

# Unconventional Success Analysis

Asset Allocation after the Financial Crisis

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## **Introduction**

Portfolio management is important to all participants in the modern economy. Avoiding the financial markets puts investors at risk of losing their purchasing power through rises in inflation. However, participating in the financial markets without a sound approach to portfolio management puts investors at risk of losing large amounts of wealth. *Unconventional Success: A Fundamental Approach to Personal Investment* (“*Unconventional Success*”) was released by David Swenson on August 9, 2005. David Swenson has been the chief investment officer of Yale’s endowment fund since 1985 and currently manages over \$25 billion in assets.

*Unconventional Success* was released with high publicity due to Swenson’s experience and the simplicity of his approach to personal investing. While Swenson’s recommended portfolio had high results prior to the book’s release, the financial crisis from late 2007 to early 2009 upended much of the financial world. I sought to analyze his strategy and recommended portfolio after the release of his book and see if it performed as he believed it would.

## **Unconventional Success Conclusion**

*Unconventional Success* examines the entire range of financial products available to individual investors and covers the main characteristics of each broadly defined asset class. The compact nature of each description allows Swenson to cover a large portion of the financial landscape. The most important takeaways for portfolio construction come in his commentary on the three sources of return available to investors, the three basic investment principles of asset allocation in a well-constructed portfolio, and his definition of the six “core” asset classes.

“Capital markets provide three tools for investors to employ in generating investment returns: asset allocation, market timing, and security selection” (Swenson 11). Asset Allocation

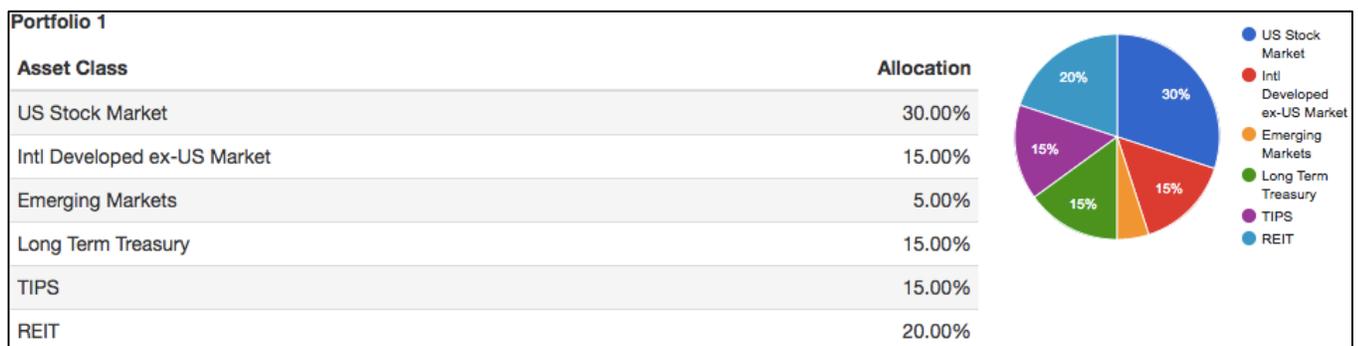
refers to the long-term decision regarding the proportion of assets that an investor chooses to place in particular classes of investments. Market timing refers to deviations from the long-term asset allocation targets. Security Selection refers to the method of construction of portfolios for each of the individual asset classes. “Asset Allocation decisions play a central role in determining investor results. A number of well-regarded studies of institutional portfolios conclude that approximately 90% of the variability of returns stems from asset allocation, leaving approximately 10% of the variability to be determined by security selection and market timing. Since long-term portfolio targets play such a powerful role in determining investment outcomes, sensible investors pay careful attention to establishing thoughtful asset-allocation structures.” (Swenson 13). Unfortunately, investors are often seduced by the appeal of security-trading decisions and the allure of market-timing moves. This leads to a focus on unproductive and expensive portfolio-churning activities.

The three basic investment principles that inform asset-allocation decisions in a well-constructed portfolio are a pronounced equity bias, substantial diversification, and tax considerations. “The principles of equity orientation, diversification, and tax sensitivity find support both in common sense and academic theory” (Swenson 13). These investment principles form the basis for Swenson’s recommended portfolio detailed in the book. “By using the basic principles of diversification and equity orientation to build a foundation that accommodates individual characteristics and risk preferences, investors establish a framework that promises superior investment outcomes” (Swenson 91). The focus on simplistic and general guidelines makes sense for individual investors. Complex and difficult strategies can confuse and demotivate individual investors who do not have the time or resources to compete with Wall Street and its vast advantages. “I concluded that individuals fare best by constructing equity-

oriented, broadly diversified portfolios without the active management component. Instead of pursuing short-term promises of market-beating strategies, individuals benefit from adopting the ironclad reality of market-mimicking portfolios managed by not-for-profit investment organizations” (Swenson Preface). The emphasis on long term targets that can be easily maintained is optimal for individual investors. The guidelines and principles detailed by Swenson form the basis for his recommended portfolio and allow investors to focus on six “core” asset classes that contribute to our goals.

Core asset classes provide three critical characteristics to our portfolio. “First, core asset classes contribute basic, valuable, differentiable characteristics to an investment portfolio. Second, core holdings rely fundamentally on market-generated returns, not on active management of portfolios. Third, core asset classes derive from broad, deep, investable markets” (Swenson 35). Swenson identified six core asset classes throughout the entire financial landscape. His recommended portfolio, detailed in the next section, only allocates capital to these six asset classes.

### Unconventional Success Recommended Portfolio



Swenson provides us with a generic portfolio (“Portfolio 1”) based on fundamental investment principles early on in his book. It is important to note that the allocation to each asset class will vary based on the age and personal preference for risk of the individual investor. For

example, a young investor should allocate slightly more towards equity securities while an older, retired investor should place a higher proportion of his capital in United States Treasuries and Treasury Inflation Protected Securities (TIPS). However, this generic portfolio provides a good starting point for discussion of portfolio construction. Our portfolio is invested only in the six “core” asset classes, as defined by Swenson. Currently, seventy percent of our assets promise equity like returns and no asset class has a weighting above 30%, meeting our requirements of equity bias and diversification.

“Six asset classes provide exposure to well-defined investment attributes. Investors expect equity-like returns from domestic equities, foreign developed market equities, and emerging market equities. Conventional domestic fixed-income and inflation-indexed securities provide diversification, albeit at the cost of expected returns that fall below those anticipated from equity investments. Exposure to real estate contributes diversification to the portfolio with lower opportunity costs than fixed-income investments” (Swenson 33). This generic portfolio recommended by Swenson accomplishes his three basic investment goals and only relies on asset allocation as our source of returns, as opposed to market timing and security selection. In order to perform analysis on Swenson’s recommended portfolio, I replicated it using historical price data on each of the previously mentioned asset classes, which I obtained from *The Vanguard Group*. *The Vanguard Group* is an American investment company that is the largest provider of mutual funds and the second-largest provider of exchange traded funds in the world (Vanguard). The asset class and my source of data are detailed in the table below. It is important to note that United States TIPS were not introduced until the late 1990s and Vanguard did not release its Vanguard Inflation-Protected Security Fund until 2001. Because of this, I started my analysis in the year 2001.

<b>Asset Class Name (Swenson)</b>	<b>Asset Class Name (Analysis)</b>	<b>Vanguard Index Fund</b>
Domestic Equity	US Stock Market	Total Stock Market Index Fund (VTSMX)
Foreign Developed Equity	International Developed ex-US Market	Developed Markets Index Fund (VDVIX)
Emerging Markets	Emerging Markets	Emerging Markets Stock Index Fund (VEIEX)
United States Treasury Bonds	Long Term Treasury	Long Term Treasury Fund (VUSTX)
United States TIPS	TIPS	Inflation-Protected Security Fund (VIPSX)
Real Estate	REITs	REIT Index Fund (VGSIX)

### **Recommended Portfolio Performance and Analysis**

I will compare Swenson's portfolio against a commonly used benchmark, the Standard and Poor's 500 (S&P500). The S&P500 is defined as an American stock market index based on the market capitalizations of the 500 largest companies having common stock listed on the NYSE or NASDAQ. It is important to note that the S&P500 is normally used as a benchmark for the United States Stock Market, only one component of Swenson's six asset classes. Because of our additional diversification, we should expect our generic portfolio to outperform our benchmark. While this somewhat defeats the purpose of our benchmark, this still provides us with a base that we can compare our portfolio to over time.

I would like to start off my analysis with **Appendix A**, which analyzes the performance of \$100,000 invested into Portfolio 1, our generic portfolio, and \$100,000 invested into the S&P500, our benchmark. As expected, our generic portfolio outperformed our benchmark from 2001-2017. This can be seen from the higher Compound Annual Growth Rate ("CAGR") and lower Standard Deviation ("Stdev") of the returns. Standard deviation represents the volatility, a

common measure of the risk of a financial instrument, of our portfolio. With higher returns and less volatility, the diversification across six asset classes allowed us to achieve higher growth with less risk. Thus, it appears that our generic portfolio is indeed a better option when compared to only investing in United States Domestic Equity. However, the picture changes when we divide the last seventeen years into distinct periods. I wanted to analyze the performance of Swenson's portfolio in the years preceding the release of the book, during the financial crisis, and from the financial crisis to date. To accomplish this, I analyzed the portfolio from 2001-2005, 2006-2010, and 2011-2017. From 2001-2005, our generic portfolio had a CAGR over twenty times our benchmark, while still exhibiting less volatility. When we move to the period 2006-2010, our generic portfolio fails to achieve the performance from the preceding period. Finally, when we analyze 2011-2017, our generic portfolio begins to underperform our benchmark.

This decline in performance from the first period to the final two periods is very concerning. As I previously stated, *Unconventional Success* was released in late 2005. The lack of performance after the release of the book is disturbing. Unfortunately, the asset class characteristics that Swenson observed over the previous years while writing *Unconventional Success* did not hold up after the release of his book. Investors that adopted Swenson's strategy after buying his book did not participate in the inflated returns from 2001-2005 and instead received dismal performance from 2006-2017. To get a better intuitive understanding of the effects on investors, I have plotted visual representations of Portfolio Annual Returns in **Appendix B** and Portfolio Growth (assuming an initial investment of \$100,000) in **Appendix C**.

Looking at **Appendix B**, we can see how our generic portfolio performed year to year from 2001-2017. In the period immediately preceding the release of *Unconventional Success*,

2001-2005, we see that Swenson's recommended portfolio drastically outperformed our benchmark, the S&P500. The generic portfolio's diversifying assets allowed investors to weather the "Dot-Com" bubble from late 2000 to early 2002 without limiting the upside of our returns in the years immediately following. However, in the two periods of analysis after the release of the book, our portfolio fails to achieve the same performance relative to the S&P500. During the great recession from late 2007 to early 2009, our portfolio still suffered a loss of nearly twenty-five percent. Unlike the previous recession, our diversification was unable to prevent an enormous loss of wealth for investors during the Financial Crisis.

**Appendix C** confirms our previous analysis. Our portfolio consistently outperforms the benchmark from 2001-2005, causing our assets to appreciate at a most faster rate compared to the S&P500. However, when we transition to the period 2006-2010, our portfolio fails to achieve the same level of performance. Finally, when we analyze the last period, our portfolio's performance continues to deteriorate. Our portfolio has significantly underperformed the S&P500 since 2011. Swenson's portfolio was able to withstand the "Dot-Com" Bubble and participate in the upturn from 2003-2005. However, after the book's release, investors who followed his recommended portfolio were devastated by the Financial Crisis and have not been able to achieve the same performance as the S&P500 since. The lack of performance of Swenson's portfolio gave me motivation to find out what caused this drastic difference before and after the release of his book.

### **Lack of Correlations During Financial Crisis**

One of Swenson's three main investment principles, substantial diversification, allows investors to attain risk reduction without return diminution. This is best illustrated with an

example of a two-asset portfolio.

In the above formula, “ $\sigma^2$ ” refers to variance, “ $w$ ” refers to the weight of the asset within the

$$\sigma_p^2 = w_A^2 \sigma_A^2 + w_B^2 \sigma_B^2 + 2w_A w_B \sigma_A \sigma_B \rho_{AB}$$

portfolio, and “ $\rho$ ” refers to the correlation coefficient between two assets. The subscripts are as follows: p for Portfolio, A for Asset A, and B for Asset B. This formula can be derived using basic properties of variance and extends to portfolios that contain  $N$  assets. As we can see from the formula, the variance of the entire portfolio is reduced as long as the correlation between A and B is less than 1. The lower (more inversely) correlated the assets in a portfolio are, the lower volatility we will have for a given level of return. This should motivate us to find assets with high expected returns and inverse correlations in order to maximize the expected returns and minimize the volatility, or risk, of our portfolio.

Unfortunately, correlations are not static. In the context of financial assets, correlations change frequently as the economy changes and investor perceptions change. In fact, we don't know the true correlation coefficient between assets. Much work is done by financial firms to provide estimates of the relationships but we can not assume these relationships will hold in the future.

The overwhelming reason Swenson's portfolio underperformed after the release of *Unconventional Success* was the change in the relationships of the six core asset classes during the financial crisis. Looking at **Appendix D**, we can see how the correlations between assets changed after the release of *Unconventional Success* in August of 2005. Remember, “Conventional and inflation-linked bonds provide diversifying power, with real estate again playing a supporting role” (Swenson 80). From 2001-2005, we can see our diversifying assets exhibited these properties. The column “PF#1” represents the correlation between the asset class

and our portfolio of six core asset classes. Both our United States Treasuries and United States TIPS were nearly independent of our portfolio. REITs also provided some diversification to our portfolio due to the relatively low correlation with the rest of our portfolio. Remember, as long as the correlation coefficient is less than 1, our portfolio's variance will decrease. Therefore, from 2001-2005, REIT's 0.71 correlation coefficient provided valuable diversification while also providing a CAGR of over 18% (**Appendix E**). "In terms of risk and return, real estate falls between higher-risk equity and lower-risk debt" (Swenson 79). This hybrid nature of the expected investment characteristics of real estate was clearly on display in the five years preceding the release of *Unconventional Success*. However, as we move past the release of Swenson's book, we can see that these relationships failed to hold up over time. During 2006-2010, which contains the financial crisis, United States TIPS and REITs failed to exhibit the same level of correlation as the previous period. In fact, the only asset that exhibited similar characteristics after the release of *Unconventional Success* was United States Treasuries, which had a correlation of 0.05 with our portfolio from 2006-2010. When we needed our diversifying assets most, they failed to exhibit the diversifying properties that Swenson observed in the years preceding the release of his book.

Correlations are not static; rather, they are dynamic and are constantly changing. It is important to realize that the properties we see during one period may not exist in the next period. Consequently, we must continuously scan the financial landscape and avoid becoming complacent with a particular set of investments. Additionally, a number of studies have documented that correlations between asset returns are higher when prices fall than when prices rise (Chordia 1). While there was research on this before the release of *Unconventional Success*, it was not until the financial crisis that researchers could confirm this phenomenon.

The underperformance of Swenson’s generic portfolio after the release of his book follows a trend of authors who sell past market beating strategies and see them fail in the future. The financial world’s hindsight bias is visible through its obsession with strategies that have been successful in the past. Unfortunately, investors who put faith in yesterday’s strategies generally find dismal performance.

**Additional Asset Classes that may Provide Diversification**

The high correlation between our portfolio and two of our three diversifying asset classes motivated me to find additional asset classes that exhibit the inverse correlation we desire. I obtained data on commonly defined asset classes that are available to invest in through Vanguard indexes and plotted their correlations with our portfolio from 2001-2017. I identified four asset classes that were consistently uncorrelated with our six core asset classes and listed them below.

<b>Asset Class Name</b>	<b>Vanguard Index Fund</b>
Cash	1 Month United States Treasury Bills
Total US Bond Market	Total Bond Market Index Fund
Long Term Corporate Bonds	Long-Term Investment Grade Fund
Gold	SPDR Gold Shares

Returning to **Appendix D**, I show correlation matrices that include our new four asset classes under “6 Core Asset Classes and Additional 4 Asset Classes.” The column “PF#1” represents the correlation coefficient between the corresponding asset class and our portfolio of six core asset classes, while the column “PF#2” represents the correlation coefficient between each asset class and our new portfolio containing all six core asset classes and all four additional asset classes. We can clearly see that these four new asset classes could have provided considerable diversification to our portfolio of six core asset classes throughout all three periods.

However, we can not conclude that a portfolio with these additional asset classes will protect us from the next recession. As stated previously, correlations are dynamic and do not remain the same over time.

While quantitative analysis can provide undeniable insight into the characteristics of asset classes, it is also important to understand the intuitive characteristics of each asset class when attempting to find assets that are uncorrelated with our portfolio. Of the three diversifying assets recommended by Swenson, only United States Treasuries exhibited the inverse correlation that we seek after the release of *Unconventional Success*. This was the result of a “flight to quality” during the financial crisis. Bond yields are inversely related to bond prices. During the financial crisis from late 2007 to early 2009, scared investors removed money from many asset groups and placed them in United States Treasury Bonds, which is perceived by the financial world as the “safest asset in the world,” because it has the full faith and backing of the United States of America. The resulting increase in price gave US Treasury holders an increase in return, and diversification for their declining portfolio. I will continue my analysis by detailing four potential assets that may provide diversification in the next recession because of their theoretical properties: US Treasuries, Safe Government Bonds, Utilities, and Consumer Staples.

United States Treasuries should exhibit inverse correlation with our return drivers due to the “flight to quality” that is often seen during times of global uncertainty. The United States economy was at the center of the recent Financial Crisis due its role in the mortgage bubble. However, despite the bankruptcy of Lehman Brothers, the largest bankruptcy filing in the history of the United States, and uncertainty around many American institutions and companies, investors still flocked to United States Treasuries because of the enormous confidence investors have in the United States government. If investors believed United States Treasuries were one of

the safest assets in the world even when the United States was at the center of the latest recession, we should have confidence that investors will again buy up United States Treasuries during the next period of global uncertainty.

While we may have confidence in United States Treasuries during the next recession, we should also look to other government bonds for potential “flights to quality” in anticipation of the next recession. When looking for governments that can weather through the next period of financial uncertainty and make payments on their bonds, we should look for low debt levels and diverse economies that can withstand periods of instability. **Appendix F** details governments that I believe may receive the same “flight to quality” seen with United States Treasury Securities during periods of global uncertainty. I have ranked countries by their level of economic activity (GDP), stopping at Australia, the 13<sup>th</sup> biggest economy in the world. From there, I have compiled each country’s level of Debt-to-GDP and level of economic complexity. Debt-to-GDP is a good measure of the solvency of a country and its ability to pay its debts, while economic complexity is defined as a holistic measure of the production characteristics of large economic systems and is a good indicator of a country’s ability to weather economic downturns. Looking at the 13 biggest economies ten year yields, South Korea, China, and the United Kingdom appear to be in stable positions should a recession occur. It may be advantageous to allocate small percentages of capital to bonds from these countries to obtain low correlation with other assets and receive the “flight to quality” boost during the next recession. It is important to recognize that the current yields of these countries incorporate and reflect all relevant information known by the financial community. It would be unwise to allocate a significant proportion of our capital to any of these securities; however, miniscule allocations would help

diversify our portfolio and could have better chances of providing the “flight to quality” boost in the next time of global uncertainty.

Finally, Utilities and Consumer Staples, specific sectors within the Domestic Equity asset class, may provide diversification during economic downturns. This is again a result of the theoretical properties of the assets. Even during economic downturns, consumers still must purchase certain goods like water, electricity, gas, food, and household goods. As a result, companies operating in these sectors see consistent earnings and cash flows, even during periods of recession. Because of the consistency of their earnings, prices stay relatively consistent in these sectors. Additionally, during recessions investors will demand more of these assets because they are perceived as safer assets due to their noncyclical nature. As a result, companies in the utilities and consumer staples sectors often see their share price rise during periods of uncertainty, providing the inverse correlation we desire.

## **Conclusion**

The generic portfolio recommended in *Unconventional Success* failed to achieve the level of performance in the years 2001-2005 after the release of the book. Unfortunately, the relationships Swenson observed did not hold up during the financial crisis. Through quantitative analysis, I identified four asset classes that could have provided additional diversification through low correlation over the last seventeen years. Through additional theoretical analysis, I identified one asset class and two sectors which could provide diversification in the next economic downturn.

In conclusion, we must allocate beyond the six core asset classes in order to obtain substantial diversification. Because correlations are dynamic, it is important to spread our exposure among different asset classes and avoid relying on three asset classes to provide all of

our diversification. While the financial markets are inherently unstable, diversification among a wide range of asset classes is essential due to the dynamic nature of asset class correlations.

## Appendix A: Portfolio Returns

2001-2017:

### Portfolio Returns

Portfolio	Initial Balance	Final Balance	CAGR	Stdev	Best Year	Worst Year	Max. Drawdown	Sharpe Ratio	Sortino Ratio	US Mkt Correlation
Portfolio 1	\$100,000	\$352,215 ⓘ	7.81% ⓘ	10.88%	26.82%	-24.40%	-40.59% ⓘ	0.62	0.89	0.88
Vanguard 500 Index Investor	\$100,000	\$260,822 ⓘ	5.89% ⓘ	14.44%	32.18%	-37.02%	-50.97% ⓘ	0.38	0.53	1.00

2001-2005:

### Portfolio Returns

Portfolio	Initial Balance	Final Balance	CAGR	Stdev	Best Year	Worst Year	Max. Drawdown	Sharpe Ratio	Sortino Ratio	US Mkt Correlation
Portfolio 1	\$100,000	\$152,303 ⓘ	8.78% ⓘ	8.64%	26.82%	-3.26%	-10.58% ⓘ	0.77	1.14	0.88
Vanguard 500 Index Investor	\$100,000	\$102,123 ⓘ	0.42% ⓘ	14.93%	28.50%	-22.15%	-38.97% ⓘ	-0.04	-0.05	0.99

2006-2010:

### Portfolio Returns

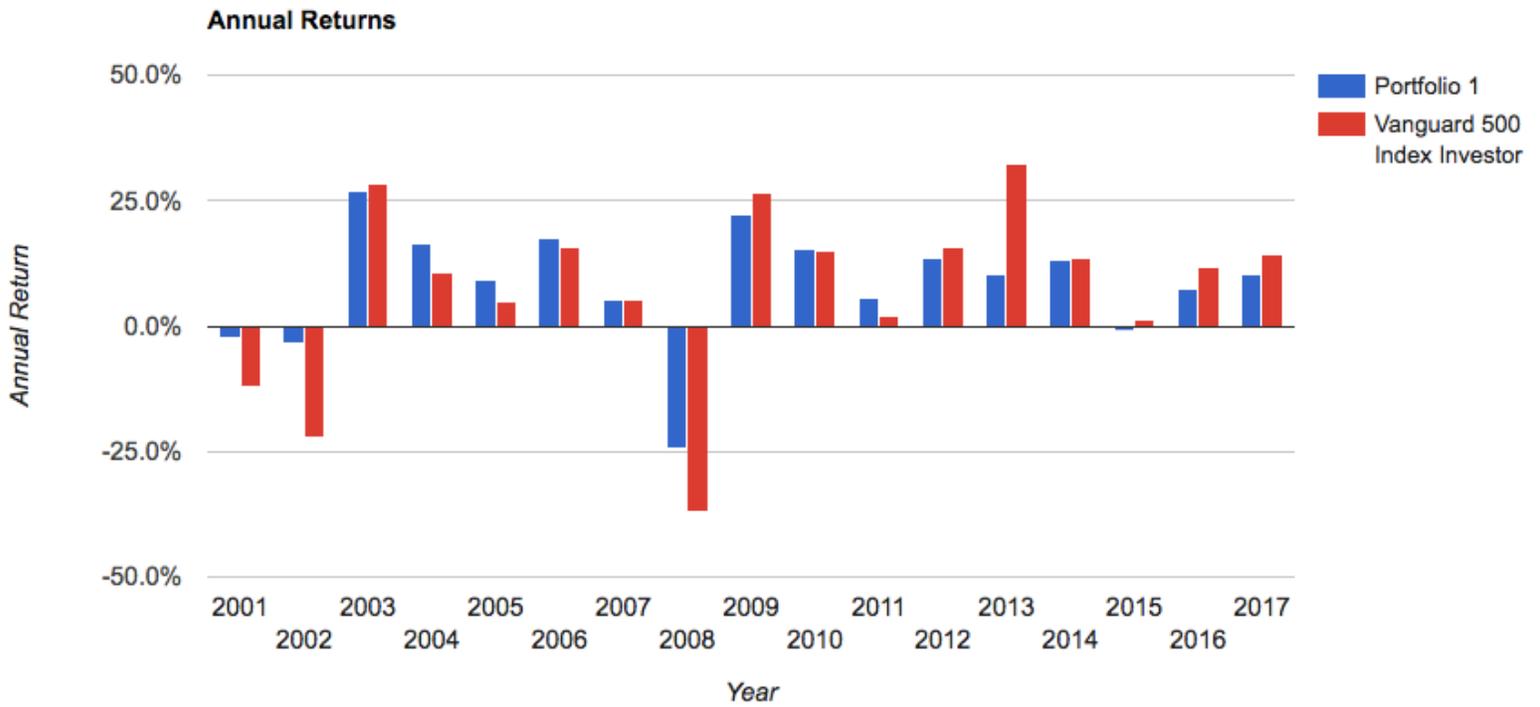
Portfolio	Initial Balance	Final Balance	CAGR	Stdev	Best Year	Worst Year	Max. Drawdown	Sharpe Ratio	Sortino Ratio	US Mkt Correlation
Portfolio 1	\$100,000	\$131,556 ⓘ	5.64% ⓘ	15.50%	22.38%	-24.40%	-40.59% ⓘ	0.29	0.39	0.94
Vanguard 500 Index Investor	\$100,000	\$111,561 ⓘ	2.21% ⓘ	17.82%	26.49%	-37.02%	-50.97% ⓘ	0.09	0.12	1.00

2011-2017:

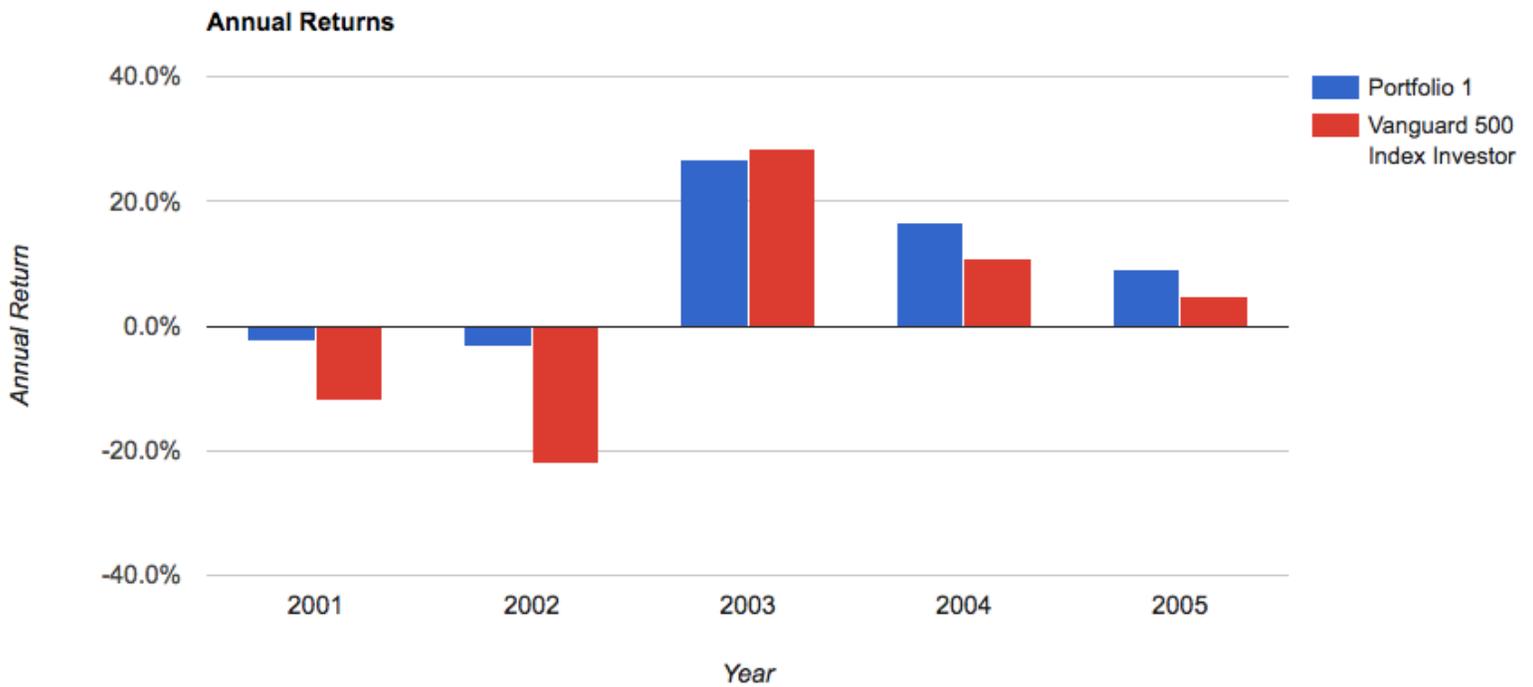
### Portfolio Returns

Portfolio	Initial Balance	Final Balance	CAGR	Stdev	Best Year	Worst Year	Max. Drawdown	Sharpe Ratio	Sortino Ratio	US Mkt Correlation
Portfolio 1	\$100,000	\$175,788 ⓘ	8.72% ⓘ	7.98%	13.63%	-0.77%	-9.17% ⓘ	1.07	1.89	0.88
Vanguard 500 Index Investor	\$100,000	\$228,934 ⓘ	13.06% ⓘ	10.83%	32.18%	1.25%	-16.31% ⓘ	1.18	2.13	1.00

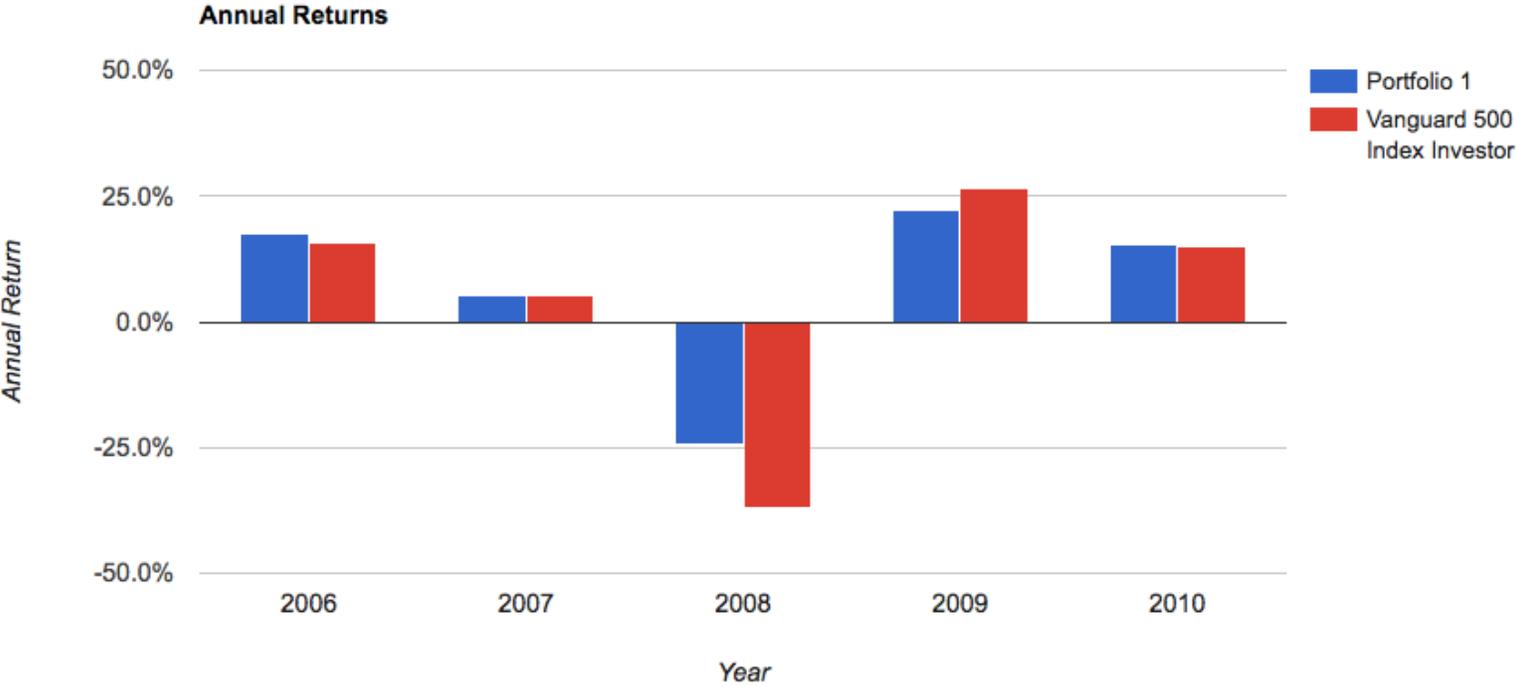
**Appendix B: Annual Returns**  
2001-2017:



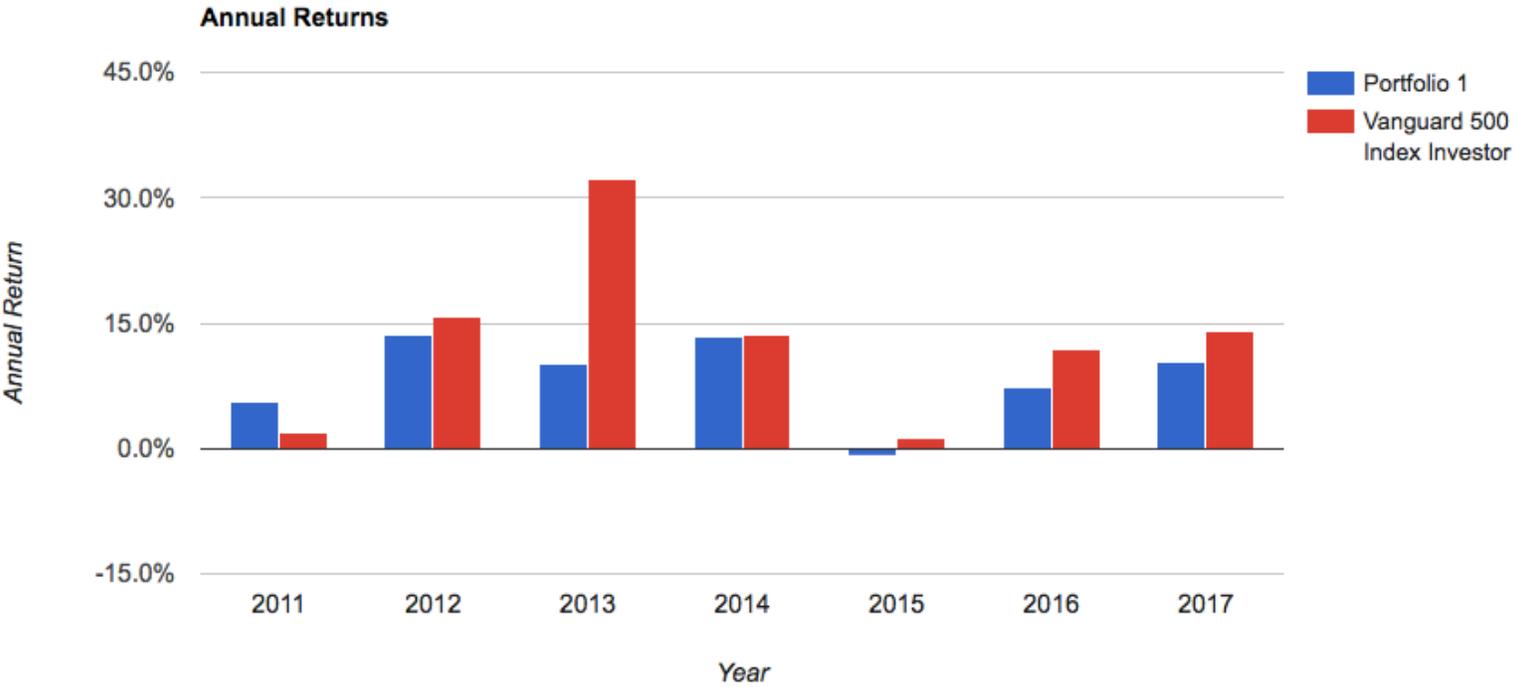
2001-2005:



2006-2010:



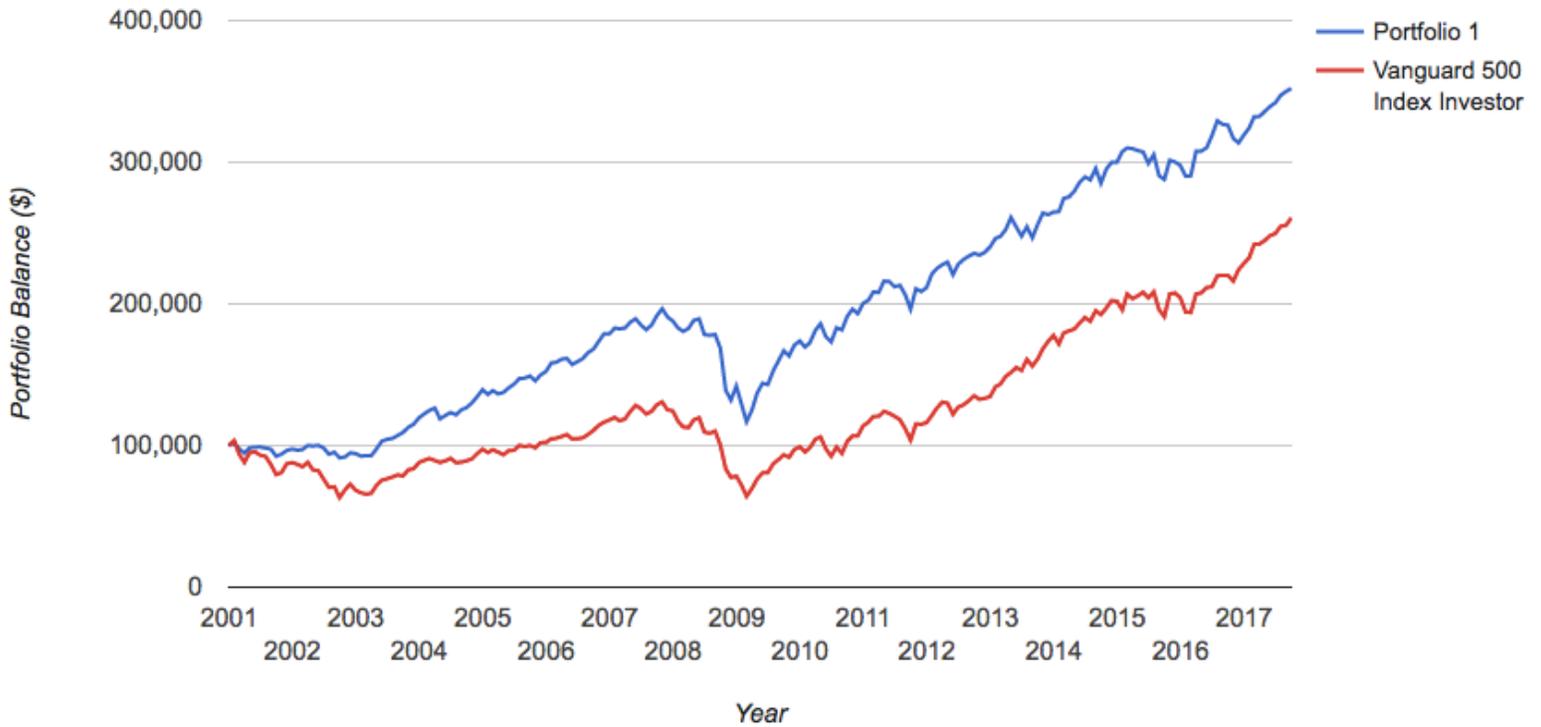
2011-2017:



## Appendix C: Portfolio Growth

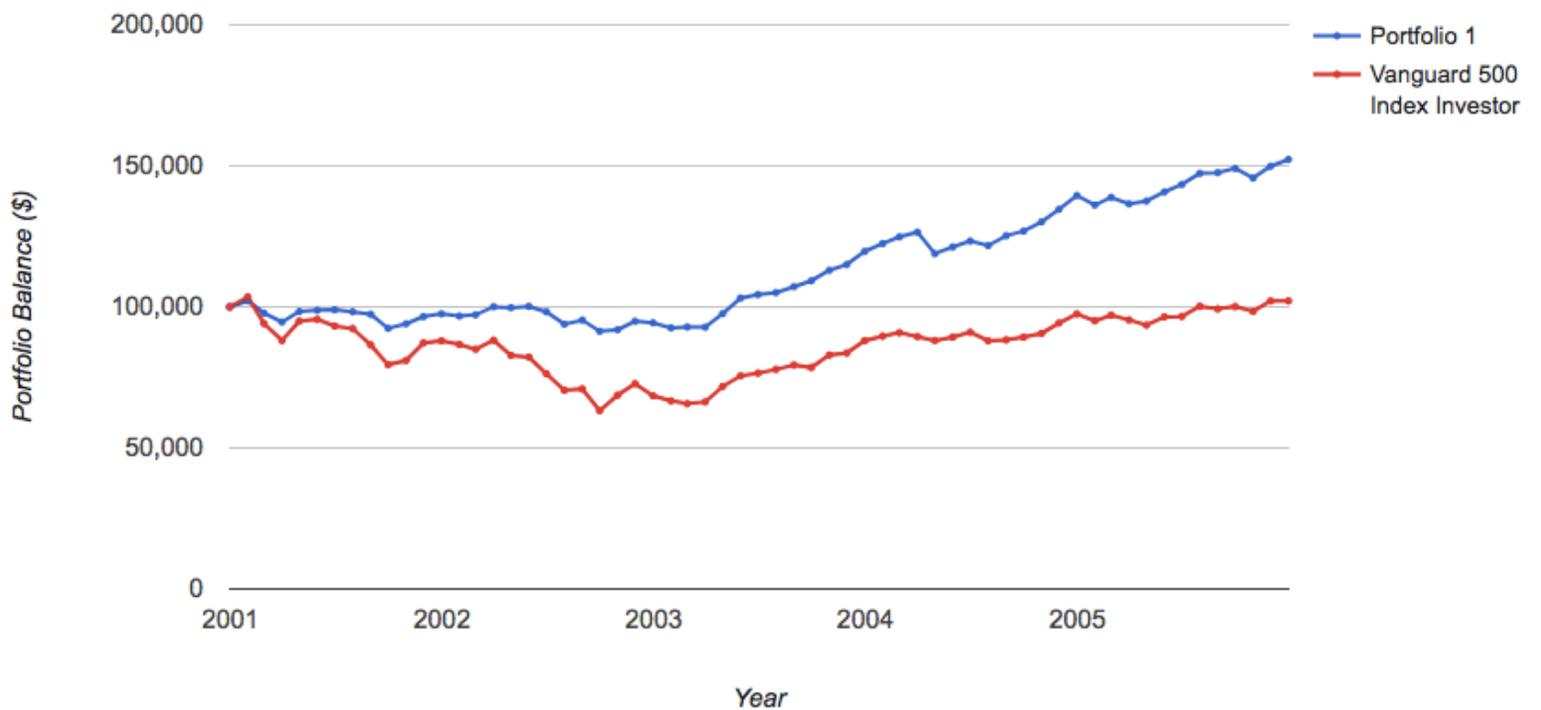
2001-2017:

### Portfolio Growth

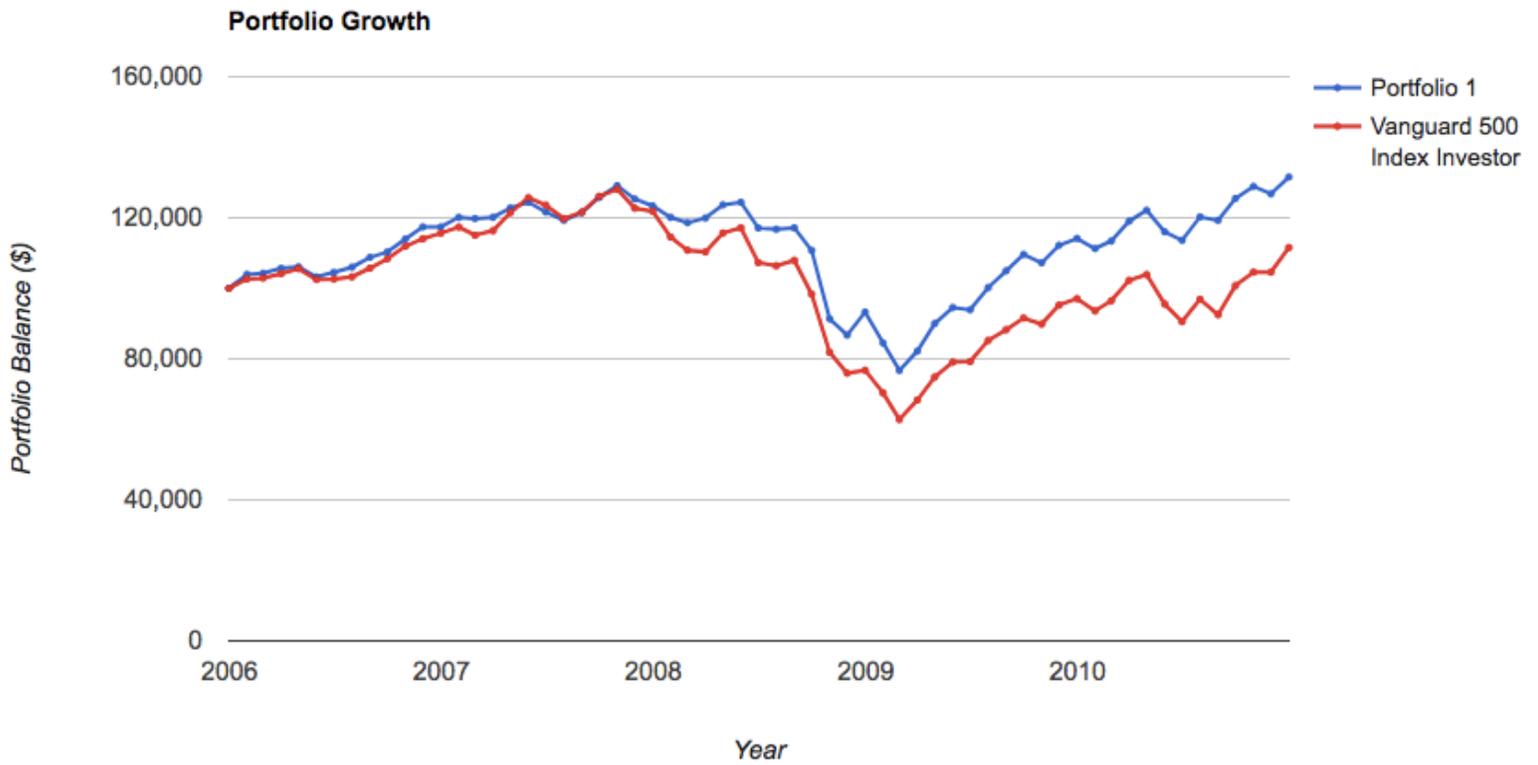


2001-2005:

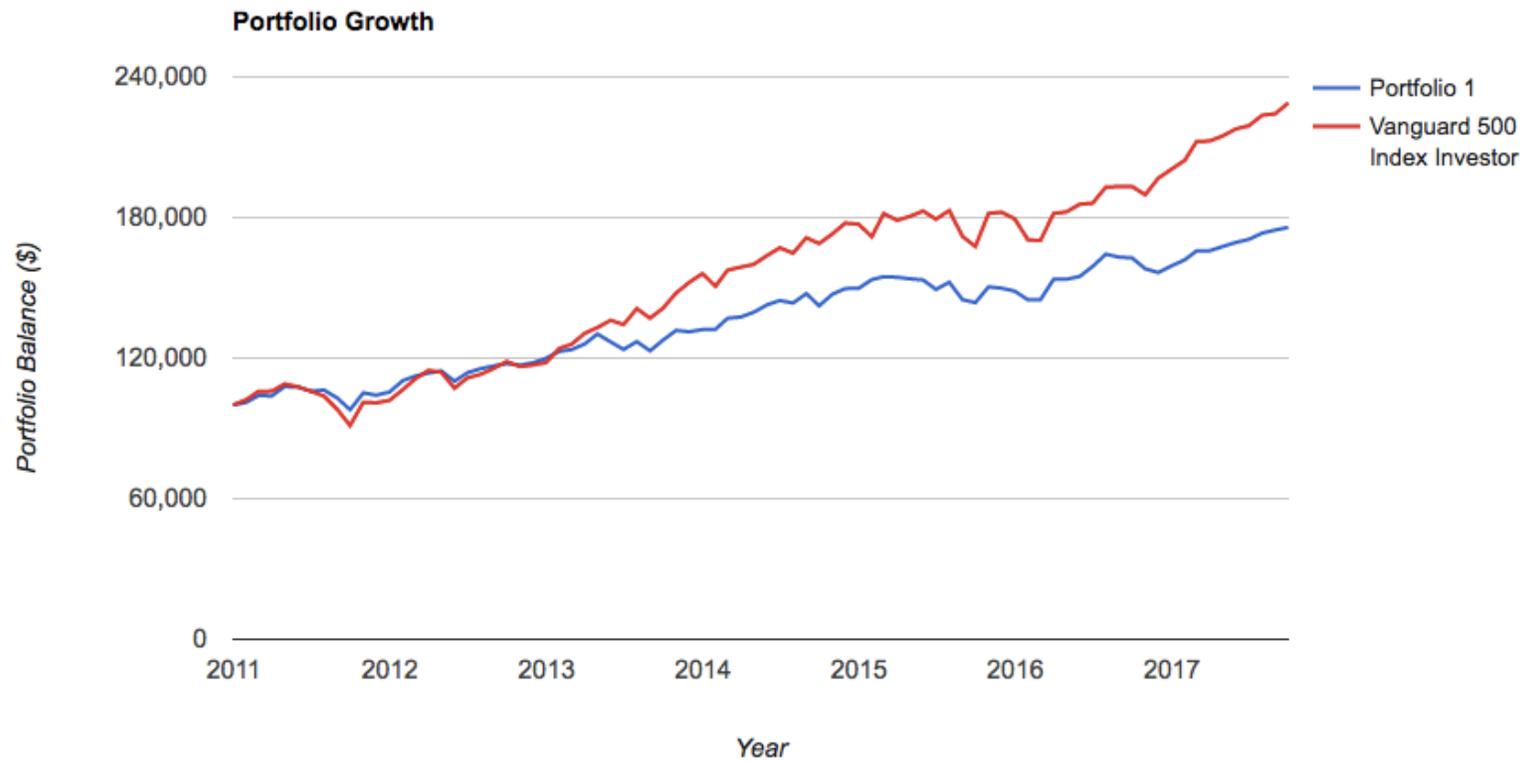
### Portfolio Growth



2006-2010:



2011-2017:



## Appendix D: Monthly Correlations

### 6 Core Asset Classes

#### 2001-2017:

#### Monthly Correlations

Name	US Stock Market	Intl Developed ex-US Market	Emerging Markets	Long Term Treasury	TIPS	REIT	PF #1	Vanguard 500 Index Investor
US Stock Market	-	0.88	0.81	-0.32	0.02	0.66	0.88	1.00
Intl Developed ex-US Market	0.88	-	0.87	-0.23	0.14	0.63	0.88	0.88
Emerging Markets	0.81	0.87	-	-0.20	0.20	0.56	0.82	0.79
Long Term Treasury	-0.32	-0.23	-0.20	-	0.63	0.00	0.02	-0.31
TIPS	0.02	0.14	0.20	0.63	-	0.25	0.34	0.01
REIT	0.66	0.63	0.56	0.00	0.25	-	0.86	0.64

#### 2001-2005:

#### Monthly Correlations

Name	US Stock Market	Intl Developed ex-US Market	Emerging Markets	Long Term Treasury	TIPS	REIT	PF #1	Vanguard 500 Index Investor
US Stock Market	-	0.87	0.86	-0.37	-0.28	0.40	0.85	0.99
Intl Developed ex-US Market	0.87	-	0.84	-0.24	-0.15	0.41	0.86	0.86
Emerging Markets	0.86	0.84	-	-0.26	-0.15	0.43	0.84	0.83
Long Term Treasury	-0.37	-0.24	-0.26	-	0.87	-0.02	-0.01	-0.38
TIPS	-0.28	-0.15	-0.15	0.87	-	0.14	0.12	-0.29
REIT	0.40	0.41	0.43	-0.02	0.14	-	0.71	0.37

#### 2006-2010:

#### Monthly Correlations

Name	US Stock Market	Intl Developed ex-US Market	Emerging Markets	Long Term Treasury	TIPS	REIT	PF #1	Vanguard 500 Index Investor
US Stock Market	-	0.92	0.86	-0.18	0.25	0.81	0.94	1.00
Intl Developed ex-US Market	0.92	-	0.92	-0.08	0.31	0.75	0.93	0.92
Emerging Markets	0.86	0.92	-	-0.11	0.34	0.64	0.85	0.85
Long Term Treasury	-0.18	-0.08	-0.11	-	0.53	-0.07	0.05	-0.16
TIPS	0.25	0.31	0.34	0.53	-	0.24	0.41	0.25
REIT	0.81	0.75	0.64	-0.07	0.24	-	0.90	0.80

#### 2011-2017:

#### Monthly Correlations

Name	US Stock Market	Intl Developed ex-US Market	Emerging Markets	Long Term Treasury	TIPS	REIT	PF #1	Vanguard 500 Index Investor
US Stock Market	-	0.84	0.71	-0.47	0.00	0.60	0.83	1.00
Intl Developed ex-US Market	0.84	-	0.81	-0.41	0.15	0.55	0.82	0.84
Emerging Markets	0.71	0.81	-	-0.28	0.32	0.53	0.77	0.71
Long Term Treasury	-0.47	-0.41	-0.28	-	0.62	0.14	0.00	-0.46
TIPS	0.00	0.15	0.32	0.62	-	0.43	0.45	-0.00
REIT	0.60	0.55	0.53	0.14	0.43	-	0.88	0.60

## 6 Core Asset Classes and Additional 4 Asset Classes

2001-2017:

### Monthly Correlations

Name	US Stock Market	Intl Developed ex-US Market	Emerging Markets	Long Term Treasury	TIPS	REIT	Cash	Total US Bond Market	Long-Term Corporate Bonds	Gold	PF #1	PF #2	Vanguard 500 Index Investor
US Stock Market	-	0.88	0.81	-0.32	0.02	0.66	-0.09	-0.11	0.05	0.03	0.88	0.88	1.00
Intl Developed ex-US Market	0.88	-	0.87	-0.23	0.14	0.63	-0.03	0.01	0.16	0.17	0.88	0.90	0.88
Emerging Markets	0.81	0.87	-	-0.20	0.20	0.56	0.05	0.05	0.16	0.28	0.82	0.85	0.79
Long Term Treasury	-0.32	-0.23	-0.20	-	0.63	0.00	-0.00	0.85	0.80	0.22	0.02	0.06	-0.31
TIPS	0.02	0.14	0.20	0.63	-	0.25	0.05	0.80	0.72	0.43	0.34	0.36	0.01
REIT	0.66	0.63	0.56	0.00	0.25	-	-0.03	0.19	0.30	0.13	0.86	0.79	0.64
Cash	-0.09	-0.03	0.05	-0.00	0.05	-0.03	-	0.07	-0.05	0.07	-0.04	-0.04	-0.09
Total US Bond Market	-0.11	0.01	0.05	0.85	0.80	0.19	0.07	-	0.89	0.34	0.24	0.28	-0.11
Long-Term Corporate Bonds	0.05	0.16	0.16	0.80	0.72	0.30	-0.05	0.89	-	0.26	0.38	0.42	0.05
Gold	0.03	0.17	0.28	0.22	0.43	0.13	0.07	0.34	0.26	-	0.21	0.30	0.02

2001-2005:

### Monthly Correlations

Name	US Stock Market	Intl Developed ex-US Market	Emerging Markets	Long Term Treasury	TIPS	REIT	Cash	Total US Bond Market	Long-Term Corporate Bonds	Gold	PF #1	PF #2	Vanguard 500 Index Investor
US Stock Market	-	0.87	0.86	-0.37	-0.28	0.40	-0.15	-0.30	-0.18	-0.01	0.85	0.87	0.99
Intl Developed ex-US Market	0.87	-	0.84	-0.24	-0.15	0.41	-0.22	-0.21	-0.10	0.17	0.86	0.89	0.86
Emerging Markets	0.86	0.84	-	-0.26	-0.15	0.43	-0.08	-0.20	-0.09	0.18	0.84	0.86	0.83
Long Term Treasury	-0.37	-0.24	-0.26	-	0.87	-0.02	0.01	0.95	0.95	0.14	-0.01	0.02	-0.38
TIPS	-0.28	-0.15	-0.15	0.87	-	0.14	0.03	0.86	0.86	0.27	0.12	0.13	-0.29
REIT	0.40	0.41	0.43	-0.02	0.14	-	-0.12	0.05	0.08	0.34	0.71	0.62	0.37
Cash	-0.15	-0.22	-0.08	0.01	0.03	-0.12	-	0.14	0.04	-0.04	-0.18	-0.18	-0.14
Total US Bond Market	-0.30	-0.21	-0.20	0.95	0.86	0.05	0.14	-	0.95	0.16	0.05	0.07	-0.30
Long-Term Corporate Bonds	-0.18	-0.10	-0.09	0.95	0.86	0.08	0.04	0.95	-	0.14	0.16	0.19	-0.19
Gold	-0.01	0.17	0.18	0.14	0.27	0.34	-0.04	0.16	0.14	-	0.25	0.29	-0.03

2006-2010:

### Monthly Correlations

Name	US Stock Market	Intl Developed ex-US Market	Emerging Markets	Long Term Treasury	TIPS	REIT	Cash	Total US Bond Market	Long-Term Corporate Bonds	Gold	PF #1	PF #2	Vanguard 500 Index Investor
US Stock Market	-	0.92	0.86	-0.18	0.25	0.81	-0.01	0.10	0.26	0.06	0.94	0.93	1.00
Intl Developed ex-US Market	0.92	-	0.92	-0.08	0.31	0.75	0.04	0.21	0.39	0.18	0.93	0.94	0.92
Emerging Markets	0.86	0.92	-	-0.11	0.34	0.64	0.01	0.18	0.33	0.28	0.85	0.88	0.85
Long Term Treasury	-0.18	-0.08	-0.11	-	0.53	-0.07	-0.01	0.83	0.73	0.25	0.05	0.11	-0.16
TIPS	0.25	0.31	0.34	0.53	-	0.24	-0.03	0.75	0.61	0.46	0.41	0.44	0.25
REIT	0.81	0.75	0.64	-0.07	0.24	-	-0.03	0.17	0.32	0.04	0.90	0.84	0.80
Cash	-0.01	0.04	0.01	-0.01	-0.03	-0.03	-	-0.07	-0.13	-0.05	-0.01	-0.01	0.01
Total US Bond Market	0.10	0.21	0.18	0.83	0.75	0.17	-0.07	-	0.86	0.40	0.32	0.38	0.12
Long-Term Corporate Bonds	0.26	0.39	0.33	0.73	0.61	0.32	-0.13	0.86	-	0.32	0.47	0.53	0.26
Gold	0.06	0.18	0.28	0.25	0.46	0.04	-0.05	0.40	0.32	-	0.18	0.27	0.06

2011-2017:

Monthly Correlations

Name	US Stock Market	Intl Developed ex-US Market	Emerging Markets	Long Term Treasury	TIPS	REIT	Cash	Total US Bond Market	Long-Term Corporate Bonds	Gold	PF #1	PF #2	Vanguard 500 Index Investor
US Stock Market	-	0.84	0.71	-0.47	0.00	0.60	0.02	-0.17	-0.06	0.07	0.83	0.81	1.00
Intl Developed ex-US Market	0.84	-	0.81	-0.41	0.15	0.55	0.10	-0.04	0.02	0.17	0.82	0.83	0.84
Emerging Markets	0.71	0.81	-	-0.28	0.32	0.53	0.18	0.11	0.12	0.33	0.77	0.79	0.71
Long Term Treasury	-0.47	-0.41	-0.28	-	0.62	0.14	-0.00	0.86	0.81	0.24	0.00	0.03	-0.46
TIPS	0.00	0.15	0.32	0.62	-	0.43	0.01	0.82	0.75	0.53	0.45	0.48	-0.00
REIT	0.60	0.55	0.53	0.14	0.43	-	-0.04	0.42	0.48	0.21	0.88	0.82	0.60
Cash	0.02	0.10	0.18	-0.00	0.01	-0.04	-	0.03	0.04	0.11	0.04	0.07	0.01
Total US Bond Market	-0.17	-0.04	0.11	0.86	0.82	0.42	0.03	-	0.91	0.42	0.35	0.38	-0.16
Long-Term Corporate Bonds	-0.06	0.02	0.12	0.81	0.75	0.48	0.04	0.91	-	0.30	0.41	0.43	-0.05
Gold	0.07	0.17	0.33	0.24	0.53	0.21	0.11	0.42	0.30	-	0.28	0.39	0.06

## Appendix E: Portfolio Assets (Core Six Asset Classes and Additional Four Asset Classes)

2001-2017:

### Portfolio Assets

Name	CAGR	Stdev	Best Year	Worst Year	Max. Drawdown	Sharpe Ratio	Sortino Ratio	US Mkt Correlation
US Stock Market	6.52%	14.84%	33.35%	-37.04%	-50.89%	0.41	0.58	1.00
Intl Developed ex-US Market	4.57%	17.15%	38.67%	-41.27%	-57.06%	0.27	0.38	0.88
Emerging Markets	9.35%	22.35%	75.98%	-52.81%	-62.70%	0.46	0.67	0.81
Long Term Treasury	6.49%	10.91%	29.27%	-13.03%	-16.68%	0.51	0.84	-0.32
TIPS	5.10%	6.07%	16.61%	-8.92%	-12.50%	0.63	0.95	0.02
REIT	10.48%	21.61%	35.66%	-37.05%	-68.28%	0.51	0.73	0.66
Cash	1.34%	0.49%	4.81%	0.00%	0.00%	N/A	N/A	-0.09
Total US Bond Market	4.55%	3.47%	8.43%	-2.26%	-3.99%	0.92	1.52	-0.11
Long-Term Corporate Bonds	7.39%	9.27%	18.17%	-5.87%	-16.82%	0.67	1.08	0.05
Gold	9.34%	17.38%	30.45%	-28.33%	-42.91%	0.53	0.85	0.03

2001-2005:

### Portfolio Assets

Name	CAGR	Stdev	Best Year	Worst Year	Max. Drawdown	Sharpe Ratio	Sortino Ratio	US Mkt Correlation
US Stock Market	1.97%	15.17%	31.35%	-20.96%	-37.14%	0.06	0.09	1.00
Intl Developed ex-US Market	4.53%	15.59%	38.67%	-21.94%	-39.56%	0.23	0.31	0.87
Emerging Markets	18.74%	21.34%	57.65%	-7.43%	-30.79%	0.82	1.25	0.86
Long Term Treasury	7.37%	9.52%	16.67%	2.68%	-9.93%	0.57	0.84	-0.37
TIPS	8.53%	6.16%	16.61%	2.59%	-5.32%	1.02	1.65	-0.28
REIT	18.27%	13.98%	35.66%	3.75%	-14.56%	1.12	1.70	0.40
Cash	2.12%	0.36%	3.82%	1.02%	0.00%	N/A	N/A	-0.15
Total US Bond Market	5.43%	3.94%	8.43%	2.40%	-3.47%	0.84	1.26	-0.30
Long-Term Corporate Bonds	8.59%	8.88%	13.22%	5.13%	-9.74%	0.74	1.09	-0.18
Gold	13.60%	13.55%	23.96%	1.41%	-9.45%	0.86	1.50	-0.01

2006-2010:

### Portfolio Assets

Name	CAGR	Stdev	Best Year	Worst Year	Max. Drawdown	Sharpe Ratio	Sortino Ratio	US Mkt Correlation
US Stock Market	2.94%	18.41%	28.70%	-37.04%	-50.89%	0.13	0.17	1.00
Intl Developed ex-US Market	2.76%	22.26%	28.27%	-41.27%	-57.06%	0.14	0.19	0.92
Emerging Markets	12.15%	28.60%	75.98%	-52.81%	-62.70%	0.47	0.69	0.86
Long Term Treasury	5.46%	11.48%	22.51%	-12.06%	-12.06%	0.33	0.55	-0.18
TIPS	5.07%	7.48%	11.59%	-2.85%	-12.50%	0.40	0.58	0.25
REIT	3.38%	32.80%	35.07%	-37.05%	-68.28%	0.20	0.28	0.81
Cash	2.23%	0.61%	4.81%	0.09%	0.00%	N/A	N/A	-0.01
Total US Bond Market	5.72%	3.70%	6.92%	4.27%	-3.99%	0.90	1.68	0.10
Long-Term Corporate Bonds	5.62%	11.25%	10.71%	2.29%	-16.82%	0.34	0.57	0.26
Gold	21.88%	19.29%	30.45%	4.92%	-25.83%	1.01	1.76	0.06

2011-2017:

Portfolio Assets

Name	CAGR	Stddev	Best Year	Worst Year	Max. Drawdown	Sharpe Ratio	Sortino Ratio	US Mkt Correlation
US Stock Market	12.85%	11.25%	33.35%	0.29%	-17.74%	1.12	1.98	1.00
Intl Developed ex-US Market	5.96%	13.79%	22.06%	-12.51%	-23.31%	0.48	0.72	0.84
Emerging Markets	0.98%	17.25%	23.46%	-18.78%	-31.38%	0.14	0.20	0.71
Long Term Treasury	6.60%	11.55%	29.27%	-13.03%	-16.68%	0.60	1.07	-0.47
TIPS	2.64%	4.66%	13.23%	-8.92%	-9.43%	0.56	0.85	0.00
REIT	10.35%	15.06%	30.13%	2.22%	-17.45%	0.72	1.22	0.60
Cash	0.12%	0.07%	0.51%	0.00%	0.00%	N/A	N/A	0.02
Total US Bond Market	3.06%	2.88%	7.56%	-2.26%	-3.76%	1.02	1.73	-0.17
Long-Term Corporate Bonds	7.82%	7.95%	18.17%	-5.87%	-10.14%	0.97	1.65	-0.06
Gold	-1.93%	18.09%	10.92%	-28.33%	-42.91%	-0.03	-0.04	0.07

## Appendix F: Safe Government Bonds

Country	GDP in \$MM (2016)	Gross Government Debt as % of GDP	Economic Complexity	10 Year Yield (%)
United States	18624450	107%	1.55	2.4
China	11232108	66%	0.89	3.92
Japan	4936543	238%	2.47	0.04
Germany	3479232	82%	1.89	0.3
United Kingdom	2629188	84%	1.54	1.23
France	2466472	90%	1.15	0.61
India	2263792	41%	0.05	7.09
Italy	1850735	126%	0.95	1.72
Brazil	1798622	71%	-0.1	10.35
Canada	1529760	87%	0.342	1.91
South Korea	1411042	34%	1.98	2.49
Russia	1283162	11%	0.142	7.6
Australia	1261645	34%	-0.47	2.54

## Works Cited

About.vanguard.com. (2017). *About Vanguard*. [online] Available at:

<http://about.vanguard.com/>[Accessed 7 Dec. 2017].

Chordia, Tarun et al. *Assymetric Correlations*. Goizueta Business Schoo, January 2011.

Swenson, David. *Unconventional Success*. Free Press, Simon and Schuster Incorporated, 2005.