase during economic downturn, because of the reduced transactions (prices not meeting reserve). Art investors face greater illiquidity risk than investors in other financial assets, Campbell (2007). Risk averse investors would like to be compensated for this risk in terms of higher expected returns. Because it is hard to measure the size of the illiquidity risk, the same goes for the desired risk premium.

[1] Source: liv-ex.com The fine Wine Market Exchange

[2] Source: “Art Market Trends 2009” obtained from http://www.artprice.com

Secondly, collectibles do not generate cash flows. Collectibles do not pay out dividends, interest or rent like other financial assets. Returns are based on price changes.

Thirdly, collectibles are often subject to high transaction- and storage costs. Investing in art can bring transactions costs of up to 30% of the sale price, Campbell (2007). The transaction costs on trading stamps amount to some 25% on average, Dimson and Spaenjers (2009). Different estimations can be of major influence on the results of the study. For example, Krasker (1979) estimate storage costs for wine to be $ 1.40 per bottle per year where Jaeger (1981) assumes storage costs to be $ 0.499 per year.

Finally, collectibles bear physical risk. Collectibles are often subject to imitation. Fakes and forgeries for some pieces are more rule rather than exception. Camille Corot for example made 3000 works in his life, however in the US alone it has been claimed that there are 8000 authentic pieces. Forgers employ new technologies, which makes it more difficult to detect a copy. One can end up having invested heavily in a collectible that turns out to be worthless. Besides this risk, there is the risk of theft or damage. One can insure these risks. Insurance costs and the risk of buying a fake object are hard to estimate and, therefore hard to value.

To deal with these problems we have decided not to consider investments directly into the respective collectibles. In our study we do as if one can invest in price indices on the collectibles as if it they were Exchange Traded Funds (ETF's). The idea of investing in assets via a financial instrument is not new. When one wants exposure to a commodity, futures can be bought instead of the real underlying asset. In section 5 we shall elaborate on the use of investing through collectible ETF's. Another reason for leaving transaction costs out is the choice of our theoretical framework. One of the assumptions underlying the MV framework is that there is no distortion by inflation or taxation costs.

2.4 Perspective

In this study we will evaluate and conclude from a United States (US) investors' point of view. Most data are available in United States Dollars (USD) which makes it practical to choose this perspective. Of course ,the US has the biggest financial market according to market capitalization, which makes our choice reasonable. Furthermore we consider that the US investor initially holds an internationally diversified portfolio. Another advantage of using a US investor as reference point is the fact that we can introduce inflation in the research. Because there is no such thing as world inflation, we feel free to use historical US inflation rates.

In our study we optimize portfolios for a period of one month. Financial literature says that the frequency of the data implies the horizon of optimization. We use monthly data in this study. Nevertheless, we assume holding periods of the investor to be longer than one month. Longer holding periods will diminish transaction costs and provides a more realistic representation of reality.

Like Campbell (2007), we suggest an investment horizon of 25 years. The use of less frequent data is not an option, because results will be less accurate and distributions will be driven away from normality.

We are interested mainly in the financial characteristics of collectibles. Investors are assumed to care about financial gains only. They are less interested in consumption or aesthetic value. Our focus is on financial investments and on opportunities to improve upon those investments.

3 Existing literature

This section elaborates on literature that touches upon our objectives. Table 1,2 and 3 at the end of the section provides an schematic overview of the literature discussed. On investments in collectibles there is some, but not a lot of literature at hand. This allows for a detailed description on most of the existing studies. Results and conclusions differ widely in different papers and between different asset classes. Literature on collectibles is discussed in the following order: Stamps, Wine, and Art. Next, the enhancement that this thesis has with respect to the literature discussed is outlined.

3.1 Stamp investments

Historically ,investment in stamps has had the least attention of the asset class examined in this thesis. There are a couple studies worth mentioning.

The first is a reading by Taylor (1983). Taylor's objective was to see whether a stamp portfolio would have yielded excess returns over the New York Stock Exchange Index (NYSE). The author used returns on a portfolio of five frequently traded US stamps. The study calculates mean returns on stamps to be 14,5% per year. However neither alpha nor beta were significant when regressed against the NYSE index. These results suggest that stamp investments do not improve an ordinary stock portfolio. When catalogue prices are used instead of auction prices, the outcome changes. In that case alpha becomes positive, suggesting that there are diversification benefits to be made. Transaction costs ,in terms of commission fees, heavily influence the results of the study. Leaving transaction costs out, or choosing long holding periods, lead to a positive perspective on stamp investments.

Cardell, Kling and Petry (1995) studied the returns on 43 different US stamps. They have found a 7,6% annual average return over a period of 40 years from 1947. The authors have also found a reverse relationship between stamps and factors that drive bond and stock returns. They conclude that stamps can be used as a hedging instrument for stocks and bonds.

More recently, Veld and Veld-Merkoula (2007) found evidence for diversification benefits using stamps. A capital asset pricing model (CAPM) was used to compute the alpha and beta on a stamp portfolio proxy. The proxy used in their research was the Stanley and Gibbons 100 index, which uses stamp prices on the 100 most frequently traded stamps. The results show alpha and beta close to zero. Only four years of data on annual returns were used in their study.

Finally, the most recent study is that of Dimson and Spaenjers (2009). Dimson et al investigate British collectible postage stamp returns, using catalogue prices. Buy and hold portfolios were created to compare returns with other financial assets.

Dimson et al used Stanley Gibbons catalogue prices to construct a periodically rebalanced index. They calculate average annual nominal returns to be 6,7%. This is higher than returns on bonds and bills, but lower than returns on equity. Equity and stamp returns are found to have a positive correlation. And both assets are calculated to have the same Treynor ratio over the investigated period (1900-2008). Like their predecessors, the authors acknowledge the hedging opportunities of stamps.

3.2 Wine investments

The relatively few studies on investments in wine show various results and conclusions. An early paper of Krasker (1979) suggests that storing red Bordeaux and Californian Cabernet Sauvignon wines yield no higher returns than the risk free rate. Krasker used a GLS regression to test his hypotheses of equal returns for wine and one year US treasury bills. The time-period of the data included two exceptionally bad years from a wine industry's point of view. The 1973-75 poor performance years covered over half of the total investigation period of 1973-77.

Two years later, Jaeger (1981) comes to the exact opposite conclusion. Jaeger improved the methodology of Krasker by adding dummy variables. This made it possible for every year to have its own intercept. She also used eight years of data (1969-77) instead of four and introduced a different interpretation of costs for storing wine. Mainly the last adjustment led to the reversion of the conclusion from 1979. Krasker estimated costs of storing wine to be $ 16.80 per case per year. Using the cost accounting figure of Freemark Abbey Winery, an annual per case storage cost of $ .449 was used. On the eight year time-span wine investments outperformed one year treasury bills by 16.6%. Even a positive excess return of 3.8 % was reported for the period earlier used by Krasker.

In the nineties, Weil (1993) calculates average annual returns on wine to be 9.9% and 11% for Bordeaux wines only. Also, Bordeaux wine returns showed a low standard deviation of 3.7. Thirteen years (1980-92) of detailed information on a single wine investor's portfolio was used. He concludes that these returns are significantly lower than returns on the NYSE stocks over that period. According to Weil one should not buy wine for investment purposes.

Burton and Jacobsen (2001) used a regression to estimate returns on Bordeaux wines. The data incorporated ten years (1986-96) of repeated sales from red Bordeaux wines. Besides an aggregate portfolio, they constructed a separate portfolio for every year. The Dow Jones Industrial Average was used as a benchmark to see whether wine portfolios would have excess returns over the same period. The vintage portfolio of 1982 was the only one which outperformed the benchmark, yielding an annual return of nearly 14%. The aggregate portfolio showed an underperformance with less than 8% annual return.

Diversification benefits were not discussed. Returns on wine are heavily influenced by transaction costs proposed by the authors.

The most recent research on wine investments is by Sanning, Shaffer and Sharratt (2006). They find that average wine returns are large, positive and in excess of risk adjusted returns. They computed excess returns to be more than 0,60 to 0,75% per month and 7,5 to 9,5% per year. Their second finding is the existence of a minimum covariance with market returns and other commonly recognized market risk factors. For their study they used both the Capital asset pricing model (CAPM) and the Fama-French 3-factor model. According to their results, there is either a negative or no significant relationship between returns on wine and the Fama-French factors. They provide us with results that justify investments in wine for both profit- as diversification opportunities. Sanning et al (2006) used eight years of monthly returns, 1996-2003. The monthly returns were created by repeated sales prices. The authors categorized the wines according to vintage, year of production, and every individual wine producer. As Benjamin et al. (2001), only red Bordeaux wines were part of their research.

3.3 Art investments

Previous studies on art as a financial investment show various results. Early papers suggest that art should not be purchased for investment purposes, since returns are calculated to be lower than risk free assets over the same holding period. Remarkable is the observation in the most recent study that results show the opposite. Improvements in the quality and availability of art market prices may have played an important role in that.

One of the earliest studies on art investments dates from 1974. In that year Robert C. Anderson examined returns on paintings over the period 1780-1970. An index was created form a repeat-sales regression from data by Reitlinger (1961, 1970). The data were divided into various periods and various schools. Anderson concludes that rates of return depend on both the period of measurement and the type of school. Modern work was found to have significantly higher returns than other groups. In the long term, the overall returns on common stocks were calculated to be twice as high as that of paintings. Anderson did not include other financial assets neither were diversification possibilities investigated.

In (1989) Frey and Pommerehne calculated annual returns on paintings to see whether art might be a good investment opportunity. Different periods were compared to give insight into returns before and after WOII. The author used repeated auction sales prices of works by “the best known painters of the world” selected by Reitlinger (1970).Frey & Pommerehne (1989) conclude that paintings should yield a higher rate of return to compensate for their risk. They calculated returns to be below that of traditional financial assets.

For the period 1635-1949, the authors find a real rate of return of 1,4% per year for paintings. This is rather low compared with government securities yielding an average return of 5% annually. The period 1949-1987 showed a slight improvement of returns on paintings of 0,2% per year annually, this improvement is not significant. Corrected for inflation this roughly means that over the investigated period, paintings yielded returns worth half the rates on government securities. The results suggest that the returns on investment for paintings have become relatively more profitable in the postwar (1949~) period than the period 1650-1949. The effect of inflation on traditional financial assets may have played a significant role in that, since the improvement of returns on paintings did not. The outcomes did not provide evidence for paintings being a viable investment opportunity for profit reasons. These findings are similar to the results of Anderson (1974). Unfortunately, the author did not elaborate on the hedging opportunities of investment in paintings that were clearly present.

Goetzmann (1993) studied the time-series behavior of art, stocks and bond markets over a very long time horizon. Three periods were subject of investigation; 1716-1986, 1850-1986 and 1900-1986. Following Anderson, Goetzmann constructed an index from data computed by Reitlinger (1961, 1963, 1971). He extended the data by including information from Mayer (various years: 1971-1987). As in the study by Anderson, a repeat-sales regression was used. Average annual returns on art were higher for every period. The author states that art did not perform significantly better than other assets when the results are corrected for risk. The high returns on art were accompanied by high volatilities. Even the 12,6% excess return of art over the London stock exchange was found to be insignificant when corrected for risk. The author finds high correlations between the London Stock Exchange and the art market. Inflation had the lowest correlation with the art market. Correlations computed in the study suggest that there are hardly diversification possibilities when adding art to a stock portfolio. Hedging opportunities against inflation are clearly there. Goetzmann (1993) finds little evidence that art might be a viable investment. Especially for a risk averse investor. He states that art can be attractive to an investor that prefers a volatile portfolio. The author finds evidence for hedging inflation risk by adding art to a portfolio.

A study of Campbell (2006) took a closer look at art as an alternative asset, and looked specifically at how this new alternative asset is expected to perform, also during bear markets. The paper looks at the risk and return characteristics of art using art market indices, and the prospects for portfolio diversification in the art market. To do so, correlations of art market indices were compared with existing asset classes. Next optimal portfolios with and without art as an asset class were constructed. The author compared the portfolios to see if it is optimal to have wealth allocated to asset class art. The Art Market Research (AMR) indices were used as proxies for market prices. The data allowed returns to be divided into different sectors; Old masters, European Impressionists, Modern and Contemporary.

Equally weighted portfolios of different artists were constructed. Along with a general art Index (containing a mixed basket of 100 well-known artists) they were used in the study. As proxies for the major asset class markets she used the MSCI US index, the MSCI UK index, the MSCI World index, the Lehman Brothers Aggregate Corporate Bond Index and the North American Real Estate Investment Trust Index (NAREIT). For hedge fund data series, the Credit Suisse/Tremont Hedge fund data series (dating from 1994) was used. Lastly, 10 year US and UK Government bond Indices and UK Government treasury Bills (from 1980) was included. Campbell concludes that there is a serious case for holding a small percentage of the investment portfolio in art. Her results show that art's low correlation with other asset classes offer diversification benefits from holding art in an investment portfolio. According to Campbell, optimal portfolio allocations ,using empirical returns over the past 25 years, provide support for investors to include art as an asset in their investment strategy. These results contradict the findings of earlier studies of Anderson, Frey and Pommerehne and Goetzmann.

3.4 Enhancement

It has become clear that different datasets and methodologies lead to various conclusions. We try to use what is best from previous studies. At the same time, the objective is to expand and improve upon the existing researches. Hopefully this will lead to more insight into the subject. We aim to enrich the current work on several points.

Firstly, this thesis combines different types of assets within the asset class collectibles. Previous studies mainly focused on one single collectible. Diversification possibilities within the class collectibles are considered unlike in any other study.

Secondly, many studies showed that results were heavily influenced by transaction costs. By using a more hypothetical approach, this influence can be left out. We use indices as if they were available on an exchange market e.g. in the form of ETF's.

Thirdly, many studies investigate returns and compare them with a given benchmark. Like some others, we compare optimal portfolios. To broaden the current studies using the same method, a broad set of assets are included in the traditional mixed asset portfolio. Not only stocks and bonds are incorporated, but also formerly alternative assets as commodities and real estate. This gives a more realistic view on today's optimal portfolios possibly held by individual- or institutional investors.

Finally, we have expanded the time scale of the dataset and the investment horizon compared with most studies. The extensive dataset allows for various horizons to be investigated and compared. Data from 1985 until 2009 provides good insight in recent developments. Reliable and accurate results can be expected from results on Twenty-five years of monthly data.

Table 1: Summary of conclusions on Wine investments drawn by previous studies

Author(s) and date	Focus	Period	Return computation	Methodology	Conclusions
Krasker (1979)	Bordeaux wines and California Cabernet vintage 1950+	1973-1977	Repeat sales regression	GLS return versus US T-bills	No outperformance on US treasury bills. Storage costs estimated to be USD 1.40 per bottle annually.
Jaeger (1981)	Bordeaux wines and Calafornia Cabernet vintage 1950+	1969-1977	Repeat sales regression	GLS return versus US T-bills	Outperformance on US treasury bills. Extension of the Krasker (1979) dataset by 4 years. Storage costs estimated to be USD 0.499 per bottle annually. Both reasons led to reversion of findings of Krasker (1979).
Weil (1993)	A portfolio including 33 Bordeaux, 32 Burgundy, 3 Rhone and 2 other whites.	1980 - 1992	Buy and hold strategy of investor	An single investors portfolio is tracked. Returns are compared with NYSE stock returns over the same period.	Returns on wine assets are found to be 9.5%. Returns on Bordeaux are found to be 11%. No outperformance over NYSE stocks. Prices include purchase price, sales tax, delivery costs, auction house transaction costs and income tax rates.
Burton and Jacobsen (2001)	Red Bordeaux vintage 1960+	1986 - 1996	Repeat sales regression	Four wine portfolios created from Repeat sales regression returns. Returns are compared with Dow Jones Industrial Average and US treasury bills over the same period.	Annual returns: 7.9% aggregate portfolio, 6.7% First growth portfolio, 8,3% Vintage 1961 portfolio and 14% Vintage 1982 portfolio. Only 1982 vintage portfolio outperformed the Dow Jones Industrial Average. All outperformed the US treasury bills.
Sanning, Shaffer and Sharratt (2006)	Red Bordeaux vintage 1893+	1996 - 2003	Repeat sales regression	The Fama-French Three-Factor Model was used to see whether for excess wine returns had excess returns overstock returns.	Average wine returns are found to be positive in excess of the risk adjusted (stock) market returns. Wine returns are found to co vary minimally with market returns and other commonly accepted risk factors.

Table 2: Summary of conclusions on Stamp investments drawn by previous studies

Author(s) and date	Focus	Period	Return computation	Methodology	Conclusions
Taylor (1983)	Five most frequently traded US stamps (The 0.05$ 1847, 0.01$ 1847, 0.9O$ 1869, $3 1893, and $4 1893)	1963 - 1977	Estimation of quality-adjusted returns from signal extraction method on transaction prices.	The CAPM was used to see whether stamps had excess returns over NYSE stock returns.	Stamps, whit a mean return of 14.5%, showed no outperformance over the NYSE index over the same period. When Scott catalogue prices are used instead of auction prices, excess returns are found.
Cardell, Kling and Petry (1995)	43 different American stamps	1947 - 1988	Repeat sales regression from 20,693 auction prices .	A regression (like Fama-Schwert (1977)) is used to estimate and report the sensitivities of U.S. stamp prices to systematic economic risk factors.	Stamp returns are found to be highly positively related to expected inflation. Stamps are also negatively related to large capitalization stocks and to bonds, but positively related to small capitalization stocks. This suggests that stamps may be a substitute for small capitalization stocks, while acting as a hedge against movements in the large stock and bond markets.
Veld and Veld-Merkoula (2007)	SG 100 Stamp index	2002 - 2006	Actual prices of 100 of the world's most frequently traded stamps	The CAPM was used to see whether stamps had excess returns over stock market indices (FTSE 100, FTSE 350, S&P 500, Dow Jones Industrial Average, and the Russel 3000 index).	For UK investors, average monthly returns are found to be lower than returns on stock indices (0.58% against 1.11% and 1.24%) and so does not have yielded excess return. For US investors average monthly returns are found to be higher than on stock indices (0.229% and 0.237 above market returns predicted by the CAPM).
Dimson and Spaenjers (2009)	British collectible postage stamps	1900 - 2008	All Stanley Gibbons stamp price catalogues are used to create a price index.	Twelve buy-and-hold portfolios were constructed containing the 50 highest priced stamps. The portfolios returns were compared with bonds, bills and equity.	Stamp returns (annual 6.7% nominal) are found to be higher than those on bonds but below those on equities. The volatility of stamp prices are found to approach that of equities.

Table 3: Summary of conclusions on Art investments drawn by previous studies

Author(s) and date	Focus	Period	Return computation	Methodology	Conclusions
Anderson (1974)	Paintings in general	1952 - 1961	A hedonic price index was created from 1900 painting prices.	Average returns are created for different groups and years. Regression is used to look for driving factors.	Returns on paintings are found to depend heavily on size, artist and the year of transaction. Returns of 3.3% per year were found. Different schools show different results.
Frey and Pommerehne (1989)	Paintings in general (800 paintings)	1635 - 1987	A Repeat sales regression was used to track prices of painting that were at least sold twice.	Returns are calculated using buy-and-hold strategy of paintings for a period of 20 years.	Investments in art have found to become more profitable in post-war years. The results show that returns on art (1.4% - 1.7%) are below that of other financial assets. Transaction costs are considered.
Goetzmann (1993)	Paintings in general	1716 - 1986	A Repeat sales regression was used to create a price index.	Returns on art for three different periods (1716 - 1986, 1850 - 1986 and 1900 - 1986) are calculated and compared with Bonds and the London stock exchange.	Returns on art are calculated to be 2%, 3.8% and 17.5%. Returns over the last period outperformed those on stocks and bonds. The growth in the last period does not make art a viable addition for portfolios. This is due to high correlation with the stock market and high volatility.
Campbell (2006)	Paintings in general	1976 - 2004	Average prices were used to compute price indices. The indices were obtained from Art Market Research.	Three periods were investigated. 5, 10 and 25 years from 1976. Returns were compared with returns on equity, bonds futures and real estate.	With 6.5% 1.26% and 3.56% art returns only outperformed equity in the last 5 year period. Diversification benefits are found to be present due to high correlation. A portfolio can be improved by using art investments.

4 Methodology

As in many financial studies, a traditional mean-variance (MV) framework (also referred to as Modern Portfolio Theory) is used to construct optimal portfolios. In order to test our objectives, these optimal portfolios are compared. Firstly, the framework is described. Secondly, the mathematical notation is of the model is presented and specified. Finally, this section ends with possible biases that may arise when using this model and the underlying set of assumptions.

4.1 Mean-Variance framework

The MV framework is a simplification of reality in which investors only cares about the mean (excepted return r) and variance (risk σ) of their portfolio. The utility that an investor derives is assumed to be an increasing function of the mean and a decreasing function of the variance. One of the founders of modern portfolio theory (MPT) is Harry Markowitz. His work (dating from the 1950's) has had an massive impact on the theory of asset pricing and portfolio management. Today, many theories are still used by academics and practitioners worldwide. Markowitz was the first to recognize the importance of the combined effects of return, risk and co variances, when allocating wealth to various assets. This insight led to a strong focus on diversification possibilities of assets when constructing optimal portfolios.

The approach is to allocate wealth in such a way, that a set of portfolios is found that minimizes the level risk for a given rate of return. All these efficient portfolios can be plotted in a mean-variance frame which allows for a graphical representation[3]. The bullet shaped line in this graph is called the efficient frontier. These efficient portfolios can be constructed using an analytical approach developed by Robert C. Merton (Merton 1972). "Given the expected returns and the matrix of co variances of returns for n individual assets, find the set of portfolio weights that minimizes the variance of the portfolio for each feasible portfolio expected return". This analytical approach does not allow for a short sell constraint. Since we do not want to include the possibility of short selling, the solver function in MS Excel was used to compute optimal portfolio weights (brute force approach). The MV framework shows ex ante optimal portfolios an can indicate, what the actual portfolio weights should be.

As mentioned earlier, MPT allows for evaluating the expected return of (portfolio's of) assets according to their volatility (risk). In order to use this framework, we have to determine expected returns and their associated return distributions. The estimation of expected asset returns is considered to be of vital importance according to Chopra & Ziemba (1993) and Merton (1980).

[3] See Appendix A for a graphical representation of a MV efficient frontier in a MV framework

Small differences in expected returns can be of major influence on the optimal portfolio weights. If the estimations on expected returns are based on time-series information only, portfolio's are found to be far removed from the 'real' optimum. Frahm (2010) investigated risk functions of 5 standard estimators for expected asset returns that are frequently used in financial studies. Frahm (2010) found that, the CAPM (which estimates betas) is preferable over the other estimators (Sample Mean, Bayes-Stein and James-Stein). This method ,however, brings two problems. Firstly, in order to estimate betas one has to determine the return and risk of the true market portfolio. Secondly, a mean-variance efficient portfolio satisfies the CAPM equation exactly. Mean-variance efficiency of the market portfolio is equivalent to the CAPM equation holding. The latter is a mathematical fact. In financial economics, these problems are often referred to as Roll's critique, Roll (1977).

Clark and Kassimatis (2006) cope with these problems by constructing a world market portfolio (WMP) from macro-economic cash flow data instead of using some index as proxy. Clark and Kassimatis argue that if the market portfolio is represented by the total value of an economy, since it includes all assets. The authors constructed a proxy for the market portfolio and tested it for efficiency. From now on we will refer to this proxy as the Clark Kassimatis World Market Proxy (CKWMP). Clark and Kassimatis (2006) find that the proxy is efficient with respect to a broad range of assets including, money markets, bonds, stock market indices, commodities and real estate. They show that the CKWMP is a powerful forecasting tool for constructing optimal portfolio's.

In this thesis we will use two different approaches to determine expected returns.

Firstly, like Campbell (2007) and many others we will use historical sample means as estimator for expected returns.

Secondly, we will use betas on the CKWMP as estimator for expected returns. We use the capital asset pricing model (CAPM) to estimate the various betas.

4.2 Notation and definition

Among different studies various notations are used to specify the same model. We use specification and definitions according to the ones proposed by Pennacchi (2008).

Let $\bar{R} = (\bar{R}_1, \bar{R}_2, \dots, \bar{R}_n)'$ be an *n x 1* vector of the expected monthly returns of the *n* assets. Also let V be the *n x n* covariance matrix of the returns on the *n* asset class. There are no identical assets in terms of covariance included in V. Put differently, there is no asset class (or an exact linear combination of asset classes) included, of which the returns have a perfect positive correlation with returns of another class. Asset classes that have this specific characteristic can be left out, since they provide no additional value to the efficient frontier.

Now let, $\omega = (\omega_1, \omega_2, \dots, \omega_n)'$ be an $n \; x \; 1$ vector of portfolio weights, such that ω_i is equal to the fraction of wealth invested in the *i*th asset class. The (ex ante) return on the portfolio is given by

(1.) $\bar{R}_p = \omega' \bar{R}$

And the variance of the portfolio return is given by

(2.) $\sigma_p^2 = \omega' V \omega$

Since all wealth has to be allocated to an asset class, total portfolio proportions should sum to 1. This constraint can be stated as $\omega' e = 1$ in which *e* is defined as an *n x 1* vector of ones. The set of MV efficient portfolios can be found using quadratic optimization, with the constraints: return = $\bar{R}_p$, portfolio weights sum to one $\omega' e = 1$ and portfolio weights are positive for every asset class $\omega_i \geq 0 \; \forall_i$ Mathematically this can be written as

(3.) $\min_\omega \frac{1}{2} \omega' V \omega + \lambda \left[\bar{R}_p - \omega' \bar{R} \right] + \gamma [1 - \omega' e]$

In which V represents the variance covariance matrix of the available asset classes.
The first order conditions (set derivatives to zero) with respect to ω and the Lagrange multipliers, $\lambda \; and \; \gamma$ are then

(4.) $V\omega - \lambda \bar{R} - \gamma e = 0$

(5.) $\bar{\bar{R}}_p = \omega' \bar{R} = 0$

(6.) $1 - \omega' e = 0$

When solving (4.), optimal portfolio weights are given by

(7.) $\omega^* = \lambda V^{-1} \bar{R} + \gamma V^{-1} e$

Solving for $\lambda \; and \; \gamma$ and substituting in (7.), optimal portfolio weights are given by

(8.) $\omega^* = \frac{e' V^{-1} e \bar{R}_p - \bar{r}' V^{-1} e}{\bar{r}' V^{-1} \bar{r} e' V^{-1} e - (\bar{r}' V^{-1} e)^2} V^{-1} \bar{r} + \frac{\bar{r}' V^{-1} \bar{r} - \bar{r}' V^{-1} e \bar{R}_p}{\bar{r}' V^{-1} \bar{r} e' V^{-1} e - (\bar{r}' V^{-1} e)^2} V^{-1} e$

In which $\bar{r}$ stands for the expected monthly return of the asset classes, $\bar{R}$ stands for the required return on the portfolio and V^{-1} stands for the (inverse) of the covariance matrix. The formula (8.) can be simplified, in such a way that it contains more scalars[4] yielding less matrix notations. The formula that remains after simplification is

(9.) $$\frac{\delta \bar{R}_p - \alpha}{\zeta\delta - \alpha^2} V^{-1}\bar{r} + \frac{\zeta - \alpha\bar{R}_p}{\zeta\delta - \alpha^2} V^{-1}e$$

The variance of an efficient portfolio is given by

(10.) $$\sigma_p^2 = \omega^{*\prime} V \omega^*$$

Short selling is considered not to be possible in this study. Our objective is to investigate positive investment proportions, because longer holding periods are assumed. In reality, short selling is often not feasible due to high cost and other barriers. Moreover, the allowance of short selling cannot improve this thesis, because the objective is to see whether acquiring collectibles can provide benefits, and not selling (naked) any asset. Portfolio proportions should all be higher than 1. This constraint can be stated as $\omega_i \geq 0 \; \forall_i$ in which ω is the proportion of wealth invested in every i^{th} asset class. Solving for the optimal portfolio is not longer possible mathematically, due to the latter constraint.

The database program excel was used to solve the equation (brute force method). For every given required return the software is able to compute the optimal portfolio weights for every asset class. Only the first 6 equations are of use. The program requires expected return of the asset classes and their accompanying standard deviations. As mentioned in section 4.1 we will use two different methods to determine expected returns. The first using historical returns and the second using betas.

When optimal portfolios, with and without collectibles, are constructed their performance needs to be compared.
To observe the effect of adding collectibles to the portfolio and to test whether the effect is statistically significant, a method is needed that can test the risk efficiency of a portfolio.

Sharp's ratio founded by W.F. Sharpe is a measure of performance that considers both risk and return simultaneously.

[4] Explanation on the computation of alpha zeta and delta can be found in appendix B

Sharp's ratio measures the excess return of a portfolio per unit of risk. The formula is adjusted, so that Sharp ratio's can be calculated for any given required return. In our case, Sharp's ratio can be defined by

(11.) $$S_i = \frac{(\bar{R}_p - R_f)}{\sigma_i}$$

In which S is the Sharpe ratio, $\bar{R}_p$ is the required return on the portfolio, R_f is the Return on a risk free benchmark and σ_i is the standard deviation of the portfolio i. The higher the Sharpe ratio the more risk efficient the portfolio. To test whether the Sharpe ratio of the portfolio with collectibles included is significantly higher than the portfolio containing traditional asset classes only, we use a test created by Jobsen and Korkie (1981). This method tests for the equality of Sharpe ratios of two portfolios. The test statistic can be formulated as

(12.) $$Z = \frac{\sigma_a(\bar{R}_p - R_f) - \sigma_b(\bar{R}_p - R_f}{\sqrt{\theta}}$$

In which σ_a is the standard deviation of the portfolio with collectibles included and σ_b is the standard deviation of the traditional mixed asset portfolio. R_f is the Return on a risk free benchmark, in our case this is the US 3 Month Treasury Bill rate. The monthly mean (log) return of this rate over the 25 year period is 0.34 %. We adjusted this to 0.30 %, because this return is not absolutely risk free. We are confident that the 0.04% reduction takes care of the default risk. θ is calculated as follows

(13.) $$\theta = \frac{1}{T}\left[2\sigma_a^2\sigma_b^2 - 2\sigma_a\sigma_b\sigma_{ab} + \frac{1}{2}\bar{R}_p^2\sigma_b^2 + \frac{1}{2}\bar{R}_p^2\sigma_a^2 - \frac{\bar{R}_p^2}{2\sigma_a\sigma_b}(\sigma_{ab}^2 + \sigma_a^2\sigma_b^2)\right]$$

Where T is the number of monthly observations, σ_b, σ_b are the standard deviations on the past returns on the new portfolio a and the traditional portfolio b. σ_{ab} is the covariance of the returns between portfolio a and b over the 25 year sample period. Jobson and Korkie (1981) show that the test statistic Z is approximately normally distributed, with zero mean and standard a deviation of 1. Significant Z statistics reject the null hypothesis of equal Sharpe ratios.

When the Sharp ratio of the portfolio with collectibles is statistically different from the Sharp ratio of the traditional mixes asset portfolio, we can conclude that improvements on the portfolio are significant when including collectibles. We will test this for every required return that is part of the efficient set.

Formally the testable hypothesis becomes

$$\textit{Alternative hypothesis: } H_a: S_b < S_a$$
$$\textit{Null hypothesis: } H_0: S_b = S_a$$

For every required return $\bar{R}_p$.

4.3 Assumptions and possible biases

An advantage of (normative) modern portfolio theory, is the fact that it focuses on the investment opportunities of a single agent. Therefore, it needs fewer assumptions than a model which describes the entire market. There are, however, a couple of important assumptions underlying the MV framework. Some of the assumptions are more controversial than others. The assumptions that we consider to be of vital importance for our study are the following:

I. Investors prefer more to less

This assumption is referred to as the nonsatiation assumption. In the case of MPT this means that ,everything else equal, the portfolio with higher expected returns is preferred over a portfolio with lower expected returns. The objectives of our study are consistent with the assumption of nonsatiation, since we assume a US investor who wants to maximize his returns.

II. Utility is a function of mean and variance only

This means that an investor can only derive utility from returns. Other objectives (social, moral etc.) are not taken into account. In reality, these goals may be there. As mentioned in section 2.2, it might well be possible that one derives utility from things other than return. Looking at a painting or stamp collection for example. By using indices on collectibles, rather than investments in physical objects we overcome this issue. Our objectives are purely from a financial point of view.

MPT defines risk as the variance on returns. This method of measuring risk is widely criticized. As many academics, we consider variance as being a believable risk measure.

III. Agents act rationally and are risk-averse

A risk averse investor dislikes risk. This means that ,everything else being equal, an investor will prefer a portfolio with lower volatility over a portfolio with higher volatility. Investors will only be prepared to take on more risk when they are compensated by higher expected returns. In reality, investors could be risk seeking.

Behavioral finance shows that people tend to be risk averse with respect to gains and risk seeking with respect to losses Kahneman and Tversky (1979). Prospect theory describes and explains this behavior. The authors conclude that investors do not act rationally when it comes to gains and losses. Because investors always have to do with gains and losses, this assumption may lead to biased outcomes. Because our objective is to compare portfolios and not to study behavior, we are confident that our results will not be influenced by this assumption.

IV. The investors' objective is to maximize utility, and they will do so for one period

The assumption that one wants to maximize returns is very reasonable for most investors. In the MPT framework returns represent wealth. Maximizing wealth is an objective that has commonly been accepted in financial theoretical frameworks since Adam Smith (1776). As stated before, we are not interested in moral or social behavior influencing investment decisions. MPT assumes that investors optimize portfolios according to their 1 period investment horizon. In our case, portfolios are optimized for 4 different periods.
This allows for a comparison between different periods and results. We expect no biased outcomes due to this assumption.

V. Returns are normally distributed

A normal distribution can be described by two parameters. In the case of MPT these are mean and variance. From those two parameters the entire distribution can be constructed. Assumption II already stated that only mean and variance are assumed to have influence on the risk return relationship. Unfortunately, the assumption that returns are normally distributed often proves to be wrong when it comes to financial data. This problem was recognized soon after Harry Markowitz presented his theories in the early fifties. Mandelbrot (1963) found that empirical distributions of price changes are too peaked compared to samples from a normal distribution. Fama and Miller (1972) found empirical evidence for common stock and bond return distributions being non-normal. Statistical financial data suggest fat tails and asymmetry (There are more extreme outcomes then one would expect according to the normal distribution and returns are not evenly spread around the mean). As a result, the MV portfolios are not efficient to their effective risk profile (especially when it comes to tail risk). There is no answer to this problem other than being cautious when interpreting outcomes. Like Campbell (2007), we recognize the problem but leave interpretations to the reader. For the comparison of different portfolios, the lack of normality might be of less importance. Both portfolios are constructed using returns that are not normally distributed. The return distributions are tested for normality in section 6.1.

5 Data

As in most financial empirical research, return data is needed to test implications. In the case of this thesis, there are data on past returns on various asset classes including the asset class collectibles. Return data on traditional asset classes are not hard to come by in contrast with the data on alternative class collectibles. An investor can easily allocate wealth to equity or debt by buying stocks or bonds on any exchange market. Direct investment in other asset classes, for example in real estate or commodities, is traditionally harder to obtain. A solution for this problem is the existence of exchange traded funds (ETF's). Deville (2006) wrote an excellent survey on these products.

ETF's allow exposure to assets without actually holding the underlying products. ETF's simulate the performance of their benchmark as close as possible. The suppliers[5] of these products cover the underlying value. In this way one can invest in a country's stock market index without holding all the stocks, or invest in commodities without having to buy and hold the physical product. Major advantages for investors are in terms of transaction costs, tax efficiency, transparency and minimal management fees. Since the introduction of ETF's, allocating wealth to various asset classes has become cheaper and accessible. This has led to more efficient markets and portfolios. Since the introduction in the early 90's, ETF's have continued to grow significantly. They grew both in number and diversity of products as in terms of assets and market value. ETF's originally tracked major stock market indices. Today, indices on international markets, fixed-income instruments and commodities are replicated. The underlying value in the latter case is based on futures rather than actual prices. The unique trading process of ETF's allows for many things as underlying value, even purely hypothetical assets. For most of the asset classes in this study ETF's exist. For collectibles however this is unfortunately not the case. The answer to this problem is relatively straightforward. In this thesis indices on collectibles will be treated as if they were traded as ETF's.

5.1 Collectible indices

Ginsburg, Mei & Moses (2005) point out that there are no major characteristics that inhibit art from being considered as a financial asset. This basically goes for every alternative asset class. There are ,however, a couple of differences with the traditional assets discussed in the previous section.

Firstly, the assembly of reliable performance data on collectibles is more difficult. This is mainly due to heterogeneity and low trading frequency.

[5] A list of suppliers of Exchange traded product is provided in appendix C

Prices of collectibles are traditionally computed by using auction sales prices. Those prices are used to compute indices. There are four common methods for constructing market price indices; hedonic regressions, repeat sales regressions, geometric means and average means. Chanel, Gerard-Varet and Ginsburgh's (1996) find that the mentioned methodologies are highly correlated in the long run. According to Campbell (2006), both the use of repeat sales regression and average prices provide good proxies of art market prices of auction sales data. Therefore, the way that indices are computed is considered not to be vital. Biases in the dataset that are thought to have significant influence are discussed more broadly later on in this thesis.

Secondly, as mentioned earlier, currently there are no ETF's available on the collectibles used in this thesis. This problem is solved by treating indices as if they were available on an exchange market in the form of an ETF. This assumption may be more viable than cynics might think. Suppliers of ETF's could theoretically introduce a fund as long as there is both demand for selling and buying the product in the secondary market. The creator has to guarantee the underlying value. Linking risks of hypothetical underlying values to financial securities is not a new idea. Managing risk for exposure to longevity has been of major interest of life assurers, annuity providers and pension plans. Blake, Cairns & Dowd (2006) investigated ways to control these risks. Both , hypothetical an real existing, mortality linked securities were analyzed. Blake et al conclude that implementing securities on indices with hypothetical value will bring some problems. These problems are ,however, not insurmountable and are believed to be solved in the future.

The Mei Moses and AMR art indices are two of the most used indices for determining art market performance. Both use sales data from major auction houses to construct indices. Data from AMR is more detailed and more frequent. In this study ,Following Campbell (2007), indices from AMR are used as a proxy for various art market prices. AMR has a very extensive database, which allows for a division into different sectors.

There are a couple of corporations that provide wine indices. The London International Vintners Exchange for example provides data on the hundred most traded wines. The index is computed by average prices between bid and ask on their own trading platform. This method hasn't proved to be a good way to construct a representative index by any study yet. Other providers of indices on wine use either blurry methodologies or use results of their own specific wine portfolio. Because a general, representative view is preferred, again a Index from AMR was purchased.Stamp indices are rare. Stanley Gibbons (SG) is maybe one of the most famous names when it comes to Stamp prices and investments. Two of their most well-known indices are the SG100 and the SG GB30.

The SG100 is based on prices of the 100 most frequently traded stamps worldwide. Veld (2007) used the SG100 index to study the diversification benefits of stamps. The index was introduced in 2002 on an annual basis and is on a monthly basis from the year 2005. Both characteristics make it useless for this thesis. For our study data back to 1985 is required and preferred on a monthly basis. The Great Brittan (GB30) index is the second index from Stanley Gibbons. This index aggregates the catalogue prices for 30 rare British high-value stamps. The SG GB30 was only introduced in 2004. Again this relatively small dataset makes it not useful for our research. AMR provides a monthly index on stamps that goes back to 1985. Again their index was obtained to use in our study. Table 1 shows some figures on the Indices.

5.2 Art indices

On art, four different indices were purchased; the General Art 100 index, the Euro 19th-Century index, the Old Masters 100 index and the Contemporary art 100 index[6]. The art index for a group represents a comparison on the average market values of paintings in that group, relative to their value in the base period (1985). This allows for a comparison among groups and over time.

The General Art 100 index is based on 78 individual artists indices and two group indices (Old Masters and Victorian group). Each individual artist index is given a weight of one, the Victorian group a weight of two and the Old masters group an weight of twenty. The Victorian group contains eight artists, where the Old Masters group contains twenty. The Victorian artists representing the respective group are therefore underweighted. This weighting is considered to be appropriate by AMR. The Euro 19th-Century index contains sales values from 96 individual artists, the Old Masters 100 index contains data from 100 individual artists and the Contemporary art index includes data from 192 individual artists.

Individual artists indices are based on average selling prices over 12 consecutive months. For each artist selling prices are recorded (from the period 1985 until the present) in Great Britain Pounds (GBP). The month of the sale is documented, which leads to monthly data. Selling prices in other currencies are converted into GBP using the exchange rate of the specific transaction date. When the number of records does not justify the construction of an individual index, the data are pooled. The pooled data are then treated as those for an individual artist. To eliminate the extreme values, which can lead to distortion of the general view, the data are trimmed. The ten percent largest values and the ten percent smallest values are ignored. This percentage may vary according to the number of extreme values in the data. The exact percentage was not provided per index. For every artists, the average of the sales values is calculated per month.

[6] A list of the components that are included in the index can be found in appendix D

This average is associated with the last time point in the 12-month period. To capture trends in the dataset, values are smoothed. The average of the current month is averaged with the previous 5-month trend values, this becomes the moving average of the current month. The index is computed as the ration of this moving average compared to that of the based period and multiplied by 1000. The value of the base period (Jan 1985) is therefore 1000. The construction of group indices is similar to that of individual artist, only now the individual means are averaged to make a group index.

5.3 Wine- and Stamp indices

For both wine and stamps, a single index was acquired; the vintage Bordeaux index and the Stamps World Index. Again, the index represents a comparison on the average market values of respectively wine and stamps, relative to their value in the base period (1985). The Bordeaux wine index contains values of 27 (Chateaux) Bordeaux wines. The Stamps world index contains values of approximately 250 Stamps from Europe, Asia and North America . The components of this index are not separately listed like other indices. Unlike on Art, indices on wine and stamps are constructed by using both actual selling prices and valuations made by experts. The database used consist of 12-montly intervals of valuations on the components. The computation of the indices is the same as on the previous Art indices. Again valuations are given in GBP. Some general figures are given in table 4.

Table 4: general figures AMR indices

Index	Art 100	19th Century	Old Masters	Contemporary	Stamps	Bordeaux
Price Bracket	Central 80%	Central 80%	Central 80%	Central 80%	Central 80%	100%
Works sold	99068	49217	20367	29964	N/A	313
Current index	6712	4389	6272	9693	2174	8727
Change 1-'85 2-'10	571,20%	338,90%	527,20%	869,30%	117,40%	772,70%

5.4 Modifications

In order to make the indices from AMR valuable for this study, and other financial applications for that matter, some modifications were made.

Firstly, the AMR indices are based on prices and valuations in GBP. Because we look at the investments opportunities from a US investors perspective, the index had to be converted into USD. Monthly average USD/GBP exchange rates were used to create USD based indices. The data were collected from the Bank of England's website.

Secondly, for all indices, returns are calculated using continuously compounded returns. This is found to be more appropriate than measuring cumulative returns and is often used in financial economics.

The returns are computed by

(14.) $$r_{it} = ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right) x\ 100$$

In which the return is the natural log return of the index at time t, such that r_{it} is the monthly return of the i[th] index.

Third, the AMR indices are modified in such a way that the base date (Jan 1985) takes the value 10000. Similar to the indices on traditional asset classes earlier, this allows for an evaluation of an initial investment of $ 10,000 into the respective asset class. Additionally, monthly returns were computed for every index.

Finally, in order to capture trends, AMR indices are smoothed, because they use moving averages. This technique has the side effect of generating volatilities which are considerably lower than the actual volatility present in the market. Indices based on valuations are generally believed to be smoothed. While smoothing of returns is often studied in relation to real estate and hedge fund indices (e.g. Geltner , MacGregor and Schann (2003)), smoothing is also found to be present for returns (indices) on other asset classes including collectibles, according to Campbell, Koedijk and de Roon (2008). Because we concentrate on investment opportunities in a MV framework, the use of actual volatilities is considered to be of vital concern. Section 5.5 elaborates on unsmoothing returns.

5.5 Unsmoothing AMR returns

There are several techniques that can be used to unsmooth returns, and that can cope with the underlying autocorrelation. Famous methods are created by Geltner (1993), Kat & Lu (2002) and Okunev and White (2003). We use the simple reversed engineering model from Geltner to unsmooth the AMR returns. The model is both easy to implement and simple to interpret. The model of Geltner can be defined by

(15.) $$R_t^0 = (1 - c_1)R_{1,t}^c + c_1 R_{t-1}^0$$

In which R_t^0 is the smoothed return, R_{t-1}^0 is the previous smoothed return, $R_{1,t}^c$ is the unsmoothed return (the subscript 1 indicates, that the returns are corrected for the first time) and c_1 is the weighted coefficient. The unsmoothed return is thus given by

(16.) $$R_{1,t}^c = \frac{R_t^0 - c_1 R_{t-1}^0}{(1-c_1)}$$

In fact, c_1 is equal to the autocorrelation coefficient of the first order AR (1) denoted by ρ_1^0. Finally the returns are unsmoothed according to

(17.) $$R_{1,t}^c = \frac{R_t^0 - \rho_1^0 R_{t-1}^0}{(1-\rho_1^0)}$$

As suspected, the unsmoothing process has had a major influence on the variance of the AMR indices. After removing first order autocorrelation, we have 298 months of return data on the AMR indices, starting from Feb. 1985. Four out of six AMR indices showed statistically significant (0,01 level) first order autocorrelation. The Old Masters index and the Contemporary Art index did not suffer from autocorrelation and did not need to be unsmoothed. The results of unsmoothing the other four indices can be gathered from table 5 & 6. The standard deviations (σ) are considerably higher after unsmoothing, where the means show a negligible increase. The higher risk is not accompanied with significantly higher returns. In our framework this means that, after unsmoothing, these assets have become less attractive to investors. Unsmoothing is found to be of major influence on especially Stamps and Vintage Bordeaux. Inquiry about this at AMR, learned us that both indices are far more exposed to valuation from experts that the other AMR indices. This is mainly caused by the relatively low number of transactions on the respective assets.

Table 5: Smoothed AMR (log) returns in % per month

		Minimum	Maximum	Mean	σ
Art 100		-26,06	18,14	,63	4,78
European 19th Century		-18,44	13,36	,49	3,98
Old Masters		-20,96	17,22	,62	5,36
Contemporary Art		-44,11	34,20	,75	7,76
Stamps World		-2,60	2,67	,27	,96
Vintage Bordeaux		-2,17	4,11	,73	1,30

Table 6: Unsmoothed AMR (log) returns in % per month

	ρ_1^0	Minimum	Maximum	Mean	σ
Art 100	0,246*	-34,16	23,89	0,63	6,15
European19th Century	0,153*	-22,42	15,35	0,52	4,65
Old Masters	-0,029	-20,96	17,22	0,6	5,36
Contemporary Art	0,057	-44,11	34,2	0,74	7,79
Stamps World	0,93*	-13,9	18,38	0,41	4,61
Vintage Bordeaux	0,916*	-36,31	29,4	0,85	5,99

*Significant at 1% confidence level

5.5 Traditional asset classes

For the construction of the traditional mixed asset portfolio, indices are used as proxies for past returns of the respective asset class. All the indices can be traded on market exchanges either directly or in the form of ETF's or mutual funds. The asset classes in the mixed asset portfolio include global equity, corporate bonds, real estate, commodities and hedge funds. Proxies for the performance of the respective class are the following. To represent global equity: Morgan Stanley Capital Indices (MSCI World, MSCI Europe, MSCI Pacific and MSCI North America), the Dow Jones Industrials and The NASDAQ 100. Proxy for corporate bonds is the: US CITIGROUP CORPORATE - AAA/AA 1-10 YEAR. FTSE NAREIT provide data on real estate investment trusts as proxies for real estate returns (Equity, Mortgage, Hybrid and All). The Standard & Poors Goldman Sachs Commodity Index (S&P GSCI Commodity Total Return index) and Moody;s commodities index represent returns on commodities. Three month US treasury bills were used as representative of the risk free object. Finally, to estimate global hedge fund performance, the Credit Suisse/Tremont Hedge Fund Index was used. Apart from the government bills and the Credit Suisse/Tremont Hedge Fund Index, DataStream was used to gather the data. The government bills data was collected via the H. 15 release of the federal reserve[7]. Data on the Credit Suisse/Tremont Hedge Fund Index were obtained from their website[8].

5.6 Modifications

The collected data did not need crucial adjustments to make them viable for this thesis. Data on all indices are provided on a monthly basis and in USD. For all indices, returns are calculated using continuously compounded returns. This is thought to be more appropriate than measuring cumulative returns and is often used in financial economics. The returns are computed by

(18.) $$r_{it} = ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right) x\ 100$$

In which the return is the natural log return of the index at time t, such that r_{it} is the monthly return of the i^{th} index. Next, all indices are modified in such a way that the base date (Jan 1985) has the value 10000. This allows for an easy evaluation on the development of an initial investment of $ 10,000 into the respective asset class.

[7] Source: http://www.federalreserve.gov/releases/h15/data.htm
[8] Source: http://www.hedgeindex.com

5.7 Possible biases

It is hard to estimate the development of prices of a whole asset class. Collectibles are no exception. When there are no concrete true price data available one will have to do with the next best thing. In our case we use AMR indices as proxies for the price development of collectibles. Biases can lead to misinterpretation of results. Therefore we discuss what we consider to be the most important biases that can occur by using AMR indices.

Firstly, AMR indices are constructed using both valuations as sales prices. When a downturn of the market for the particular asset takes place, this will lead to increased illiquidity. More unsold items at auctions (reserve price not met) lead to fewer transactions. Less transactions increases the estimation error. Mei & Moses find that returns on art seem significantly higher during times of war. The lack of liquidity in failing markets was also recognized by Campbell (2006). There have been no suggestions how to deal with this problem yet. As methods to create indices are becoming more and more sophisticated, we are confident that this bias will disappear in the future.

Secondly, indices on collectibles may be an incomplete representation of real values. Not all Sales on art, wine and stamps are recorded. Private deals or the dealer market are ignored by AMR which mainly uses information from auction houses. We are convinced ,however, that when collectibles get more attention from the financial point of view, indices will become more representative. Increased intention from investors will undoubtfully lead to more sophisticated valuation methods. It is likely that prices on different markets (auctions, dealers and private) will become equal (arbitrage mechanism). For now, we pretend if the AMR markets represent the full market.

When one chooses to invest directly into collectibles, other problems may arise. You can think of transaction, transportation and storage costs. Also the state of the collectible is a very important indicator for the price. By the state one can think of, damages or completeness. The last problem is that of counterfeits. Collectors items are often subject of copying, which may lead to objects that are invaluable. Because we treat indices as if they were available as ETF´s, we do not have to deal with these problems.

6 Results

6.1 Test on return distributions

The MV criteria are only correct when returns follow a normal distribution. To test whether a distribution deviates from a normal distribution one can perform a Kolmogorov-Smirnov test or a Shapiro-Wilk test. These tests produce p-values, that can be interpreted according to the readers desired level of significance. We reject the null hypotheses of normality at the 95% confidence level. We performed both tests on our dataset. The results are presented in Table 7[9]. According to the test results, none of the distributions is normal according to both tests. We find mixed results for 4 indices; The MCSI Pacific index, the corporate bond index US CITIGROUP CORPORATE - AAA/AA 1-10 YEAR (USBC2A110) , the 5 year US treasuries index and the Stamp World index from AMR. Skewness and Kurtosis values are presented to indicate in what respect the distribution deviates from normality. Under normality, skewness should be 0 and Kurtosis should be 3. The absence of normality for the return distributions may lead to an underestimation of risk. Therefore, one should be cautious when interpreting results on numbers of variance (risk).

Table 7: Tests of Normality

Asset	Kolmogorov-Smirnova	Shapiro-Wilk	Skewness	Kurtosis	Reject Normality
MSCI_World	,001	,000	-,788	2,414	yes
MSCI_Europe	,000	,000	-,869	2,396	yes
MSCI_Pacific	,200	,035	-,153	1,118	no/yes
MSCI_NAmerica	,000	,000	-1,122	4,353	yes
DOWJONES	,001	,000	-1,073	4,726	yes
NASDAQ_100	,000	,000	-,647	2,191	yes
USCG Corporate	,200	,000	-,563	4,493	no/yes
Three_monthUSTbill	,000	,000	-,284	-,629	yes
S&P_GS Commodities	,001	,000	-,777	3,905	yes
Moody's Commodities	,002	,000	-,272	4,554	yes
NAR_Mortgage	,000	,000	-1,026	3,410	yes
NAR_Hybrid	,000	,000	-,780	8,395	yes
NAR_All	,000	,000	-1,899	18,805	yes
NAR_Equity	,000	,000	-2,045	20,348	yes
Art100Index	,000	,000	-,530	6,684	yes
European19thCentury	,000	,000	-,082	3,095	yes
OldMasters	,000	,000	,026	2,522	yes
ContemporaryArt	,000	,000	,142	7,346	yes
Stamps_WorldIndex	,200	,010	,268	1,163	no/yes
VintageBordeaux	,000	,000	-,204	9,167	yes
CS_TR_Hedge	,000	,000	-,354	2,569	yes

*Significant on 5% confidence level

[9] See appendix E for more detailed results.

6.2 Performance evaluation

In this section we will evaluate the past performance of all assets. To do so, we distinguish 3 different periods. The first period is the total sample period of 298 months (almost 25 years) dating from February 1985 until November 2009. This period captures a couple of major events; Black Monday October 19 1987, The dot-com bubble and burst 1995-2000, The terrorist attacks of September 11 2001 and the current financial crisis 2007-2010. We will evaluate the performance of collectibles during one of these periods in section 6.5 in more detail. We calculate past performance over different time horizons. Three periods of approximately 8 years each are considered. Statistics for 96 consecutive months from December 1993 and 192 consecutive months from December 1993 are computed. The periods of 8 years and 16 years include returns on hedge funds, which are only available from December 1993. Table 5 at the end of this section shows the descriptive statists of all the assets. In addition, statistics on US CPI[10] (proxy for inflation) are included. We can see some quit remarkable things in this table.

Most of the extreme outcomes are found in the recent 8 years. For that reason, 11 out of 14 traditional assets have had the highest volatility in the recent eight years. Only the MSCI_Pacific, The Nasdaq 100 and the proxy for hedge funds showed higher volatility on longer periods. For the collectibles indices however, highest volatility was shown in the recent 8 years for only half of them.

For the 25 year period every asset but Mortgage- and Hybrid Reits outperformed both the 3 month US T-bills and Inflation (CPI). The Nasdaq was the index that showed the highest return, with an average monthly return of 0.89%, followed by the Vintage Bordeaux index yielding a monthly average return of 0.85%. The lowest returns over the 25 year period were Mortgage- and Hybrid Reits (0.26 and -0.01 %), followed by the world Stamps index (0.41%).

For the 16 year period every asset but the Hybrid Reits and the MSCI Pacific outperformed both the 3 month US T-bills and Inflation (CPI). The Vintage Bordeaux (0.98%) index yielded the highest return, followed by the Nasdaq 100 (0.79%). The lowest returns over the 16 years period were Hybrid Reits (0.13) and the MSCI pacific index (-0.01), followed by the World Stamps index and MSCI World index (both 0.36%).

For the 8 year period, 5 indices did not outperform inflation. All equity indices, except the MSCI Pacific index and the MSCI Europe index are amongst them. All six collectible indices were amongst the 8 asset with the highest return. Moody's Commodities index yielded the highest return (1.35%).

Hybrid Reits had the lowest return (-0.52%) followed by the MSCI North America index (0.04%), the Dow Jones index (0.07) and the Nasdaq 100 (0.14).

[10] Data obtained from U.S. Department Of Labor Bureau of Labor Statistics Source: http://www.bls.gov/CPI/

Figure 1 gives give a graphical representation of the performance of 10,000 $ invested in one index from every asset class[11].

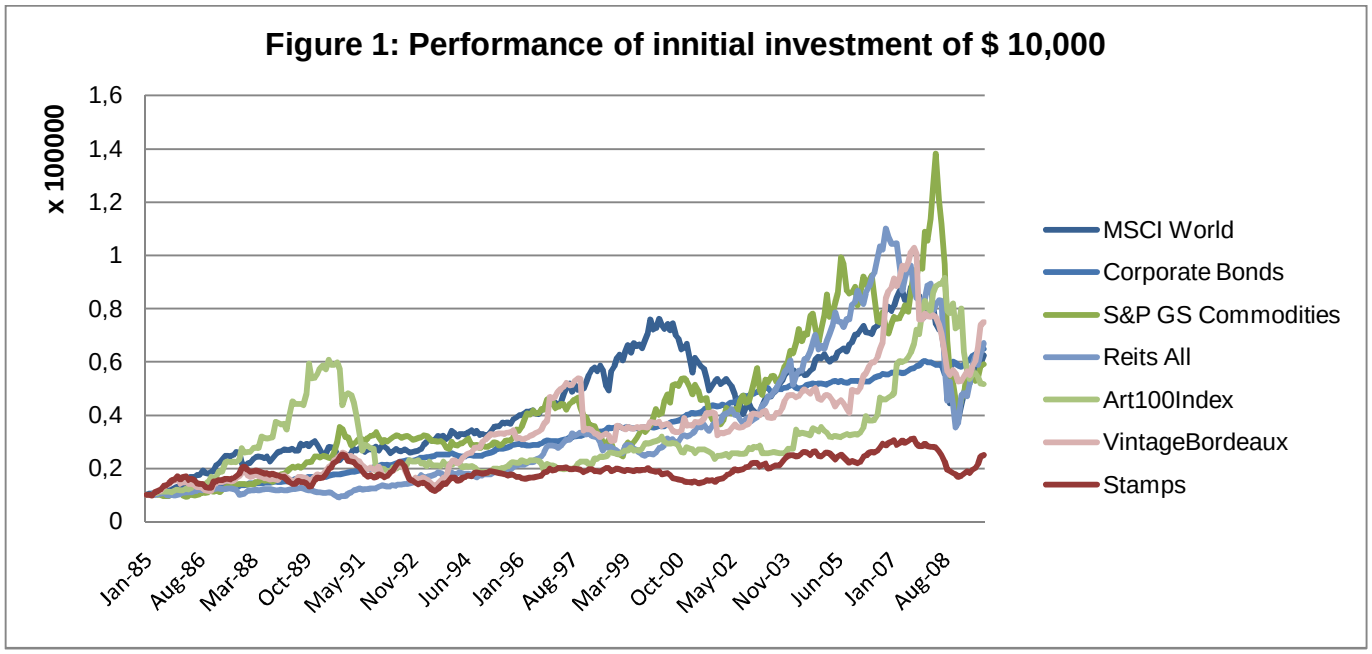


Figure 1 shows some interesting things. From this figure it is clear that the most recent financial crisis has had a different effect on various asset classes. All asset classes showed at least some decline during the 2007-2008 period. The moment of declines differ widely across various classes. Real estate (represented by Reits) was the first asset class that declined, followed by equity and Bordeaux wines. It took about a year for the commodities and Art 100 index to show losses.

Direct economic reasons for the moment of decline are not hard to come by. The burst of the house price bubble in the US led to the decline in Reits. Homeowners were not longer able to pay their mortgages an defaulted on their mortgage. These mortgages were repacked and sold to different parties (mainly financial institutions). When Banks began to fall, liquidity dried up in equity markets which led to an decline in equity prices and Bordeaux wine prices. Next, businesses worldwide suffered from the crisis. Sales and productivity dropped in most industries. This low productivity led to an decreasing demand for energy and thus for oil. The decrease of the oil price (2008) led to a sharp decline of commodities index. The components of the S&P GS commodity index are for 70% energy related (36,4% oil). Performances and correlations across various assets classes during this period are more widely discussed in section 6.6.

[11] Figures for every separate asset class can be found in appendix F.

The Dot-Com bubble of the late 1990's is illustrated by the increase and decline of the MSCI World index over that period. The effect of the 1998 Long Term Capital Collapse is also noticable in that same index. One of the largest hedge funds in the US, LTCM, collapsed triggering a $ 3.5 billion bailout by a consortium of major US Financial institutions. Stocks in the US and Europe dropped.

Apart from these events there are two bubble like patterns observable for The Art 100 index and the Vintage Bordeaux index.

For the Art 100 index this pattern exists during the period 1988-1991. This period coincides with the Japanese asset price bubble. According to Money Week this is no coincidence , *"Japanese investors piled into the art market, snapping up trophy art to show off the money they had made on the Tokyo stock market*[12]*".* When Tokyo's asset bubbles burst in 1990 the the whole Japanese nation was dragged into deflation as a consequence the turnover in fine-art auctions worldwide sank by some 60%.

For the Vintage Bordeaux index, a bubble like pattern is visible during the period 1997-1998. This period coincides with the 1997 Asian financial crisis. The same reasoning as for the Art market and Japanese investors could be applicable.

When comparing performances between different asset classes it is important to take risk into consideration as well. Risk-adjusted returns, as measured by Sharpe's ratio provides a tool to do this. Equation (11) in section 4.2 shows how this ratio is computed. Basically, the ratio allow us to compare returns adjusted for the risk (volatility). Returns are compared with the risk and return of a benchmark. Our benchmark is the US 3 month treasury bill. The Sharpe ratios for every asset are also presented in table 8.

We see that within the traditional asset classes, Citigroup's Corporate bond index was amongst the best 5 performers for every period. Moody's commodities index performed good over the last 16 years. The Dow Jones index and the MSCI Europe index showed good performance over the long 25 year period. Mortgage and Hybrid Reits are found to be amongst the worst performers for every period. Equity indices showed weak performance when it comes to the most recent 8 year period.

Collectible indices particularly showed good performance over the most recent 8 year period. After Moody's commodities index, Citigroup's corporate bond index and Credit Suisse Tremont Hedge fund index they had the highest Sharpe ratios. Over the full 25 year sample period, Stamps and 19th century European art had very low Sharpe ratios. Vintage Bordeaux performed good, no matter what period is considered. The mid- and long term performance of Contemporary Art and Old Masters are similar to the average traditional asset class.

[12] Source: NewsWeek, June 13, 2007

Data on the Credit Suisse/Tremont hedge fund index is available for the past 16 years. For both the 16 year period as for the 8 year period, this index has respectively had the highest and the next to highest Sharpe ratio.

We can conclude that collectible indices behaved differently than most traditional assets in terms of performance over the last 25 years. For all collectibles the highest means were found for the most recent 8 year period, apart from one exception. This is in contrast with most other assets that yielded the highest returns over the longest 25 year period and so before the most recent 8 year period. Vintage Bordeaux is amongst the best 5 performers for the full 25 year sample period. All collectibles show the highest performance in terms of Sharpe ratio over the most recent 8 year, contrary to most traditional asset classes like equity. Over the long and midterm period, Stamps and 19th century European art had very low Sharpe ratios which brought them amongst the worst performers.

Table 8: Desciptive statistics

	25 years					16 years					8 years				
Assets	**Sharpe**	**Min**	**Max**	**Mean**	**σ**	**Sharpe**	**Min**	**Max**	**Mean**	**σ**	**Sharpe**	**Min**	**Max**	**Mean**	**σ**
MSCI_World	0,18	-20,84	13,57	0,60	4,7	0,07	-20,84	13,57	0,36	4,8	0,00	-20,84	13,56	0,18	5,33
MSCI_Europe	0,26	-23,23	13,66	0,76	5,41	0,12	-23,23	13,66	0,48	5,51	0,09	-23,23	13,66	0,35	6,34
MSCI_Pacific	0,05	-25,96	21,5	0,45	6,38	-0,18	-20,58	21,5	-0,01	5,63	0,14	-20,58	11,73	0,39	5,26
MSCI_NAmerica	0,19	-24,5	14,72	0,61	4,7	0,14	-19,59	14,72	0,49	4,85	-0,09	-19,59	14,72	0,04	5,23
DOWJONES	0,26	-27,03	13,93	0,71	4,69	0,19	-16	13,77	0,54	4,7	-0,08	-16	13,77	0,07	4,76
NASDAQ_100	0,24	-32,06	23,48	0,89	7,76	0,21	-28,12	23,48	0,79	8,36	-0,02	-20,15	15,74	0,14	6,77
USCG Corporate	0,79	-6,26	5,36	0,62	1,18	0,59	-6,26	5,36	0,49	1,22	0,58	-6,26	5,36	0,42	1,4
S&P_GS Commodities	0,13	-34,99	17,84	0,59	6,07	0,05	-34,99	17,84	0,39	6,82	0,12	-34,99	17,84	0,47	8,07
Moody's Commodities	0,17	-17,76	13,51	0,52	3,25	0,42	-17,76	13,51	0,73	3,63	0,88	-17,76	13,51	1,35	4,62
NAR_Mortgage	-0,05	-27,58	13,25	0,26	6,02	0,05	-27,58	13,25	0,39	7	0,02	-27,58	10,61	0,22	7,58
NAR_Hybrid	-0,19	-29,53	28,42	-,01	6,69	-0,19	-29,53	28,42	-0,13	7,82	-0,25	-29,53	28,42	-0,52	9,79
NAR_all	0,18	-35,99	24,67	0,62	5,17	0,22	-35,99	24,67	0,67	5,96	0,18	-35,99	24,67	0,58	7,71
NAR_Equity	0,27	-38,08	27,02	0,77	5,4	0,24	-38,08	27,02	0,71	6,21	0,19	-38,08	27,02	0,63	8,09
Art100Index	0,15	-34,16	23,89	0,63	6,15	0,16	-21,92	23,89	0,52	4,98	0,41	-21,92	23,89	0,89	5,95
European19thCentury	0,12	-22,42	15,35	0,52	4,65	0,08	-22,42	15,35	0,39	4,61	0,43	-15,12	15,35	0,79	4,95
OldMasters	0,16	-20,96	17,22	0,60	5,36	0,23	-20,96	17,22	0,67	5,54	0,37	-20,96	17,22	0,85	6,33
ContemporaryArt	0,17	-44,11	34,2	0,74	7,79	0,13	-44,11	25,41	0,55	7,04	0,26	-44,11	23,82	0,82	8,55
Stamps_WorldIndex	0,04	-13,9	18,38	0,41	4,61	0,06	-13,9	13,96	0,36	3,71	0,35	-13,9	13,96	0,62	4,29
VintageBordeaux	0,29	-36,31	29,4	0,85	5,99	0,39	-36,31	29,4	0,98	6,15	0,36	-23,96	23,89	0,8	5,93
CS_TR_HEDGE						0,71	-7,85	8,18	0,74	2,25	0,79	-6,78	3,98	0,57	1,7
Three_UST-bill		0	0,7	0,35			0	0,5	0,29	0,15		0	0,41	0,18	0,13
CPI		-1,93	1,21	0,24	0,32		-1,93	1,21	0,2	0,36		-1,93	1,21	0,21	0,47

6.3 Correlations

To get a first impression of the diversifying benefits of adding collectibles to a mixed asset portfolio, we constructed a correlation matrix. Table 9 shows the correlations between the different assets. The correlations are computed over the long past return period of 25 years, except for correlations with the Credit Suisse/Tremont Hedge fund index. For that index, only 16 years of data are available. The period of 25 years reflect the investment horizon suggested in the perspective section. Furthermore, a large sample period inhibits more major events (financial shocks) and accuracy increases with the number of observations. We can draw several conclusions from the correlation matrix. For the yellow market values, the null-hypotheses of the correlation coefficient being equal to 0 cannot be rejected on a 5 % confidence level. All negative correlation coefficients are highlighted as well, since only positive correlations decreases diversification benefits. These low ore negative coefficients imply diversification possibilities or hedging opportunities.

All equity indices are highly correlated with each other. Apart from two exceptions, the same goes for Reits. The commodity indices, the hedge fund index and corporate bond index inhibit low correlations with the other indices. The high correlation of the S&P GS Commodities index with inflation (0.647) is quit unsuspected. No further big surprises were found for the traditional asset indices.

Insignificant correlations are found between the collectible indices with almost every other index. Some correlations are even negative. Stamps and Vintage Bordeaux are correlated with both commodity indices.

There is a broad difference of correlations within the group collectibles. The European 19th century index, the Art 100 general index and the contemporary Art index show relatively high correlation whit each other. The same goes for the Stamp World index and the Vintage Bordeaux index. The Old masters index is not correlated with any other index.

Four out of six collectible indices are not correlated with the US CPI, this means that those collectibles are good hedgers against inflation risk. The same goes for the Dow Jones index, the Nasdaq, corporate bonds and mortgage Reits.

When we look at the correlations between collectible indices and the traditional asset we observe very low (and even negative) correlations between most traditional assets. The (low) correlations suggest that there might be a positive effect ,of adding collectibles to the portfolio, in terms of diversification. The low correlations between some of the Collectibles imply that there are diversification possibilities within the group collectibles. Low correlations between the Art 100 index, the European 19th century index, the Old Masters index, the Contemporary Art index and the US CPI show hedging opportunities against inflation. Stamps and Vintage Bordeaux show the least opportunities for hedging specific risks.

Table 9: Correlations between all assets

	MSCI_World	MSCI_Europe	MSCI_Pacific	MSCI_NAmerica	DOWJONES	NASDAQ_100	USCG Corporate	S&P_GS Commodities	Moody's Commodities	NAR_Mortgage	NAR_Hyvrid	NAR_All	NAR_Equity	Art100Index	European19thCentury	OldMasters	ContemporaryArt	StampsWorldIndex	VintageBordeaux	CS_TR_HEDGE	Three_monthUSTbill	CPI
MSCI_WORLD	1	,905	,792	,879	,836	,715	,180	,259	,268	,272	,442	,534	,545	-,012	,067	,074	,060	,140	,099	,276	,086	,167
MSCI_EUROPE	,905	1	,607	,786	,747	,620	,186	,277	,266	,233	,408	,512	,527	-,020	,066	,103	,074	,258	,189	,327	,112	,185
MSCI_PACIFIC	,792	,607	1	,480	,463	,393	,149	,242	,190	,140	,269	,308	,322	-,046	,013	,045	-,039	,110	,095	,179	,023	,149
MSCI_NAMERICA	,879	,786	,480	1	,949	,823	,179	,200	,252	,325	,471	,559	,564	,027	,066	,055	,113	,042	,010	,251	,101	,143
DOWJONES	,836	,747	,463	,949	1	,729	,133	,134	,224	,313	,425	,522	,528	,011	,051	,019	,088	,024	,012	,224	,107	,067
NASDAQ_100	,715	,620	,393	,823	,729	1	,060	,129	,152	,198	,291	,345	,352	,017	,104	,017	,077	-,034	-,029	,177	,048	,085
USCG Corporate	,180	,186	,149	,179	,133	,060	1	,033	-,026	,280	,279	,201	,194	-,047	-,009	-,079	,006	,112	,062	,107	,094	,023
S&P_GS Commodities	,259	,277	,242	,200	,134	,129	,033	1	,360	-,015	,159	,175	,182	,054	,048	,070	,157	,231	,148	,125	,103	,647
Moody's Commodities	,268	,266	,190	,252	,224	,152	-,026	,360	1	,180	,246	,302	,300	,086	,093	,143	,051	,224	,209	,119	-,109	,226
NAR_Mortgage	,272	,233	,140	,325	,313	,198	,280	-,015	,180	1	,605	,552	,474	-,095	-,112	,004	-,039	,050	,014	,124	-,089	-,065
NAR_Hybrid	,442	,408	,269	,471	,425	,291	,279	,159	,246	,605	1	,661	,623	-,008	-,028	-,009	,052	,061	,060	,309	-,004	,143
NAR_All	,534	,512	,308	,559	,522	,345	,201	,175	,302	,552	,661	1	,989	-,080	-,126	,053	-,029	,089	,085	,233	-,017	,155
NAR_Equity	,545	,527	,322	,564	,528	,352	,194	,182	,300	,474	,623	,989	1	-,072	-,114	,065	-,025	,087	,081	,227	,015	,171
Art100Index	-,012	-,020	-,046	,027	,011	,017	-,047	,054	,086	-,095	-,008	-,080	-,072	1	,437	,079	,446	-,030	-,040	-,047	,102	,087
European19thCentury	,067	,066	,013	,066	,051	,104	-,009	,048	,093	-,112	-,028	-,126	-,114	,437	1	,138	,220	,047	,006	,070	,090	,077
OldMasters	,074	,103	,045	,055	,019	,017	-,079	,070	,143	,004	-,009	,053	,065	,079	,138	1	-,016	,061	-,008	,010	,084	,037
ContemporaryArt	,060	,074	-,039	,113	,088	,077	,006	,157	,051	-,039	,052	-,029	-,025	,446	,220	-,016	1	,001	-,001	-,038	,136	,090
StampsWorldIndex	,140	,258	,110	,042	,024	-,034	,112	,231	,224	,050	,061	,089	,087	-,030	,047	,061	,001	1	,671	,175	,034	,219
VintageBordeaux	,099	,189	,095	,010	,012	-,029	,062	,148	,209	,014	,060	,085	,081	-,040	,006	-,008	-,001	,671	1	,181	,064	,180
CS_TR_HEDGE	,276	,327	,179	,251	,224	,177	,107	,125	,119	,124	,309	,233	,227	-,047	,070	,010	-,038	,175	,181	1	,141	,115
Three_monthUSTbill	,086	,112	,023	,101	,107	,048	,094	,103	-,109	-,089	-,004	-,017	,015	,102	,090	,084	,136	,034	,064	,141	1	,199
CPI	,167	,185	,149	,143	,067	,085	,023	,647	,226	-,065	,143	,155	,171	,087	,077	,037	,090	,219	,180	,115	,199	1

6.4 Constructing optimal portfolios using historical returns

To construct optimal ex-ante portfolios we have to make assumptions about expectations. Expected returns have to be estimated for every asset class included in our study.
As mentioned in the methodology section, we will make use of two different approaches of estimating expected returns. In this section we use historical returns and variances as input for the MV model. In section 6.5 we will use returns estimated by beta.

Optimal portfolios with and without collectibles are constructed. Monthly data over the full 25 year period is used. We do not allow for short selling, because we are interested in positive investments only. Figure 2 shows the efficient frontiers of both ex ante optimal portfolios. The green dots indicate the individual indices. The efficient frontier of optimal portfolios including collectibles clearly shows improvement over the efficient frontier over portfolios that only contains traditional asset classes. At first sight , required returns between 0.75 and 0.85 illustrate the most improvement.

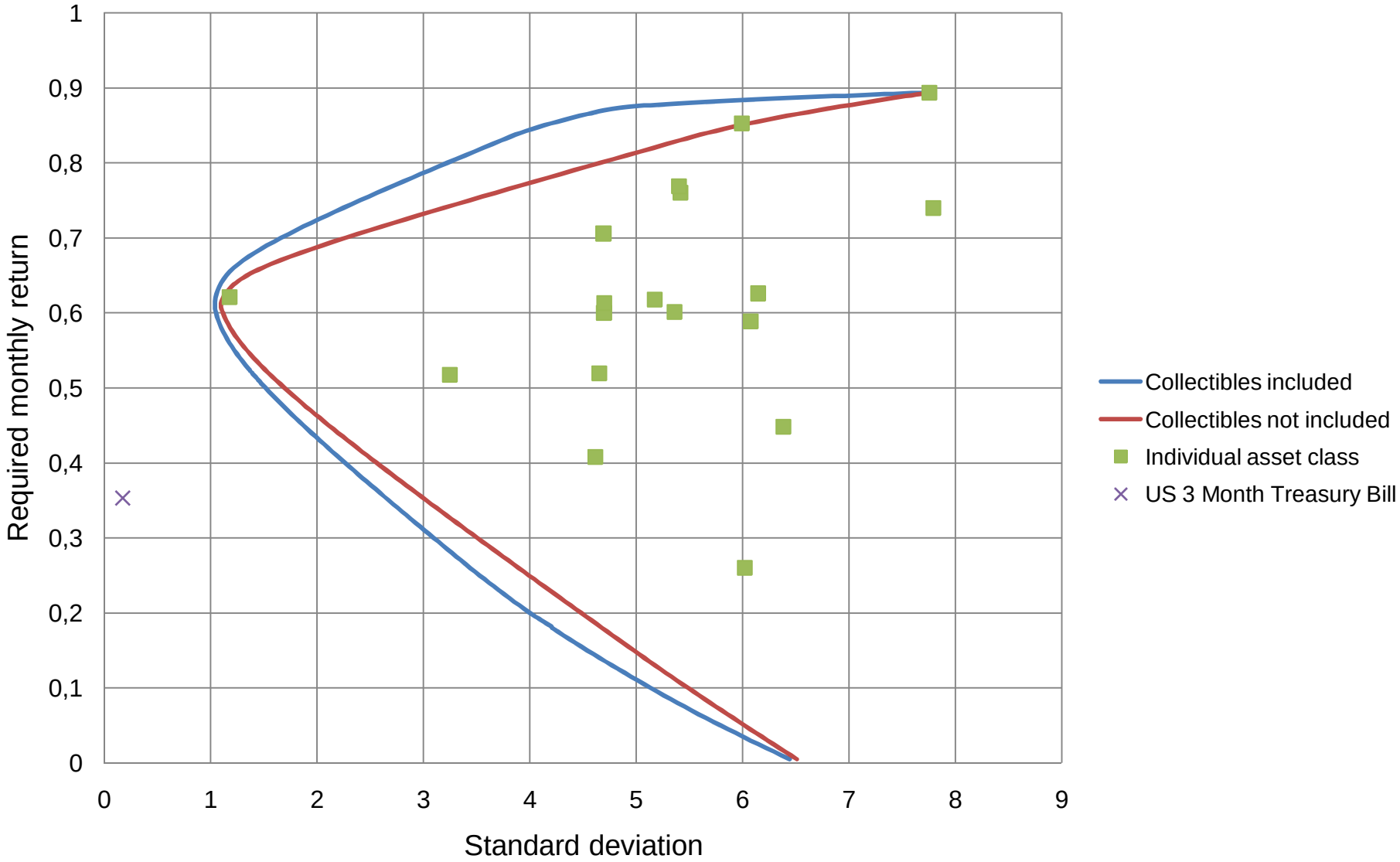
Table 10 and 11 at the end of the section show the optimal portfolio weights for both portfolios. We consider only the required returns that are above the minimum risk portfolio and are therefore part of the efficient part of the frontier. When we compare the weights for both optimal portfolios there are a couple of noteworthy things.

Firstly, for both cases the only equity indices that enter the portfolio are the Dow Jones industrial average index and the Nasdag 100 index.
The weights assigned to the Dow Jones index are minimal and the index is only included at low returns. The obvious reason is the high correlation between the equity indices.

Secondly, from the real estate class Equity Reits are incorporated in both optimal portfolios. High correlations and relative bad performance of other Reits are explanations for this fact. When only traditional asset classes are considered, the weight put on Equity Reits is quite substantial (up to 45 %).

Thirdly, commodity indices are included in both portfolios. They are only part of the portfolio when the required return is low. Adding collectibles drives the Standard and Poors / Goldman Sachs commodity index out of the portfolio. The weight on that index was already very minimal (below 1%) and only included when required returns are low.
The inclusion of collectibles has a major effect on the optimal portfolios. At least one collectible index enters the optimal portfolio at some level of required return. The effect of including the Stamp World index is near negligible. The index is part of the portfolio only for the smallest required return and count for only 0,5%. The European 19th century Art index in included for low required returns (up to 0.63 %), the Old Masters index is included in half the portfolios (required returns up to 0.75 %). The Indices with the most impact are the Contemporary Art index and the Vintage Bordeaux index, both indices are included in almost every (up to 0.87% required return) portfolio.

Figure 2: MV Efficient Frontiers



The significance of the improvement of including collectibles is tested for every required return. Like described in the methodology section we use Jobson and Korkie's (1981) Z distributed test statistic to compare Sharpe ratios. For the Risk free rate we use the average monthly return on US Treasury bills. The null hypothesis of Jobson and Korkie's (1981) test is that, the Sharpe ratio of the optimal traditional portfolio is equal to that of the alternative portfolio (under MV criteria and given the required return). The alternative hypothesis becomes: The optimal alternative portfolio has a higher Sharpe ratio than the optimal traditional portfolio.

$$\textit{Alternative hypothesis: } H_a: S_b < S_a$$
$$\textit{Null hypothesis: } H_0: S_b = S_a$$

Table 9 shows the results of this test on 30 required returns varying from 0.61% to 0.89 %. These returns are all part of the efficient set. From the information in the table, two things are notable.

Firstly, there is only a small range of required returns for which the improvement in Sharpe ratio is significant. Only alternative portfolios with a required monthly return between 0.67% and 0.73% outperform traditional mixed asset portfolios in terms of risk efficiency. Secondly, the improvement in risk efficiency is only significant at a 10% confidence level. We are not able to reject the null hypothesis of no difference for smaller confidence levels for any level of required return.

If we use a well considered confidence level (5%), we can conclude that adding collectibles to an optimal mixed asset portfolio is not beneficiary in terms of risk efficiency. There is little evidence on improvement for only a small number of require returns.

Table 10: Optimal portfolio weights Collectibles included

Return	Std	Dow Jones	Nasdaq	USCG Corporate	MOCMDTY	Equity Reits	Art100Index	Europ. 19th C.	Old Masters	Cont. Art	Stamps	Bordeaux
0,61	1,042	0,48%	0,00%	80,35%	8,91%		1,72%	2,82%	3,91%	0,55%	0,49%	0,79%
0,62	1,047	0,24%	0,92%	80,75%	6,97%		2,02%	1,88%	4,13%	0,84%		2,25%
0,63	1,067		2,00%	80,97%	4,63%		2,38%	0,77%	4,37%	1,19%		3,68%
0,64	1,101		2,86%	80,78%	2,09%	0,45%	2,67%		4,57%	1,53%		5,06%
0,65	1,149		3,71%	79,15%		1,41%	2,65%		4,53%	1,94%		6,61%
0,66	1,218		4,92%	75,12%		2,32%	2,40%		4,12%	2,53%		8,59%
0,67	1,308		6,12%	71,10%		3,24%	2,14%		3,71%	3,12%		10,56%
0,68	1,414		7,33%	67,07%		4,17%	1,89%		3,30%	3,72%		12,54%
0,69	1,533		8,53%	63,04%		5,09%	1,63%		2,88%	4,31%		14,51%
0,70	1,663		9,74%	59,02%		6,01%	1,37%		2,47%	4,90%		16,49%
0,71	1,801		10,94%	54,99%		6,94%	1,11%		2,06%	5,49%		18,47%
0,72	1,946		12,15%	50,97%		7,86%	0,86%		1,65%	6,08%		20,44%
0,73	2,095		13,35%	46,94%		8,78%	0,60%		1,24%	6,67%		22,42%
0,74	2,249		14,55%	42,92%		9,70%	0,34%		0,82%	7,27%		24,39%
0,75	2,406		15,77%	38,89%		10,60%	0,09%		0,43%	7,84%		26,38%
0,76	2,565		16,96%	34,72%		11,57%				8,39%		28,35%
0,77	2,727		18,19%	30,05%		12,49%				8,89%		30,37%
0,78	2,892		19,42%	25,37%		13,42%				9,40%		32,39%
0,79	3,058		20,65%	20,69%		14,35%				9,90%		34,41%
0,80	3,225		21,88%	16,01%		15,28%				10,40%		36,43%
0,81	3,394		23,10%	11,33%		16,21%				10,90%		38,45%
0,82	3,563		24,33%	6,65%		17,14%				11,40%		40,47%
0,83	3,734		25,56%	1,97%		18,07%				11,91%		42,49%
0,84	3,914		28,96%			15,18%				10,47%		45,40%
0,85	4,136		33,94%			9,50%				7,61%		48,95%
0,86	4,397		38,92%			3,82%				4,76%		52,50%
0,87	4,694		43,85%							0,51%		55,64%
0,88	5,489		66,70%									33,30%
0,89	7,057		90,94%									9,06%
0,89	7,755		100,00%									

Table 11: Optimal portfolio weights Collectibles not included

Return	Std	Dow Jones	Nasdaq	USCG Corporate	GSCITOT	MOCMDTY	Equity Reits
0,61	1,0949	0,33%	0,34%	87,36%	0,36%	11,61%	
0,62	1,1136		2,53%	89,47%	0,61%	7,38%	
0,63	1,1629		3,90%	90,47%	0,75%	3,40%	1,48%
0,64	1,2352		5,30%	90,76%	0,68%		3,25%
0,65	1,3409		7,67%	86,84%			5,49%
0,66	1,4834		10,13%	82,15%			7,72%
0,67	1,6538		12,58%	77,47%			9,95%
0,68	1,8445		15,03%	72,78%			12,19%
0,69	2,0497		17,49%	68,09%			14,42%
0,7	2,2655		19,94%	63,41%			16,65%
0,71	2,4891		22,40%	58,72%			18,88%
0,72	2,7187		24,85%	54,04%			21,11%
0,73	2,9528		27,30%	49,35%			23,35%
0,74	3,1905		29,76%	44,66%			25,58%
0,75	3,4309		32,21%	39,98%			27,81%
0,76	3,6736		34,66%	35,29%			30,04%
0,77	3,9181		37,12%	30,61%			32,28%
0,78	4,1642		39,57%	25,92%			34,51%
0,79	4,4115		42,02%	21,23%			36,74%
0,8	4,6599		44,48%	16,55%			38,97%
0,81	4,9091		46,93%	11,86%			41,21%
0,82	5,1591		49,39%	7,18%			43,44%
0,83	5,4098		51,84%	2,49%			45,67%
0,84	5,6673		56,90%				43,10%
0,85	5,9707		64,92%				35,08%
0,86	6,3207		72,94%				27,06%
0,87	6,7099		80,96%				19,04%
0,88	7,1319		88,98%				11,02%
0,89	7,5812		97,00%				3,00%
0,89	7,7552		100,00%				

6.5 Computing expected returns from estimated betas

In this section we will compute expected returns estimated by beta. More specific, the CAPM is used to estimate Betas of the individual asset class on the World Market Portfolio (WMP). We will test whether the WMP has significant explanatory power across all asset classes. We will consider both the Clark Kassimatis World Market Portfolio (CKWMP) and the MSCI World index as a proxy for the WMP. When the WMP does not have significant explanatory power (T-value of Betas higher than 2) or significant intercepts (Alpha's) we will reject the CAPM for the respective WMP. When the CAPM is not rejected for either of the proxies, we will construct and compare ex ante optimal portfolios using returns estimated by the CAPM.

The CAPM can be defined by

(19.) $$(E)R_i = R_f + \beta_i((E)R_{mp} - R_f)$$

In which $(E)R_i$ is the expected quarterly expected return on the i[th] asset and R_f is the return on risk free object. We use historical returns on the 3 month US Treasury bill as estimator, for the sample period this is 4.6% annually, 1.13% quarterly or 0.3755% monthly. $(E)R_{mp}$ is the expected return on the WMP. Since the expected returns of the various assets depend on their betas, the estimation of the WMP return is not of vital importance. Fernández (2009) investigated the market risk premium used by different finance professors by using surveys. Professors in the US estimated the Market risk premium to be 6.3% on average for the year 2008. Clark and Kassimatis (2006) calculate the CKWMP return to be 9.4% annually. Taking both figures into consideration we estimate the WMP to yield 7.5% annually, 0,605% quarterly or 0.6045% monthly. standard deviations are calculated from historical return data.

Since the CKWMP is available on a quarterly basis only, the findings are based on 91 quarterly observations from 1985 (second quarter) for all asset. Like Clark and Kassimatis (2006) we used simple arithmetic excess returns. Excess returns are computed using 3 month US Treasury bill rates. The MSCI World index is available to us on a monthly basis, we use 298 monthly observations for our test.

Table 12 and 13 report the results of a Ordinary Least Squares regression of the form (19) for each asset in our sample.

The MSCI World index proves to be a good market proxy when only Equity and Commodities are considered. Betas for the collectible indices are ,however, not significant. We consider the MSCI World index to be a imperfect proxy for the WMP. Estimations on returns using betas computed by this WMP are likely to be flawed.

Optimal portfolio's will show weights that are unreliable. Optimal portfolios will be dominated by Equity indices since they have high betas. Equity indices get rewarded for their (systematic) risk since the MSCI World Index only takes risk on equity into account.

Unlike Clark and Kassimatis (2006) we find that the CKWMP is not a good proxy for the WMP. Only 4 out of 19 betas are significant. 4 alpha's are significantly different from 0. Optimal portfolios using expected returns computed in this way will be dominated by the 4 asset classes that have high significant betas. This is demonstrated by table 14 which shows the portfolio weights of the ex ante optimal portfolio.
The Stamp index, the Bordeaux index and the MSCI Pacific index are included due to their high betas and thus high expected returns. Corporate bonds and commodities indices are included due to their low historical standard deviation.

We will not proceed to compare optimal portfolios with and without collectibles, because they will not have any added value to our study. The CAPM with our proxies of the WMP cannot provide us with reliable expected returns for our asset classes.

Table 12: Testing the CAPM using MSCI

Asset	Alpha	t-value	Beta	t-value	Risk Free	(E) return	Std
MSCI World	**0**		**1**			**0,60%**	
MSCI_EUROPE	,002	1,364	1,034	35,564	0,38%	0,61%	5,35%
MSCI_PACIFIC	-,001	-,408	1,095	22,452	0,38%	0,63%	6,40%
MSCI_NAMERICA	,001	,453	,870	31,308	0,38%	0,57%	4,62%
DOWJONES	,002	1,125	,828	25,918	0,38%	0,57%	4,63%
NASDAQ_100	,004	1,341	1,169	17,172	0,38%	0,64%	7,69%
USCG Corporate	,003	3,842	,044	3,054	0,38%	0,39%	1,18%
S&P_GS Commodities	,003	,914	,300	4,113	0,38%	0,44%	6,00%
Moody's Commodities	,002	,815	,181	4,560	0,38%	0,42%	3,26%
NAR_Mortgage	,000	,090	,127	1,743	0,38%	0,40%	5,82%
NAR_Hybrid	-,001	-,385	,113	1,374	0,38%	0,40%	6,58%
NAR_All	,003	1,132	,243	3,964	0,38%	0,43%	5,02%
NAR_Equity	,005	1,618	,256	4,007	0,38%	0,43%	5,24%
Art100Index	,004	1,104	-,022	-,292	0,38%	0,37%	6,13%
European19thCentury	,002	,822	,060	1,025	0,38%	0,39%	4,68%
OldMasters100Index	,004	1,157	,077	1,135	0,38%	0,39%	5,42%
ContemporaryArt100Index	,007	1,427	,085	,850	0,38%	0,39%	8,02%
STAMPSWorldIndex	,000	,032	,132	2,309	0,38%	0,41%	4,62%
VintageBordeaux	,005	1,332	,119	1,581	0,38%	0,40%	6,03%

Table 13: Testing the CAPM using the CKWMP

Asset	Alpha	t-value	Beta	t-value	Risk Free	(E) return	Std
CKWMP	**0**		**1**		1,13%	**1,82%**	
MSCI_WORLD	,012	1,309	,332	1,259	1,13%	1,36%	8,21%
MSCI_EUROPE	,017	1,767	,451	1,591	1,13%	1,44%	8,91%
MSCI_PACIFIC	,001	,060	1,307	3,571	1,13%	2,04%	12,05
MSCI_NAMERICA	,018	2,111	-,320	-1,274	1,13%	0,91%	7,85%
DOWJONES	,021	2,470	-,316	-1,279	1,13%	0,91%	7,75%
NASDAQ_100	,036	2,217	-,482	-1,000	1,13%	0,80%	14,94
USCG Corporate	,007	3,180	,150	2,394	1,13%	1,23%	2,07%
S&P_GS Commodities	,000	-,707	-,020	-1,313	1,13%	1,12%	4,58%
Moody's Commodities	,017	1,497	,165	,504	1,13%	1,25%	10,14
NAR_Mortgage	,040	,727	,041	,227	1,13%	1,16%	5,46%
NAR_Hybrid	,009	,747	-,325	-,959	1,13%	0,91%	10,42
NAR_All	,007	,711	-,159	-,530	1,13%	1,02%	9,13%
NAR_Equity	,017	1,988	-,175	-,713	1,13%	1,01%	7,50%
Art100Index	,004	,425	-,058	-,206	1,13%	1,09%	7,53%
European19thCentury	-,005	-1,000	-,007	-,046	1,13%	1,13%	8,95%
OldMasters100Index	-,006	-1,174	-,208	-,157	1,13%	0,99%	7,59%
ContemporaryArt100Index	,024	-1,895	-,046	-,123	1,13%	1,10%	7,74%
STAMPSWorldIndex	-,013	-1,305	1,018	3,522	1,13%	1,84%	13,96
VintageBordeaux	-,005	-,461	,847	2,531	1,13%	1,72%	2,51%

Table 14: Optimal portfolio weights using returns estimated by beta

Required return (Quarterly)	Std	MSCI_PACIFIC	USCG Corporate	S&P_GS Commodities	Stamps	Bordeaux	SUM
2,49%	12,0%	100%	0%	0%	0%	0%	100%
2,40%	9,9%	80%	0%	0%	20%	0%	100%
2,30%	8,4%	66%	0%	0%	22%	12%	100%
2,20%	7,0%	55%	0%	0%	18%	27%	100%
2,10%	5,7%	43%	0%	0%	15%	43%	100%
2,00%	4,4%	31%	0%	0%	11%	58%	100%
1,90%	3,3%	19%	0%	0%	7%	74%	100%
1,80%	2,6%	8%	0%	0%	3%	89%	100%
1,70%	2,3%	5%	7%	0%	2%	86%	100%
1,60%	2,1%	5%	15%	0%	2%	79%	100%
1,50%	2,0%	4%	23%	0%	2%	71%	100%
1,40%	1,8%	4%	21%	8%	2%	65%	100%
1,30%	1,6%	3%	19%	16%	2%	60%	100%
1,20%	1,5%	3%	17%	25%	1%	54%	100%
1,10%	1,3%	3%	15%	33%	1%	48%	100%
1,00%	1,2%	2%	12%	41%	1%	42%	100%
0,90%	1,0%	2%	10%	50%	1%	36%	100%
0,80%	0,9%	2%	8%	58%	1%	31%	100%
0,70%	0,7%	1%	7%	65%	0%	25%	100%

6.6 In times of crisis

One of the biggest problems of the recent financial crisis is the lack of liquidity. Decrease in Interbank loans led to illiquidity in many asset classes. Equity, real estate, commodities and hedge funds suffered from the lack of liquidity. Due to the enormous size and the presence of exchange markets, counterparties to trade will almost always be available.

In markets that are already illiquid this might not be the case. For collectibles buyers may be more difficult to find especially in recession periods. In this thesis we act as if collectible indices are publically available through ETF's. In that case a large financial institution guarantees the underlying value of the index which means that the asset is liquid.

For the sake of practical insight we will devote some attention to the liquidity of collectibles during the recent crisis.

The art sales saw one of the biggest falls in history during the 2007-2009 period. From 2007 to 2008, the number of transactions in the art market decreased with some 12%. From 2008 to 2009 some 18% less art works were sold. However, sales in 2009 were well above any year before 2006. Global demand for collectibles was weaker and average prices dropped during the crisis period[13]. The most active market places were effected the most by illiquidity and lower prices. Auction sales turnover in the UK declined with $ 1.9 Billion and Auction sales turnover in the US with $ 1.6 Billion. Withdrawal of investment funds and liquidity constraints amongst collectors led to a great fear of a total freeze of the art market. The feared freeze never took place, sales slowed down but the illiquidity in the total art market proved to be no more severe than for other asset classes[14]. Since Stamps are also sold through action houses, we assume that the previous is applicable to that market as well. Accounted for by auction houses. Exact sales numbers on other trades are not available to us at this moment.

From section 6.3 we know that correlations of collectibles with other asset classes are not significantly different from 0. This makes collectibles good diversifiers. Collectibles may not improve an internationally diversified portfolio in terms of risk efficiency (section 6.4) that much, but hedging specific exposure belongs to the possibilities (e.g. Inflation risk). In this section we investigate the characteristics of collectibles when diversification is most needed, namely in times of financial distress. To do so, we will compare correlation coefficients across assets in two periods; a stable period, and a crisis period.

[13] Source: Mc Andrew C. (2010) "The international art market 2007-2009 - Trends in the Art Trade during Global Recession," European Fine Art foundation

[14] Source: "Art market trends 2009" obtained from artprice.com

To evaluate performances, we compare risk adjusted returns for every asset class during both periods. Next, we will look for increased correlation across different asset classes. King and Wadhwani (1989) and Lee and Kim (1993) use a method to test for contagion of various stock markets. King et al and Lee et al construct a sided t-test is used to test whether cross market correlation coefficients are significantly higher for the crisis period than for the stable period. When correlation coefficients increase significantly , this suggests that the diversification benefit of particular market decreases in times of recession. To test for the significance of the increased correlations highly frequent data is needed. Because we only have access to monthly return data, we cannot perform the same test with confidence. Instead, as in table 9, we highlighted correlation coefficients that are not significantly different from 0. All negative correlation coefficients are highlighted as well, since only positive correlations decreases diversification benefits. This allows for relevant evaluation of the correlations between the different periods.

Our dataset captures several events and crisis periods; Black Monday October 19 1987, The dot-com bubble and burst 1995-2000, the terrorist attacks of September 11 2001, the 1997 Asian crisis, and the current financial crisis 2007-2010. The crisis period that we will take into consideration is the most recent financial crisis. There are a couple of reasons why we chose this particular period.

Firstly, there is a practical reason. Because our dataset only contains monthly data, we are only able to focus on an event that endures for a sufficiently large period. Claessens, Kose and Terrones (2008) find that recession associated with credit crunches and house price bursts (like the 2007-2010 crisis) are deeper and last longer than other recessions. The authors estimate an recession of this type to last for an average of 30 months.

Secondly, Claessens et al (2008) expect future recessions to be more costly and severe than the 2007-2010 crisis as global integration of financial markets continue to increase.

The recession period can be defined as the period between June 2007 and November 2009. This gives us a sample period of 30 consecutive months.

For the stable period we take 30 consecutive months from Jan 2004. This is after the effects of the dot-com bubble and burst. We consider a stable period close to the recession period to rule out other factors that may influence volatilities on financial markets (like political tensions).

Figure 3[15] shows a magnified view on the performance of both the stable and the crisis period for an asset from every class. The returns imply that almost all asset classes were affected by the crisis. The stable period shows no major shocks for any asset class.

All equity benchmarks experienced a major downfall between May 2007 and Jan 2009. Both commodity indices declined in the period from May 2008 to Jan 2009. The Standard & Poors/Goldman Sachs commodity index showed a sharper decline than Moody's commodity index. The only index that seems to be almost unaffected during the crisis period is the US Corporate bond index from Citigroup. The real estate proxies all experienced major declines from August 2008 until March 2009. The Credit Suisse/Tremont hedge fund index showed a minor downfall between August 2008 and March 2009. Apart from the World Stamp index, all collectible indices showed sharp declines. The decline took place from Sep 2007 until Sep 2009. The temporary art index was the most affected collectible asset.

A noticeable thing is the fact that various asset classes showed declines in different stages during the crisis. Equity and real estate stood at the beginning of the period, where collectibles and commodities were affected months later.

Figure 3: Performance of innitial investment of $ 10,000

For both the stable and the crisis period descriptive statistics are computed. As earlier in the study, (unsmoothed) monthly log returns were used. Table 15 shows a summary of the figures.

[15] Figures for every separate asset class can be found in appendix G.

Table 15: Descriptive Statistics

	Stable Period			Crisis Period		
Asset	**Mean**	**Std. Deviation**	**Sharpe**	**Mean**	**Std. Deviation**	**Sharpe**
MSCI_WORLD	0,83	2,3	0,36	-1,09	8,11	-0,13
MSCI_EUROPE	1,14	3	0,38	-1,24	9,22	-0,13
MSCI_PACIFIC	1,24	3,74	0,33	-1,03	7,32	-0,14
MSCI_NAMERICA	0,55	2,15	0,26	-1,02	8	-0,13
DOWJONES	0,24	2,17	0,11	-0,89	7,05	-0,13
NASDAQ_100	0,26	4,14	0,06	-0,25	8,65	-0,03
USCG Corporate	0,16	0,89	0,18	0,5	1,97	0,25
Three_monthUSTbill	0,23	0,11		0,11	0,12	
S&P_GS Commodities	1,47	6,46	0,23	-0,86	11,13	-0,08
Moody's Commodities	1,38	3,66	0,38	0,92	6,87	0,13
NAR_Mortgage	0,06	7,3	-0,10	-1,9	9,71	-0,29
NAR_Hybrid	0,61	4,77	0,01	-5,49	15,4	-0,36
NAR_All	1,55	5,12	0,23	-1,69	12,21	-0,14
NAR_Equity	1,7	5,1	0,27	-1,67	12,98	-0,13
CS_TR_HEDGE	0,71	1,15	0,61	-0,02	2,58	-0,01
Art100Index	1,38	5,6	0,24	-0,42	7,18	-0,06
European19thCentury	0,15	3,51	0,04	0,56	6,41	0,09
OldMasters	1,02	5,72	0,18	1,14	8,39	0,14
ContemporaryArt	0,42	7,29	0,06	-0,6	12,04	-0,05
StampsWorldIndex	0,39	3,65	0,11	-0,43	5,46	-0,08
VintageBordeaux	0,96	5,17	0,18	-0,44	6,58	-0,07

The risk adjusted performance is indicated by the Sharpe ratio. Only the Citigroup corporate bond index and the European 19th Century art index shows a higher Sharpe ratio for the crisis period compared with the stable period. The steepest decline in Sharp ratio is seen among Real estate, Equity and hedge funds. Both lower means and increased volatility are responsible. There are just 4 positive Sharpe ratios in the crisis period. Two out of those four are collectibles, European 19th Century art and the Old Masters index. This indicates that there might be benefits of investing in at least two collectible asset classes during recessions. Evaluating and comparing correlation coefficients can give a definite answer to that.

Table 16 and 17 at the end of this section show correlation coefficients between all asset classes for both the stable and the crisis period. For the yellow market values, the null-hypotheses of the correlation coefficient being equal to 0 cannot be rejected on a 5 % confidence level. The null hypotheses is rejected at relatively high values due to the small sample size. Negative values are highlighted as well.

During the stable period, City Group's Corporate bonds index, both Commodity indices, , the Credit.Suisse/Tremont hedge fund index and all collectible indices are not significantly correlated with equity. The S&P/Goldman Sachs commodity index, the Credit.Suisse/Tremont hedge fund index and all collectible indices are uncorrelated with all the Reit indices.

During the crisis period, this pattern changes drastically. throughout this period, the only indices that show insignificant correlations with every other asset class are four out of six collectible indices. Group's Corporate bonds index show low correlations with the Dow Jones index, the Nasdaq 100 index and with US CPI. The correlation coefficients of the World Stamp index and the Vintage Bordeaux index increased enormously during the crisis period. In section 6.4 we saw that the optimal ex ante portfolio has up to 56% of its weight allocated to the Vintage Bordeaux index. In times of crisis, this is not the optimal choice for an investor. In the crisis period, the respective index shows a negative mean return accompanies by significant positive correlations with most asset classes.

The correlations coefficients of the Art 100 index, the European 19th century index, the Old Masters index and the Contemporary Art index remained insignificant in the crisis period. This suggest that these four collectibles are very good diversifiers in periods of financial turmoil. Moreover, the positive mean average returns and positive Sharpe ratios of the European 19th century index and Old Masters index suggest that they are not only good diversifiers, but also recession proof. We conclude that including particular collectibles to a portfolio leads to an increase of risk efficiency of the total portfolio.

Table 16: Correlations all assets stable period

	MSCI_World	MSCI_Europe	MSCI_Pacific	MSCI_NAmerica	DOWJONES	NASDAQ_100	USCG Corporate	S&P_GS Commodities	Moody's Commodities	NAR_Mortgage	NAR_Hyvrid	NAR_All	NAR_Equity	Art100Index	European19thCentury	OldMasters	ContemporaryArt	StampsWorldIndex	VintageBordeaux	CS_TR_HEDGE	Three_monthUSTbill	CPI
MSCI_WORLD	1,00	0,94	0,67	0,91	0,81	0,78	-0,00	0,06	0,48	0,48	0,51	0,46	0,45	-0,33	-0,22	-0,17	-0,13	0,10	0,10	0,24	0,07	-0,00
MSCI_EUROPE	0,94	1,00	0,61	0,76	0,67	0,62	-0,03	0,21	0,50	0,39	0,43	0,36	0,35	-0,26	-0,19	-0,15	-0,01	0,24	0,23	0,29	0,11	0,17
MSCI_PACIFIC	0,67	0,61	1,00	0,38	0,31	0,31	0,19	-0,06	0,33	0,38	0,33	0,41	0,40	-0,37	-0,38	0,07	-0,15	0,15	0,23	0,12	0,05	0,11
MSCI_NAMERICA	0,91	0,76	0,38	1,00	0,91	0,89	-0,05	-0,04	0,40	0,47	0,51	0,44	0,42	-0,27	-0,09	-0,25	-0,18	-0,05	-0,11	0,19	0,03	-0,18
DOWJONES	0,81	0,67	0,31	0,91	1,00	0,77	-0,18	-0,19	0,44	0,34	0,39	0,29	0,27	-0,15	-0,07	-0,29	-0,14	-0,00	-0,11	0,04	0,14	-0,27
NASDAQ_100	0,78	0,62	0,31	0,89	0,77	1,00	-0,15	-0,05	0,28	0,37	0,49	0,43	0,42	-0,23	-0,08	-0,30	-0,16	-0,09	-0,15	0,17	-0,02	-0,28
USCG Corporate	-0,00	-0,03	0,19	-0,05	-0,18	-0,15	1,00	-0,09	0,03	0,52	0,43	0,45	0,43	-0,44	-0,18	0,03	-0,22	-0,01	0,04	0,24	-0,13	-0,02
S&P_GS Commodities	0,06	0,21	-0,06	-0,04	-0,19	-0,05	-0,09	1,00	-0,08	-0,18	-0,21	-0,28	-0,28	0,10	0,08	-0,03	0,25	0,32	0,22	-0,01	-0,13	0,73
Moody's Commodities	0,48	0,50	0,33	0,40	0,44	0,28	0,03	-0,08	1,00	0,49	0,37	0,36	0,34	-0,24	-0,26	0,04	-0,44	0,19	0,25	0,11	0,14	-0,10
NAR_Mortgage	0,48	0,39	0,38	0,47	0,34	0,37	0,52	-0,18	0,49	1,00	0,83	0,80	0,76	-0,59	-0,24	0,06	-0,51	0,09	0,07	0,12	-0,03	-0,22
NAR_Hybrid	0,51	0,43	0,33	0,51	0,39	0,49	0,43	-0,21	0,37	0,83	1,00	0,86	0,84	-0,62	-0,04	0,00	-0,53	0,12	0,03	0,07	-0,06	-0,13
NAR_All	0,46	0,36	0,41	0,44	0,29	0,43	0,45	-0,28	0,36	0,80	0,86	1,00	1,00	-0,70	-0,20	-0,01	-0,57	0,06	-0,02	0,16	-0,00	-0,23
NAR_Equity	0,45	0,35	0,40	0,42	0,27	0,42	0,43	-0,28	0,34	0,76	0,84	1,00	1,00	-0,69	-0,18	-0,02	-0,56	0,06	-0,03	0,16	0,00	-0,23
Art100Index	-0,33	-0,26	-0,37	-0,27	-0,15	-0,23	-0,44	0,10	-0,24	-0,59	-0,62	-0,70	-0,69	1,00	0,40	0,07	0,59	0,01	0,00	-0,04	-0,11	0,08
European19thCentury	-0,22	-0,19	-0,38	-0,09	-0,07	-0,08	-0,18	0,08	-0,26	-0,24	-0,04	-0,20	-0,18	0,40	1,00	0,08	0,24	0,11	-0,00	-0,21	-0,02	0,05
OldMasters	-0,17	-0,15	0,07	-0,25	-0,29	-0,30	0,03	-0,03	0,04	0,06	0,00	-0,01	-0,02	0,07	0,08	1,00	-0,22	-0,27	-0,21	-0,08	0,02	0,16
ContemporaryArt	-0,13	-0,01	-0,15	-0,18	-0,14	-0,16	-0,22	0,25	-0,44	-0,51	-0,53	-0,57	-0,56	0,59	0,24	-0,22	1,00	0,04	0,05	-0,05	-0,11	0,18
StampsWorldIndex	0,10	0,24	0,15	-0,05	-0,00	-0,09	-0,01	0,32	0,19	0,09	0,12	0,06	0,06	0,01	0,11	-0,27	0,04	1,00	0,74	-0,09	0,02	0,35
VintageBordeaux	0,10	0,23	0,23	-0,11	-0,11	-0,15	0,04	0,22	0,25	0,07	0,03	-0,02	-0,03	0,00	-0,00	-0,21	0,05	0,74	1,00	0,22	0,18	0,37
CS_TR_HEDGE	0,24	0,29	0,12	0,19	0,04	0,17	0,24	-0,01	0,11	0,12	0,07	0,16	0,16	-0,04	-0,21	-0,08	-0,05	-0,09	0,22	1,00	0,12	0,03
Three_monthUSTbill	0,07	0,11	0,05	0,03	0,14	-0,02	-0,13	-0,13	0,14	-0,03	-0,06	-0,00	0,00	-0,11	-0,02	0,02	-0,11	0,02	0,18	0,12	1,00	0,01
CPI	-0,00	0,17	0,11	-0,18	-0,27	-0,28	-0,02	0,73	-0,10	-0,22	-0,13	-0,23	-0,23	0,08	0,05	0,16	0,18	0,35	0,37	0,03	0,01	1,00

Table 17: Correlations all assets crisis period

	MSCI_World	MSCI_Europe	MSCI_Pacific	MSCI_NAmerica	DOWJONES	NASDAQ_100	USCG Corporate	S&P_GS Commodities	Moody's Commodities	NAR_Mortgage	NAR_Hyvrid	NAR_All	NAR_Equity	Art100Index	European19thCentury	OldMasters	ContemporaryArt	StampsWorldIndex	VintageBordeaux	CS_TR_HEDGE	Three_monthUSTbill	CPI
MSCI_WORLD	1,00	0,99	0,93	0,99	0,95	0,92	0,41	0,68	0,61	0,40	0,71	0,84	0,83	0,06	-0,12	0,10	0,16	0,64	0,49	0,52	-0,01	0,57
MSCI_EUROPE	0,99	1,00	0,92	0,96	0,93	0,89	0,44	0,68	0,60	0,37	0,69	0,82	0,82	0,05	-0,13	0,09	0,13	0,66	0,51	0,55	-0,01	0,56
MSCI_PACIFIC	0,93	0,92	1,00	0,87	0,83	0,80	0,49	0,69	0,59	0,50	0,73	0,77	0,76	0,07	-0,09	-0,03	0,13	0,66	0,53	0,60	-0,00	0,57
MSCI_NAMERICA	0,99	0,96	0,87	1,00	0,97	0,93	0,36	0,65	0,59	0,39	0,70	0,84	0,83	0,08	-0,13	0,14	0,18	0,60	0,44	0,47	-0,01	0,55
DOWJONES	0,95	0,93	0,83	0,97	1,00	0,86	0,33	0,55	0,52	0,36	0,65	0,81	0,81	0,09	-0,09	0,13	0,17	0,56	0,41	0,42	-0,02	0,39
NASDAQ_100	0,92	0,89	0,80	0,93	0,86	1,00	0,31	0,58	0,48	0,26	0,67	0,72	0,72	-0,07	-0,18	0,11	0,14	0,52	0,41	0,48	0,03	0,57
USCG Corporate	0,41	0,44	0,49	0,36	0,33	0,31	1,00	0,16	0,34	0,36	0,46	0,28	0,26	0,03	0,10	-0,14	0,07	0,38	0,39	0,52	-0,06	0,21
S&P_GS Commodities	0,68	0,68	0,69	0,65	0,55	0,58	0,16	1,00	0,80	0,15	0,36	0,49	0,49	0,21	0,14	0,14	0,33	0,70	0,41	0,35	0,27	0,80
Moody's Commodities	0,61	0,60	0,59	0,59	0,52	0,48	0,34	0,80	1,00	0,30	0,38	0,46	0,46	0,08	0,24	0,24	0,15	0,73	0,49	0,42	0,02	0,65
NAR_Mortgage	0,40	0,37	0,50	0,39	0,36	0,26	0,36	0,15	0,30	1,00	0,62	0,43	0,38	0,08	-0,02	0,01	0,01	0,23	0,08	0,31	-0,34	0,13
NAR_Hybrid	0,71	0,69	0,73	0,70	0,65	0,67	0,46	0,36	0,38	0,62	1,00	0,58	0,56	0,19	-0,05	0,04	0,10	0,38	0,33	0,64	-0,14	0,40
NAR_All	0,84	0,82	0,77	0,84	0,81	0,72	0,28	0,49	0,46	0,43	0,58	1,00	1,00	0,08	-0,25	0,13	-0,03	0,49	0,40	0,43	-0,04	0,48
NAR_Equity	0,83	0,82	0,76	0,83	0,81	0,72	0,26	0,49	0,46	0,38	0,56	1,00	1,00	0,07	-0,26	0,14	-0,03	0,49	0,41	0,42	-0,03	0,49
Art100Index	0,06	0,05	0,07	0,08	0,09	-0,07	0,03	0,21	0,08	0,08	0,19	0,08	0,07	1,00	0,31	0,12	0,53	-0,00	0,06	-0,05	0,35	0,21
European19thCentury	-0,12	-0,13	-0,09	-0,13	-0,09	-0,18	0,10	0,14	0,24	-0,02	-0,05	-0,25	-0,26	0,31	1,00	0,28	0,22	0,15	0,06	0,03	0,33	0,14
OldMasters	0,10	0,09	-0,03	0,14	0,13	0,11	-0,14	0,14	0,24	0,01	0,04	0,13	0,14	0,12	0,28	1,00	-0,04	0,12	0,06	-0,11	0,23	0,11
ContemporaryArt	0,16	0,13	0,13	0,18	0,17	0,14	0,07	0,33	0,15	0,01	0,10	-0,03	-0,03	0,53	0,22	-0,04	1,00	0,01	0,06	-0,16	0,43	0,19
StampsWorldIndex	0,64	0,66	0,66	0,60	0,56	0,52	0,38	0,70	0,73	0,23	0,38	0,49	0,49	-0,00	0,15	0,12	0,01	1,00	0,77	0,61	-0,04	0,52
VintageBordeaux	0,49	0,51	0,53	0,44	0,41	0,41	0,39	0,41	0,49	0,08	0,33	0,40	0,41	0,06	0,06	0,06	0,06	0,77	1,00	0,53	-0,09	0,32
CS_TR_HEDGE	0,52	0,55	0,60	0,47	0,42	0,48	0,52	0,35	0,42	0,31	0,64	0,43	0,42	-0,05	0,03	-0,11	-0,16	0,61	0,53	1,00	-0,02	0,39
Three_monthUSTbill	-0,01	-0,01	-0,00	-0,01	-0,02	0,03	-0,06	0,27	0,02	-0,34	-0,14	-0,04	-0,03	0,35	0,33	0,23	0,43	-0,04	-0,09	-0,02	1,00	0,17
CPI	0,57	0,56	0,57	0,55	0,39	0,57	0,21	0,80	0,65	0,13	0,40	0,48	0,49	0,21	0,14	0,11	0,19	0,52	0,32	0,39	0,17	1,00

7 Concluding remarks

The objective of investors to obtain the highest returns as possible per unit of risk has historically led to a quest for alternatives investment possibilities. We contributed to this quest by considering collectibles as a financial asset class. Three possible benefits were investigated. The benefit of adding collectibles to a global mixed asset portfolio, the benefit of diversification and hedging proposes and the benefits of including collectibles to a portfolio in times of financial headwind. All benefits are from a financial perspective. Emotional, consumption or aesthetic value are not considered.

The results are of theoretical value, because of the use of hypothetical indirect investment possibilities. We are however confident that these possibilities will arise in the near future, due to the ever increasing attention towards alternative investments. The same argument freed us from other limitations as costs connected to trading and holding collectible objects.

As for the results of this study we can conclude that collectible indices behaved differently than most traditional assets in terms of performance over the last 25 years. The performance within the group collectibles also vary widely. There was a collectible index amongst the best 4 and amongst the worst 4 performers in terms of Sharpe ratio during the last 25 years. Vintage Bordeaux wines outperformed most other assets in terms of Shape ratio, where Stamps showed an underperformance compared with other assets. For an investor who seeks for the highest risk adjusted return for just a single asset, Vintage Bordeaux are attractive, Stamps are not.

Very low correlations are found for the collectible indices with most other indices. Some correlations are even negative. There is a broad difference of correlations within the group collectibles. The European 19th century index, the Art 100 general index and the contemporary Art index show relatively high correlation whit each other. The same goes for the Stamp World index and the Vintage Bordeaux index. The Old masters index is not correlated with any other index. The low correlations lead to the conclusion that collectibles are good diversifiers. They can be used as hedge against particular exposure. The low correlation with US inflation, makes them a good hedge against inflation risk. Stamps and Vintage Bordeaux behave more similar as traditional asset classes than art. Stamps and Vintage Bordeaux show significant correlations with US CPI, World and European Equity, Hedge funds and commodities. Investment in Art is most beneficial for investors that want to hedge against particular risks.

If we use a well considered confidence level (5%), we can conclude that adding collectibles to an optimal mixed asset portfolio is not beneficiary in terms of efficiency. There is weak evidence on improvement for only a small number of required returns.

The correlation coefficients of the World Stamp index and the Vintage Bordeaux index increased enormously during the crisis period. The correlations coefficients of the Art 100 index, the European 19th century index, the Old Masters index and the Contemporary Art index remained insignificant in the crisis period. This suggest that these four Art classes are very good diversifiers in periods of financial turmoil.
Moreover, the positive sharp ratios of the European 19th century index and Old Masters index suggest that they are not only good diversifiers, but also recession proof.

The characteristics of collectibles lead to the conclusion that they can be beneficial for various purposes. Diversifying and hedging risk and good performance during recession are the most valuable. Investing in Art is most beneficial when hedging (over) exposure to other assets or hedging against particular events like recession. Vintage Bordeaux behaves most like equity and can be seen as an alternative to this asset class. Relative good performance of this asset class shows profit opportunities. Investing in Stamps is not found to be beneficial for any purpose investigated in this thesis. We found no proof for collectibles contributing to the risk efficiency of a mixed asset international portfolio.

8 References

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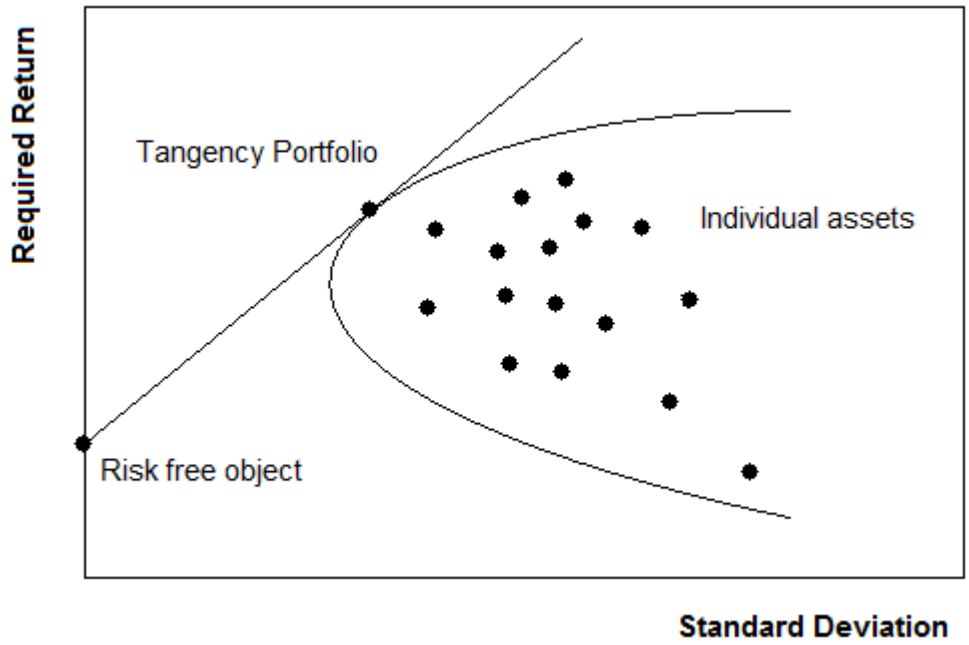
9 Appendices

Appendix A: Graphical representation of a MV framework



Appendix B: Computing alpha, delta and zeta

Explanation of alpha, delta zeta.

The scalars $\alpha, \delta \; and \; \zeta$ are computed as follows:

$a = \bar{R}'V^{-1}e = e'V^{-1}\bar{R}$, $\zeta = \bar{R}'V^{-1}\bar{R}$ and $\delta = e'V^{-1}e$

Appendix C: Big suppliers of ETF's

Ameristock manages Ameristock ETF's.
Barclays Global Investors manages iShares.
Claymore Securities manages specialty Claymore ETF's.
Deutsche Bank manages PowerShares DB commodity- and currency based ETF's.
ETF Capital Management manages a mondial fund of ETF's.
ETF Securities manages ETF's or specializes ETCs
First Trust Advisors manages First Trust ETF's.
Lyxor Asset Management manages Lyxor ETF's.
Merrill Lynch manages HOLDRS.
PowerShares manages PowerShares ETF's.
ProFunds manages *short* and leveraged ETF's.
RevenueShares manages Revenue-Weighted ETF's
Rydex Investments manages Rydex ETF's.
SPA ETF's manages Fundamentally-Weighted ETF's
State Street Global Advisors manages streetTRACKS and SPDRs.
Van Eck Global manages Market Vectors ETF's.
Vanguard Group manages Vanguard ETF's, formally known as VIPERs
WisdomTree manages WisdomTree ETF's.

Appendix D: Components of Indices

Art 100 Index

Pierre ALECHINSKY, Helen ALLINGHAM, Sir Lawrence ALMA-TADEMA, Michael ANCHER, Karel APPEL, Georg BASELITZ, Jean Michel BASQUIAT, Albert BIERSTADT, Pierre BONNARD, Fernando BOTERO, Francois BOUCHER, Eugene BOUDIN, Arthur Merric Bloomfield BOYD, Georges BRAQUE, Bernard BUFFET, Sir Edward Coley BURNE-JONES, CANALETTO, Marc CHAGALL, Sandro CHIA, Giorgio de CHIRICO, Pieter CLAESZ, Jean Baptiste Camille COROT, Gustave COURBET, Salvador DALI, Montague DAWSON, Otto DIX, Jean DUBUFFET, Max ERNST, Henri FANTIN-LATOUR, Lyonel FEININGER, Lucio FONTANA, Myles Birket FOSTER, Jean Honore FRAGONARD, Sam FRANCIS, Thomas GAINSBOROUGH, John William GODWARD, Jan van GOYEN, Jean-Baptiste GREUZE, Atkinson GRIMSHAW, Francesco GUARDI, Keith HARING, Henri HARPIGNIES, Childe HASSAM, Paul-Cesar HELLEU, John Frederick (snr) HERRING, Ferdinand HODLER, Antonio JACOBSEN, Johan-Laurents JENSEN, Johan Barthold JONGKIND, Asger JORN, Jan van KESSEL, Ernst Ludwig KIRCHNER, Moise KISLING, Paul KLEE, Gustav KLIMT, Willem KOEKKOEK, Oskar KOKOSCHKA, Willem de KOONING, Nicolas de LARGILLIERE, Carl LARSSON, Marie LAURENCIN, Fernand LEGER, Lord Frederic LEIGHTON, Sir Peter LELY, Bruno LILJEFORS, Nicolaes MAES, Rene MAGRITTE, Michele MARIESCHI, Ben MARSHALL, Henri MATISSE, Sir John Everett MILLAIS, Joan MIRO, Claude MONET, Giorgio MORANDI, Sir Alfred MUNNINGS, Emil NOLDE, A R PENCK, Pablo PICASSO, Serge POLIAKOFF, Pierre Auguste RENOIR, Sir Joshua REYNOLDS, Jean-Paul RIOPELLE, Diego RIVERA, Hubert ROBERT, Dante Gabriel ROSSETTI, Salomon van RUYSDAEL, Gino SEVERINI, Dorothea SHARP, Leon SPILLIAERT, Carl SPITZWEG, Alfred STEVENS, Marcus STONE, Abraham STORCK, Antonio TAPIES, David (younger) TENIERS, Fritz THAULOW, Archibald THORBURN, Giovanni Battista TIEPOLO, James Jacques Joseph TISSOT, Maurice UTRILLO, Louis VALTAT, Edouard VUILLARD, Andy WARHOL, Tom WESSELMANN, Jack Butler YEATS, Anders ZORN

Euro 19th-Century

Oswald ACHENBACH, Helen ALLINGHAM, Sir Lawrence ALMA-TADEMA, Albert ANKER, Jean BERAUD, Mose BIANCHI, Giovanni BOLDINI, William Adolphe BOUGUEREAU, Alfred de (snr) BREANSKI, Sir Edward Coley BURNE-JONES, John Wilson CARMICHAEL, Emile CLAUS, John CONSTABLE, Thomas Sidney COOPER, Jean Baptiste Camille COROT, Hermann David Salomon CORRODI, Gustave COURBET, Jose CUSACHS Y CUSACHS, Charles Francois DAUBIGNY, Honore DAUMIER, Franz von DEFREGGER, Eugene DELACROIX, Hippolyte Camille DELPY, Narcisse-Virgile DIAZ DE LA PENA, Anton DOLL, Pieter Christian DOMMERSEN, Jules DUPRE, Adrianus EVERSEN, Joseph FARQUHARSON, Giovanni FATTORI, John (snr) FERNELEY, Myles Birket FOSTER, Caspar David FRIEDRICH, Eugene GALIEN-LALOUE, Jean Leon GEROME, Atkinson GRIMSHAW, Eduard von GRUTZNER, Henri HARPIGNIES, Paul-Cesar HELLEU, John Frederick (snr) HERRING, Carl Frederik HILL, Abraham HULK, Jean Auguste Dominique INGRES, Charles Emile JACQUE, Johan-Laurents JENSEN, Luis JIMENEZ Y ARANDA, Johan Barthold JONGKIND, Hugo Wilhelm KAUFFMANN, Willem KOEKKOEK, Alexander KOESTER, Peder Severin KROYER, Wilhelm KUHNERT, Charles Euphrasie KUWASSEG, Carl LARSSON, Benjamin Williams LEADER, Edward LEAR, Charles LEICKERT, Lord Frederic LEIGHTON, Leon LHERMITTE, Bruno LILJEFORS, Raimundo de MADRAZO Y GARRETA, Jacob MARIS, Anton MAUVE, Adolph MENZEL, Sir John Everett MILLAIS, Jean Francois MILLET, Pierre Eugene MONTEZIN, Adolphe MONTICELLI, Giuseppe de NITTIS, Alberto PASINI, Sidney Richard PERCY, Attilio PRATELLA, Vittorio REGGIANINI, Henriette RONNER, Felicien ROPS, Dante Gabriel ROSSETTI, Theodore ROUSSEAU, Rubens SANTORO, Giovanni SEGANTINI, William (snr) SHAYER, Joaquin SOROLLA Y BASTIDA, Carl SPITZWEG, Eloise Harriet STANNARD, Alfred STEVENS, Johan Mari TEN KATE, Fritz THAULOW, James Jacques Joseph TISSOT, Paul Desire

TROUILLEBERT, Constant TROYON, Joseph Mallord William TURNER, Eugene VERBOECKHOVEN, Jose VILLEGAS Y CORDERO, Frederick William WATTS, James WEBB, Peter de WINT, Federico ZANDOMENEGHI,

Old Masters
Osias I BEERT, Nicolaes BERCHEM, Louis Leopold BOILLY, Francois BOUCHER, Jan (elder) BRUEGHEL, Jan (younger) BRUEGHEL, CANALETTO, Annibale CARRACCI, John CONSTABLE, Aelbert CUYP, Arthur DEVIS, Carlo DOLCI, Sir Anthony van DYCK, Jean Honore FRAGONARD, Frans I FRANCKEN, Thomas GAINSBOROUGH, Theodore GERICAULT, Luca GIORDANO, Jan van GOYEN, Jean-Baptiste GREUZE, Francesco GUARDI, Giacomo GUARDI, Giovanni Francesco GUERCINO, Jan Davidsz de HEEM, Egbert van HEEMSKERK, Meindert HOBBEMA, William HOGARTH, Melchior de HONDECOETER, Jean Baptiste HUET, Jacob van HULSDONCK, Jan van HUYSUM, Julius Caesar IBBETSON, Antonio JOLI, Jacob JORDAENS, Jan van I KESSEL, Nicolas LANCRET, Nicolas de LARGILLIERE, Sir Thomas LAWRENCE, Sir Peter LELY, Carle van LOO, Nicolaes MAES, Alessandro MAGNASCO, Michele MARIESCHI, Ben MARSHALL, Adam Frans van der MEULEN, Jan Miense MOLENAER, Klaes MOLENAER, Joos de MOMPER, Peter MONAMY, Jean Baptiste MONNOYER, George MORLAND, Alexander NASMYTH, Charles-Joseph NATOIRE, Jean Marc NATTIER, Aert van der NEER, Adriaen van OSTADE, Isaac van OSTADE, Jean Baptiste OUDRY, Giovanni Paolo PANINI, Jean Baptiste PATER, Giambattista PIAZZETTA, Giovan Battista PIRANESI, Guido RENI, Sir Joshua REYNOLDS, Marco RICCI, Sebastiano RICCI, Hubert ROBERT, George ROMNEY, Salvator ROSA, Thomas ROWLANDSON, Sir Peter Paul RUBENS, Jacob van RUYSDAEL, Salomon van RUYSDAEL, Paul SANDBY, Francis (elder) SARTORIUS, John Nott SARTORIUS, Jan STEEN, George STUBBS, Giovanni Battista TIEPOLO, Giovanni Domenico TIEPOLO, Jacopo TINTORETTO, Joseph Mallord William TURNER, Lucas van UDEN, Willem van de (elder) VELDE, Simon VERELST, Nicolas van VERENDAEL, Joseph VERNET, Paolo VERONESE, David VINCKEBOONS, Simon de VLIEGER, Sebastian VRANCX, Jean Antoine WATTEAU, Jan WEENIX, Adam WILLAERTS, John WOOTTON, Philips WOUWERMAN, Joseph WRIGHT OF DERBY, Jan WYNANTS, Johann ZOFFANY, Francesco ZUCCARELLI

Contemporary Art
Carl ANDRE, Richard ARTSCHWAGER, Miguel BARCELO, Matthew BARNEY, MATTHEW BARNEY**, Georg BASELITZ, Jean Michel BASQUIAT, Vanesa BEECROFT, VANESSA BEECROFT**, Ross BLECKNER, Christian BOLTANSKI, CHRISTIAN BOLTANSKI**, Maurizo CATTELAN, Sandro CHIA, Francesco CLEMENTE, Tony CRAGG, Enzo CUCCHI, Carl D3 ANDRE, Richard D3 ARTSCHWAGER, Miguel D3 BARCELO, Matthew D3 BARNEY, Jean Michel D3 BASQUIAT, Christian D3 BOLTANSKI, Maurizo D3 CATTELAN, Sandro D3 CHIA, Francesco D3 CLEMENTE, Tony D3 CRAGG, Enzo D3 CUCCHI, Wim D3 DELVOYE, Tracey D3 EMIN, Rainer D3 FETTING, Eric D3 FISCHL, Peter and WEISS, David D3 FISCHLI, Dan D3 FLAVIN, Gunther D3 FORG, D3 GILBERT and GEORGE, Robert D3 GOBER, Felix D3 GONZALEZ-TORRES, Douglas D3 GORDON, Dan D3 GRAHAM, Keith D3 HARING, Mona D3 HATOUM, Damien D3 HIRST, Jenny D3 HOLZER, Jorg D3 IMMENDORF, Jasper D3 JOHNS, Donald D3 JUDD, Alex D3 KATZ, Mike D3 KELLEY, Ellsworth D3 KELLY, Anselm D3 KIEFER, Martin D3 KIPPENBERGER, Jeff D3 KOONS, Jannis D3 KOUNELLIS, Sol D3 LEWITT, Robert D3 LONGO, Mario D3 MERZ, Juan D3 MUNOZ, Bruce D3 NAUMAN, Claes D3 OLDENBURG, Gabriel D3 OROZCO, Nam June D3 PAIK, Mimmo D3 PALADINO, D3 PANAMERENKO, A R D3 PENCK, Michelangelo D3 PISTOLETTO, Sigmar D3 POLKE, Richard D3 PRINCE, Robert D3 RAUSCHENBERG, Charles -American D3 RAY, Gerhard D3 RICHTER, Pipilotti D3 RIST, Mimmo D3 ROTELLA, Edward D3 RUSCHA, Niki de D3 SAINT-PHALLE, David D3 SALLE, Julian D3 SCHNABEL, Thomas D3 SCHUTTE, Sean D3 SCULLY, George D3 SEGAL, Richard -American D3 SERRA, Joel D3 SHAPIRO, Cindy D3 SHERMAN, Frank D3 STELLA, Donald D3 SULTAN, Rosemarie D3 TROCKEL, Cy D3 TWOMBLY, Jeff D3 WALL,

Franz D3 WEST, Olivier DEBRE, Wim DELVOYE, THOMAS DEMAND**, RINEKE DIJKSTRA**, Peter DOIG, STAN DOUGLAS**, Marlene DUMAS, Tracey EMIN, Luis FEITO, Rainer FETTING, Eric FISCHL, P.& WEISS FISCHLI**, Dan FLAVIN, Gunther FORG, GUNTHER FORG**, Lucian FREUD, GILBERT & GEORGE**, GILBERT and GEORGE, Robert GOBER, NAN GOLDIN**, Felix GONZALEZ-TORRES, Douglas GORDON, DAN GRAHAM**, Andreas GURSKY, ANDREAS GURSKY**, Keith HARING, Damien HIRST, DAMIEN HIRST**, Jenny HOLZER, Gary HUME, Jorg IMMENDORF, Jasper JOHNS, Donald JUDD, Alex KATZ, Mike KELLEY, Ellsworth KELLY, Anselm KIEFER, ANSELM KIEFER**, Martin KIPPENBERGER, Jeff KOONS, Jannis KOUNELLIS, Sol LEWITT, Robert LONGO, Sarah LUCAS, SARAH LUCAS**, Robert MANGOLD, Brice MARDEN, Mario MERZ, Juan MUNOZ, Bruce NAUMAN, Shirin NESHAT, SHIRIN NESHAT**, Chris OFILI, Claes OLDENBURG, Gabriel OROZCO, GABRIEL OROZCO**, Nam June PAIK, Mimmo PALADINO, PANAMERENKO, A R PENCK, Michelangelo PISTOLETTO, Sigmar POLKE, SIGMAR POLKE**, Richard PRINCE, RICHARD PRINCE**, Robert RAUSCHENBERG, ROBERT RAUSCHENBERG**, Charles -American RAY, CHARLES RAY**, Gerhard RICHTER, GERHARD RICHTER**, PIPILOTTI RIST**, Mimmo ROTELLA, Susan ROTHENBERG, Thomas RUFF, THOMAS RUFF**, Edward RUSCHA, EDWARD RUSCHA**, Niki de SAINT-PHALLE, David SALLE, Antonio SAURA, Jenny SAVILLE, Julian SCHNABEL, Thomas SCHUTTE, Sean SCULLY, George SEGAL, Richard -American SERRA, Andres SERRANO, ANDRES SERRANO**, Joel SHAPIRO, Cindy SHERMAN, CINDY SHERMAN**, Jose Maria SICILIA, Frank STELLA, THOMAS STRUTH**, Donald SULTAN, Rosemarie TROCKEL, Luc TUYMANS, Cy TWOMBLY, JEFF WALL**, Franz WEST, Christopher WOOL

Bordeaux Wine Index

Lafite; Latour; Margaux; Mouton-Rothschild; Haut Brion; Brane-Cantenac; Lascombes; Léoville-Barton; Léoville-Poyferre; Léoville Lascases; Pichon-Longueville Baron; Pichon-Longueville Lalande; Rauzan-Gassies; Ducru-Beaucaillou; Cos d'Estournel; Montrose; Gruaud-Larose; Rauzan-Ségla; Palmer; Giscours; La Lagune; Talbot; Beychevelle; Lynch Bages; Cantemerle; Ausone; Cheval Blanc; Pétrus.

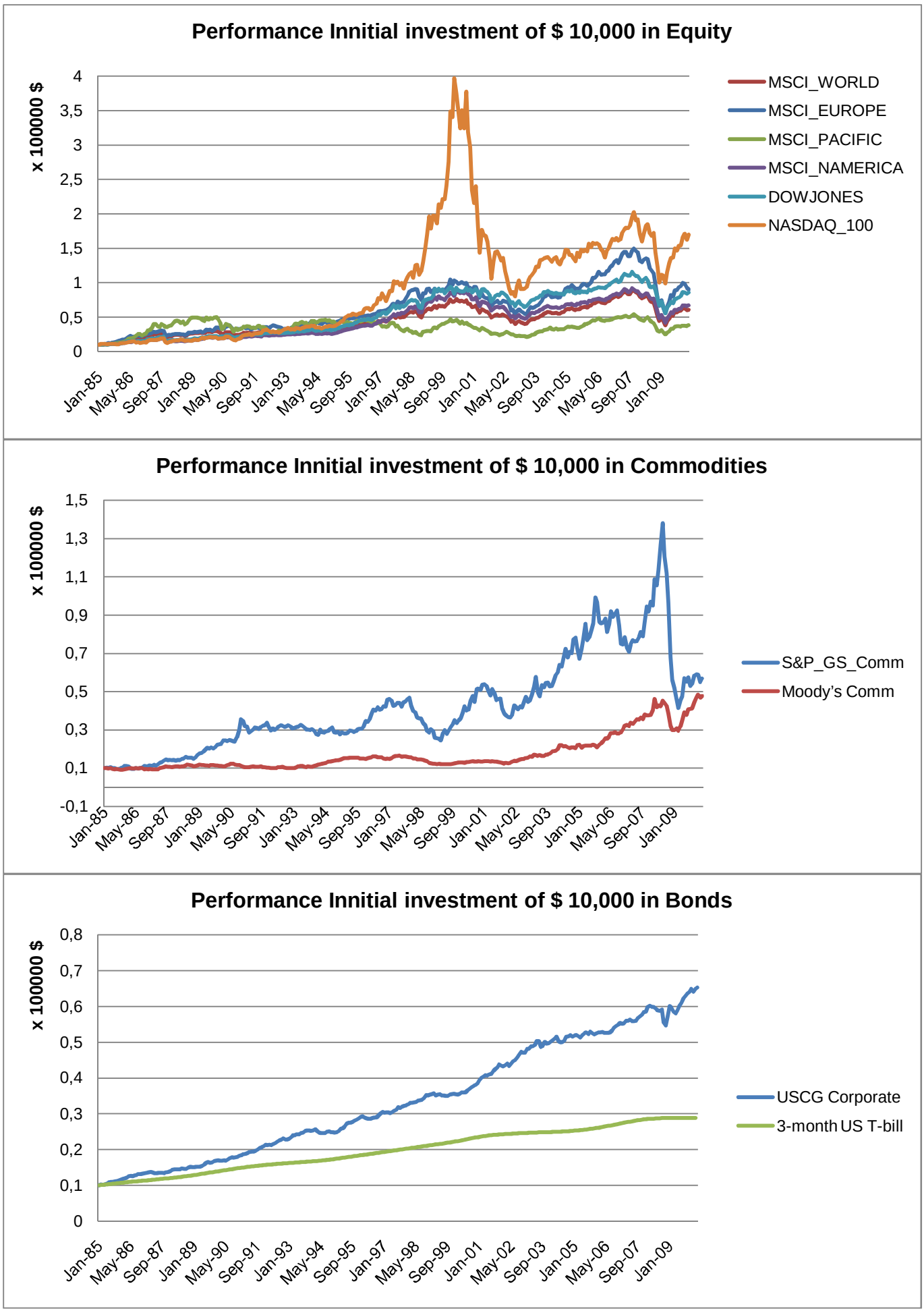
Appendix E: Test on normality of return distributions

Tests of Normality

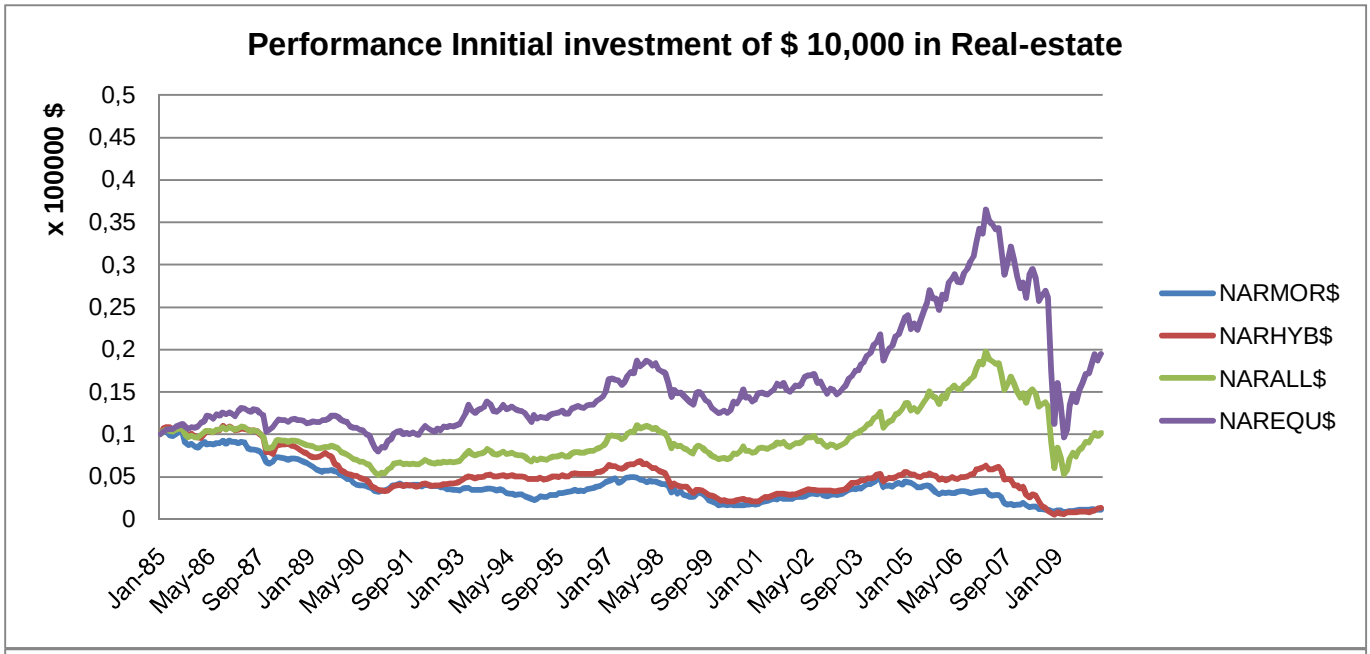
Asset	Kolmogorov-Smirnova			Shapiro-Wilk			Skewness		Kurtosis		Reject Normallity
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	Std. Error	Statistic	Std. Error	
MSCI_WORLD	,071	298	,001	,957	298	,000	-,788	,141	2,414	,281	yes
MSCI_EUROPE	,082	298	,000	,955	298	,000	-,869	,141	2,396	,281	yes
MSCI_PACIFIC	,041	298	,200	,990	298	,035	-,153	,141	1,118	,281	no/yes
MSCI_NAMERICA	,080	298	,000	,934	298	,000	-1,122	,141	4,353	,281	yes
DOWJONES	,074	298	,001	,940	298	,000	-1,073	,141	4,726	,281	yes
NASDAQ_100	,081	298	,000	,963	298	,000	-,647	,141	2,191	,281	yes
USBC2A110	,041	298	,200	,957	298	,000	-,563	,141	4,493	,281	no/yes
Three_monthUSTbill	,108	298	,000	,965	298	,000	-,284	,141	-,629	,281	yes
Six_monthUSTbill	,107	298	,000	,967	298	,000	-,301	,141	-,640	,281	yes
Five_yearUSTreasury	,051	298	,058	,989	298	,021	,105	,141	-,619	,281	no/yes
GSCITOT	,072	298	,001	,961	298	,000	-,777	,141	3,905	,281	yes
MOCMDTY	,068	298	,002	,946	298	,000	-,272	,141	4,554	,281	yes
NARMOR$	,106	298	,000	,940	298	,000	-1,026	,141	3,410	,281	yes
NARHYB$	,165	298	,000	,817	298	,000	-,780	,141	8,395	,281	yes
NARALL$	,134	298	,000	,760	298	,000	-1,899	,141	18,805	,281	yes
NAREQU$	,142	298	,000	,743	298	,000	-2,045	,141	20,348	,281	yes
Art100Index	,142	298	,000	,863	298	,000	-,530	,141	6,684	,281	yes
European19thCentury	,099	298	,000	,944	298	,000	-,082	,141	3,095	,281	yes
OldMasters	,093	298	,000	,948	298	,000	,026	,141	2,522	,281	yes
ContemporaryArt	,170	298	,000	,832	298	,000	,142	,141	7,346	,281	yes
STAMPSWorldIndex	,043	298	,200	,987	298	,010	,268	,141	1,163	,281	no/yes
VintageBordeaux	,132	298	,000	,860	298	,000	-,204	,141	9,167	,281	yes
CS_TRHEDGE$	,097	192	,000	,949	192	,000	-,354	,175	2,569	,349	yes

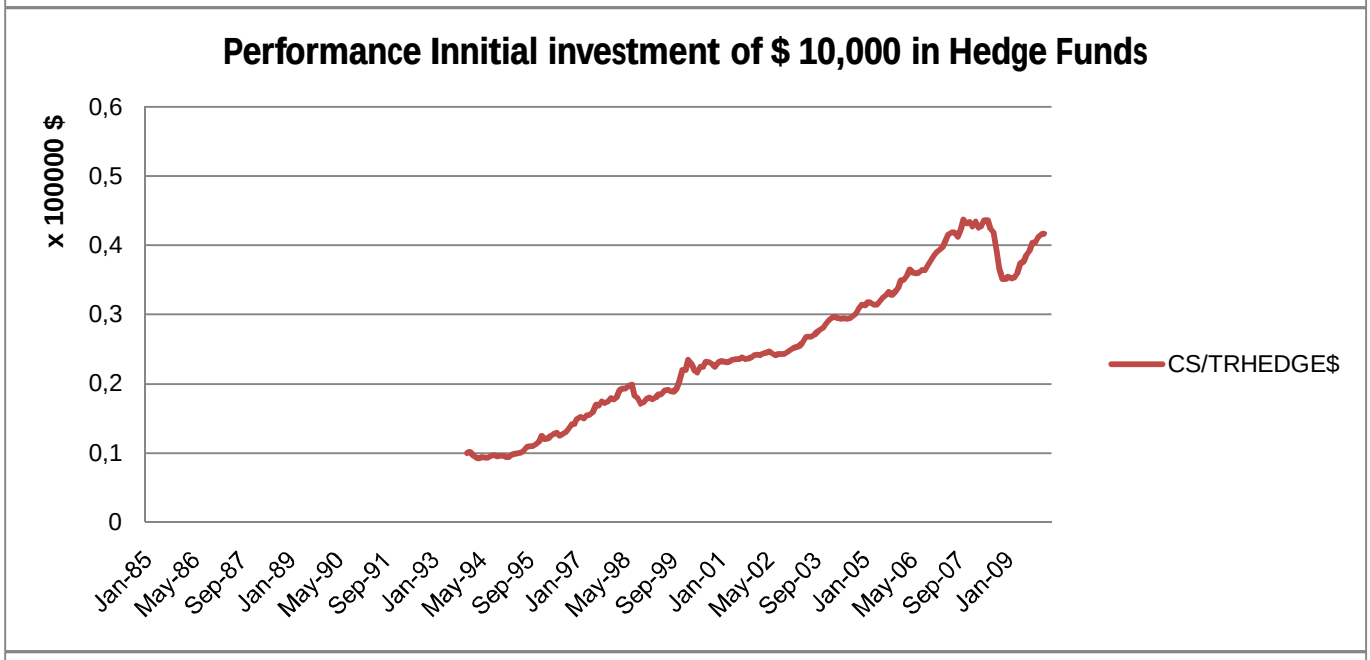
Significant on 5% confidence level.

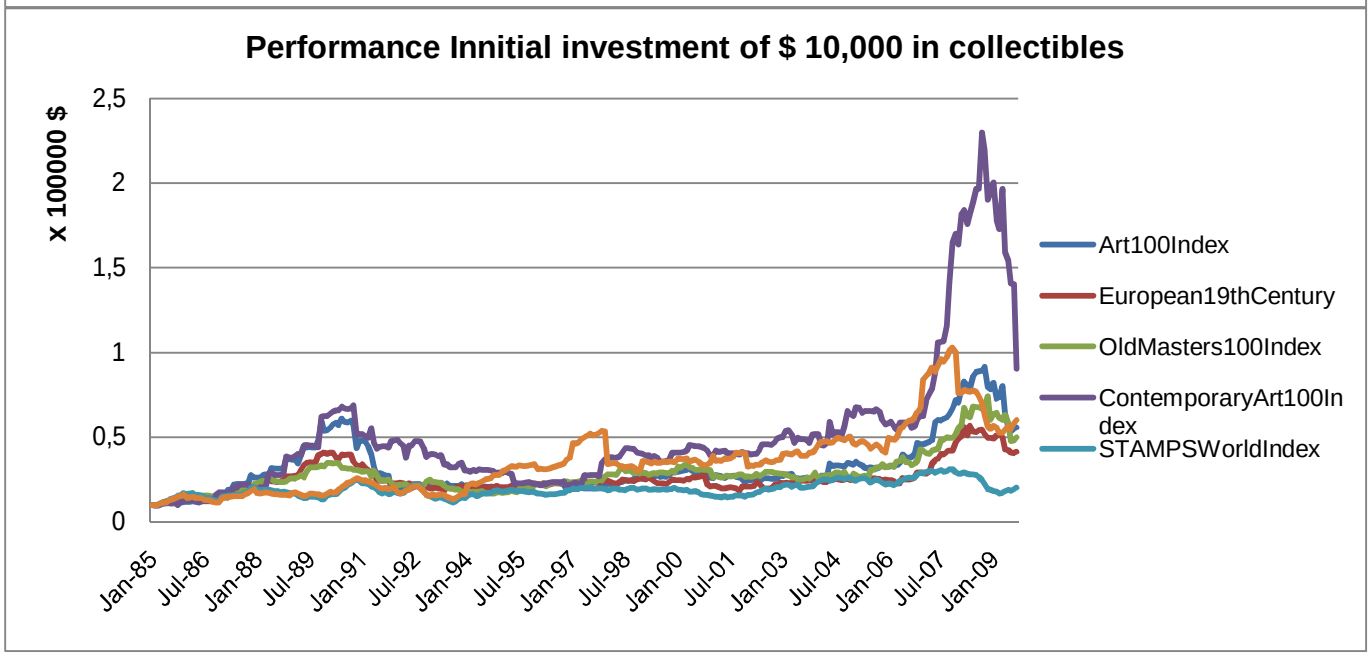
Appendix F: Figures of Performance of $ 10,000 invested per asset class



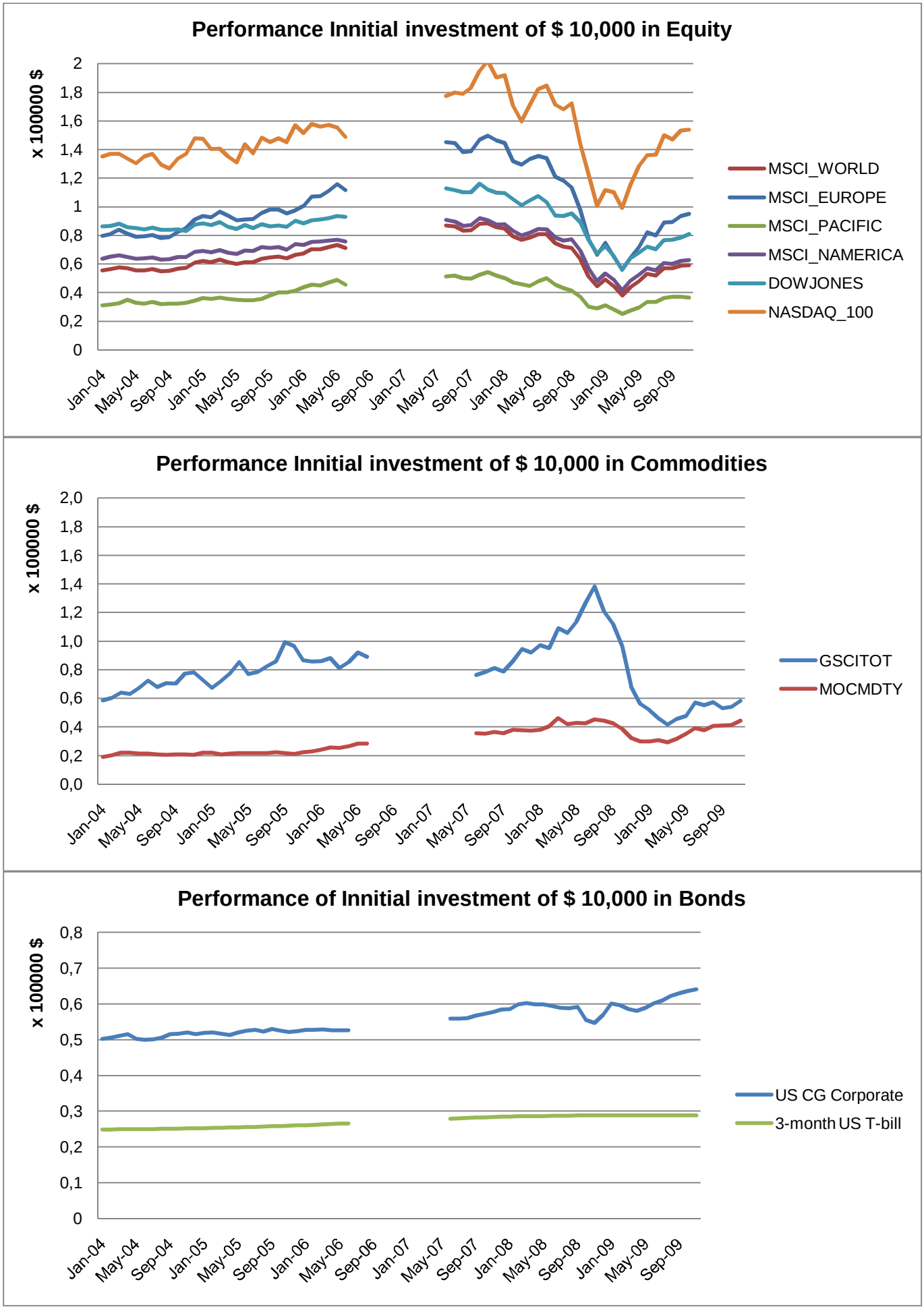
Appendix F: Figures of Performance of $ 10,000 invested per asset class







Appendix G: Figures of Performance of $ 10,000 invested per asset class



Appendix G: Figures of Performance of $ 10,000 invested per asset class