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Are Collectibles Investable?

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ABSTRACT

Academics and Wall Street professionals have long worked to determine the optimal composition of a portfolio of assets. Traditionally, equity and fixed income products are at the forefront of this discussion. More robust studies have considered the merits of real estate, commodities, and currency-based investments and whether they deserve inclusion in a portfolio. This study goes one step further in an effort to assess whether or not items traditionally viewed as 'collectibles' belong in an investment portfolio. In order to make this determination, an analysis of the historical returns data for four different collectibles: whiskey, wine, baseball cards, and vintage videogames, is conducted. The risk-return profile from this data is analyzed using the Sharpe Ratio and is later sensitized to create a more concrete answer for the ultimate question: Are Collectibles Investable?

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Chapter 1

Introduction

Studies have shown that between 33 and 40 percent of Americans have a collection of some sort. Whether that collection is baseball cards, beanie babies, fine art, or vintage records, it is worth wondering: are these individuals significantly mismanaging their finances by allocating their capital to these 'assets,' or are they actually far shrewder investors than those who limit themselves strictly to traditional investments?

This paper will use portfolio optimization strategies based on the mean-variance framework and Sharpe ratio in order to investigate the above claim. Data was collected from a plethora of typical investments including various equity indices, bond indices, real estate proxies, and commodity proxies in order to create a baseline portfolio representing what a typical investor may own. Later, data from four key collectibles: whiskey, wine, baseball cards, and vintage videogames, was collected and analyzed in order to determine whether or not collectibles have a place in an individual's investment portfolio.

While this study seeks to uncover whether or not adding collectibles as a whole is prudent, institutional investors has already allocated significant capital to specific collectibles. During the COVID-19 pandemic, interest in collecting – or investing in – baseball cards increased precipitously. Since then, a number of investment funds have been created solely for this asset. Many of these funds are said to have raised upwards of $15 million in initial capital. However, the idea that alternative investments can be non-financial in nature is not just a recent phenomenon. In 1974, the British Rail Pension Fund made one of the first known investments in a non-financial asset when it allocated 3 percent of its portfolio to fine art. Institutional investing in art was further popularized in 2017 with the creation of Masterworks, a digital platform that allows individual and

institutional investors to buy fractional shares of specific paintings. The introduction of fractional shares by Masterworks and similar platforms greatly lowers the barriers to entry for investing in high-end collectibles. With it now being easier now than it has ever been to invest in this category, it is crucial to uncover whether or not investors should invest in collectible assets.

After it is determined whether or not the data suggests collectibles are a lucrative addition to investment portfolios, a number of other considerations specific to collectibles must be thought through. Specifically, the additional costs associated with collectibles must be considered. Storage and insurance costs can eat significantly into the return associated with any collectible. Some collectibles require specific amounts of light or precise temperatures in order to remain in their original condition. Another key cost consideration for collectibles is the transaction cost associated with its sale, either through an auction house or a digital platform.

With the above considerations relating to the downside of collectibles, one must also consider the additional appeal of owning a collectible instead of a traditional investment. The collectible could directly replace the cost of additional directions in one's home, or more abstractly, one could extract utility from owning a collectible, a utility that could be converted into a monetary value.

In this paper it is expected that investing in collectibles will prove attractive on a risk-return basis when analyzing indices of collectibles. However, when considering factors that indices tend to ignore like additional costs specifically associated with collectibles, it is expected that this attractiveness will deteriorate. With this in mind, an individual would need to extract a fair amount of utility from investing in collectibles in order to justify the practice.

Chapter 2

Literature Review

Definition of Collectible

The very idea of treating collectibles as an investment vehicle is not necessarily intuitive. Because so many individuals collect without seeking financial gain, the concept can be seen as quite foreign. With that in mind, researchers in this particular area have taken great care to first define what a collectible exactly is, as in theory, it could be just about anything.

In a 1999 edition of the *Journal of Economic Perspectives*, Benjamin J. Burton and Joyce P. Jacobsen explicitly state what a collectible is not. Burton and Jacobsen eliminate real estate, precious metals, and gemstones from the potential pool of collectibles under the notion that because these entities can be used as inputs in the production process, they must be disqualified. While this distinction may seem arbitrary on its surface, it encapsulates a certain tone seen in all academic works about collectibles, that they are inherently not useful beyond the utility acquired from possessing them. A collectible coin is no longer used as currency, and if it is still legal tender, using it as valid currency would be a destruction of value. A collectible car is no longer enjoyed on the road, and if it is still driven, the driving incrementally destroys value. A collectible sneaker is no longer worn on one's feet, and if it is, the shoe loses value as it wears. These examples effectively demonstrate the inherent lack of usefulness attributed to collectibles-as-investments and expands it beyond the idea that their potential use stems only from potentially being an input in the production process, as Burton and Jacobsen asserted.

When working to define 'collectible' Kleine, Peschke, and Wagner's July 2020 publication in *Finance Research Letters* stated that collectibles are 'speculative'. Without arguing the implications of this claim in relation to the returns of collectibles, this statement provides value in that it eliminates financial assets from being considered a part of the collectible space. Saving is the act of collecting financial assets, be it cash, stocks, bonds, real estate, or cryptocurrency, so it would not be entirely unreasonable to consider

these assets as collectibles at face value. However, because financial assets have underlying value associated with a stream of cash flows, they are inherently not speculative. For collectibles, the underlying value is only based on prior sales or theorized future sales, thus providing a clear distinction between baseball cards and mid-cap equities or between vintage wines and coastal real estate.

In its October 2020 overview of collectibles as investments, Credit Suisse, one of the largest banks in Europe, included the word 'tangible' in its definition of the word collectible. This notion is one that will not be assumed throughout the remainder of this paper. The increasing popularity of non-fungible-tokens, or NFTs, throughout 2020 and 2021 has turned the collectible market on its head via the most significant increase in the digital, or intangible, collectibles to date. With technology rapidly becoming a more prevalent part of society and the metaverse looming as a potentially widely-used digital living space, limiting the definition of collectible to things one can touch with their human hands seems imprudent. This particular paper will differentiate itself from past works written about the collectibles space with this added element of inclusivity baked in.

Finally, and potentially most importantly, the dictionary definition of collectible must be considered. Investopedia, a crowd-sourced website pooling finance-related knowledge, claims that a collectible must be worth more than it originally cost to purchase. While this claim is not one that necessarily needs to be true, as one can collect items widely considered to be worthless, for the purpose of this analysis, only assets that were at some point worth more than their original purchase price will be considered. This creates a sort of survivorship bias, but one that should not overtly alter the usefulness of this paper's results as individuals tend to only consider collectibles as investments if they have already appreciated in value to some degree.

Overall, the collectible base that can be viewed as a potential investment is any item, tangible or intangible, excluding financial assets, that has at some point appreciated in value beyond its original purchase price.

Baseball Cards in Other Studies

Baseball cards have existed since 1865, but considering their 157 years of production, remarkably little has been written about them by the academic community, especially in relation to their value. In a 2000 article featured in the *Journal of Financial Education*, James H. Gilkeson and Reinhold P. Lamb mentioned baseball cards as a prime example of a collectible that is established as an investment vehicle. Gilkeson's and Lamb's work contrasted baseball cards with a more speculative collectible, Beanie Babies, which did not have the same extended track record as a store of value and a returns generator. More recently, an academic paper produced by Joseph Engelberg, Linh Thompson, Jared Williams for The Financial Review in 2019 lent further credence to the notion that baseball cards are a valid investment vehicle by drawing a number of parallels between the market for baseball cards and that for publicly-traded equities. The authors observed that the market for individual baseball cards sees a price increase followed by a period of underperformance immediately after initial distribution, similar to observations made about equities after their initial public offering. Furthermore, phenomena including momentum, price drift, and the rapid diffusion of publicly available information were all observed in the baseball card market, after first being observed in more established equity markets. Outside of the academic community however, a fascination with the appropriate price for baseball cards has existed for the better part of 60 years. This fascination is best illustrated by the Beckett Baseball Card Price Guide, an annually-published book that contains the average, high, and low sale price of thousands of baseball cards from the past several decades. A 2008 study conducted by Jannett Highfill and Kevin O'Brien concluded that the information in guides like these, and their original inspiration, the *1979 Sport Americana Baseball Card Price Guide*, are highly correlated with prices that have been observed at auction. Beyond these studies, much of the focus on the baseball card market has been surrounding what factors make one baseball card more valuable than another. Generally, older cards, rookie cards, those belonging to Hall of Famers, those with the most limited production runs, and those in the best condition are considered the most valuable. Understanding and applying these principles is imperative if one wants to be a successful baseball card investor. This study will look at

whether or not baseball cards, among other collectibles, are a viable investment vehicle on a risk-adjusted basis, assuming that the above principles are upheld. Additionally, this study will be the first to look at baseball cards in conjunction with the specific set of other collectibles analyzed here, including whiskey, wine, and videogames.

Whiskey in Other Studies

Whiskey, in its current form, has existed for at least 600 years; however, because its original purpose was functional (to be consumed), the idea of collecting the item and treating it like an investment is certainly much newer. Because of this, there is a dearth of academic research on this particular subject. While whiskey itself is very prevalent in society, its primary focus in the finance world until more recently was as a 'vice investment' often seen as morally reprehensible, counter-cyclical, or both. However, things began to change in 2010, when preeminent whiskey investors Andy Simpson and David Robinson started their whiskey investing platform, Rare Whisky 101. Spurred by this development, the general public began to take a greater interest in whiskey collecting and investing. Today, niche companies like Whiskey Invest Direct, a platform for whiskey investing, and large publications, like *Forbes* magazine both contribute to the growing popularity and culture of the whiskey investing space. In a recent *Forbes* publication, the company cited the immense importance of assessing 'rarity and quality' when making whiskey investments. It is important to note that all data relating to whiskey that will be presented in this thesis is based on investors who were generally making investments with these factors in mind. This paper will be among the first papers analyzing the broader collectibles market that features whiskey so prominently.

Wine in Other Studies

While investing in baseball cards or whiskey may be under-represented in academic literature relative to the societal prominence of the items in question, the same cannot be said for wine. Studies relating to wine investing cover a wide variety of topics, but the chief among them is of supreme relevance to the discussion to be had in this thesis. Are there benefits to be incurred by diversifying one's financial portfolio by including wine as an alternative investment class. The results of these studies are rather different, necessitating the need for further exploration. Most recently, in June 2020, Thomas Nahmer published a study in the *Journal of Alternative Investments* where he said definitively that wine investments may provide a slight return advantage relative to equity investments, but when volatility is considered, the asset class does not belong in an optimal portfolio of assets. Nahmer goes on to say that when considering the costs associated with wine investing that are not associated with an index, (i.e., storage, insurance, etc.) the risk-return trade off become even more undesirable. However, not all experts agree with Nahmer. A 2010 study produced by professors from the University of Fribourg in Switzerland determined that wine is in fact an attractive addition to a portfolio of assets due to both its higher return and its lower volatility. This study cited wine's performance during the Great Financial Crisis as evidence that the asset performs especially well in bear markets, relative to equities. A prior study from 2001 published in *Economic Inquiry* by oft cited experts Benjamin J. Burton and Joyce P. Jacobsen reached a similar conclusion about the attractiveness of wine as an asset class. This thesis will use the Liv-ex 100 as a proxy for wine price behavior to determine which line of thinking rings true today.

Videogames in Other Studies

Until recent years, the idea of investing in videogames strictly meant investing one's time in a hobby. Today, investing in vintage videogames is a strong niche in the collectibles-as-an-investment ecosystem. That being said, the idea of investing in videogames has not been yet been investigated by the academic community. Publications on the subject have largely been limited to brief news articles highlighting the impressive returns certain videogame consoles, games, or accessories have generated. While auction houses, blogs, and fractional trading platforms are beginning to embrace the idea of retro videogames being an investable asset class, it will be up to studies like this one to push retro videogame investing from the corners of the Internet to the mainstream of the alternative investment space.

Differentiation of this Study

In the past, the academic community has examined the viability of collectibles as actual investments that can be implemented in one's overall portfolio. Typically, these studies have analyzed the merits of a single collectible and whether its risk-return profile merits its inclusion in a particular investment portfolio. This study however, will look at a group of four collectibles, and while the risk-return profile of each collectible will be analyzed on an individual basis, the focus of the study will be on the group of collectibles as a whole. Examples of studies that are similar to this are present, albeit limited, but no study uses the same four collectibles (whiskey, wine, baseball cards, and video games) as this one. Additionally, the collectibles in this study are rather liquid. As a result of the liquidity of these collectibles, recent price data is available for each of them. This study will provide analysis that is inherently more up-to-date than studies from two, five, or ten years ago that are based on now stale information.

Chapter 3

Methodology

Methodology Summary – Sharpe Ratio

This study uses the Sharpe Ratio in order to determine what the optimal portfolio of assets is when considering both financial assets and collectible assets. While teaching finance at the University of Washington in 1966, William F. Sharpe created the Sharpe Ratio, a tool designed to simplify and streamline the process for creating portfolios of assets. The ratio considers both return and risk in evaluating the merits of a particular asset. To encompass returns, the formula relies on the user to input the 'expected return' of the asset. Traditionally, the average historical return is used when considering large indices, which make the implementation of a discounted cash flow model or any other asset pricing model impractical. When considering risk, the formula relies on the historical standard deviation of the asset, with a lower standard deviation representing less volatility and thus less risk. The following subchapters outline the indices utilized for this analysis, the process that led to their selection, and how the returns data associated with those indices was found and formatted. After the data selection portion of the methodology is complete, an outline of how the various elements of the Sharpe Ratio were calculated, is presented. And finally, sensitivities and statistical analysis tools are discussed that help support the validity of the data produced through the portfolio optimization process.

Selecting the Financial Asset Proxies

The first step in determining whether or not collectibles belong in a portfolio of financial assets is to determine what is already in a portfolio of financial assets. Generally speaking, financial assets fall into five categories: equity, fixed income, real estate, commodities, and currency. For the purposes of this study, currency is ignored as the strength of various global currencies is a factor in the value of the other four asset classes. Thus, omitting currency avoids a degree of double counting. With the four remaining categories in place, financial products with publicly available returns data are selected to serve as proxies for each of the asset classes. Because equities receive much of the attention of the individual investor, a broad swath of proxies are selected in order to more fully provide representation to a number of different equity-investment strategies. The following Indices and ETFs are utilized as proxies for the equity space:

1. The S&P 500
2. The Dow Jones Industrial Average
3. The NASDAQ
4. Vanguard Developed Markets Index Fund Admiral Shares (VTMGX)
5. Vanguard Emerging Markets Stock Index Fund Admiral Shares (VEMAX)

The above indices and ETFs are selected because they encompass a wide variety of equities that represent a significant number of actual strategies used by a typical investor. Many investors own just the S&P 500 index; others own just the NASDAQ. Some prefer a hybrid of the two indices, while others may look abroad for international diversification. This collection of five indices encompasses a wide enough array of strategies that the typical investor can feel as if the study can be applied to their portfolio.

The following ETFs are used as the proxies for the fixed income asset class:

1. Vanguard High-Yield Corporate Fund Investor Shares (VWEHX)
2. iShares Core U.S. Aggregate Bond ETF (AGG)

The above ETF products include countless high yield and low yield fixed income products, where it is expected that the lower yielding products provide an additional degree of safety. A hybrid of the two indices is representative of what a typical investor would own within the fixed income portion of a portfolio.

The following ETF is used as a proxy for the real estate asset class:

1. iShares Residential and Multisector Real Estate ETF (REZ)

The real estate asset class is particularly important to focus on in studies that focus on optimal asset allocation like this one. The U.S. Federal Reserve published a study that stated that approximately half of U.S. household net worth is tied into real estate. For most individuals, this wealth is placed in the home in which they live, but for many others this asset category also includes second homes and rental properties. While most individuals do not own investment properties or have a specific product in their brokerage account relating to real estate, including real estate in this analysis is imperative as so many individuals do have such a large portion of their assets allocated to the category. The iShares Residential and Multisector Real Estate ETF is primarily compromised of REITs focusing on residential real estate, but also includes non-residential REITs to account for individuals' real estate holdings outside of their homes.

And finally, the following ETF is used as a proxy for the global commodities market:

1. Invesco DB Commodity Index Tracking Fund (DBC)

The above ETF tracks a wide variety of commodities products in an effort to capture the returns of the entire commodities marketplace. While commodities are not the most popular asset class to include in an investment portfolio, their recognized ability to serve as a hedge against inflation makes their inclusion in this analysis worthwhile, especially considering that they may be similar to collectibles in this way.

Data for all of the various ETFs and indices mentioned above is publicly available and verified by Yahoo Finance. This data includes the effects of all stock splits and dividend payments, allowing it to serve as a truly effective representation of the performance of each asset class. Monthly data is used for the years 2013 through 2021, inclusive, in order to conduct an apples-to-apples comparison with the data available for collectibles.

Selecting the Collectible Indices

With the financial asset categories and their appropriate proxies selected, we then curate a list of collectibles to create the collectibles portfolio. It is important that the collectibles considered meet the criteria outlined earlier in the study. The list of candidates includes the following: art, baseball cards, basketball cards, Bored Apes, classic cars, coins, designer handbags, football cards, general sports memorabilia, NBA Top Shot NFTs, Pokémon Cards, rare books, rare instruments, Rolex watches, sneakers, stamps, videogames, whiskey, and wine. Each of these collectibles can be purchased with the thought that it will increase in value in the future, unless that collectible is 'used' in some way, which will nearly certainly diminish value. While each of these collectibles meets the criteria necessary to be considered a collectible, a final criterion must be met for the collectible to be included in the study. There must be regularly updated, publicly available returns data that covers a significant historical period and a wide sample of the collectible. Without this data, the portfolio optimization process cannot be completed. In the end, four collectibles meet this final criterion:

1. Baseball Cards
2. Videogames
3. Whiskey
4. Wine

The index representing the returns of baseball cards is provided by PWCC, an online trading cards marketplace. PWCC receives its transaction data from VintageCardPrices.com, another reputable trading cards platform. The index includes cards from 1888 – 1999 with a PSA grade of 4 or higher. All cards represented in the index receive their values from their most recent auction sale. Changes in the price of the index occur when the same card in the same condition is auctioned off at a later time. Only cards with ten sales in the last ten years and two sales in the last twelve months are included in the data set. This prevents certain illiquid cards from artificially maintaining the level of the index. Additionally, cards that sell for outlier prices, on the high end or the low end, are excluded from the index calculation. Currently, there are

100 cards in the index. The index is updated daily and is presented in a percent change format. In order to use the data for this analysis specifically, the data is converted from this format into a monthly index.

The index representing the returns of videogames is provided by PriceCharting.com, an online database that tracks the returns of Pokémon Cards and retro videogames. The index represents the average price of videogames sold on early Nintendo, Sega, Atari, and PlayStation consoles. Only licensed, wide release, commercially-available games are included in the index. Limited edition and special edition games are excluded. The games represented in the index could presumably be found in the collection of an average videogame player, albeit these would likely be their older games. All games represented in the index were released between 1982 and 2008. The data from this index is updated monthly and covers a period starting in September 2008 and continuing through the present.

The index representing the returns of whiskey is provided by RareWhisky101.com. RareWhisky101is a U.K. based brokerage firm that arranges transaction in the collectible whiskey space, while collecting data for various indices that track subsets of the whiskey marketplace. Their oldest index, the Rare Whisky Icon 100 Index, includes 100 of the most iconic bottles of whiskey ever sold at auction. Data for the index comes directly from the United Kingdom's largest auction houses. The index begins on December 31, 2012. Being the shortest running index in our sample, this index created the analysis period of 2013 – 2021 for this study. Finally, the information provided by the Rare Whisky Icon 100 Index is presented in a weekly format. A conversion to monthly returns is necessary to create an apples-to-apples comparison for the portfolio optimization portion of the study.

Lastly, the index representing the returns of wine is provided by Liv-ex. The Livex100 index can be obtained via the Bloomberg Terminal. This index is based on transactions for 100 of the most desired wines by collectors including numerous Bordeaux-wines, the most frequently collected wine. Data from the Liv-ex index is presented in a monthly format. Because all data sets represented must be the same frequency to accommodate the portfolio optimization mathematics, all indices must be converted to a monthly format in order to accommodate this one.

The wines, whiskeys, and baseball cards that make up the above indices can be seen in the Appendix.

Preparing the Data

With all of the data compiled, completing a portfolio optimization process is now possible. Each of the 13 assets (9 traditional investment proxies and 4 collectible proxies) is entered into a table that includes each of their prices from the first day of each month from 2013 – 2021. Using this data, a second table is created to represent the month over month returns for each of the assets over the same investment period. The second table is created using the traditional percent change formula, starting at the second data point in the set. The formula is as follows:

$$Percent\ Change = \frac{Current\ Month - Prior\ Month}{Prior\ Month}$$

Following the completion of the initial percent change table, a second percent change table is completed before analysis can officially commence. This percent change table shows only the excess returns above the risk-free rate and is created by subtracting the risk-free rate from the appropriate monthly return. The risk-free rate for this study is the U.S. 10-year treasury bond yield. This rate is used because it is the most frequently used risk-free rate and because it best matches the 9-year time horizon of this analysis. Because the returns for this study are monthly returns, the 10-year treasury yield, which is quoted in annual terms, is first converted to a monthly yield before the subtraction occurs. A table of excess returns above the risk-free rate is appropriate to use for the calculation of standard deviations that will serve as a key input variable in the portfolio optimization process. This allows the standard deviation of returns, the risk measure in the portfolio optimization process, to represent only the variability in the risk premiums.

Portfolio Optimization

With a table of monthly excess returns in place, the data is ready to be analyzed using Excel's suite of data analysis tools. The data is highlighted and the 'Descriptive Statistics' analysis tool is run on each of the 13 assets simultaneously. This provides an abundance of data that could be relevant for additional analysis, but only the 'Mean' and 'Standard Deviation' are necessary for this analysis. Excel's method for calculating the aforementioned statistics is as follows:

$$Mean = \frac{\sum Monthly\ Returns}{Number\ of\ Monthly\ Returns}$$

$$Standard\ Deviation = \sqrt{\frac{\sum(Monthly\ Return\ X - Mean\ Monthly\ Return)^2}{Number\ of\ Monthly\ Returns - 1}}$$

In order to conduct a portfolio optimization process using the Sharpe Ratio, the average return for each asset is needed and the standard deviation of each asset is needed. These figures are used as proxies for the expected future return of the asset and the expected future standard deviation of the asset, respectively.

The optimal portfolio, according to the risk return framework outlined by the Sharpe Ratio, is the one that maximizes the Sharpe Ratio. The typical formula for the Sharpe Ratio is as follows:

$$Sharpe\ Ratio = \frac{Portfolio\ Expected\ Return - Risk\ Free\ Rate}{Portfolio\ Standard\ Deviation}$$

However, because this analysis is based on excess returns data, or just the risk premiums, over the 9-year analysis period, subtracting the risk-free rate a second time would be double counting. As a result, the relevant Sharpe Ratio to maximize is as follows:

$$Sharpe\ Ratio = \frac{Portfolio\ Expected\ Return}{Portfolio\ Standard\ Deviation}$$

With this in mind, both portfolio expected return and portfolio standard deviation must be calculated. Portfolio expected return is represented with the proxy, average portfolio return, for the initial stages of this study. The weighted average portfolio return is calculated by multiplying the average return for each asset by its weight in the portfolio, and then summing each of the results. This process can be represented using the following formula:

$$Weighted\ Average\ Portfolio\ Return = \sum (Asset\ Weight * Asset\ Average\ Return)$$

However, utilizing matrix algebra is a more efficient way to compute the average portfolio return in Microsoft Excel. Applying the =mmult and =transpose functions to the following equation returns the average portfolio return, where ω^T is a vector of the weights of each asset in the portfolio, transposed, and e is a vector of the average return of each asset, which again serves as the proxy for the expected future returns of each asset.

$$Average\ Portfolio\ Return = \omega^T * e$$

The same matrix algebra techniques are applied to the calculation of portfolio standard deviation. This formula is appreciably more complex than the simple sample standard deviation formula, but provides extreme value in that it considers the correlation between the various assets and how that correlation reduces risk. The following formula calculates the standard deviation of the portfolio, where ω^T is a vector of the weights of each asset, transposed, *covm* is a matrix of the covariances between each of the assets, and ω is a vector of the weights of each asset.

$$Portfolio\ Standard\ Deviation = \sqrt{\omega^T * covm * \omega}$$

While establishing a vector of weights is straightforward, creating a covariance matrix is not necessarily so. However, utilizing the 'Data Analysis Toolpak' in Microsoft Excel makes the process rather painless. The 'Covariance' tool within the Data Analysis Toolpak creates a partial matrix of covariances between each of the assets. To convert this covariance table into a complete matrix, the values must be reflected over the diagonal axis. Microsoft Excel calculates 'Covariance' utilizing the following formula:

$$Covariance = \frac{\sum(Asset\ 1\ Return - Asset\ 1\ Average\ Return) * (Asset\ 2\ Return - Asset\ 2\ Average\ Return)}{Number\ of\ Observations - 1}$$

Below is a sample covariance matrix:

	Asset A	Asset B	Asset C
Asset A	Variance of A	Covariance of B &A	Covariance of C & A
Asset B	Covariance of A &B	Variance of B	Covariance of C & B
Asset C	Covariance of A & C	Covariance of B & C	Variance of C

Portfolio average return and portfolio standard deviation are calculated for the following portfolios:

1. An equal-weight portfolio of all 13 assets (9 financial assets, 4 collectibles)
2. An equal-weight portfolio of just the 4 collectibles
3. An equal-weight portfolio of just the 9 financial assets
4. A 'typical portfolio' of financial assets with the following weightings
    - 50% Residential Real Estate
    - 25% S&P 500
    - 5% Emerging Markets ETF
    - 10% Core Bonds ETF
    - 10% Junk Bonds ETF

With all of the portfolio mathematics established, the final step in creating an optimal portfolio is to determine the weights in the portfolio that maximize Sharpe Ratio by creating the highest returns relative to the standard deviation. This can be done using Microsoft Excel's 'Solver' functionality. The Sharpe Ratio cell is set to be maximized by manipulating the cells that contain the weights of each asset in the portfolio. Two key constraints are put in place to ensure that Excel can produce an optimum value and to ensure that the value Excel produces is rooted in reality. The first constraint is that all of the weights must sum to 100%. Without this constraint, Excel would be unable to reach an answer. The second constraint is

that each of the weights must be greater than or equal to zero. While it is possible to have a negative weight, as a negative weight would represent the shorting of a particular asset, allowing Excel to produce an answer with a subzero weight does not match up with reality. This is because there is no instrument in place, financial or tangible, that allows an investor to short a collectible. While this may exist in the future, current conditions necessitate the inclusion of this second constraint.

The previously mentioned optimization process is followed for the following portfolios:

1. A portfolio containing all 13 assets [The Optimal Portfolio]
2. A portfolio containing just the 9 financial assets [The Optimal Financial Portfolio]
3. A portfolio containing just the 4 collectibles [The Optimal Collectible Portfolio]
4. A portfolio combining the Optimal Financial Portfolio and the Optimal Collectible Portfolio
5. A portfolio combining the Optimal Financial Portfolio and the Equal-Weight Collectible Portfolio
6. A portfolio combining the Typical Financial Portfolio and the Optimal Collectible Portfolio
7. A portfolio combining the Typical Financial Portfolio and the Equal-Weight Collectible Portfolio
8. A portfolio combining the Optimal Financial Portfolio and the Optimal Collectible Portfolio (with 50% of the Historical Returns)
9. A portfolio combining the Optimal Financial Portfolio and the Equal-Weight Collectible Portfolio (with 25% of the Historical Returns)
10. A Portfolio combining the Typical Financial Portfolio and the Optimal Collectible Portfolio (with a 100% increase in the Historical Standard Deviation)
11. A Portfolio combining the Typical Financial Portfolio and the Equal-Weight Collectible Portfolio (with a 100% increase in the Historical Standard Deviation and 50% of the Historical Returns)

Following the portfolio optimization process for each of these 11 portfolios creates data that can lead to the overarching goal of this study: to determine whether or not collectibles belong in a portfolio that now consists only of financial assets.

Sensitivity Procedure

With that in mind, sensitivities and additional statistical analysis tools serve to strengthen the claims that the initial data output would suggest. The primary sensitivity tools for this study focus on the area for which a typical investor would have the most doubt: the returns for the collectibles. Without underlying cash flows backing up potential future returns, there is reason to question the stability of the returns for the collectible assets. To account for this doubt, the portfolio mathematics and portfolio optimization processes are re-run with a forecast of lesser returns for the collectible portfolios.

Later, to account for different *risk* scenarios, sensitivities are run where the standard deviation of the collectible portfolios are varied. Because the formula for the standard deviation of a portfolio (the risk measure) accounts for both the risk of the asset (its own variance) and how that asset relates to the other assets in the portfolio (covariance), a replica data set must be created that has the desired level of risk, a corresponding relationship with the other assets, and the same mean observed historically. To create this data set, the original data points were altered with the following formula:

$$New\ Data\ Point = 2 * (Original\ Data\ Point - Average\ Value) + Average\ Value$$

This transformation is used on the equal-weight collectible portfolio's returns data and the optimal collectible portfolio's returns data in order to create a data set with the same expected return as the two portfolios mentioned, but a risk level twice as great as the original data indicates. Testing this series of data is useful in determining whether or not the collectibles are attractive at higher risk levels.

The primary statistical analysis tools for this study are confidence intervals for the correlation coefficients between the assets. Including collectibles in a portfolio without assurances regarding their returns is only a wise strategy if they have a low or inverse correlation with the financial assets in question. This low or inverse correlation allows the portfolio to benefit from the risk-reducing properties of diversification. Creating a confidence interval surrounding the correlation coefficients produced by Microsoft Excel's correlation tool can provide additional certainty in the results of the study.

The process for creating a confidence interval for a correlation coefficient for this study is as follows:

1. Perform the Fischer Transformation on the correlation coefficient, r, using the following formula:

$$z_r = \frac{\ln(1+r)}{\ln(1-r)}{2}$$

2. Find the upper and lower bounds of the confidence interval, in the logarithmic form, using the following formulas:

$$Upper\ Bound\ (Log\ Form) = z_r + \frac{z\alpha/_2}{\sqrt{n-3}} = U$$

$$Lower\ Bound\ (Log\ Form) = z_r + \frac{z\alpha/_2}{\sqrt{n-3}} = L$$

3. Convert the logarithmic form of the confidence interval to the same -1 to +1 scale used for the correlation coefficient, using the following formulas:

$$Upper\ Bound = \frac{e^{2U}-1}{e^{2U}+1}$$

$$Lower\ Bound = \frac{e^{2L}-1}{e^{2L}+1}$$

This mathematically verified process creates confidence intervals for the correlation coefficients created in this study.

Chapter 4

Results

The following series of tables captures the results of the study described above.

First, data relating to each of the individual assets is presented.

Next, the optimal portfolios of assets, produced using the Solver tool on Microsoft Excel are presented.

Later, optimal portfolios made up of previously established portfolios of assets are presented.

Following that, optimal portfolios made up of altered collectibles portfolios are presented.

Subsequently, data relating to the optimal portfolios established on the three prior pages is presented.

And finally, correlation coefficient matrices between the 13 assets are presented, including lower and upper bounds for each coefficient.

Individual Asset Sharpe Ratio Table

The following table shows the average monthly historical return, the monthly historical standard deviation, and the individual Sharpe Ratio for each of the 13 assets considered in this study over the period 2013 – 2021.

Asset	Average Monthly Historical Return	Monthly Historical Standard Deviation	Sharpe Ratio
S&P 500	0.93%	3.89%	0.2395
NASDAQ	1.34%	4.52%	0.2966
Dow Jones Industrial Average	0.77%	3.98%	0.1944
Residential Real Estate	0.26%	4.68%	0.0557
Commodities Proxy	0.44%	4.18%	0.1049
Emerging Markets	0.83%	5.06%	0.1648
Developed Markets	-0.24%	4.96%	-0.0484
Core Bond	0.05%	0.99%	0.0458
Junk Bond	0.24%	1.73%	0.1375
Whiskey	1.33%	5.32%	0.2507
Baseball Cards	2.31%	4.61%	0.5016
Wine	0.33%	5.26%	0.0637
Retro Video Games	0.54%	2.20%	0.2472

Figure 1: Individual Asset Sharpe Ratio Table

Optimal Portfolios of Assets

The following figure shows the optimal portfolio allocation of a portfolio that includes these 13 assets.

Asset	Portfolio Weights
S&P 500	0.00%
NASDAQ	14.78%
Dow Jones Industrial Average	0.00%
Residential Real Estate	0.00%
Commodities Proxy	0.00%
Emerging Markets	0.00%
Developed Markets	0.00%
Core Bond	19.96%
Junk Bond	0.00%
Whiskey	10.94%
Baseball Cards	26.63%
Wine	1.82%
Retro Video Games	25.87%

Figure 2: Optimal Portfolio of Assets

The following table shows the optimal weightings for a portfolio of assets that includes only the 9 financial assets.

Asset	Portfolio Weights
S&P 500	0.00%
NASDAQ	74.52%
Dow Jones Industrial Average	0.00%
Residential Real Estate	0.00%
Commodities Proxy	0.00%
Emerging Markets	0.00%
Developed Markets	0.00%
Core Bond	25.48%
Junk Bond	0.00%

Figure 3: Optimal Portfolio of Financial Assets

The following table shows the optimal weightings for a portfolio of assets that includes only the 4 collectibles.

Asset	Portfolio Weights
Whiskey	14.71%
Baseball Cards	37.17%
Wine	5.82%
Video Games	42.30%

Figure 4: Optimal Portfolio of Collectible Assets

Binary Portfolios

The following table shows the optimal weightings for a portfolio of assets that includes the optimal financial assets portfolio and optimal collectibles portfolio.

Asset	Portfolio Weights
Optimal Financial Assets	10.03%
Optimal Collectible Asset	89.97%

Figure 5: Optimal Financial - Optimal Collectible Binary Portfolio

The following table shows the optimal weightings for a portfolio of assets that includes the typical portfolio of financial assets and the optimal collectibles portfolio.

Asset	Portfolio Weights
Typical Financial Assets	9.71%
Optimal Collectible Assets	90.29%

Figure 6: Typical Financial - Optimal Collectible Binary Portfolio

The following table shows the optimal weightings for a portfolio of assets that includes the optimal portfolio of financial assets and the equal-weight portfolio of collectibles.

Asset	Portfolio Weights
Optimal Financial Assets	12.43%
Equal-Weight Collectible Assets	87.57%

Figure 7: Optimal Financial - Equal-weight Collectible Binary Portfolio

The following table shows the optimal weightings for a portfolio of assets that includes the typical portfolio of financial assets and the equal-weight portfolio of collectibles.

Asset	Portfolio Weights
Typical Financial Assets	12.21%
Equal-Weight Collectibles	87.79%

Figure 8: Typical Financial – Equal-Weight Collectible Binary Portfolio

Sensitivity Portfolios

The following table shows the optimal weightings for a portfolio of assets that includes the optimal financial assets portfolio and an optimal collectibles portfolio, with the assumption that the optimal collectibles portfolio returns just half its historical average.

Asset	Portfolio Weights
Optimal Financial Assets	29.04%
Optimal Collectible Assets (w/ -50% Returns)	70.96%

Figure 9: Optimal Collectible (-50% Returns) Sensitivity Portfolio

The following table shows the optimal weightings for a portfolio of assets that includes the optimal financial assets portfolio and an equal-weight collectibles portfolio, with the assumption that the collectibles portfolio returns just one quarter its historical average.

Asset	Portfolio Weights
Optimal Financial Assets	75.43%
Equal-Weight Collectible Assets (w/ -75% Returns)	24.57%

Figure 10: Equal-Weight Collectible (-75% Returns) Sensitivity Portfolio

The following table shows the optimal weightings for a portfolio of assets that includes the typical financial assets portfolio and the optimal collectibles portfolio, with the assumption that the optimal collectibles portfolio has a standard deviation two times as high as is observed historically.

Asset	Portfolio Weights
Typical Financial Assets	36.77%
Optimal Collectible Assets (w/ +100% σ)	63.23%

Figure 11: Optimal Collectible (+100% Risk) Sensitivity Portfolio

The following table shows the optimal weightings for a portfolio of assets that includes the typical financial assets portfolio and the optimal collectibles portfolio, with the assumption that the optimal collectibles portfolio has a standard deviation two times as high as is observed historically and returns are just half as high as they were historically.

Asset	Portfolio Weights
Typical Financial Assets	67.15%
Equal-Weight Collectible (-50% Returns & +100% σ)	32.85%

Figure 12: Equal-Weight Collectible (-50% Returns & +100% Risk) Sensitivity Portfolio

Portfolio Sharpe Ratios

The following table shows the average monthly historical return, the monthly historical standard deviation, and the Sharpe Ratio for each of the portfolios referenced above.

Portfolio	Average Monthly Historical Return	Monthly Historical Standard Deviation	Sharpe Ratio
Optimal Portfolio (All Assets)	1.12%	1.56%	0.7131
Optimal Portfolio Financial Assets + Optimal Portfolio of Collectibles	1.27%	1.96%	0.6507
Typical Portfolio Financial Assets + Optimal Portfolio of Collectibles	1.24%	1.91%	0.6490
Optimal Portfolio (Collectible Assets)	1.30%	2.03%	0.6422
Optimal Portfolio Financial Assets + Equal-weight Portfolio of Collectibles	1.12%	2.12%	0.5254
Typical Portfolio Financial Assets + Equal-weight Portfolio of Collectibles	1.07%	2.04%	0.5248
Equal-Weight Portfolio (Collectible Assets)	1.13%	2.19%	0.5161
Optimal Portfolio Financial Assets + Optimal Portfolio of Collectibles (w/ -50% Returns)	0.75%	2.01%	0.3756
Typical Portfolio Financial Assets + Optimal Portfolio of Collectibles (w/ +100% σ)	1.05%	2.99%	0.3519
Equal-Weight Portfolio (All Assets)	0.69%	2.26%	0.3069
Optimal Portfolio (Financial Assets)	1.01%	3.38%	0.2986
Optimal Portfolio Financial Assets + Equal-weight Portfolio of Collectibles (w/ -75% Returns)	0.83%	3.06%	0.2717
Typical Portfolio Financial Assets + Equal-weight Portfolio of Collectibles (w/ -50% Returns & +100% σ)	0.60%	2.89%	0.2083
Typical Portfolio of Financial Assets	0.62%	3.37%	0.1845
Equal-Weight Portfolio (Financial Assets)	0.50%	2.97%	0.1676

Figure 13: All Portfolio Sharpe Ratio Table

Correlation Tables

The following tables show the correlation between the returns of each of the 13 financial assets.

The point estimate, the lower bound, and the upper bound are presented on three separate tables.

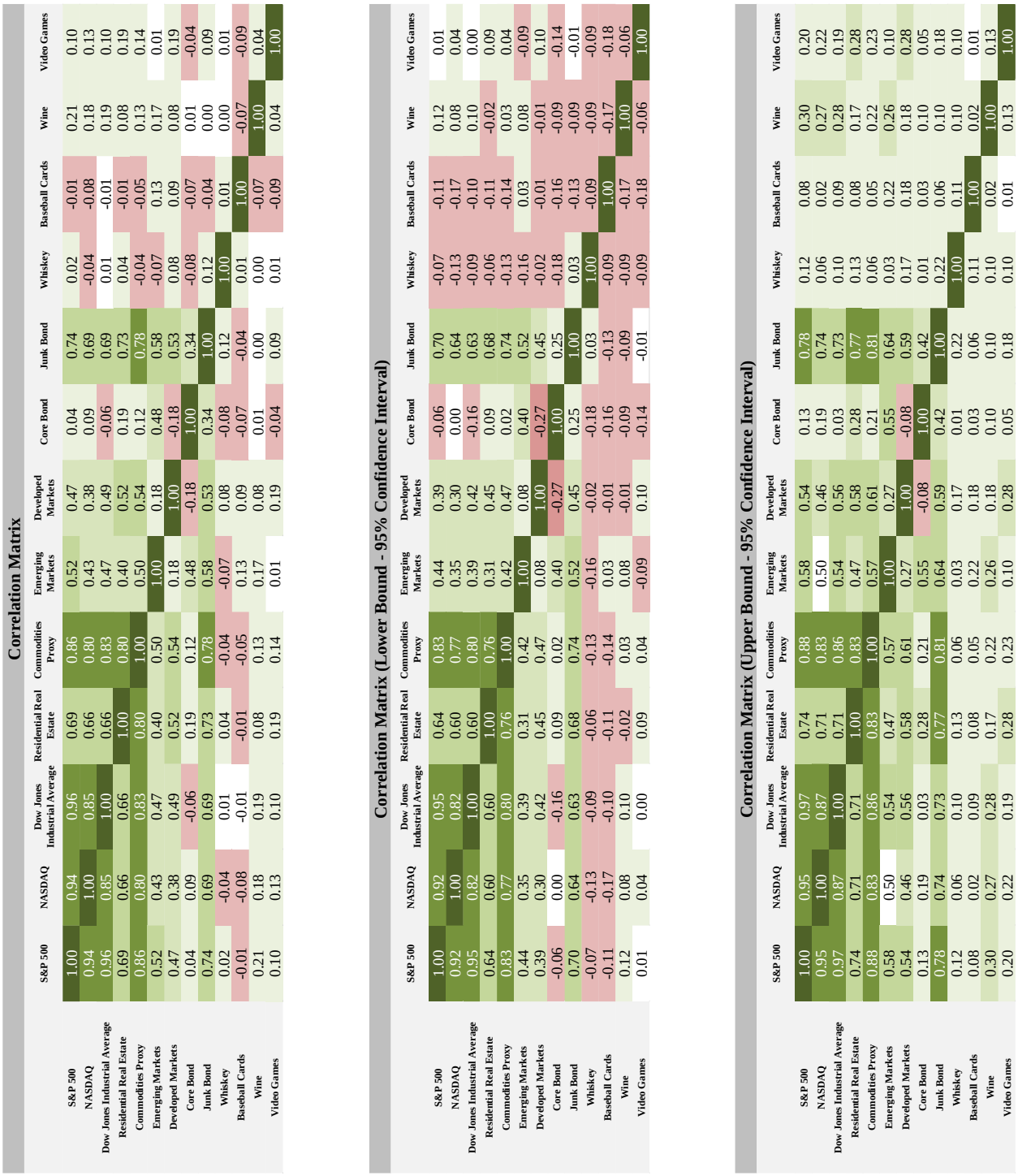

Figure 14: Correlation Table

Chapter 5

Analysis

Portfolio Summary

The portfolio optimization process revealed one thing with absolute certainty. If an investor held a portfolio with these four collectibles, in addition to their pre-existing portfolio of financial assets, from January 1st, 2013 through December 31st, 2021, that investor would have realized a larger risk-adjusted return than a similar investor without the collectibles. Because the data used for this study is backwards looking, making extrapolations beyond this claim is where a degree of uncertainty enters the picture, but this claim, that these collectibles would have helped an investor in this particular period, is strong. This realization is evidenced first by the optimal portfolio of all 13 assets, including the nine financial assets and the four collectibles. While a typical investor would likely have 0% of one's portfolio allocated to baseball cards, whiskey, wine, or retro videogames, the portfolio with the greatest risk-adjusted return during this period would have had a 26.63% allocation towards baseball cards, a 10.94% allocation towards whiskey, a 1.82% allocation towards wine, and a 25.87% allocation towards retro videogames. This portfolio produced a Sharpe Ratio of 0.7131, which is appreciably higher than the Sharpe Ratio of 0.2986 belonging to the optimal portfolio of financial assets, and the 0.1845 Sharpe Ratio belonging to the 'typical portfolio' of financial assets. With the success of collectibles in the eyes of the Sharpe Ratio apparent, the question arises, what exactly about them and their returns drove this analysis' preference for them over other assets. The first, and most elementary factor driving the inclusion of collectible in the optimal portfolio of assets is their elevated returns relative to the financial assets. Among the 13 assets, the four collectibles had the first, third, seventh, and ninth highest average monthly return. This is certainly strong performance, and one would expect assets with this return profile to be included in an optimal portfolio, but in order to be sure, risk must also be analyzed. Among the 13 assets, the four collectibles had the first, second, sixth, and eleventh highest standard deviations, this study's proxy for risk. With this in mind, the appeal of collectibles

is less apparent. Even though they have a high return, their elevated risk would suggest that there is not an abundance of appeal that the typical investor missed out on. However, this is not true for two reasons. First, their superiority in the arena of returns is greater than their deficiency in the area of risk. This is evidenced by their Sharpe Ratio rankings of first, third, fourth, and tenth. While wine does lag behind the others in this area, the performance of the group as a whole is certainly quite strong. And second, while the assets do appear quite volatile on their own, their volatility is different from the other assets analyzed in this study. The result of this is correlations with the financial assets that are quite low. As the previously mentioned portfolio math indicates, assets with different correlations from one another serve to reduce the overall standard deviation of a particular portfolio. That is why the optimal portfolio of financial assets has a standard deviation of 3.38%, while the optimal portfolio of all 13 assets has a much smaller standard deviation of 1.56%. In particular, baseball cards stood out from the rest of the collectible by having eight different negative correlations with the other assets. Possibly even more impressive, no single collectible had a correlation of greater than 0.21 with any other asset. Meanwhile, many of the financial assets had much higher correlations during the period, including the correlation between junk bonds and equities. This is particularly noteworthy as fixed income securities are frequently included in portfolios specifically because of their low correlations with equities.

Sensitivity Analysis

While it is interesting to know that a Sharpe Ratio analysis of collectibles and financial assets indicates that the optimal portfolio of assets from 2013 – 2021 would overwhelmingly be allocated towards collectibles, that information alone does not benefit the typical investor. The typical investor should only allocate ~90% of their portfolio to those four collectibles if the returns and risk level observed over that exact 9-year period are perfectly prescriptive of what will happen in the future. And the only certainty in this study is that that exact behavior for collectible assets will assuredly not be repeated over the next nine years. For this reason, it is worthwhile to consider whether or not collectibles would be included in a portfolio if their returns were lower or if their risk was higher than what was observed from 2013 – 2021. This was done with the sensitivity analysis portion of the study.

First, assuming a constant risk level and steady correlations between the assets, the returns of the collectible portfolio are forecast at 50% of their observed level from 2013 – 2021. In practice this looks like a reduction from 1.30% returns per month to returns of 0.65% per month. With this forecast in place, the portion of a binary portfolio containing just the optimal portfolio of financial assets and the optimal portfolio of collectible assets, allocated to the collectible assets would fall from 89.97% to 70.96%. This is true, even with returns for collectibles (adjusted to 0.65%) being markedly lower than the returns for the optimal portfolio of financial assets (1.01%), which speaks to the power of the lack of correlation between the collectible assets and their financial counterparts. With collectibles still dominating the overall portfolio even with returns reduced by 50%, further sensitivities are run to assess the effects of a larger drop-off in performance. This time, a 75% reduction in returns is simulated, once again keeping risk and correlations constant. With this assumption in place, a binary portfolio holding the equal-weight collectibles portfolio and the optimal financial portfolio is analyzed. The share of the equal-weight collectibles portfolio

in the overall portfolio decreases from 89.57% to 24.56%. Even with returns so drastically diminished, the collectibles portfolio still makes up a meaningful portion of the overall portfolio. However, without testing, this can only be assumed true under the conditions that the risk level of the collectibles is consistent with the level represented by the historical standard deviations from 2013 – 2021. With this in mind, a final simulation was conducted with both a 50% decrease in returns, relative to the historical period, and a 100% increase in the standard deviation, relative to the historical period. This simulation looks at a binary portfolio containing the equal-weight collectibles portfolio and the 'typical portfolio' held by an investor. Prior to the reduction in return and the increase in risk, 87.79% of the portfolio is allocated towards the equal-weight collectibles portfolio. Following the significant decrease in forecasted returns and the significant increase in risk, this share falls to 32.85%. So, even if collectibles had performed significantly worse from 2013 – 2021 and had a risk level two times as high (as measured by standard deviation), they still would make up a meaningful portion of the optimal portfolio. While the initial data from the unsensitized portfolio optimizations makes a strong case for including collectibles in a financial portfolio, for a risk-averse investor, the case made by the sensitizations of returns and risk is even stronger.

Limitations of the Study

Every study has limitations, including this one, which has several. Below are the primary limitations of this study, which are important to consider before acting on any of the information this analysis revealed.

1. **Only 9 Years of Data Were Analyzed**

   For any study that relies on backwards looking data, having a significant historical period to analyze is imperative. For this study, only nine years of data were available for certain collectibles, which necessitated the use of this shorter time period. While the most recent timeframe is likely the most relevant timeframe, expanding backwards historically would provide more confidence in each of the claims made in this thesis, both from a mathematical and anecdotal standpoint. Further study in this area can be done if datasets involving longer time periods are constructed.

2. **Collectibles Come with Other Costs**

   In this study, the returns of the collectible assets were 'artificially' reduced in order to see if collectibles are meaningful contributors to portfolios of financial assets under the hypothetical assumption that their returns would be lower than they have been historically. However, this hypothetical is much closer to reality than one would think because investing in collectibles comes with a number of fees and expenses that are not seen with financial assets. The primary expenses associated with financial assets are storage costs, insurance costs, and transaction costs. For each collectible these costs can vary significantly. For example, in order to collect physical wine bottles, one needs a temperature-controlled area where the bottles are exposed to minimal sunlight and not in danger of breaking. If one has this storage area already,

then the costs associated with investing in wine is limited to the opportunity cost incurred from giving up that space for this purpose. However, if one does not already have this space, then a significant investment may be needed to acquire it. While not every collectible comes with hefty storage costs, each collectible comes with the prospect of insurance costs. Holding large sums of value in physical assets like collectibles comes with the risk that they may be stolen or damaged. Some investors, depending on the size of their investment, may want to insure these physical assets to protect their principal investment. However, the costs associated with insurance can significantly eat into returns. Insurance costs vary widely for each person, location, and investment size and type, making the degree to which they erase returns difficult to calculate. In addition to each asset facing potential insurance cost, each asset faces transaction costs when it becomes time to sell. Some assets need to be prepared for auction by being graded, shipped, or authenticated, which can be quite costly and time consuming in its own right, but transaction costs likely apply to all collectible transactions. In an auction setting, the fee is paid at the time of acquisition of the asset. At Sotheby's, a world-renowned auction house, the 'Buyer Premium' ranges from 20% to 25%. Other mediums of selling, like eBay, the online auction house, charge a premium primarily to the seller, which under certain circumstances be as much as 15%, but usually is approximately 6%. This significant cost is important to consider in the analysis of investments in collectibles, but avoiding this cost through estate sale transactions or by finding a buyer outside of an auction setting would serve as a viable strategy to acquire returns more similar to those presented by the indices.

3. The Sharpe Ratio is not Perfect

This analysis heavily relies on the Sharpe Ratio's ability to assess the attractiveness of various assets and portfolios on the risk-return spectrum. With this in mind, it is important to note that the Sharpe Ratio does have flaws and these flaws should be taken into account when applying its claims. The chief flaw in the Sharpe Ratio is that in relying on standard deviation as its measure of risk, it inherently assumes that the distribution of the returns data is 'normal.' However, while returns data can approximate normality, there is often skewness that makes the application of the Sharpe Ratio, imperfect. For example, below is a histogram showing the returns of baseball cards. While the distribution is not drastically different from a normal distribution, there is certainly skewness.

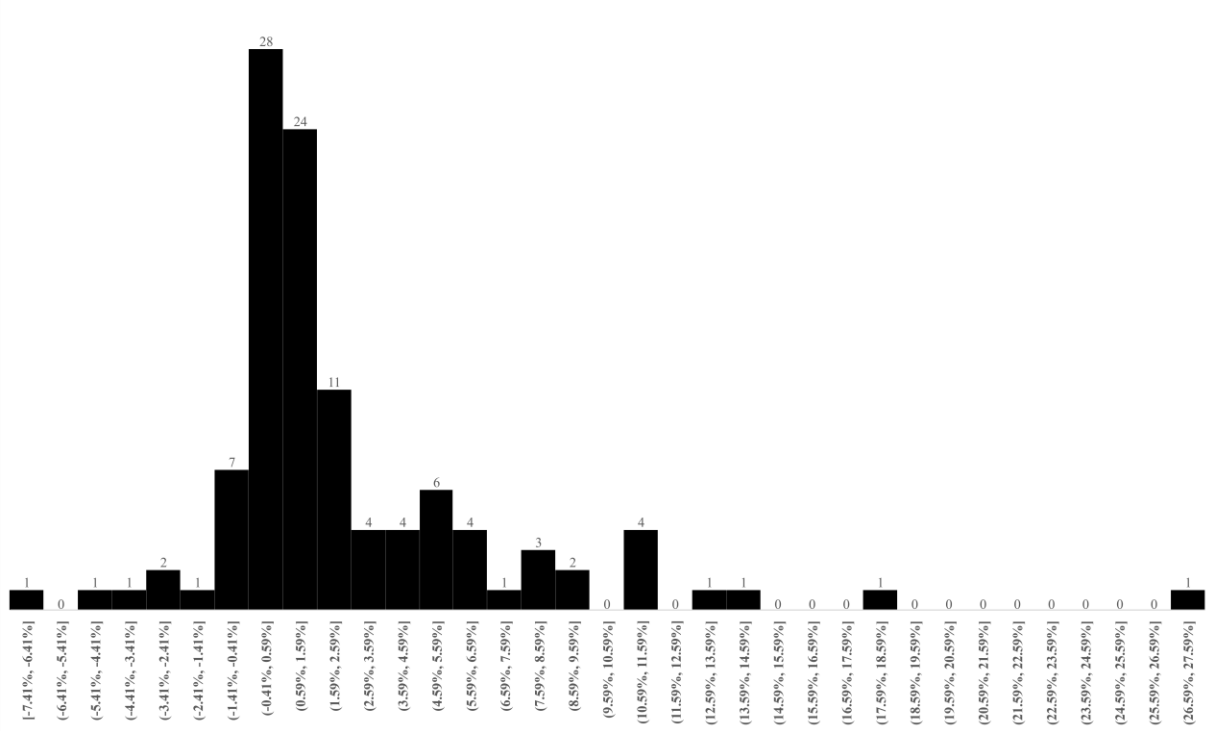

Figure 15: Baseball Card Returns Histogram

4. **Only Four Collectibles Were Analyzed**

   Due to constraints on the availability of data, only four collectibles were analyzed in this study. There is danger in extrapolating the data provided by just these four collectibles to the entire collectibles marketplace. For every successful collectible investment like whiskey, for example, there could be an unsuccessful collectible investment, like Beanie Babies or NBA Top Shot NFTs. The collectibles space is absolutely susceptible to survivorship bias, where only the collectibles that survive the test of time are remembered well enough to be analyzed. While it would certainly be unwise to extrapolate the performance of these four collectibles to the entire collectibles space, extrapolation from a smaller sample to a larger sample is not always foolhardy. For this study, it may be fair to extrapolate the results to similar collectibles with an exceptionally long track record of both financial returns and real-world collecting interest like coins, stamps, and sneakers.

5. **The Indices Primarily Include Only Premium Assets**

   The indices analyzed in this study focus primarily on premium assets within the space associated with each collectible. The whiskey in the Rare Whisky Icon Index is hard to find and quite expensive, which makes the prospect of potentially recreating that index daunting. Typical liquor store whiskey bottles likely do not have the same returns profile as the premium vintage bottles that have seen the strong performance represented by the index. Finding enough of the premium whiskey to represent significant portions of a portfolio is unlikely at certain portfolio sizes.

6. You Cannot Invest in The Indices

While it is quite easy to invest in any of the financial products via ETFs (Exchange Traded Funds), the same cannot be said for the collectible indices. Masterworks has created an ETF for fine art products, but the rest of the collectible space remains very difficult to invest in in a way that achieves the broad diversification of the indices used in this study. Until ETF products or fractional shares of physical assets are more widely available, investors will have to take on increased risk by concentrating their collectible portfolios into fewer bottles, cards, or videogames.

Chapter 6

Conclusion

After conducting the portfolio optimization process for the nine financial assets and the four collectible assets, it is fair to say that no evidence was produced that suggests that collectibles should not be included in an investor's portfolio. The strong returns, reasonable risk level, and lack of correlation with the financial assets observed over the period from 2013 – 2021 suggest that they do provide value to a portfolio of assets. This claim is strengthened by the performance of the collectible assets after various scenarios were created where the returns of the collectibles were reduced and the risk level was elevated. Even under these conditions, the Sharpe Ratio suggests that they should still be included in a portfolio of financial assets, which certainly increases confidence in their prowess as investment vehicles. However, while it appears as if collectibles are absolutely a worthwhile part of a portfolio, there are several complicating factors. Collectibles are subject to a number of fees that are not incurred when investing in a financial asset. Collectible indices do not have associated financial products that allow for easy investing, so portfolios must be handcrafted by the investor. And finally, collectibles are quite expensive, requiring a significant amount of upfront capital in order to produce a diversified portfolio of collectible assets. With these return erasing, time consuming, and capital hoarding concerns in mind, the appeal of collectibles as an investment is reduced significantly. Because of this, additional motivation may be necessary for investing in collectibles to become a part of someone's life, not just financial their financial life. If a prospective investor enjoys searching for whiskey bottles, crafting a diversified portfolio, and showing off their collection to their peers, then investing in collectibles absolutely makes sense. However, if one would not enjoy owning the collectibles, then their appeal is significantly limited. Going forward, this could change. The creation of ETF products for collectible assets and the introduction of fractional shares on numerous investing platforms for alternative assets will reduce much of the friction surrounding investing in collectibles. No longer will one need to store or insure the collectibles. Hunting for the exact right collectibles for one's portfolio will become appreciably easier. Crafting a portfolio with the proper amount

allocated towards collectibles will become easier. In a world where these frictions are gone, even an investor who does not derive utility from owning a collectible will be able to include the risk-return relationship associated with collectibles in their personal portfolio. Right now, collectibles are for the select few that are wealthy enough or interested enough to invest in them. Their attractiveness is limited to the select few that are able and willing to make them a part of their portfolios. In the future, when the barriers to investing in collectibles are reduced, a large group of investors will be able to take advantage of assets that have historically been an exceptional addition to a portfolio, as this study bears out.

Appendix A
Real Whisky Icon 100 Index

Distillery	Bottler	Detail	Vintage	Age	Vol
Ardbeg	Distillery	Provenance. 1st Release	1974	23 yrs	70 cl
Ardbeg	Distillery	Vintage Bottling. Bottled 2000	1975	N/A	70 cl
Ardbeg	Distillery	Vintage Bottling. Bottled 2001 - 2004	1977	N/A	70 cl
Ardbeg	Distillery	Vintage Bottling. Bottled 1998	1978	N/A	70 cl
Ardbeg	Distillery	Discontinued Bottling. Green box	N/A	17 yrs	70 cl
Ardbeg	Distillery	Lord of The Isles	N/A	25 yrs	70 cl
Ardbeg	Distillery	Guaranteed 30 year old	N/A	30 yrs	70 cl
Balblair	Distillery	Bottled Sept 2004	1966	38 yrs	70 cl
Balvenie	Distillery	Vintage Cask. Bottled Sept 2000	1968	32 yrs	70 cl
Balvenie	Distillery	Rose. 1st Release	1991	16 yrs	70 cl
Balvenie	Distillery	Rose. 2nd Release	N/A	16 yrs	70 cl
Bowmore	Distillery	Sherry Wood. Bottled 2005	1971	34 yrs	70 cl
Bowmore	Distillery	Vintage Release. Casks 4864, 65 & 66	1972	27 yrs	70 cl
Bowmore	Distillery	Black Ceramic Bottling. Sea Dragon	N/A	30 yrs	70 cl
Bowmore	Distillery	Bicentenary of the distillery	N/A	N/A	75 cl
Brora	Distillery	Rare Malts Selection	1972	22 yrs	70 cl
Brora	Distillery	Rare Malts Selection	1972	22 yrs	70 cl
Brora	Distillery	2002 Bottling	N/A	30 yrs	70 cl
Brora	Distillery	2003 Bottling	N/A	30 yrs	70 cl
Brora	Distillery	2004 Bottling	N/A	30 yrs	70 cl
Brora	Distillery	2008 Bottling	N/A	25 yrs	70 cl
Bunnahabhain	Distillery	Auld Acquaintance	1968	N/A	70 cl
Caol Ila	Distillery	Managers Dram	N/A	15 yrs	75 cl
Caol Ila	Distillery	150th Anniversary	N/A	20 yrs	70 cl
Dalmore	Distillery	Matusalem Sherry	1973	30 yrs	70 cl
Dalmore	Distillery	Cabernet Sauvignon	1973	33 yrs	70 cl
Dalmore	Distillery	Distillery Exclusive	1985	N/A	70 cl
Dalwhinnie	Distillery	Bottled in 2002	1966	36 yrs	70 cl
Glen Garioch	Distillery	Vintage 21 Release	1965	21 yrs	75 cl
Glen Grant	Distillery	Silver Jubilee	N/A	25 yrs	26 2/3 fl oz
Glendronach	Distillery	Bottled 1993	1968	25 yrs	75 cl
Glendronach	Distillery	Oloroso sherry casks	N/A	33 yrs	70 cl
Glenesk	Distillery	Glenesk Maltings	1969	N/A	75 cl
Glenfarclas	Distillery	Bottled June 2001	1972	N/A	70 cl
Glenfiddich	Distillery	Vintage Reserve. Bottled May 2006	1973	33 yrs	70 cl
Glenfiddich	Distillery	Queen Mary 2	1976	N/A	70 cl
Glenfiddich	Distillery	Rare Collection. Bottled Oct 2004	N/A	40 yrs	75 cl
Glenglassaugh	Distillery	The Family Silver	1973	N/A	70 cl
Glengoyne	Distillery	Vintage Reserve	1967	N/A	70 cl
Glengoyne	Distillery	Vintage Reserve	1968	N/A	70 cl
Glenlivet	Distillery	Cellar Collection. Bottled 2000	1967	N/A	70 cl
Glenlivet	Distillery	Cellar Collection. Bottled 2006	1969	N/A	70 cl
Glenlivet	Distillery	Cellar Collection. Bottled 2005	1972	N/A	70 cl
Glenlivet	Distillery	Royal Wedding Reserve	N/A	25 yrs	75 cl
Glenlivet	Distillery	Silver Jubilee Reserve	N/A	25 yrs	26 2/3 fl oz
Glenmorangie	Distillery	The Culloden Bottle	1971	N/A	70 cl
Glenmorangie	Distillery	Tain L'Hermitage	1975	28 yrs	70 cl
Glenmorangie	Distillery	Tain L'Hermitage	1978	N/A	70 cl
Glenmorangie	Distillery	Sauternes Finish	1981	N/A	70 cl

Highland Park	Distillery	Vintage Release	1973	28 yrs	70 cl
Highland Park	Distillery	Vintage Release	1973	28 yrs	70 cl
Highland Park	Distillery	Bicentenary (1798-1998)	1977	N/A	70 cl
Highland Park	Distillery	Eunsons Legacy	N/A	12 yrs	70 cl
Highland Park	Distillery	Lunar Bottling	N/A	18 3/5 yrs	70 cl
Highland Park	Distillery	John Goodwin	N/A	35 yrs	70 cl
Jura	Distillery	Rare Vintage Release	1966	40 yrs	70 cl
Lagavulin	Distillery	Bottled 2006.	1976	30 yrs	70 cl
Lagavulin	Distillery	Distillers Edition.	1979	N/A	70 cl
Lagavulin	Distillery	Bottled 2007	1985	21 yrs	70 cl
Lagavulin	Distillery	Bottled 2002	N/A	25 yrs	70 cl
Laphroaig	Distillery	In green wood hay lined box	N/A	30 yrs	70 cl
Laphroaig	Distillery	Vintage Reserve. Bottled 2001	N/A	40 yrs	70 cl
Macallan	Distillery	Boxed. Bottled 1984	1966	18 yrs	75 cl
Macallan	Distillery	Boxed. Bottled 1988	1970	18 yrs	75 cl
Macallan	Distillery	Anniversary Malt. Bottled 1996	1970	25 yrs	70 cl
Macallan	Distillery	Anniversary Malt. Bottled 1997	1971	25 yrs	70 cl
Macallan	Distillery	Anniversary Malt. Bottled 1998	1972	25 yrs	70 cl
Macallan	Distillery	Boxed. Bottled 1992	1974	18 yrs	70 cl
Macallan	Distillery	Anniversary Malt. Bottled 2000	1975	25 yrs	70 cl
Macallan	Distillery	Boxed. Bottled 1996	1978	18 yrs	70 cl
Macallan	Distillery	Gran Reserva. Bottled 1997	1979	18 yrs	70 cl
Macallan	Distillery	Gran Reserva. Bottled 1998	1980	18 yrs	70 cl
Macallan	Distillery	In card Presentation tube	1982	18 yrs	70 cl
Macallan	Distillery	In card Presentation tube	1986	18 yrs	70 cl
Macallan	Distillery	Easter Elchies Cask selection 2008	95 & 96	12 yrs	70 cl
Macallan	Distillery	Robert Burns decanter	97 & 98	11 yrs	70 cl
Macallan	Distillery	Over 25 yr old. Anniversary Malt	N/A	25 yrs	70 cl
Macallan	Distillery	Sherry Oak. Blue labels	N/A	30 yrs	70 cl
Macallan	Distillery	Royal Marriage. Bottled 1981	N/A	N/A	75 cl
Macallan	Distillery	Private Eye	N/A	N/A	70 cl
Mortlach	Distillery	Natural Cask Strength. Bottled 2004	1971	32 yrs	70 cl
Oban	Distillery	Natural Cask Strength. Bottled 2002	1969	32 yrs	70 cl
Oban	Distillery	Managers Dram. 200th anniversary	N/A	16 yrs	70 cl
Port Ellen	Distillery	Rare Malts. Bottled Oct 1998	1978	20 yrs	70 cl
Port Ellen	Distillery	1st Release	1979	22 yrs	70 cl
Port Ellen	Distillery	2nd Release	1978	24 yrs	70 cl
Port Ellen	Distillery	3rd Release	1979	24 yrs	70 cl
Port Ellen	Distillery	4th Release	1978	25 yrs	70 cl
Port Ellen	Distillery	5th Release	1979	25 yrs	70 cl
Port Ellen	Distillery	2008 Feis Ile	1981	27 yrs	70 cl
Rosebank	Distillery	Rare Malts. Bottled May 2002	1981	20 yrs	70 cl
Rosebank	Distillery	Rare Malts. Bottled Apr 2004	1981	22 yrs	70 cl
Springbank	Distillery	Tall clear bottle. Faun bottle label	N/A	21 yrs	70 cl
Springbank	Distillery	Frank McHardy bottling	N/A	25 yrs	70 cl
Springbank	Distillery	Released in 2005. Black card box	N/A	32 yrs	70 cl
St Magdalene	Distillery	Rare Malts. Bottled Oct 1998	1979	19 yrs	70 cl
Talisker	Distillery	Special Release	1973	28 yrs	70 cl
Talisker	Distillery	Bottled 2001	1975	25 yrs	70 cl
Talisker	Distillery	Bottled 2002. Map of Skye in gold	1981	20 yrs	70 cl
Talisker	Distillery	Bottled 2006	N/A	30 yrs	70 cl

Appendix B
Liv-ex 100 Wine Index

Wine	Vintage	Region
Bartolo Mascarello, Barolo	2016	Piedmont
Bollinger, La Grande Annee	2012	Champagne
Bouchard Pere et Fils, Montrachet Grand Cru	2018	Burgundy
Chateau Angelus Premier Grand Cru Classe A, Saint-Emilion Grand Cru	2016	Bordeaux
Chateau Beausejour Duffau-Lagarrosse Premier Grand Cru Classe B, Saint-Emilion Grand Cru	2016	Bordeaux
Chateau Beychevelle 4eme Cru Classe, Saint-Julien	2018	Bordeaux
Chateau Cheval Blanc Premier Grand Cru Classe A, Saint-Emilion Grand Cru	2018	Bordeaux
Chateau Cheval Blanc Premier Grand Cru Classe A, Saint-Emilion Grand Cru	2015	Bordeaux
Chateau Cheval Blanc Premier Grand Cru Classe A, Saint-Emilion Grand Cru	2010	Bordeaux
Chateau Figeac Premier Grand Cru Classe B, Saint-Emilion Grand Cru	2015	Bordeaux
Chateau Haut-Brion Premier Cru Classe, Pessac-Leognan	2018	Bordeaux
Chateau Haut-Brion Premier Cru Classe, Pessac-Leognan	2016	Bordeaux
Chateau Haut-Brion Premier Cru Classe, Pessac-Leognan	2009	Bordeaux
Chateau Haut-Brion Premier Cru Classe, Pessac-Leognan	2005	Bordeaux
Chateau La Mission Haut-Brion Cru Classe, Pessac-Leognan	2009	Bordeaux
Chateau La Mission Haut-Brion Cru Classe, Pessac-Leognan	2005	Bordeaux
Chateau Lafite Rothschild Premier Cru Classe, Pauillac	2018	Bordeaux
Chateau Lafite Rothschild Premier Cru Classe, Pauillac	2017	Bordeaux
Chateau Lafite Rothschild Premier Cru Classe, Pauillac	2016	Bordeaux
Chateau Lafite Rothschild Premier Cru Classe, Pauillac	2015	Bordeaux
Chateau Lafite Rothschild Premier Cru Classe, Pauillac	2010	Bordeaux
Chateau Lafite Rothschild Premier Cru Classe, Pauillac	2009	Bordeaux
Chateau Lafleur, Pomerol	2018	Bordeaux
Chateau Latour Premier Cru Classe, Pauillac	2005	Bordeaux
Chateau Latour Premier Cru Classe, Pauillac	2003	Bordeaux
Chateau Leoville Barton 2eme Cru Classe, Saint-Julien	2016	Bordeaux
Chateau Leoville Las Cases 2eme Cru Classe, Saint-Julien	2016	Bordeaux
Chateau Leoville Poyferre 2eme Cru Classe, Saint-Julien	2009	Bordeaux
Chateau Lynch-Bages 5eme Cru Classe, Pauillac	2010	Bordeaux
Chateau Margaux Premier Cru Classe, Margaux	2018	Bordeaux
Chateau Margaux Premier Cru Classe, Margaux	2016	Bordeaux
Chateau Margaux Premier Cru Classe, Margaux	2010	Bordeaux
Chateau Margaux Premier Cru Classe, Margaux	2005	Bordeaux
Chateau Montrose 2eme Cru Classe, Saint-Estephe	2010	Bordeaux
Chateau Mouton Rothschild Premier Cru Classe, Pauillac	2018	Bordeaux
Chateau Mouton Rothschild Premier Cru Classe, Pauillac	2016	Bordeaux
Chateau Mouton Rothschild Premier Cru Classe, Pauillac	2009	Bordeaux
Chateau Mouton Rothschild Premier Cru Classe, Pauillac	2008	Bordeaux
Chateau Mouton Rothschild Premier Cru Classe, Pauillac	2000	Bordeaux
Chateau Palmer 3eme Cru Classe, Margaux	2018	Bordeaux
Chateau Pavie Premier Grand Cru Classe A, Saint-Emilion Grand Cru	2017	Bordeaux
Chateau Pichon Baron 2eme Cru Classe, Pauillac	2018	Bordeaux
Chateau Pontet-Canet 5eme Cru Classe, Pauillac	2010	Bordeaux
Chateau Pontet-Canet 5eme Cru Classe, Pauillac	2009	Bordeaux
Chateau d'Yquem Premier Cru Superieur, Sauternes	2015	Bordeaux
Chateau de Beaucastel Hommage a Jacques Perrin, Chateauneuf-du-Pape	2019	Rhone
Clos de Tart, Clos de Tart Grand Cru	2018	Burgundy
Clos des Papes, Chateauneuf-du-Pape, Rouge	2019	Rhone

Comm. G.B. Burlotto, Barolo, Monvigliero	2016	Piedmont
Cos d'Estournel 2eme Cru Classe, Saint-Estephe	2016	Bordeaux
Dom Perignon	2010	Champagne
Dom Perignon	2008	Champagne
Domaine Armand Rousseau, Chambertin Grand Cru	2018	Burgundy
Domaine Armand Rousseau, Chambertin-Clos de Beze Grand Cru	2018	Burgundy
Domaine Comte Georges de Vogue, Bonnes Mares Grand Cru	2018	Burgundy
Domaine Comte Georges de Vogue, Musigny Grand Cru, Cuvee Vieilles Vignes	2018	Burgundy
Domaine Faiveley, Corton Grand Cru, Clos des Cortons Faiveley	2019	Burgundy
Domaine Jean Louis Chave, Hermitage, Rouge	2017	Rhone
Domaine Leflaive, Bienvenues-Batard-Montrachet Grand Cru	2018	Burgundy
Domaine Ponsot, Clos de la Roche Grand Cru, Cuvee Vieilles Vignes	2018	Burgundy
Domaine de la Romanee-Conti, La Tache Grand Cru	2017	Burgundy
Domaine de la Romanee-Conti, Richebourg Grand Cru	2017	Burgundy
Domaine de la Romanee-Conti, Romanee-Conti Grand Cru	2017	Burgundy
Domaine des Lambrays, Clos des Lambrays Grand Cru	2018	Burgundy
Dominus, Napa Valley	2018	California
Ducru-Beaucaillou 2eme Cru Classe, Saint-Julien	2009	Bordeaux
E. Guigal, Cote Rotie, La Turque	2017	Rhone
E. Guigal, Cote Rotie, La Turque	2016	Rhone
Gaja, Barbaresco	2018	Piedmont
Giacomo Conterno, Barolo, Monfortino Riserva	2014	Piedmont
Giacomo Conterno, Barolo, Monfortino Riserva	2013	Piedmont
Harlan Estate, Napa Valley	2017	California
Joseph Drouhin, Montrachet Grand Cru, Marquis de Laguiche	2018	Burgundy
Krug, Vintage Brut	2008	Champagne
Louis Roederer, Cristal	2013	Champagne
Louis Roederer, Cristal Rose	2012	Champagne
Masseto, Toscana	2017	Tuscany
Masseto, Toscana	2016	Tuscany
Opus One, Napa Valley	2017	California
Ornellaia, Bolgheri	2018	Tuscany
Paul Jaboulet Aine, Hermitage, La Chapelle Rouge	2018	Rhone
Penfolds, Grange, South Australia	2016	South Australia
Petrus, Pomerol	2016	Bordeaux
Petrus, Pomerol	2010	Bordeaux
Poggio di Sotto, Brunello di Montalcino	2016	Tuscany
Pol Roger, Sir Winston Churchill	2012	Champagne
Robert Groffier, Chambolle-Musigny Premier Cru, Les Amoureuses	2018	Burgundy
Sassicaia, Tenuta San Guido, Bolgheri	2018	Tuscany
Sassicaia, Tenuta San Guido, Bolgheri	2017	Tuscany
Sassicaia, Tenuta San Guido, Bolgheri	2016	Tuscany
Screaming Eagle, Cabernet Sauvignon, Oakville	2018	California
Screaming Eagle, Cabernet Sauvignon, Oakville	2016	California
Solaia, Toscana	2018	Tuscany
Soldera Case Basse, 100% Sangiovese, Toscana	2016	Tuscany
Taittinger, Comtes de Champagne Blanc de Blancs	2008	Champagne
Taittinger, Comtes de Champagne Rose	2007	Champagne
Tignanello, Toscana	2018	Tuscany
Tignanello, Toscana	2016	Tuscany
Trapet Pere et Fils, Chambertin Grand Cru	2018	Burgundy
Vega Sicilia, Unico, Ribera del Duero	2010	Castilla y Leon

Appendix C
PWCC 100 Sports Cards Index

Card	Price
1952 Topps Mickey Mantle #311 PSA 8	$1,667,500.00
1954 Topps Hank Aaron #128 PSA 9	$487,500.00
1951 Bowman Mickey Mantle #253 PSA 8	$424,202.67
1952 Topps Mickey Mantle #311 PSA 7	$316,666.67
1933 Goudey Babe Ruth #149 PSA 8	$401,295.33
1955 Topps Sandy Koufax #123 PSA 9	$280,460.00
1952 Topps Mickey Mantle #311 PSA 6	$126,102.00
1963 Topps 1963 Rookie Stars #537 PSA 9	$141,931.33
1980 Topps Bird/Erving/Johnson #16 PSA 10	$718,188.33
1993 SP Derek Jeter (FOIL) #279 PSA 10	$415,209.67
1910 Anonymous "Set of 30" Ty Cobb #8 PSA 9	$36,000.00
1933 Goudey Babe Ruth #144 PSA 8	$374,912.00
1933 Goudey Sport Kings Babe Ruth #2 PSA 8	$195,386.00
1951 Bowman Willie Mays #305 PSA 8	$234,000.00
1933 Goudey Babe Ruth #181 PSA 8	$288,378.67
1948 Leaf Jackie Robinson #79 PSA 8	$402,400.00
1952 Topps Mickey Mantle #311 PSA 5	$85,505.13
1955 Topps Roberto Clemente #164 PSA 8	$82,144.00
1980 Topps Rickey Henderson #482 PSA 10	$113,366.67
1953 Topps Mickey Mantle #82 PSA 8	$102,843.93
1957 Topps Frank Robinson #35 PSA 9	$52,530.00
1952 Topps Willie Mays #261 PSA 8	$218,000.00
1951 Bowman Mickey Mantle #253 PSA 7	$84,400.00
1969 Topps Lew Alcindor #25 PSA 9	$156,992.00
1968 Topps Mets Rookies #177 PSA 9	$107,770.67
1956 Topps Mickey Mantle (Gray Back) #135 PSA 9	$152,951.33
1951 Parkhurst Gordie Howe #66 PSA 8	$47,716.67
1938 Goudey Joe DiMaggio #274 PSA 8	$58,006.80
1957 Topps Bill Russell #77 PSA 8	$187,579.33
1955 Topps Harmon Killebrew #124 PSA 9	$31,940.67
1979 O-Pee-Chee Wayne Gretzky #18 PSA 9	$136,160.00
1961 Fleer Wilt Chamberlain #8 PSA 9	$317,774.33
1933 Goudey Sport Kings Nat Holman (Basketball) #3 PSA 8	$11,096.73
1934 Goudey Lou Gehrig #37 PSA 8	$142,400.00
1986 Fleer Michael Jordan #57 PSA 10	$347,000.00
1965 Topps Joe Namath #122 PSA 8	$58,800.00
1952 Topps Mickey Mantle #311 PSA 4	$69,400.00
1958 Topps Mickey Mantle #150 PSA 9	$73,734.40
1975 Topps Mini George Brett #228 PSA 10	$38,466.67
1968 Topps Reds Rookies #247 PSA 10	$96,000.00
1952 Topps Eddie Mathews #407 PSA 7	$30,546.50
1959 Topps Bob Gibson #514 PSA 9	$35,930.00
1933 Goudey Lou Gehrig #92 PSA 8	$119,335.33
1939 Play Ball (1939) Ted Williams #92 PSA 8	$42,898.93
1957 Topps Don Drysdale #18 PSA 9	$23,240.00
1988 Fleer Sticker Michael Jordan #7 PSA 10	$59,666.67
1954 Topps Hank Aaron #128 PSA 8	$60,305.33
1934 Goudey Lou Gehrig #61 PSA 8	$88,316.40
1961 Fleer Jerry West #43 PSA 9	$60,063.00

1952 Topps Jackie Robinson #312 PSA 8	$168,431.67
1971 Topps Terry Bradshaw #156 PSA 9	$29,161.00
1960 Topps Mickey Mantle #350 PSA 9	$38,858.00
1972 Topps Red Sox Rookies #79 PSA 10	$26,615.23
1976 Topps Walter Payton #148 PSA 10	$63,927.60
1969 Topps Reggie Jackson #260 PSA 9	$50,600.47
1958 Topps Bobby Hull #66 PSA 7	$19,203.33
1956 Topps Roberto Clemente (White Back) #33w PSA 9	$22,480.77
1941 Play Ball "Joe" DI Maggio #71 PSA 8	$44,400.00
1981 Topps Joe Montana #216 PSA 10	$56,026.00
1933 Goudey Babe Ruth #144 PSA 7	$58,284.00
1978 Topps Eddie Murray #36 PSA 10	$44,750.00
1961 Fleer Oscar Robertson #36 PSA 9	$65,384.00
1960 Topps Carl Yastrzemski #148 PSA 9	$22,960.67
1957 Topps Brooks Robinson #328 PSA 9	$18,530.00
1956 Topps Roberto Clemente (Gray back) #33g PSA 9	$29,300.00
1951 Bowman Whitey Ford #1 PSA 8	$25,321.23
1986 Topps Jerry Rice #161 PSA 10	$77,550.50
1959 Topps Mickey Mantle #10 PSA 9	$104,844.00
1958 Topps Roger Maris #47 PSA 9	$22,844.33
1954 Wilson Franks Ted Williams #20 PSA 6	$28,180.80
1951 Bowman Willie Mays #305 PSA 7	$50,020.00
1985 O-Pee-Chee Mario Lemieux #9 PSA 10	$52,800.00
1951 Bowman Mickey Mantle #253 PSA 6	$38,702.77
1996 Topps Chrome Refractor Kobe Bryant #138 PSA 10	$164,820.00
1963 Topps Mickey Mantle #200 PSA 9	$72,745.60
1909-11 T206 Ty Cobb (Bat Off Shoulder) #98 PSA 7	$35,600.00
1966 Topps Mickey Mantle #50 PSA 9	$17,525.53
1962 Topps Lou Brock #387 PSA 9	$13,000.00
1948 Leaf Jackie Robinson #79 PSA 7	$120,414.00
1948 Bowman George Mikan #69 PSA 7	$35,070.00
1965 Topps Mickey Mantle #350 PSA 9	$30,754.80
1953 Topps Mickey Mantle #82 PSA 7	$21,166.67
1968 Topps Milton Bradley Koosman/Ryan #177 PSA 8	$7,435.31
1969 Topps Mickey Mantle (Yellow Letters) #500-y PSA 9	$16,683.33
1933 Goudey Sport Kings Jim Thorpe (Football) #6 PSA 8	$24,300.40
1955 Topps Sandy Koufax #123 PSA 8	$32,790.50
1966 Topps USA Test Bobby Orr #35 PSA 6	$17,066.67
1952 Topps Willie Mays #261 PSA 7	$33,423.33
1975 Topps Rookie Catchers-Outfielders #620 PSA 10	$13,487.73
1975 Topps Mini Robin Yount #223 PSA 10	$18,038.58
1933 Goudey Babe Ruth #53 PSA 5	$45,600.00
1957 Topps Bill Russell #77 PSA 7	$53,411.60
1954 Bowman Ted Williams #66ted PSA 8	$12,778.67
1961 Topps Ron Santo #35 PSA 10	$20,594.67
1933 Goudey Babe Ruth #149 PSA 6	$41,766.33
1952 Topps Eddie Mathews #407 PSA 6	$17,446.73
1933 Goudey Sport Kings Red Grange (Football) #4 PSA 8	$25,097.20
1911 Turkey Reds Walter Johnson #99 PSA 5	$11,866.67
1967 Topps Mets Rookies #581 PSA 9	$23,572.00
1972 Topps Roger Staubach #200 PSA 9	$14,166.67

WORKS CITED

"Glossary." *Sothebys.Com*, https://www.sothebys.com/en/glossary. Accessed 23 Mar. 2022.

"Liv-Ex | The Global Marketplace for the Fine Wine Trade." Liv-Ex, https://www.liv-ex.com/. Accessed 17 Feb. 2022.

"PriceCharting Index: Average Video Game Price." PriceCharting, https://www.pricecharting.com/page/price-index-details. Accessed 12 Feb. 2022.

"Rare Whisky 101: Rare Whisky Icon 100 Index." Rare Whisky 101, https://www.rarewhisky101.com/indices/market-performance-indices/rare_whisky_100_index. Accessed 8 Feb. 2022.

"The Earliest Known Baseball Card | Baseball as the National Game | Origins and Early Days | Explore | Baseball Americana | Exhibitions at the Library of Congress | Library of Congress." Library of Congress, Washington, D.C. 20540 USA, https://www.loc.gov/exhibitions/baseball-americana/about-this-exhibition/origins-and-early-days/baseball-as-the-national-game/the-earliest-known-baseball-card/. Accessed 14 Mar. 2022.

"Trading Card Market Indices | PWCC Marketplace." PWCC, https://www.pwccmarketplace.com/market-indices?index=100&sort=rank&direction=asc&page=4. Accessed 05 Jan. 2022.

Adjei-Darko, Kevin. "Old School Video Games 'Better Investments than Cars and Watches.'" South West Londoner, 17 Dec. 2020, https://www.swlondoner.co.uk/news/17122020-old-school-video-games-better-investments-than-cars-and-watches.

Ahrens, Dan. Investing In Vice: The Recession-Proof Portfolio of Booze, Bets, Bombs, and Butts. First Edition, St. Martin's Press, 2004, https://books.google.com/books?hl=en&lr=&id=taFI7GXjH3EC&oi=fnd&pg=PR5&dq=investing+in+whiskey&ots=5Clx0XxC5l&sig=5X_13exDCUMU_Yo3o-1t-zSOVQU#v=onepage&q&f=false

Burton, Benjamin J., and Joyce P. Jacobsen. “The Rate of Return on Investment in Wine.” World Scientific Reference on Handbook of the Economics of Wine, vol. Volume 6, WORLD SCIENTIFIC, 2018, pp. 247–70, https://doi.org/10.1142/9789813232747_0011.

Engelberg, J, Thompson, L, Williams, J. Stock market anomalies and baseball cards. Financial Review. 2020; 55: 461– 479. https://doi-org.ezaccess.libraries.psu.edu/10.1111/fire.12223

Gilkeson, James H., and Reinhold P. Lamb. “From Beanie Babies To Baseball Cards: A Financial Application Of Collectibles Markets.” Journal of Financial Education, vol. 26, Financial Education Association, 2000, pp. 14–21, http://www.jstor.org/stable/41948322.

Highfill, Jannett, and Kevin O’Brien. “Do Price Guides Guide Ebay Prices: The Market for Individual Baseball Cards.” The American Economist, vol. 52, no. 1, Mar. 2008, pp. 58–65, doi:10.1177/056943450805200105.

Hills, Megan. “Why Your Old Video Games May Be Worth Millions - CNN Style.” CNN, 15 Apr. 2021, https://www.cnn.com/style/article/most-expensive-video-games/index.html.

Howard, Jeremy. “Art As Investment.” Britannica, https://www.britannica.com/topic/art-market/Art-as-investment. Accessed 21 Mar. 2022.Methodology Sources

Iacoviello, Matteo. “FRB: Housing Wealth and Consumption.” Federal Reserve, Apr. 2011, https://www.federalreserve.gov/pubs/ifdp/2011/1027/ifdp1027.htm.

Masset, Philippe, and Jean-Philippe Weisskopf. Raise Your Glass: Wine Investment and the Financial Crisis. SSRN Scholarly Paper, ID 1457906, Social Science Research Network, 1 Feb. 2010. papers.ssrn.com, https://doi.org/10.2139/ssrn.1457906.

McCarthy, John. “Investing In Whisky: A User’s Guide.” Forbes, 17 Dec. 2020, https://www.forbes.com/sites/johnmccarthy12/2020/12/17/investing-in-whisky-a-users-guide/?sh=597e295539ad.

Mueller, Shirley. “Collecting: An Urge That’s Hard to Resist | Psychology Today.” Psychology Today, 29 Oct. 2020, https://www.psychologytoday.com/us/blog/the-mind-collector/202010/collecting-urge-s-hard-resist.

Nahmer, Thomas. “Diversification Benefit of Actual Investing in Fine Wine.” The Journal of Alternative Investments, vol. 22, no. 4, Mar. 2020, p. 59, https://doi.org/10.3905/jai.2020.1.087.

Satchell, Stephen. Collectible Investments for the High Net Worth Investor. Elsevier, 2009.

Sharpe, William. “William F. Sharpe Biographical.” NobelPrize.Org, https://www.nobelprize.org/prizes/economic-sciences/1990/sharpe/biographical/. Accessed 12 Mar. 2022.

Uitts, Ross. “Baseball Card Values: How To Determine Their Worth.” Old Sports Cards, 16 Aug. 2017, https://www.oldsportscards.com/baseball-card-values-and-price-guide/.

Walgreen, D. Investing in Collectibles. Erasmus University Rotterdam, May 2010, https://thesis.eur.nl/pub/7103.

ACADEMIC VITA

Brandon Szwalbenest

EDUCATION

The Pennsylvania State University | Schreyer Honors College — University Park, PA
B.S. Finance | Smeal College of Business | Major
B.S. Economics | College of the Liberal Arts | Minor — Graduation**:** May 2022

RELEVANT EXPERIENCE

Wealthspire Advisors (A Barron's Top 25 R.I.A.) — New York, New York
Wealth Management Intern — *June 2021 – August 2021*

- Applied knowledge from Wealthspire's financial education program to implement optimal-asset-location strategies, recommend third-party financial products, evaluate ESG opportunities, and execute tax-loss harvesting strategies
- Received extensive training and acquired an abundance of experience using a wide array of wealth management technologies including client relationship management (CRM) software, goals-based financial planning software (MoneyGuidePro), rebalancing software (iRebal), trading software (Schwab), and reporting software (Tamarac)

Nittany Lion Fund, LLC. — University Park, PA
Lead Fund Manager | Real Estate — *May. 2020 – May 2021*

- Managed the $315,000 Real Estate portfolio within Penn State's $14,000,000 student-run investment fund by completing stock performance reports and equity pitches with a goal of outperforming the S&P 500
- Generated qualitative and quantitative analysis for equities using discounted cash flow models, net asset value models, and ratio analyses by employing data gathered from the Bloomberg Terminal, FactSet, and SEC filings

Penn State's Finance Department — University Park, PA
Teacher's Assistant, Research Assistant — *Jan. 2020 - Present*

- Supported the academic development of more than 300 students through tutoring, grading, and test proctoring
- Ran a research study analyzing the effects of business plans on the long-term financial performance of their source companies by conducting a series of interviews with business plan writers and successful entrepreneurs

International Business Association — University Park, PA
President — *Aug. 2018 - Present*

- Conducted research on current events in the stock market and in the international business space in order to prepare and deliver 15 minute "Market Update" presentations for the club's 30+ regularly attending members
- Planned "International Night," the club's signature networking event, attended by over 100 students each semester
- Led the executive board by generating and executing ideas to enhance the overall experience of club members

LEADERSHIP

Philanthropic Fantasy Sports — University Park, PA
Treasurer | Head of Fantasy Basketball | Head of Fantasy Soccer — *Aug. 2018 - Present*

- Participated in a weekly sports debate competition modeled off ESPN's *Around the Horn* program, where panelists are rewarded points for articulating unique insights throughout a competitive debate process
- Allocated donated funds to charitable organizations including Thon Charities and St. Jude's Cancer Research Center

CERTIFICATIONS, HONORS, & INTERESTS

Certifications: Bloomberg Core Market Concepts, Intro to the Bloomberg Terminal Certificate, E-Money Certification
Honors: Dean's List 7/7 Semesters, Schreyer Honors CollegeScholarship, Ronald Reagan Leadership Award
Interests: Fantasy sports, mystery novels, *The Fast and the Furious* franchise, Adam Sandler movies, Krispy Kreme