5-2013

Comparing Portfolio Diversification Strategies in Different Market Environments

Kyle Tobias Koerten
kkoerten@utk.edu

Comparing Portfolio Diversification Strategies in Different Market Environments

Kyle T. Koerten
Chancellor's Honors Program
Senior Thesis

Table of Contents

Introduction……... 3

The Portfolios…… 3

Time Horizons…….. 11

Results…….....…. 15

Overview of Results……. 29

Conclusion…… 32

References……..... 34

Introduction

Investors are always looking for ways to get more returns on their investments with less risk. Most investors don't have the risk tolerance to invest solely in equites, and they want more return than just investing in bonds. As a result, there are a plethora of strategies that investors can choose from to try to accomplish this goal of high returns with less risk. This paper will look at some of the most popular diversification strategies and examine how these performed over the various market cycles of the last 15 years. The portfolio strategies that will be looked at include variations of: 60/40 portfolio, portfolio of non-correlated assets, global diversification, and the risk parity strategy.

The Portfolios

Individuals, professional advisors, and mutual fund managers use these portfolios extensively. While the strategies all contain similar components, each one is different, and there are strong opinions in the financial world about which one works the best. It should be noted that for the purpose of this evaluation, broad indices were used as the portfolio components. While many of these strategies usually involve picking individual bonds, stocks, or commodities it is impractical to do this looking back because we already know what happened. Rather, the following broad indices are used to reveal how the broad market performed during this time period. Below are a list and description of the indices use to test the portfolios:

1. S&P 500 Total Return
    - The total return index that includes 500 leading companies in leading industries in the U.S. economy. It is widely regarded as the best single gauge of the large cap U.S. equities market.

2. FTSE 100 Total Return
    - The total return index that represents the performance of the 100 largest blue chip companies listed on the London Stock Exchange.
3. MSCI Emerging Markets
    - This total return index covers over 2,700 securities in 21 markets currently classified as emerging market countries.
4. Barclays US Aggregate Bond Index
    - This total return index covers the USD- denominated, investment-grade, fixed-rate, and taxable areas of the bond market. It is considered the broadest measure of the U.S. bond markets.
5. Bank of America Merrill Lynch 20+ Treasury Index
    - This total return index covers treasury securities with maturities greater than 20 years.
6. DJUBS Commodity TR
    - This total return index is a broadly diversified index that tracks the performance of the commodity market.
7. DJUBS Oil
    - The total return index that covers the performance of the oil market as a whole.
8. DJUBS Gold
    - Total return index that tracks the performance of gold.
9. DJUBS Agriculture

- Total return index that covers the performance of the broad agriculture market.

These indices were used to recreate the following portfolios:

60/40 Portfolio

This strategy is probably the most well known diversification strategy and is used by investors worldwide. There are many variations to this strategy, but the basic premise is to hold 60% equity and 40% bonds. This portfolio has been extremely popular due to its simplicity. Investors can select whatever stocks they wish combined with whichever bonds they want to select. It provides an average investor with a form of discipline needed to protect his or her investment ("Striking a Balance").

The theory behind this portfolio is that combining risky equities with less volatile bonds will lower the risk of the portfolio. Bonds are an extremely important part of the portfolio because even when the stock markets are performing poorly, bonds will still provide constant returns. In addition, if the bonds happen to be treasuries, the price of treasuries usually has a negative correlation to the equity markets. This means that portfolio can avoid some losses during bad times in the equity markets. A typical 60/40 portfolio in the United States will be made up of 60% U.S. equity and 40% varied bonds. These bonds will include both treasuries and corporate bonds.

<u>Composition</u>

There are three separate variations of the 60/40 portfolio that will be tested:

1. 60% S&P 500 Total Return 40% Barclays US AGG

- This portfolio is the most common variation. Most investors will construct a portfolio of bonds comprised of varying types of bonds. The Barclays US. Aggregate tracks the performance of the broad bond market.

2. 60% S&P 500 Total Return 40% BofA Merrill 20+ Treasury
    - This portfolio would most likely be used by a more risk adverse investor. The entire bond allocation is made up of treasuries with a maturity greater than 20 years.
3. 60% S&P 500 Total Return 20% BofA Merrill 20+ Treasury 20% Barclays US AGG
    - This portfolio is a combination of the first two. Half of the bond portfolio consists of the broad bond market, and the other half is made up of long term treasuries.

Criticisms

Although this strategy is one of the most popular, it does not come without its criticisms. The biggest is that the portfolio performs almost identically to that of the S&P 500. Over the fifteen-year period from 1998 to 2012, the correlation of the 60/40 S&P 500 Barclays US aggregate portfolio with the S&P 500 is .99 on a monthly basis. In addition, the risk of the S&P 500 makes up 98% of a typical 60/40 portfolio ("Salient Risk Parity Fund"). These factors cause critics to believe that a 60/40 portfolio is not true diversification, and it gives investors a false sense of security.

Asset Allocation (Non-Correlated Assets)

This diversification strategy is built on the premise of correlation. The portfolio is built by combining assets that are non-correlated to each other. Typically, this is

accomplished by combing stocks, bonds, currencies, commodities, real estate investment trusts (REITs), or other alternative investments (Eychenne, Karl). Since the value of these securities all depend on factors that may be unrelated to each other, returns of the portfolio as a whole will be much less volatile. This occurs because on days where stocks perform poorly, bonds and commodities may perform differently. However, the opposite is also true. When one asset performs well, there is a chance that the other assets in the portfolio will perform poorly and cancel out the good returns. However, over time, proponents of this strategy claim that the portfolio will have better returns with much less risk than a portfolio consisting entirely of equities (Eychenne, Karl).

The way this portfolio could have better returns is that it is expected to have much better performance during periods where the stock market performs poorly. This will occur because assets like gold and treasuries are likely to have a negative correlation to the stock market. As a result, performance during bull markets may not be very strong, but it will be made up for by the above average performance during market downturns.

Composition

1. 33% S&P 500 Total Return 33% BofA Merrill 20+ Treasury 33% DJUBS commodity TR
    - This is an example of a base allocation for a non-correlated portfolio. The portfolio is equal weighted between U.S. stocks, long-term treasuries, and commodities.
2. 16.65% S&P 500 Total Return 16.65% FTSE 100 16.65% Barclays US AGG 16.65% BofA Merrill 20+ Treasury 11.1% Gold 11.1% Oil 11.1% Agriculture

- This portfolio is a more specific non-correlated portfolio that seeks non-correlation in each of the three main holding areas. Equities are made up of U.S. Stocks and European Stocks. Bonds are made up of U.S. Treasuries and the broad bond market. Commodities are made up of gold, oil, and agriculture.

Criticisms

There are many critics who don't think this is a viable strategy. One reason is that although this type of portfolio clearly reduces risk, it gives up too much return potential. The only way for this portfolio to perform well is for there to but significant downturns in the equity market. These critics would argue that in a long sustained bull market, this portfolio would perform very poorly.

Another criticism questions the underlying theory of this portfolio. These critics would argue that in theory this works well, but it is extremely difficult to find non-correlated assets in the real world (Philips, Christopher). Correlation between assets is constantly changing, and the only data investors have to use is historical data. This presents a problem because investors need to set up their portfolio in regards to future correlation. Furthermore, there is some evidence that during severe financial crashes, correlation of asset classes approach one (Philips, Christopher). If this is true, then the times where non-correlation is most needed is the exact time when it stops working. The validity of this statement is not universally accepted, but there is definitely evidence that the correlation of asset classes does seem to change during times of crisis.

Global Diversification

This strategy is the most basic of the diversification strategies. It is inherently a more risky strategy because all of the investments are in equities. The strategy is based on the idea that markets in different countries respond to different stimuli. As a result, holding equities from different countries will result in a portfolio with less risk than a portfolio consisting of all equities from a single country (Fisher, Gregg).

Composition

1. 50% S&P 500 Total Return 50% FTSE 100 Total Return
    - This portfolio consists of half U.S. stocks and half European stocks.
2. 33% S&P 500 Total Return 33% FTSE 100 Total Return 33% MSCI Emerging Markets
    - This portfolio consists of equities equal weighted between the United States, Europe, and emerging markets.

Criticisms

The main criticisms for this strategy focus on the fact that this type of strategy may be too risky for the average investor ("Striking a Balance"). These critics would suggest that a portfolio consisting of just equities does not adequately protect the investor from market downturns even if the investor is invested in different countries ("The Case for Dynamic Asset Allocation"). This argument would be even stronger in recent times, since markets have begun to be much more interconnected in recent years. We see that a significant downturn in the U.S., like the one that occurred in 2008 affects every market worldwide, not just the United States.

Risk Parity Strategy

This strategy is the most complex of the diversification strategies and has many different variations. The basic premise of this strategy is to allocate assets based on risk. For example, rather than committing 60% of the dollar value of a portfolio to equities, a risk parity strategy may commit to 25% of the risk of the portfolio to equities. By doing this, the portfolio managers are able to create a portfolio with a much lower risk profile than a typical equity portfolio ("Risk Parity").

This type of portfolio is extremely hard to replicate on a historical basis due to complexity of most of these portfolios. A typical portfolio manager will target a specific amount of risk and hold the required amount of each security to equal that amount of risk. Furthermore, leverage is typically used to increase the risk of the fixed income portion of this portfolio (Partridge, Lee).

Composition

- Since the volatility of the components are already known for the time period we will be testing, we cannot predict volatility like a typical investor with a risk parity portfolio would do. Rather, this portfolio will be a very low risk portfolio with an equal risk weighting of the S&P 500, Barclays U.S. Aggregate, Bank of America 20+ Year Treasury, and the DJUBS Commodity index. The weight of the portfolio will be based on the trailing one-year standard deviation and will be rebalanced quarterly.
- 25% S&P 500 Total Return 25% Barclays US AGG 25% BofA Merrill 20+ Treasury 25% DJUBS commodity TR

Criticisms

The main criticism of the risk parity strategy is that it typically uses leverage to increase the returns of the portfolio. If borrowing becomes more expensive, the performance of a portfolio that uses leverage will be hurt. Second a levered portfolio has much more left tail risk than a normal portfolio. Thirdly, this portfolio is very complicated to implement, and average investors would not be able to do this without professional help. Lastly, this portfolio (specifically the one tested in this paper) has an extremely large exposure to fixed income securities due to the low risk of these types of securities. A large increase in interest rates could significantly hurt this portfolio. This is extremely relevant in present times since interest rates are at historic lows, and many investors believe rates will increase in the near term future. ("Risk Parity") (Inker, Ben)

Time Horizons

To examine the performance of these portfolios, a time period of January 1, 1998 through December 31, 2012 has been selected. This time period has had a variety of different market cycles. The big events were the "Dot Com Bubble" in 2000 and the Housing Market Collapse in 2008. Throughout this fifteen-year period there are 3 bull markets, 2 bear markets, and several other significant events.

Another reason this period was selected was because of the availability of market indices. Prior to 1998, there are not many commodity or fixed income indices that could be used to recreate these portfolios. It is important to note that the performance during this period does not indicate future performance; rather, there are things that can be learned about these portfolios by examining their performance during different market

cycles throughout this fifteen-year period. Below are the time periods that will be examined.

Note: Statistics are calculated on a monthly basis, so every period must start on the first day of a month and end on the last day of a month. For example, if a bull market began on October 9, for the sake of this experiment we will begin on October 1 for the month to be included.

15-year Period

The first period that will be examined is the entire 15-year period. This period is highly representative of the risk involved with investing in the stock market. There were two significant market crashes and three bull markets. While a period exactly like this 15-year period will never occur again, this period represents the historical volatility of the stock market. Looking at a fifteen-year period will give insight into which portfolios perform best during a long holding period.

Peak to Peak

The worst fear of an investor is investing at the top. This scenario will examine how a portfolio performs when it decreases significantly in value at first, and then the rest of the time is used trying to gain back the initial losses.

- March 24, 2000 – Oct 10, 2007
- Oct 10, 2007 – Dec, 31 2012

Valley to Valley

This scenario will examine a portfolio that is created at the low point of the market and held through the peak all the way until the following valley. This will give insight on how the portfolio performs when there are substantial gains in the stock market followed by substantial losses.

- January 1, 1998 – Oct 9, 2002

- Oct. 9, 2002 – March 9, 2009

Bull Market

This scenario assumes that an investor times the market perfectly and invests at the low point and exits the market at the subsequent peak. While it is highly unlikely that an investor would time the market perfectly, this will give insight into how these different portfolios generate gains during bull markets.

- January 1, 1998 – March 24, 2000
- Oct. 9 2002 – Oct 10 2007
- March 9 2009 – Dec 31 2012

Bear Market

This scenario assumes that an investor invests in the stock market at the worst possible time. The investor invests at the peak of the S&P 500 and exits at the subsequent valley. This scenario will give insight into the ability of a portfolio to limit losses during downturns in the stock market.

- March 24 2000 – Oct. 9 2002
- Oct 10 2007 – March 9 2009

3-year periods

This scenario is a more realistic view of the performance of a portfolio for a typical investor. This scenario will look at every three-year period starting in January during this fifteen-year time horizon. Tests were done to see if there was a bias for always starting in January, but none were found. There are 13 periods. This is important for investors because investors can't predict when a bear market or bull market will

occur. Rather they need a portfolio that will perform well whenever they have the money to invest.

5-year periods

This scenario provides the same information as the above scenario except with longer time horizon. There are 11 time periods in this scenario.

Results

The following tables show the average ranking for each of the portfolios during the time periods that were tested. Following these tables is an individual look at each time period.

Note: The risk free rate used in the Sharpe Ratio calculation is the Citigroup 3 month Treasury Bill Index.

Annualized Return Rankings

	5 year	3 year	Bear	Bull	Peak to Peak	Valley to Valley
60_20_20_SP500_AGG_LTT	5.00	4.85	5.00	5.00	5.50	5.50
60_40_SP500_LTT	3.82	3.85	4.00	3.67	3.50	4.00
60_40_SP500_USAGG	6.18	6.00	6.00	5.33	7.00	6.50
CORRELATION_1	3.18	3.46	2.50	5.67	4.00	3.00
CORRELATION_2	2.18	3.08	2.50	5.33	2.50	2.50
GLOBAL_1	6.09	5.62	7.50	2.00	6.50	8.00
GLOBAL_2	6.09	4.62	7.50	1.00	4.00	4.50
Risk Parity	2.45	4.46	1.00	8.00	3.00	2.00

Sharpe Ratio Ranking

	5 year	3 year	Bear	Bull	Peak to Peak	Valley to Valley
60_20_20_SP500_AGG_LTT	5.09	4.69	5.00	3.33	4.50	5.50
60_40_SP500_LTT	4.18	4.15	4.00	3.33	3.50	3.50
60_40_SP500_USAGG	6.36	5.92	6.00	4.67	6.50	6.50
CORRELATION_1	3.64	3.54	2.50	4.67	4.00	2.50
CORRELATION_2	2.18	3.08	2.50	5.00	3.00	3.00
GLOBAL_1	7.27	6.77	8.00	5.33	8.00	8.00
GLOBAL_2	5.55	5.08	7.00	4.00	5.50	6.00
Risk Parity	1.73	2.77	1.00	5.67	1.00	1.00

Peak to Peak

Annualized Return		
Description	March 2000 - Oct 2007	Oct 2007 - Dec 2012
60_20_20_SP500_AGG_LTT	5.33%	5.12%
60_40_SP500_LTT	5.69%	6.45%
60_40_SP500_USAGG	4.94%	3.66%
CORRELATION_1	8.34%	4.33%
CORRELATION_2	9.25%	5.26%
GLOBAL_1	5.75%	-0.57%
GLOBAL_2	10.56%	-0.55%
S&P 500 - Total Return	3.34%	0.93%
Risk Parity	7.97%	6.26%

Annualized Standard Deviation		
Description	March 2000 - Oct 2007	Oct 2007 - Dec 2012
60_20_20_SP500_AGG_LTT	7.91%	10.75%
60_40_SP500_LTT	8.08%	11.06%
60_40_SP500_USAGG	7.97%	11.26%
CORRELATION_1	7.10%	11.32%
CORRELATION_2	6.63%	12.12%
GLOBAL_1	12.88%	19.94%
GLOBAL_2	14.65%	22.37%
S&P 500 - Total Return	13.76%	18.54%
Risk Parity	4.26%	5.68%

Sharpe Ratio		
Description	March 2000 - Oct 2007	Oct 2007 - Dec 2012
60_20_20_SP500_AGG_LTT	0.26	0.42
60_40_SP500_LTT	0.30	0.53
60_40_SP500_USAGG	0.21	0.27
CORRELATION_1	0.72	0.33
CORRELATION_2	0.91	0.38
GLOBAL_1	0.19	-0.06
GLOBAL_2	0.50	-0.05
S&P 500 - Total Return	0.01	0.02
Risk Parity	1.12	0.99

Discussion of results:

Based on returns, the "Correlation_2" portfolio performed the best, but the "Risk Parity" portfolio had the best Sharpe ratio over these two time horizons. Both of these time periods began with extreme downturns in the market. The first period began with the "Dot Com Bubble" burst and the second period began with the burst of the housing bubble. Both of these crashes were followed by bull markets.

It is interesting to note that even though the average winner was the "Correlation_2" portfolio, the best performer in terms of return from March 2000 – October 2007 was the "Global_2" portfolio. Even though significant losses were incurred during the market decline, the high returns during the subsequent bull market far outpaced the diversified portfolios. This is mostly due to the strong performance of emerging markets during this time period. This point shows that even though the "Correlation_2" portfolio was the average winner, there will still be times when portfolios perform differently than expected.

Valley to Valley

Annualized Return		
Description	Jan 1998 - Oct 2002	Oct 2002 - March 2009
60_20_20_SP500_AGG_LTT	3.63%	3.91%
60_40_SP500_LTT	3.93%	4.65%
60_40_SP500_USAGG	3.31%	3.11%
CORRELATION_1	4.63%	5.24%
CORRELATION_2	3.93%	6.60%
GLOBAL_1	-1.85%	2.42%
GLOBAL_2	-0.45%	6.06%
S&P 500 - Total Return	-0.54%	1.64%
Risk Parity	6.17%	5.79%

Annualized Standard Deviation		
Description	Jan 1998 - Oct 2002	Oct 2002 - March 2009
60_20_20_SP500_AGG_LTT	10.55%	9.43%
60_40_SP500_LTT	10.39%	10.25%
60_40_SP500_USAGG	10.84%	9.04%
CORRELATION_1	8.22%	10.10%
CORRELATION_2	7.45%	9.69%
GLOBAL_1	16.22%	14.96%
GLOBAL_2	17.28%	17.41%
S&P 500 - Total Return	18.69%	14.64%
Risk Parity	4.23%	5.85%

Sharpe Ratio		
Description	Jan 1998 - Oct 2002	Oct 2002 - March 2009
60_20_20_SP500_AGG_LTT	-0.07	0.14
60_40_SP500_LTT	-0.04	0.20
60_40_SP500_USAGG	-0.10	0.06
CORRELATION_1	0.03	0.26
CORRELATION_2	-0.06	0.41
GLOBAL_1	-0.39	-0.01
GLOBAL_2	-0.28	0.20
S&P 500 - Total Return	-0.26	-0.07
Risk Parity	0.42	0.54

Discussion of results:

The best performer during this period in terms of Sharpe ratio and return was the Risk Parity portfolio. The correlation portfolios were the second best, followed by the 60/40 portfolios. The “Global_2” portfolio beat out the “60_20_20” and the “60_40_SP500_USAGG” in terms of return, but not Sharpe ratio. This shows that once again, the Risk Parity portfolios and correlation portfolios provide superior diversification to protect against downside loss during these time periods.

Bull Market

Annualized Return			
Description	Jan 1998 - Mar 2000	Oct 2002 - Oct 2007	Mar 2009 - Dec 2012
60_20_20_SP500_AGG_LTT	16.12%	11.22%	16.91%
60_40_SP500_LTT	16.42%	11.39%	17.90%
60_40_SP500_USAGG	15.81%	11.03%	15.78%
CORRELATION_1	9.89%	12.01%	13.89%
CORRELATION_2	8.66%	13.97%	14.41%
GLOBAL_1	17.82%	19.16%	20.87%
GLOBAL_2	17.82%	25.62%	22.29%
S&P 500 - Total Return	22.96%	15.54%	21.45%
Risk parity	4.91%	7.73%	9.54%

Annualized Standard Deviation			
Description	Jan 1998 - Mar 2000	Oct 2002 - Oct 2007	Mar 2009 - Dec 2012
60_20_20_SP500_AGG_LTT	10.58%	5.90%	7.47%
60_40_SP500_LTT	10.56%	6.31%	6.76%
60_40_SP500_USAGG	10.68%	5.77%	8.97%
CORRELATION_1	8.62%	6.33%	7.75%
CORRELATION_2	7.78%	6.03%	9.51%
GLOBAL_1	15.11%	9.55%	17.07%
GLOBAL_2	15.11%	11.01%	18.84%
S&P 500 - Total Return	17.74%	9.54%	15.37%
Risk Parity	4.55%	4.33%	3.50%

Sharpe Ratio			
Description	Jan 1998 - Mar 2000	Oct 2002 - Oct 2007	Mar 2009 - Dec 2012
60_20_20_SP500_AGG_LTT	1.06	1.42	2.25
60_40_SP500_LTT	1.09	1.35	2.63
60_40_SP500_USAGG	1.02	1.42	1.75
CORRELATION_1	0.57	1.45	1.78
CORRELATION_2	0.47	1.84	1.50
GLOBAL_1	0.85	1.71	1.22
GLOBAL_2	0.85	2.07	1.18
S&P 500 - Total Return	1.01	1.33	1.39
Risk parity	-0.01	1.12	2.69

Discussion of results:

As expected, the all equity portfolios provided the strongest returns during bull markets. The Global portfolios performed extremely well in terms of return, but the 60/40 portfolios had the best Sharpe ratios. The Correlation and Risk Parity portfolios performed poorly in terms of return, but were fairly competitive in terms of Sharpe ratio due to their low standard deviations. It is clear based on these findings that if an investor is confident that he or she will be investing in a bull market, an only equity or 60/40 strategy would provide the best returns.

Bear Market

Annualized Return		
Description	Mar 2000 - Oct 2002	Oct 2007 - Mar 2009
60_20_20_SP500_AGG_LTT	-3.64%	-16.84%
60_40_SP500_LTT	-3.19%	-14.61%
60_40_SP500_USAGG	-4.12%	-19.19%
CORRELATION_1	1.95%	-13.82%
CORRELATION_2	0.93%	-13.06%
GLOBAL_1	-13.32%	-37.18%
GLOBAL_2	-11.05%	-37.98%
S&P 500 - Total Return	-13.86%	-33.53%
Risk Parity	8.17%	0.12%

Annualized Standard Deviation		
Description	Mar 2000 - Oct 2002	Oct 2007 - Mar 2009
60_20_20_SP500_AGG_LTT	10.43%	14.74%
60_40_SP500_LTT	10.26%	16.72%
60_40_SP500_USAGG	10.77%	13.44%
CORRELATION_1	8.00%	16.38%
CORRELATION_2	7.01%	15.74%
GLOBAL_1	16.54%	20.63%
GLOBAL_2	18.53%	25.20%
S&P 500 - Total Return	18.82%	21.02%
Risk Parity	4.06%	9.07%

Sharpe Ratio		
Description	Mar 2000 - Oct 2002	Oct 2007 - Mar 2009
60_20_20_SP500_AGG_LTT	-0.73	-1.27
60_40_SP500_LTT	-0.70	-0.99
60_40_SP500_USAGG	-0.75	-1.57
CORRELATION_1	-0.25	-0.96
CORRELATION_2	-0.43	-0.95
GLOBAL_1	-1.04	-1.89
GLOBAL_2	-0.81	-1.58
S&P 500 - Total Return	-0.95	-1.69
Risk Parity	1.04	-0.20

Discussion of results:

Due to its extremely conservative allocation with a large portion invested in fixed income, the Risk Parity portfolio performed the best in terms of Sharpe ratio and return.

The correlation portfolios came in second, followed by the 60/40 portfolios, and finally the global portfolios. During the bear markets over this time horizon, it is clear the Risk Parity portfolio was the strongest performer. An investor with a main goal of protecting capital during market crashes should definitely consider a risk parity portfolio if future bear markets are similar to the ones examined in this experiment.

3-Year Intervals

Annualized Return													
Description	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
60_20_20_SP500_AGG_LTT	10.79%	2.05%	-3.91%	1.34%	5.91%	10.77%	8.32%	7.51%	-0.58%	-0.15%	1.80%	11.93%	11.80%
60_40_SP500_LTT	11.16%	1.73%	-3.13%	1.41%	6.62%	11.39%	8.86%	7.95%	1.37%	0.05%	2.07%	11.94%	14.03%
60_40_SP500_USAGG	10.40%	2.37%	-4.71%	1.25%	5.18%	10.14%	7.77%	7.05%	-2.57%	-0.47%	1.37%	11.74%	9.46%
CORRELATION_1	9.71%	4.92%	3.29%	4.52%	11.36%	13.35%	9.52%	9.77%	0.51%	0.58%	1.89%	9.87%	9.84%
CORRELATION_2	6.80%	3.35%	2.21%	6.48%	13.12%	13.25%	10.87%	12.47%	2.68%	3.27%	2.92%	11.88%	9.69%
GLOBAL_1	9.09%	-3.36%	-14.67%	-2.86%	7.04%	16.78%	14.65%	12.03%	-8.88%	-6.10%	-4.69%	14.59%	8.92%
GLOBAL_2	9.09%	-2.22%	-12.48%	1.26%	10.99%	22.78%	19.68%	19.47%	-8.12%	-3.08%	-3.64%	16.61%	7.86%
S&P 500 - Total Return	12.26%	-1.03%	-14.55%	-4.05%	3.59%	14.39%	10.44%	8.62%	-8.36%	-5.63%	-2.86%	14.11%	10.87%
Risk Parity	6.73%	5.96%	8.76%	7.48%	9.01%	7.76%	6.39%	6.89%	5.44%	5.27%	5.53%	7.82%	7.63%

Annualized Standard Deviation													
Description	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
60_20_20_SP500_AGG_LTT	10.43%	9.91%	10.26%	9.82%	8.29%	6.07%	4.63%	4.48%	9.40%	12.58%	13.36%	10.63%	6.72%
60_40_SP500_LTT	10.47%	10.02%	10.05%	9.73%	8.43%	6.80%	5.19%	4.69%	9.83%	13.48%	13.96%	11.02%	5.62%
60_40_SP500_USAGG	10.47%	9.92%	10.65%	10.19%	8.45%	5.64%	4.33%	4.56%	9.48%	12.32%	13.48%	11.16%	8.59%
CORRELATION_1	8.65%	8.58%	7.64%	7.94%	6.92%	7.02%	5.79%	5.53%	10.70%	13.11%	13.86%	10.53%	7.50%
CORRELATION_2	7.84%	7.77%	6.76%	7.12%	6.12%	6.17%	5.63%	5.91%	11.48%	13.38%	14.09%	11.09%	9.26%
GLOBAL_1	15.09%	14.64%	16.38%	16.67%	14.45%	9.74%	6.91%	7.77%	16.46%	20.54%	22.99%	19.68%	16.82%
GLOBAL_2	15.09%	16.48%	18.28%	18.44%	14.86%	10.93%	9.86%	10.64%	20.24%	23.98%	25.77%	21.11%	17.93%
S&P 500 - Total Return	17.42%	16.71%	18.55%	18.07%	14.86%	9.04%	6.82%	7.68%	15.08%	19.63%	21.85%	18.71%	15.09%
Risk Parity	4.66%	4.49%	3.94%	4.75%	4.79%	5.00%	3.74%	3.21%	5.75%	7.04%	7.09%	5.15%	2.98%

Sharpe Ratio													
Description	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
60_20_20_SP500_AGG_LTT	0.53	-0.29	-0.76	-0.10	0.55	1.48	1.15	0.75	-0.46	-0.19	0.08	1.11	1.74
60_40_SP500_LTT	0.56	-0.32	-0.70	-0.09	0.63	1.41	1.13	0.81	-0.24	-0.16	0.10	1.07	2.48
60_40_SP500_USAGG	0.49	-0.26	-0.81	-0.10	0.45	1.49	1.10	0.63	-0.67	-0.22	0.05	1.04	1.09
CORRELATION_1	0.52	-0.00	-0.08	0.28	1.45	1.65	1.13	1.01	-0.30	-0.12	0.09	0.93	1.30
CORRELATION_2	0.20	-0.20	-0.25	0.59	1.92	1.86	1.40	1.41	-0.09	0.08	0.16	1.06	1.04
GLOBAL_1	0.25	-0.57	-1.13	-0.31	0.39	1.54	1.69	1.01	-0.77	-0.40	-0.23	0.74	0.52
GLOBAL_2	0.25	-0.43	-0.90	-0.06	0.65	1.92	1.69	1.44	-0.59	-0.22	-0.17	0.78	0.43
S&P 500 - Total Return	0.40	-0.36	-0.99	-0.35	0.15	1.40	1.09	0.58	-0.80	-0.40	-0.16	0.75	0.71
Risk Parity	0.32	0.23	1.23	1.10	1.60	1.20	0.91	0.85	0.29	0.43	0.68	1.49	2.53

Discussion of results:

The interval time periods are arguably the most important to look at because investors usually can't decide to wait and invest at peaks or valleys; rather, they choose to

invest whenever they have additional capital set aside for investing. These three-year time periods are relatively short investment horizons, but there are definitely trends in performance. Over this time period, the correlation portfolios had the strongest performance in terms of return followed by the 60/40 long-term treasury, and the Risk Parity portfolio. In terms of Sharpe Ratio, the Risk Parity portfolio performed the best followed by the correlation portfolios and the 60/40 portfolios.

It was surprising to see the wide disparity between the "60_40_SP500_USAGG" and the "60_40_SP500_LTT." The former was the worst performing in terms of return and the second to the last in terms of Sharpe, while the latter was third in return and 4th in Sharpe.

5-Year Intervals

Annualized Return											
Description	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
60_20_20_SP500_AGG_LTT	3.68%	2.91%	2.77%	3.67%	6.66%	9.93%	2.49%	2.96%	4.49%	4.52%	5.41%
60_40_SP500_LTT	4.03%	2.94%	3.36%	4.16%	7.21%	10.30%	4.13%	3.20%	4.67%	5.88%	6.65%
60_40_SP500_USAGG	3.32%	2.87%	2.15%	3.17%	6.09%	9.54%	0.82%	2.63%	4.21%	3.03%	4.02%
CORRELATION_1	5.03%	7.70%	7.43%	7.11%	10.51%	11.42%	4.62%	3.97%	4.52%	4.82%	4.01%
CORRELATION_2	4.41%	7.35%	7.24%	8.15%	11.97%	13.58%	5.82%	6.02%	7.25%	6.39%	4.44%
GLOBAL_1	-1.76%	-0.78%	-1.46%	2.35%	9.94%	16.03%	-1.50%	1.64%	2.71%	-1.53%	-0.07%
GLOBAL_2	-0.25%	1.73%	1.43%	7.09%	14.84%	22.25%	1.02%	5.87%	5.70%	-0.54%	-0.43%
S&P 500 - Total Return	-0.59%	-0.57%	-2.30%	0.54%	6.19%	12.83%	-2.19%	0.42%	2.29%	-0.25%	1.66%
Risk Parity	6.51%	7.54%	8.72%	7.12%	7.79%	7.60%	5.90%	5.55%	6.26%	6.75%	5.99%

Annualized Standard Deviation											
Description	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
60_20_20_SP500_AGG_LTT	10.55%	9.73%	9.28%	8.24%	6.99%	5.48%	7.97%	10.18%	10.75%	10.99%	10.98%
60_40_SP500_LTT	10.37%	9.80%	9.39%	8.33%	7.20%	6.03%	8.39%	10.92%	11.22%	11.35%	11.30%
60_40_SP500_USAGG	10.87%	9.88%	9.38%	8.42%	7.07%	5.23%	7.97%	9.96%	10.86%	11.40%	11.49%
CORRELATION_1	8.11%	8.20%	7.70%	7.21%	6.52%	6.41%	9.17%	10.87%	11.27%	11.43%	11.55%
CORRELATION_2	7.36%	7.42%	6.85%	6.49%	6.02%	6.14%	9.57%	11.03%	11.65%	12.12%	12.29%
GLOBAL_1	16.17%	15.59%	15.24%	13.75%	12.00%	9.18%	13.74%	16.66%	18.70%	19.87%	20.24%
GLOBAL_2	17.24%	16.73%	16.63%	15.65%	13.24%	10.90%	17.12%	19.85%	21.30%	22.37%	22.61%
S&P 500 - Total Return	18.75%	17.01%	16.21%	14.82%	12.30%	8.54%	12.75%	15.91%	17.67%	18.73%	18.88%
Risk Parity	4.21%	4.74%	4.66%	4.44%	4.32%	4.32%	5.11%	5.87%	5.82%	5.81%	5.81%

Sharpe Ratio											
Description	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
60_20_20_SP500_AGG_LTT	-0.06	-0.06	-0.00	0.18	0.62	1.27	-0.08	0.01	0.20	0.29	0.45
60_40_SP500_LTT	-0.03	-0.06	0.06	0.23	0.68	1.22	0.12	0.03	0.21	0.40	0.55
60_40_SP500_USAGG	-0.09	-0.06	-0.07	0.11	0.53	1.26	-0.29	-0.02	0.18	0.15	0.31
CORRELATION_1	0.09	0.51	0.60	0.68	1.25	1.32	0.17	0.10	0.20	0.30	0.31
CORRELATION_2	0.02	0.52	0.65	0.91	1.60	1.73	0.28	0.28	0.42	0.41	0.32
GLOBAL_1	-0.37	-0.27	-0.28	0.01	0.63	1.43	-0.33	-0.07	0.02	-0.15	-0.03
GLOBAL_2	-0.26	-0.11	-0.08	0.31	0.94	1.77	-0.12	0.15	0.16	-0.09	-0.04
S&P 500 - Total Return	-0.26	-0.24	-0.31	-0.11	0.31	1.16	-0.41	-0.15	-0.00	-0.09	0.06
Risk Parity	0.52	0.85	1.27	1.10	1.26	1.08	0.55	0.46	0.68	0.93	0.96

Discussion of results:

The 5-year interval had similar results to the three-year, but the results are more apparent. The "Correlation_2" portfolio and "Risk Parity" performed significantly better

than the other portfolios. The former was first in return and second in Sharpe, while the latter was second in return and first in Sharpe. It is evident that the Correlation and Risk Parity portfolios performed much better than the other diversification strategies over these five-year periods.

Once again, it is evident that long-term treasuries performed much better than the Barclays U.S. Aggregate over this fifteen-year horizon. This may be due to the fact that treasuries tend to perform better during economic downturns, or it could be a phenomena that occurred during this 15-year period and may not occur during other market cycles.

15-Year Period

Description	Annualized Return	Annualized Standard Deviation	Sharpe Ratio
60_20_20_SP500_AGG_LTT	6.31%	9.37%	0.40
60_40_SP500_LTT	6.96%	9.54%	0.46
60_40_SP500_USAGG	5.59%	9.64%	0.31
CORRELATION_1	6.77%	8.99%	0.47
CORRELATION_2	7.39%	9.07%	0.53
GLOBAL_1	4.44%	15.99%	0.12
GLOBAL_2	6.68%	17.77%	0.23
S&P 500 - Total Return	4.47%	16.20%	0.12
Risk Parity	6.70%	4.84%	0.86

Discussion of results:

It is important to remember that these returns occurred over one random 15-year period in the long history of investments, so investment decisions should not be made solely by looking at this one set of returns. Running the same simulation 5 years earlier could provide different results that lead to an entirely different conclusion. With that being said, we can still examine how these portfolios performed over this time period.

The "Correlation_2" portfolio was the best performing portfolio in terms of return with an annualized return of 7.39%. This compared to a 4.47% return by the S&P 500. The "60_40_SP500_LTT" had the second best returns followed by "Correlation_1," "Risk Parity," and "Global_2."

In terms of Sharpe Ratio, the Risk Parity portfolio significantly outperformed its peers with a Sharpe ratio of .86. This compares to a .12 Sharpe ratio for the S&P 500. The second best performer was the "Correlation_2" portfolio followed by "Correlation_1" and "60_40_SP500_LTT."

Overview of results

It is important to remember that these past results are not indicative of future results. There will never be a 15-year period exactly like the 15-year period from January 1998 – December 2012; however, since the inception of the stock market, there have been many bull markets, bear markets, neutral markets, and everything between. As a result, we can examine how these portfolios during the various market cycles within this fifteen-year time period and use this knowledge to make informed decisions in the future.

1. Diversification Works

   Over this time period, it is clear that a diversified portfolio performed better than a portfolio consisting solely of stocks. The 60/40, Correlation, and Risk Parity portfolios all performed better than the S&P 500 in terms of return and Sharpe Ratio over this fifteen-year period. In addition the S&P 500 was outperformed by the "Correlation_2" portfolio over every 5-year period tested. The market only outperformed the "Risk Parity" portfolio on one occasion and the 60/40 portfolios on 2 occasions. This clearly shows that diversified portfolios performed better over 5-year investment horizons during this time period.

2. Global Diversification isn't a sound diversification strategy

   Over this time period, global diversification was outperformed by the other diversification strategies in nearly every scenario. The only scenarios where a Global Diversification performed the best was during bull markets; therefore during this time period, an investor who was confident a bull market was going to occur could have considered investing in a Global Diversification portfolio.

However, if the investor was wrong, this portfolio does not provide adequate protection for downside risk.

3. Risk Parity Portfolios

   The "Risk Parity" portfolio produced the best Sharpe Ratios of any portfolio in every time period except the bull market scenario where it performed the worst. The reason for this is the extremely conservative allocation of this particular Risk Parity portfolio. The annualized standard deviation for the portfolio over the fifteen-year period was only 4.84%. The next lowest was "Correlation_1" with a standard deviation of 8.99%, and the S&P 500 had a standard deviation of 16.2%. This extremely low standard deviation helped boost the Sharpe Ratio, but this portfolio also produced very strong returns over this time period as well. While it is very difficult to replicate the way a Risk Parity portfolio is actually managed due to the frequent use of leverage and active management, it is clear that this particular Risk Parity strategy was extremely effective over this fifteen-year period and it appears that this type of strategy will likely perform well during future turbulent market cycles.

4. 60/40 Portfolios

   The 60/40 critics (the same people who are typically proponents of non-correlated portfolios) seem to over exaggerate the problems with the 60/40 portfolio. While the correlation portfolios did tend to perform better (except for during bull markets), the differences were not very large. All three 60/40 portfolios had significantly lower standard deviation than the S&P 500 and much better Sharpe Ratios. The best performing 60/40 portfolio over the entire period was the

portfolio comprised of 60% S&P 500 and 40% 20+ Year U.S. Treasuries. Overall, the 60/40 portfolio showed that it does do an adequate job diversifying, but it did not perform as strongly as the Risk Parity or correlation portfolios. The 60/40 portfolio would have been a good choice for investors who thought they were in a bull market. The 60/40 portfolios performed very well over this time period, but still provided adequate downside protection.

5. Correlation Portfolios

   While the proponents of this type of portfolio may over exaggerate the inadequacy of the 60/40 portfolio, this fifteen year time period does show that the non-correlation strategy is very effective. The "Correlation_2" portfolio had the highest return over the fifteen-year period and the second highest Sharpe Ratio. This portfolio successfully limited losses during bear markets, but still provided decent returns during bull markets. The "Correlation_2" portfolio outperformed the S&P 500 over every 5-year period during this fifteen-year period. This shows the versatility of the portfolio. It is important to note that the success of this portfolio could possibly be attributed to the strong performance of Gold an Oil that may not be as strong in the future. Although this portfolio did perform strongly, it was still significantly riskier than the Risk Parity portfolio.

Conclusion

The results of this test clearly state that the following portfolios performed the best during the corresponding market cycles in terms of Sharpe ratio and return.

	Best Average Return	Best Average Sharpe Ratio
Peak to Peak	Correlation_2	Risk Parity
Valley to Valley	Risk Parity	Risk Parity
Bull	Global_2	60_40_SP500_LTT 60_20_20_ SP500_AGG_LTT
Bear	Risk Parity	Risk Parity
3-Year Intervals	Correlation_2	Risk Parity
5-Year Intervals	Correlation_2	Risk Parity
Entire Period	Correlation_2	Risk Parity

While it is true that these portfolios performed the best over this 15-year horizon, it cannot be assumed that the same will happen over the next 15-years. What we can determine from this, however, is that diversified portfolios tend to provide superior returns than an only equity portfolio during volatile market cycles.

Further, it is clear that the particular Risk Parity strategy used in this experiment is a much more conservative portfolio than the other diversification strategies and tends to produce the highest Sharpe ratios. We can also observe that out of the diversified portfolios, the correlation portfolio tends to produce the best returns and still provides adequate diversification against market downturns.

Based on these two finding, it appears that in nearly every potential market condition over the last few years, it would have been beneficial to pick either one of these

two portfolios. If future market cycles are similar to the market cycles from 1998-2012, most investors should invest in either a Risk Parity portfolio or non-correlated portfolio. If an investor has the ability to use leverage, the Risk Parity portfolio should always be used due to the superior Sharpe ratio in nearly every market condition. However, if an investor isn't able to use leverage but desires higher returns than provided by the Risk Parity portfolio, the portfolio of non-correlated assets would be a good choice.

The fifteen-year period examined in the project was a wild ride for investors. If the volatility of the stock market continues in this manner, there will always be a need for diversified portfolios. From 1998-2012, the best portfolios were the Risk Parity and non-correlated assets portfolio, but this could be completely different over the next 15-years. It is extremely important for investors to base decisions on current market conditions rather than the past.

References

Eychenne, Karl; Martinetti, Stéphane; Roncalli, Thierry. "Strategic Asset Allocation." Lyxor Asset Management. March 2011. Web. <www.lyxor.com>.

Eychenne, Karl; Martinetti, Stéphane; Roncalli, Thierry. "Strategic Asset Allocation." Lyxor Asset Management. March 2011. Web. <www.lyxor.com>.

Inker, Ben. "The Hidden Risks of Risk Parity Portfolios." *GMO*. March 2010. Web. <www.cfainstitute.org>.

Phillips, Christopher; Walker, David; Kinniry, Francis."Dynamic Correlations: The Implications for Portfolio Construction." *Vanguard Research.* April 2012. Web. <www.vanguard.com>.

"Risk Parity," *Meketa Investment Group*. April 2010. Web. <www.meketagroup.com>.

Partridge, Lee, Roberto Croce, Katherine Kellert. "Risk Parity and Efficient Asset Allocation." *Salient*. December 15, 2011. Web. <www.salientpartners.com>.

"Salient Risk Parity Fund." *Salient*. 2013. Web. <www.salientpartners.com>.

"Striking a Balance." *MFS White Paper Series*. December 2012. Web. <www.mfs.com>.

"The Case for Dynamic Asset Allocation." *Mellon Capital Management Corporation Research Team*. February 2012. Web. <www.usbnymellonam.com>.

Yavas, Burhan. "Benefits of International Portfolio Diversification." *Graziadio Business Review*. 2007 Volume 10. Web. <www.gbr.pepperdine.edu>.