Department of Economics and Finance

Chair of Finance

VALUE AND MOMENTUM PORTFOLIO STRATEGIES AMONG DIFFERENT ASSET CLASSES

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To my Grandparents
and my family,
Francesco.

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Introduction

The consensus advice proffered to nonprofessional investors is to buy a diversified portfolio of risky assets and hold for the long term, while parking some percentage of the portfolio in low-risk assets that are expected to outperform during market downturns. Explicit in this counsel is the view that the nonprofessional investor should not expect to beat the market, either by picking individual investments that will outperform or by identifying investment managers who can generate above-market returns.

However, the shortcomings of passive investing have been widely documented. Critics question the wisdom of blindly holdings a portfolio with weights determined by market values in the face of recurring bubbles and panics. They point out that in 1989, when the Japanese stock market was trading at close to 100 times earnings, a passive index portfolio of global equities would have had roughly 40% allocated to Japanese equities.

A large body of research has been put forth attempting to reconcile these two seemingly incompatible views of the market: on one hand, markets are very efficient and thus difficult to beat; but on the other hand, they tend to exhibit periods in which valuations move far away from intrinsic values. Two important findings in the literature are that value and momentum are two persistent and often opposing characteristics of asset price dynamics.

In recent years value and momentum have been studied in combinations and across markets. Recent research finds that value and momentum effects offer higher returns and lower risk when used in combination rather than independently, primarily because value and momentum tend to operate over different time horizons. The negative correlation arises from value investing's reliance on reversion to fair value (i.e., negative autocorrelation), while momentum investing is predicated on divergence from the mean (i.e., positive autocorrelation). Often momentum acts as a check on value, discouraging an investor from buying before a bottom or selling before a peak. The attractiveness of the combined value and momentum approach was documented over a broad range of assets by Asness, Moskowitz, and Pedersen [2013][1]. Their studies were focus on value and momentum return premia across eight diverse markets and asset classes. They find that value and momentum return correlate more strongly across asset classes than passive exposures to the asset classes, but value and momentum are negatively correlated with each other, both within and across asset classes.

However, what is important to evidence is the fact that Relative Value strategies across different asset classes is difficult to analysed and for long time debated from most famous Funds Managers.

[1] "Value and Momentum Everywhere" Asness, Moskowitz and Pedersen, The journal of Finance, June 2013.

The important body of research about Value and Momentum used at the asset class level is the study of Victor Haghani (founder and CEO of Elm Partners) and Richard Dewey that study value and momentum effects to returns of two Baseline portfolios of Index[2]: "Three country Portfolio" and "Globally Diversified Portfolio". They consider three types of strategies: Buy and Hold, Buy and Hold plus Value, Buy and Hold plus Value plus Momentum and apply it to Baseline portfolios. The results demonstrate that adjusting for value and momentum yields higher and better quality returns that are statistically and economically significant. Research conduct by Haghani examines the value and momentum effects at the asset class level and uses long-only approach. Their research uses simple non- optimized metrics for value and momentum, which reduce the chances that results are attributable to data mining.

The historical studies that Haghani describe in detail in the body of his paper cove two reasonably long periods:

- End of January 1926 to end of end of December 2013 (87 years)
- End of December 1974 to end of February 2013 (38 years)

The two Baseline Portfolios used by Haghani to implement historical studied can be divided in "Three country Portfolio" and "Globally diversified Portfolio".
The next Table show this Baseline portfolio composition:

30%	US Equities			Equities	
20%	UK Equities		10.0%	US broad	
10%	Japanese Equities		10.0%	US value	
20%	US Investment Grade Corporate bonds		4.5%	Europe broad	
10%	US 10 year Treasury note		4.5%	Europe value	
10%	US 3 month T-bills		2.5%	UK broad	
			2.5%	UK value	
100%	Total		3.5%	Japan broad	
			3.5%	Japan value	
			2.0%	Pacific x-Japan broad	
			2.0%	Pacific x-Japan value	
			1.0%	Canada broad	
			1.0%	Canada value	
			8.0%	Emerging Market broad	
			10.0%	US 10 year Treasury note	
			5.0%	US Investment Grade Corporate bonds	
			10.0%	Real Estate (REITs)	
			10.0%	Commodities (GSCI)	
			10.0%	US 3 month T-bills	
			100%	Total	

Table 1.1: Haghani, Three Country Portfolio and Globally Diversified Portfolio asset classes Composition.

[2] "A Case Study for Using Value and Momentum at the Asset Class Level", Haghani and Dewey, The Journal of Portfolio Management, Spring 2016.

The asset classes choose for study of Haghani are based on the following criteria:

- Big enough to feel like an asset class and to carry risk that isn't easy for investors in aggregate to diversify.
- Assets available for investment through low cost, liquid vehicles where ordinary investors could get exposure and have low transactions costs in rebalancing. These include index funds and ETFs.
- Indices where we could find reasonably accurate historical data, including information not only on historical prices, but also total returns including dividends as well as some valuation metrics, such as earnings.

	Data Sources	
Asset Class	**Data 1926**	**Data 1975**
U.S. Equities	SP	MSCI
U.K. Equities	FTSE	MSCI
Europe X U.K. Equities	NA	MSCI
Japan Equities	TOPIX	MSCI
Pacific X Japan Equities	NA	MSCI
Canada Equities	NA	MSCI
EM Equities	NA	MSCI
U.S. REITS	NA	NAREIT
Commodities GSCI	NA	GSCI
U.S. Nominal Treasuries	Fed	Fed
U.S. Investment Grade Credit	Moody's	Moody's
Cas (90 Day Treasuries)	Fed	Fed

Table 1.2: Haghani, Index Funds used to implement index Portfolio Strategies.

What Haghani did is to take this Total Return Index and constructed the two Total Return Index Baseline portfolios.

Then as I do in my study and explained in detail in Chapter 1 Haghani each month calculate value and momentum factor, and value and momentum weight adjustment. The long only strategies that Haghani implemented are:

1) Buy and Hold
2) Buy and Hold plus Value
3) Buy and Hold plus Momentum
4) Buy and Hold plus Value plus Momentum

The Table and figure in next page provide a summary of what Haghani found. The risk of the strategies was calculated has function of worst 1 year, and 5-year losses since this study was implemented early after 2008 crisis (my study take account for standard deviation of portfolio as measure of risk).

Haghani evidences also portfolios standard deviation. In the figure the final three pairs of columns on the right show the return for strategies that he described in his paper of Haghani.

		Results of Studies			
		Baseline	**Value**	**Momentum**	**Val + Mom**
Study 1	Mean Return	5.77%	6.63%	7.32%	8.43%
Intnl (1975)	Stdev	9.05%	9.09%	9.09%	9.17%
	Sharpe	.50	.59	.67	.78
	t-stat	NA	2.2	3.2	4.6
	Worst 1-Yr	–35.4%	–34.0%	–23.1%	–20.2%
	Worst 5-Yr	–18.6%	–21.4%	–5.6%	2.5%
	Worst 1-Yr vs Baseline	NA	–5.7%	–16.7%	–7.8%
	Worst 5-Yr vs Baseline	NA	–16.5%	–8.5%	–1.4%
Study 2	Mean Return	5.28%	6.38%	6.87%	7.94%
Equal Weights	Stdev	7.89%	8.62%	8.51%	8.87%
	Sharpe	.51	.60	.66	.76
	t-stat	NA	3.2	3.3	5.3
	Worst 1-Yr	–35.1%	–34.2%	–24.4%	–23.2%
	Worst 5-Yr	–18.6%	–20.7%	–0.7%	3.7%
	Worst 1-Yr vs Baseline	NA	–5.6%	–13.9%	–4.7%
	Worst 5-Yr vs Baseline	NA	–9.9%	–2.8%	4.3%

Note: The return figures are annual, inflation-adjusted geometric returns.

Table 1.3: Haghani, Annual Real Return, standard deviation, Sharpe ratio for Three Country Portfolio 1975-2013 and Globally Diversified Portfolio 1975-2013.

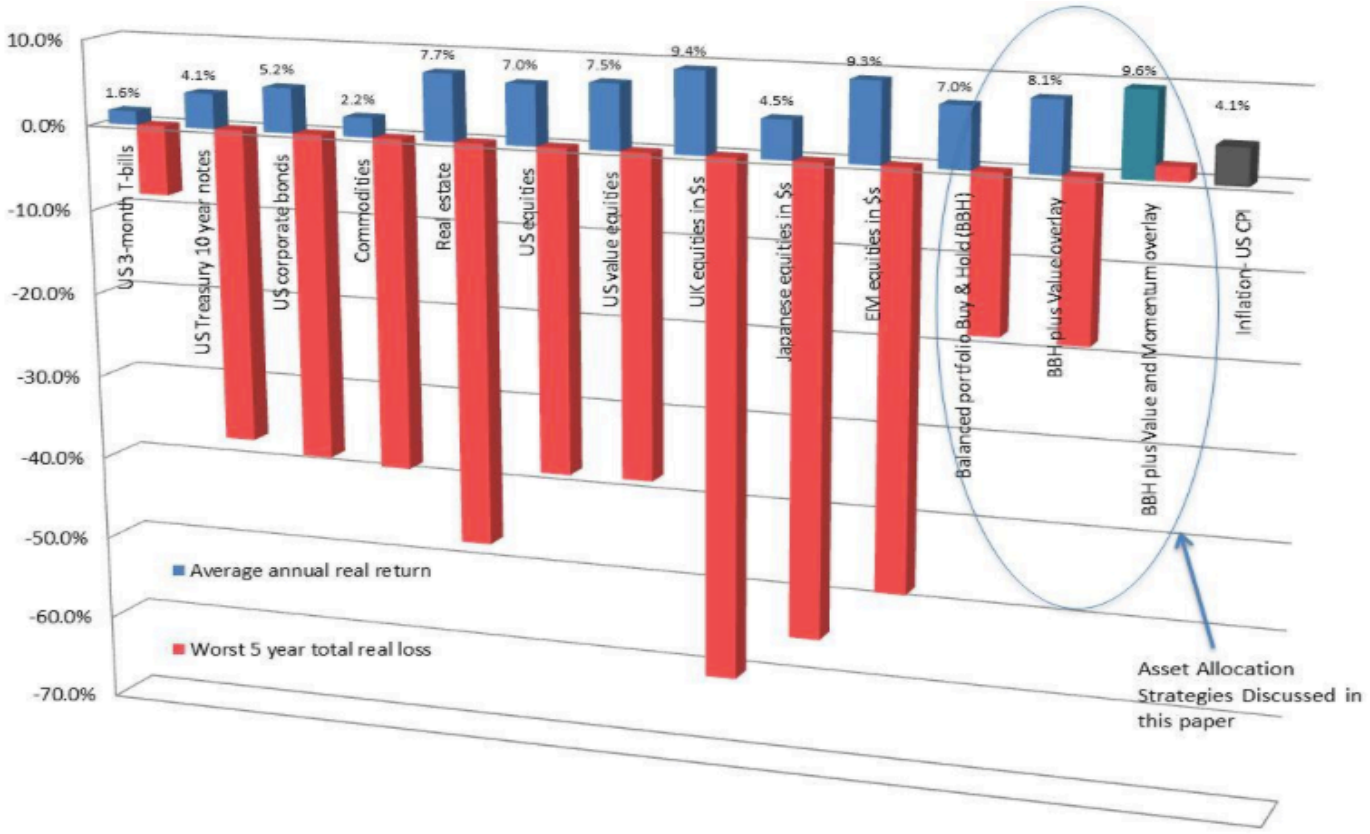

Figure 1.1: Haghani, average Annual Real Return and worst 1,5-year losses for single assets and Three Country Portfolio Strategies.

Research conduct by Haghani results were consistent with three of the most widely held tenets of investment theory and practice:

1) Portfolios with a healthy weight in equities have delivered robust returns to investors. A portfolio made up of 30% US equities, 20% UK equities, 10% Japan equities, 20% US Treasury bonds, 10% US corporate bonds and 10% in 3-month US T-bills, rebalanced to those weights every month, would have generated a real return after inflation of 5.7% from 1975 to the present (yes, including the 80% drop in US equity prices from September 1929 to June 1932) and 6.0% from 1975 to the present,
2) Diversification not only reduces risk but increases returns as well. From 1926 to the present, a portfolio that had 30% in US equities, 20% in UK equities and 10% in Japanese equities, 20% in US T-bonds, 10% in US corporate bonds and 10% in cash returned 0.1% per annum more than the US only portfolio above and had less risk, despite the fact that Japanese equities lost 98% of their real value through WWII. From 1975 to the present, a more heavily diversified portfolio showed the benefits of diversification more powerfully by outperforming a US-centric portfolio by 0.8% per year over the same period, also with less risk, and,
3) A disciplined approach to portfolio management that periodically rebalances to fixed weights adds to return and increases the quality of those returns.

The essence of this approach is to attempt to identify and avoid cases of extreme overvaluation in asset prices, while providing comfort in holding or buying risky assets when the returns are attractive. Haghani show that superior returns are available to investors using basic valuation metrics and cost efficient strategies to allocate capital among different sources of return across time periods and economic climates. We believe the returns a disciplined investor would have earned following the simple and intuitively appealing investment strategy based on diversification, value and momentum challenges the view that expert active management and alternative investments are preferable to what can be achieved in the public marketplace by investors that are willing to allocate a moderate time commitment to their investment portfolios.

My study:

What did I do in my study is simply try to replicate this particular study of Haghani, calculating value and momentum metric following the method used by Haghani (Section 1.2 and 1.3), estimating Index Portfolio return and standard deviation, and adding an analysis of the historical performance of ETFs portfolios constructed with the intent to replicate performance of Index portfolio.
The historical studies and results described in detail in the body of this study cover one long period, from end of January 1988 to end of December 2017 (30 years).
I apply value and momentum strategies to three Baseline Portfolio following the composition of Baseline Portfolio used by Haghani.
I call it "Core Domestic", "Core plus Satellite" and "Global".

In Chapter 1 are explained the mechanics to construct Baseline portfolios and are specified Value and Momentum metrics to calculate value and momentum weight.

Chapter 2 are highlighted results and performance of my three Baseline Index Portfolios strategies from 1988 to present.

Chapter 3 is dedicated to ETFs Portfolios with which we really could implement the strategies. In this case I want only to replicate the return, standard deviation and Sharpe ratio of Baseline Index Portfolios calculated in previous Chapter 2.

The last Chapter show how ETFs Portfolio performed with respect to Index Portfolio used as benchmark through the evolution of a capital amount invested in those portfolios, last Section specify Tracking Error Volatility and Information ratio of ETFs Portfolio and ETFs Portfolio strategies.

The following table summarize the percentage of fund allocated among equities, corporate bond, treasury bond and cash (and commodities, and Real Estate):

	Core Domestic	Core plus Satellite	Global
Equities	60%	60%	55%
Corporate Bond	20%	10%	5%
Treasury Bond	10%	10%	10%
Cash	10%	5%	10%
Commodities		7,50%	10%
Real Estate		7,50%	10%

Table 1.4: Asset classes Baseline portfolio allocation of this study.

The following asset classes were used in the historical study from end of January 1988 to end of December 2017, the Baseline Portfolio that is used to construct the strategies are three:

	Baseline portfolio	
Core Domestic	Core plus Satellite	Global
30% US equities	15% US equities	10% US broad equities
20% UK equities £	15% US value equities	10% US value equities
10% Japan equities ¥	15% UK equities £	4,5% Europe broad eq.
10% US corporate bond	10% Japan equities ¥	4,5% Europe value eq.
10% high yield bond	5% em.mkt equities	2,5% UK broad eq. £
10% US 10 y T-notes	7,5% commodities	2,5% UK value eq. £
10% US 3-month T-bills	7,5% Real Estate US	3,5% Japan broad eq. ¥
	5% US corporate bonds	3,5% Japan value eq. ¥
	5% high yield bond	2% Pacific ex Japan broad
	10% US 10 y T-notes	2% Pacific ex japan value
	5% US 3-month T-bills	1% Canada broad eq.
		1% Canada value eq.
		8% em.mkt equities
		10% commodities
		10% Real Estate US
		2,5% US corporate bonds
		2,5% high yield bond
		10% US 10 y T-notes
		10% US 3-month T-bills

Table 1.5: Baseline Portfolios and weight of this study.

These portfolios consisted of one or more publicly traded equity Total Return indices, US government and investment grade bonds, US T-bills, and, in the most diversified portfolio, indices of real estate and commodities. In each case, we started by examining the historical returns of those portfolios rebalanced back to fixed weights at the end of each month.

The Total Return Indices used to calculate portfolio returns are summarized in the following Table:

Portfolio 1-2	Tot Return Index	Portfolio 3	Tot Return Index
US euities	SP500	US broad equities	MSCI USA
UK equities	FTSE100	US value equities	MSCI USA VALUE
Japan Equities	TOPIX	europe broad eq.	MSCI EUROPE
em.mkt equities	MSCI EMERGING MKT	europe value eq.	MSCI EUROPE VALUE
US value equities	SP500 VALUE	UK broad eq.	MSCI UK
commodities	GSCI	UK value eq.	MSCI UK VALUE
Real Estate US	REIT	Japan broad eq.	MSCI JAPAN
US corporate bonds	Bloomberg Barclays US Corporate	Japan value eq.	MSCI JAPAN VALUE
high yield bond	Bloomber Barclays US High Yield Bond	Pacific ex Japan broad	MSCI PACIFIC EX JAPAN
US 10 y T-notes	Bloomber Barclays US 7-10 year Aggregate Bond	Pacific ex japan value	MSCI PACIFIC EX JAPAN VALUE
US 3 moth T-bills	Bloomberg Barclays US 3 month T-Bills	Canada broad eq.	MSCI CANADA
		Canada value eq.	MSCI CANADA VALUE
		em.mkt equities	MSCI EMERGING MARKET
		commodities	GSCI
		Real Estate US	REIT
		US corporate bonds	Bloomberg Barclays US Corporate
		high yield bond	Bloomber Barclays US High Yield Bond
		US 10 y T-notes	Bloomber Barclays US 7-10 year Aggregate Bond
		US 3 moth T-bills	Bloomberg Barclays US 3 month T-Bills

Table 1.6: Total Return Index used to calculate Returns of this study.

The term "value equities" refers to that sector of the broad equity market having lower price-to- book and price-earnings ratios than the average of the broad market. Historically, the value sector of the market has generated higher returns than the growth sector (its complement) and therefore the broad market as well. Various risk premium arguments have been put forward to explain this extra return[3]. For instance, many observers view this as compensation for the risk that value equities will do worse in a severe economic downturn. However, during the recent credit crisis from mid 2007 to mid 2009, US value equities only slightly under-performed the broad market's performance.

[3] Fama and French did some of the earliest and most referenced work in this field.

[4] From June 30, 2007 to June 30, 2009 the US broad market had an excess return of -21% versus the Value sector's -24.5% annual return.

The following chart provide a summary of what results of my study evidence. The final three pairs of columns on the right-hand side show the return for Portfolio 1 value and momentum strategies that is described in this paper:

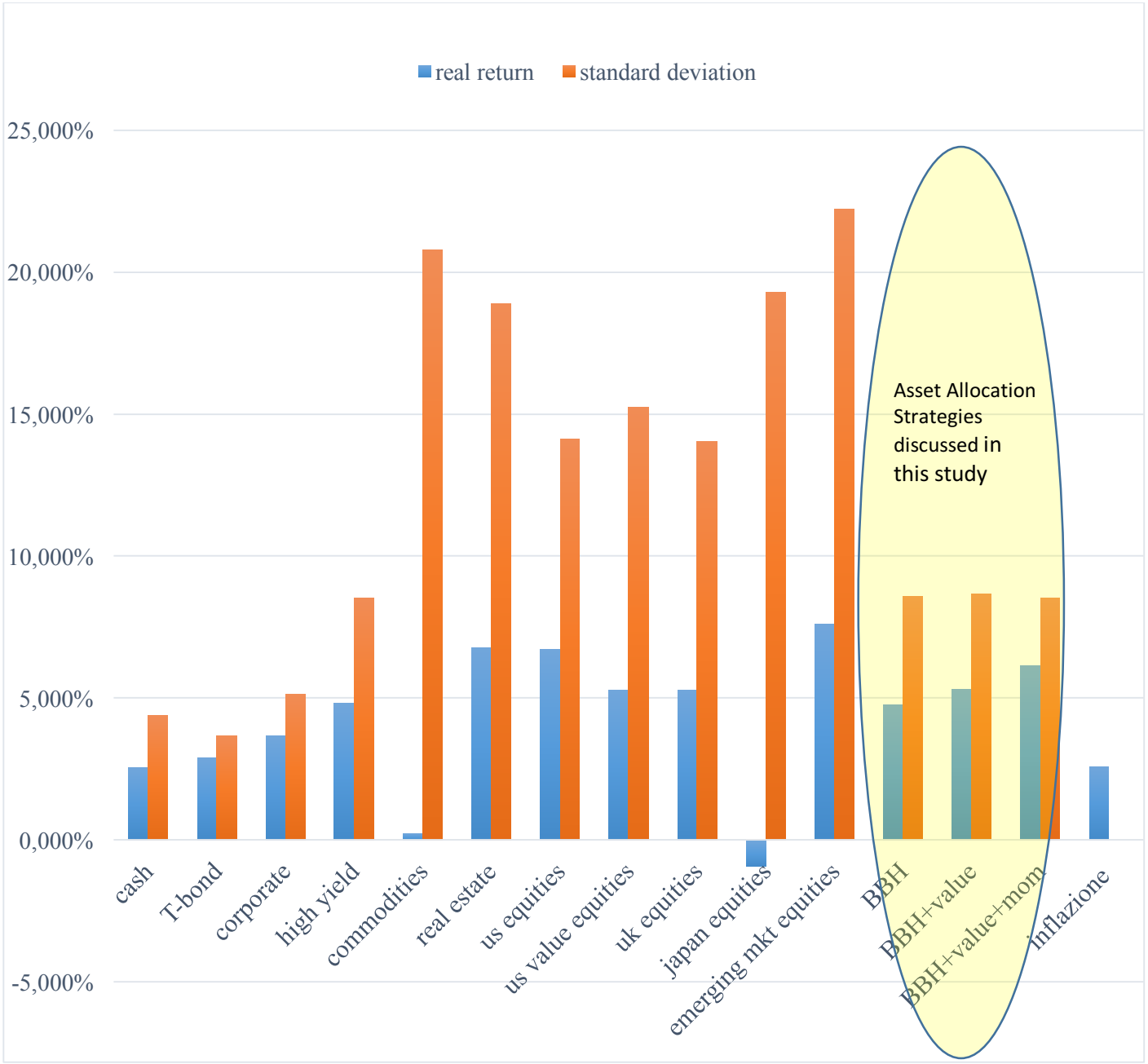

Figure 1.2: Real Return and Standard Deviation chart of single asset used in this study and comparison with returns and standard deviation of the "Core Domestic" Portfolio Strategies (1988-2017).

As in Figure 1 in this are showed return and standard deviation for single asset analysed and for "Core Domestic" Portfolio strategies.

The main results that is specific and central in my study are the following two points concerning value and momentum:

1) Following a strategy of modestly changing exposure to assets as they appear more cheaply or expensively valued adds return of about 0,5% per annum with respect to a buy and hold strategy and increases the quality of return by adding more to return than to risk.
2) Giving a moderate weight to trends increases return [3] and decreases risk. Momentum adjustment adds return of about 0,9% per annum with respect to a buy and hold plus value overlay strategy. Standard deviation of portfolio is little bit less then buy and hold portfolio.
3) Interesting result emerged from the analysis of recent performance is the fact that Buy and Hold portfolios has over performed with respect to BH plus value and BH plus value and momentum. This superior return of Buy and Hold strategies arise only when we consider "Core plus settled yet" and "Global" Portfolios. From 2008 to present portfolios performance line up but risk and Sharpe ratios support value and momentum strategies. Results from 2012 to present show that Buy and Hold strategy bear superior returns and higher Sharpe ratios in all portfolio analysed. Probably this is due to the impact of the introduction of commodities and Real Estate as asset classes in the Portfolio
4) The "Core Domestic" Portfolio does not evidence this extra performance of Buy and Hold strategy so in this case what I want to evidence is that recent returns of Value and Momentum strategies are useful and produce higher returns as in longer period analysis.

[3] and, as expected, increases portfolio turnover even further, to 150-200% per annum. Given the low transactions costs involved in moving among the major asset classes, even this relatively high degree of portfolio turnover does not result in dramatic diminution of return.

In next table we want to highlight comparability of return of my Index Portfolio strategies relative to returns of Haghani Index Portfolio. I compare the two study analysing the "Global" Portfolio (my study) relative to "Globally diversified" Portfolio (study of Haghani).

"Globally Diversified" Portfolio 1975-2013	Buy and Hold	BH + value	BH + value + mom
Real Return	5,28%	6,3%	7,94%
Standard Deviation	7,89%	8,6%	8,87%
Sharpe ratio	0,51	0,6	0,76

"Three Country" Portfolio 1975-2013	Buy and Hold	BH + value	BH + value + mom
Real Return	5,77%	6,6%	8,43%
Standard Deviation	9,05%	9,0%	9,17%
Sharpe ratio	0,5	0,59	0,78

"Global" Portfolio 1988-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	3,36%	4,2%	5,75%
Standard Deviation	10,88%	11%	11,19%
Sharpe ratio	0,04	0,11	0,25

"Core Domestic" Portfolio 1988-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	4,76%	5,3%	6,53%
Standard Deviation	8,59%	8,6%	8,42%
Sharpe ratio	0,21	0,27	0,43

Table 1.7: Relationship between Haghani return and my return

CHAPTER 1

The mechanics: how these strategies are constructed for the historical study

1.1 Step by step guide for Portfolio weight calculation

Here is how the historical studies described in this study were implemented:

1) Chose a benchmark, base weighting of assets to form the baseline portfolio. As described above, we used three baseline portfolios. In the case of the pure buy and hold strategy, rebalance back to the baseline weights at the end of each month.

2) Chose the valuation measures and assign an attractiveness measure, on a scale from 0 to 10, to those valuation metrics. For instance, when looking at equity markets, we assign a 0 (least attractive) to the market when the P/E[4] is greater than 32, a 10 (most attractive) when the P/E is less than 8, and a 5 when the P/E is between 16 and 18. We use a simple valuation metric, discussed in more detail in section 1.2. above for each asset class under consideration in our portfolio.

3) Determine how much to increase or decrease exposure relative to baseline given attractiveness scale of 0 to 10. In all of our studies, we went with a very simple scheme of increasing or decreasing baseline exposure by ½ when the attractiveness measure was at its most extreme. For attractiveness measures in between, we adjusted the weighting of the asset in question by proportionately less than the ½ maximum adjustment.

4) Chose a simple measure for momentum. We used the difference between today's price and the average inflation adjusted price over the past year as our measure of momentum.

5) As with value, map the momentum into a desired change to the baseline exposures. Here we decided to decrease by 1/3 when momentum is negative and to increase by 1/3 when positive. It is interesting to note here that we vary portfolio weights less based on momentum than we do based on valuation changes, because, despite the fact that momentum has been a stronger signal historically than value, we feel more comfortable with the view that value will be more likely to persist going forward than momentum.

6) Additionally, and importantly, we did not allow the portfolio to have any leverage, so when the desired baseline weights, after making the desired adjustments for value and momentum, added up to more than 100%, we scaled all the desired weights down by the sum so that the actual exposures added up to 100%.

This six step process is all that we did in order to arrive at the historical return results we present in this paper. We chose to go through this rebalancing process on a monthly basis. For the "Buy and Hold" strategy, we stopped at step 1, rebalancing back to those weights at the end of each month. For the full strategy of "Buy

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[4] The Shiller P/E as described earlier.

and Hold with Value and Momentum" we used all 6 steps, performing steps 2 through 6 at the end of each month, while for the "Buy and Hold and Value" strategy we left out steps 4 and 5.

Now I summarise Baseline Portfolio fixed weight with three Pie Figures:

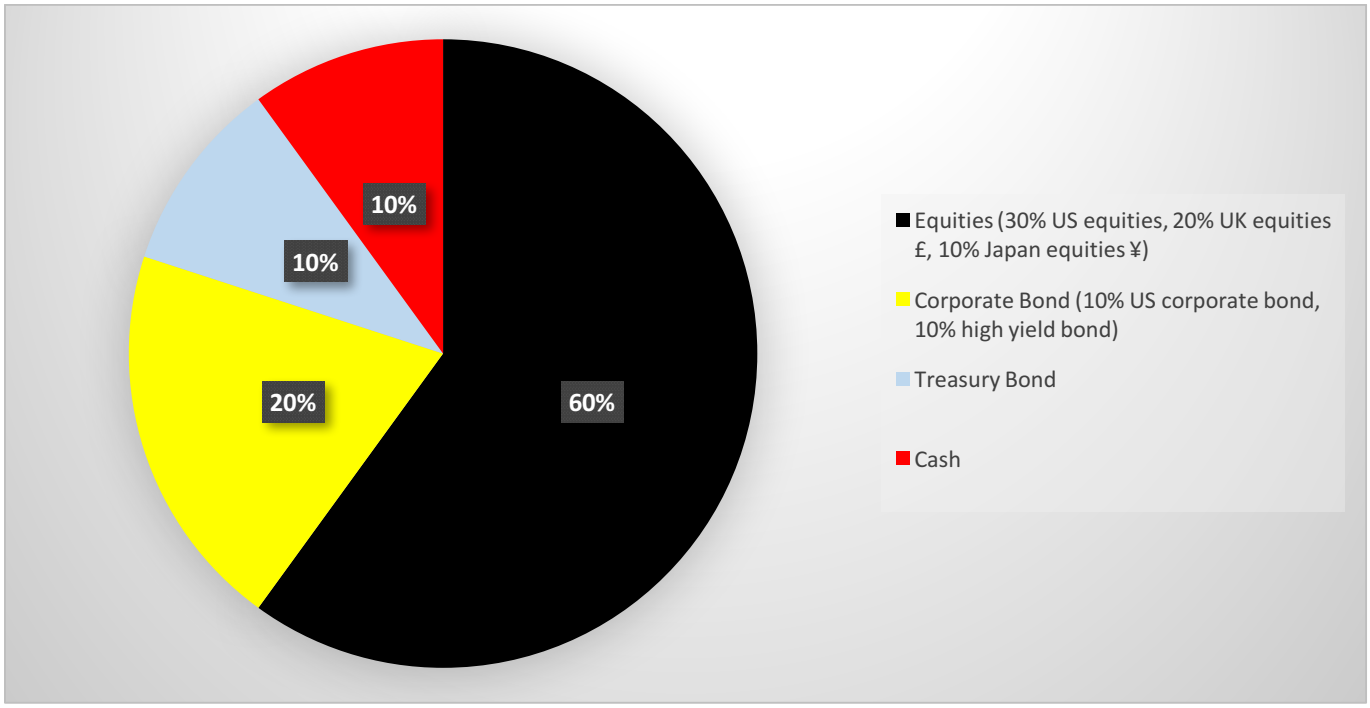

Figure 2.1: "Core Domestic" Portfolio

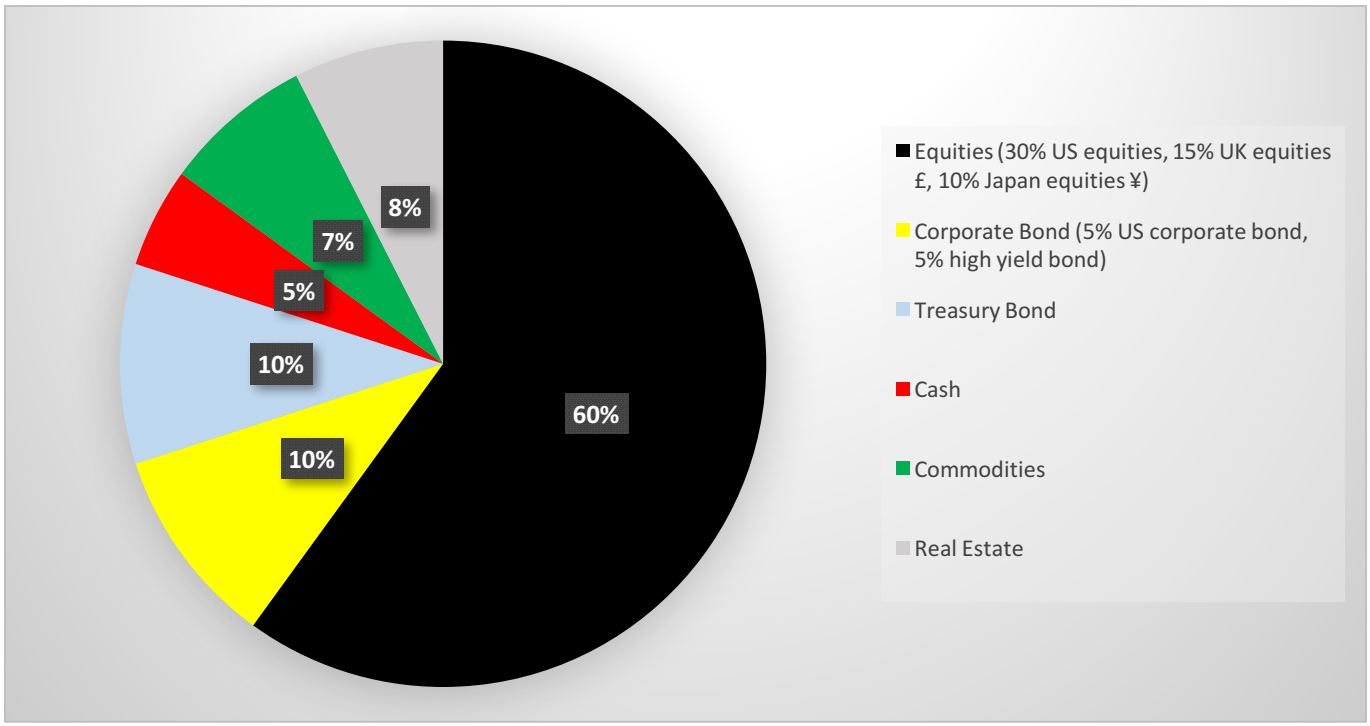

Figure 2.2: "Core plus Satellite" Portfolio Composition

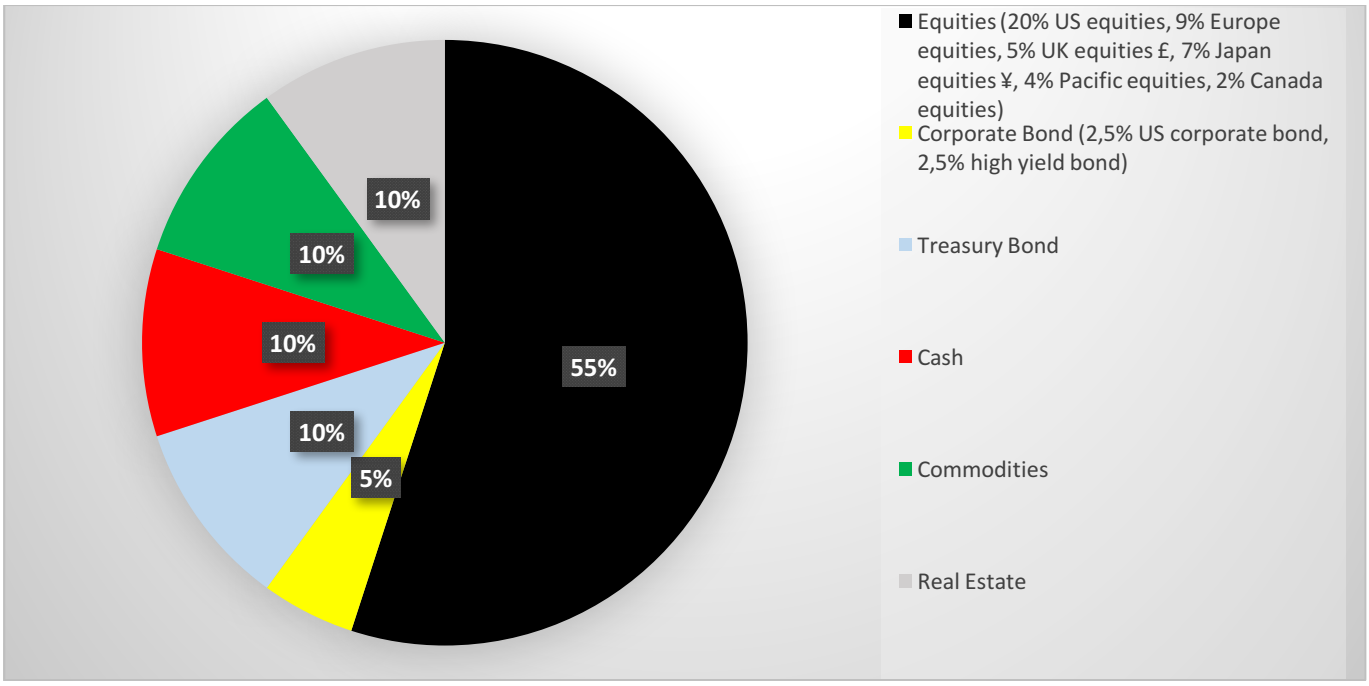

Figure 2.3: "Global" Portfolio Composition.

In the following charts we show asset allocation turnover for the three portfolios and among two historical studies (1988 to present; 2008 to present):

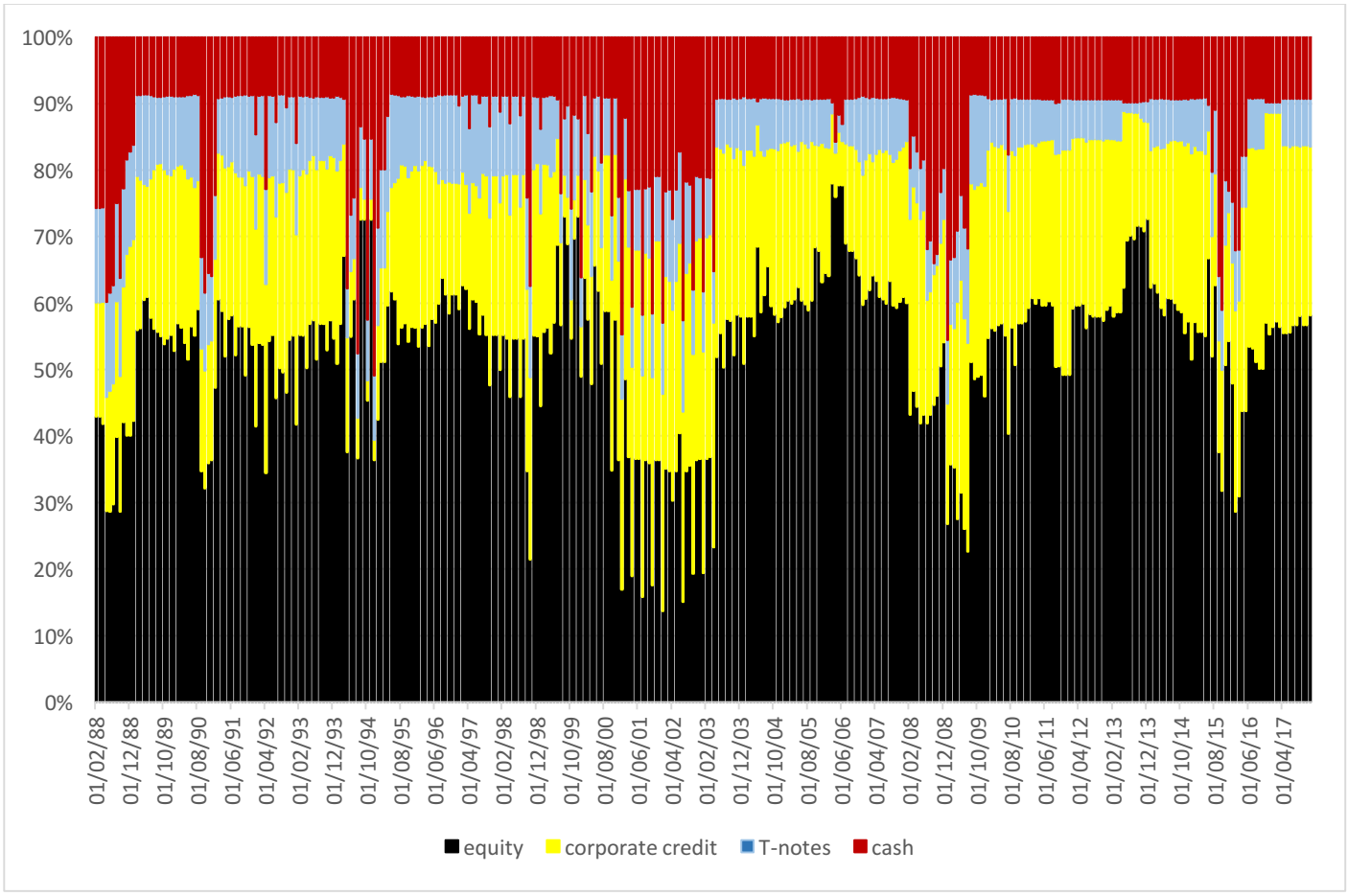

Figure 2.4: "Core Domestic" Portfolio Buy and Hold + Value + Momentum overlay 1988 to 2017.

All charts present a great variability of asset allocation in the period previous 2008, this is due to the fact that the core part of portfolios is composed by equity and the value adjustment for equities is calculate on the basis of a quarterly value signal. The lat charts of this section cover a shorter period (2008 to present) so this volatility of weight do not persist at all.

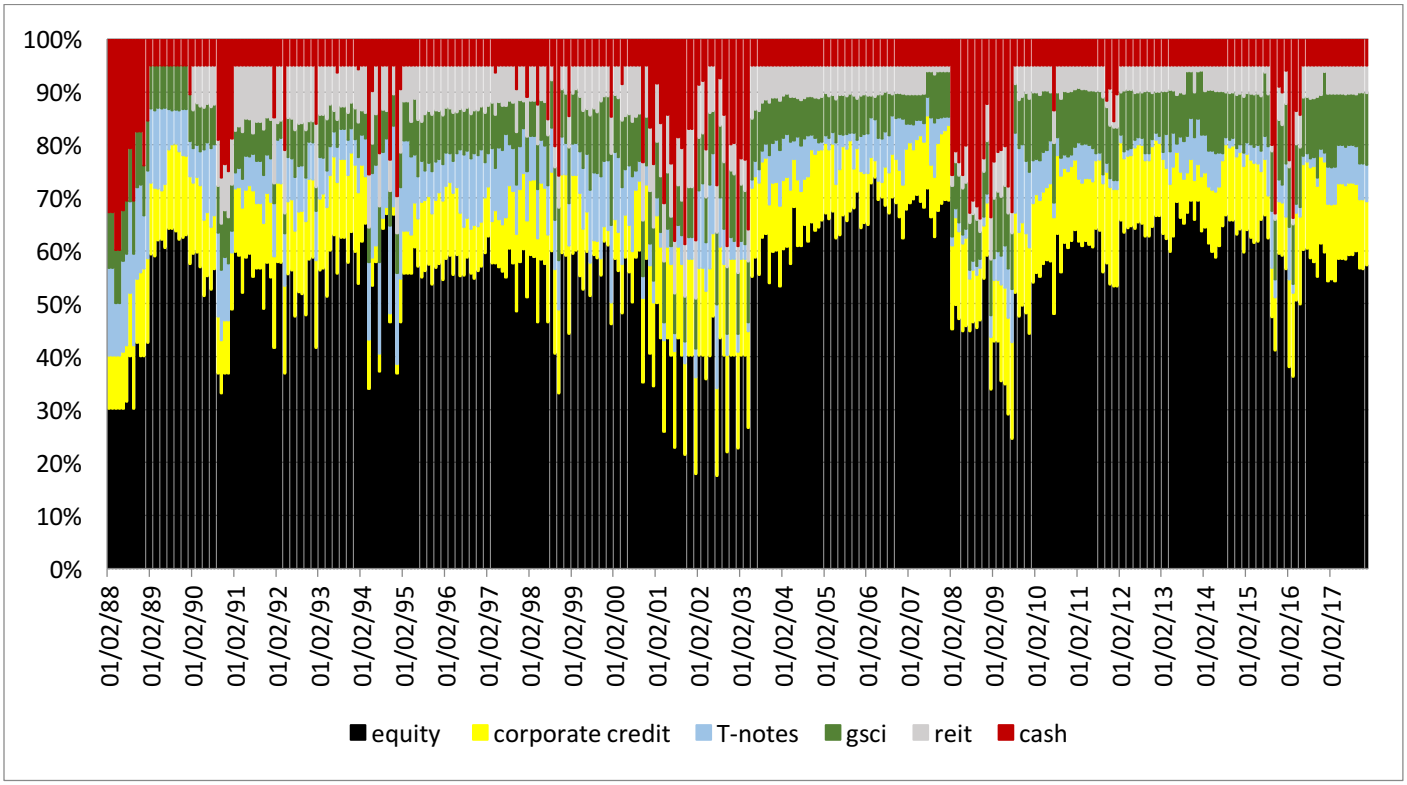

Figure 2.5: "Core plus Satellite" Portfolio Buy and Hold + Value + Momentum overlay 1988 to present.

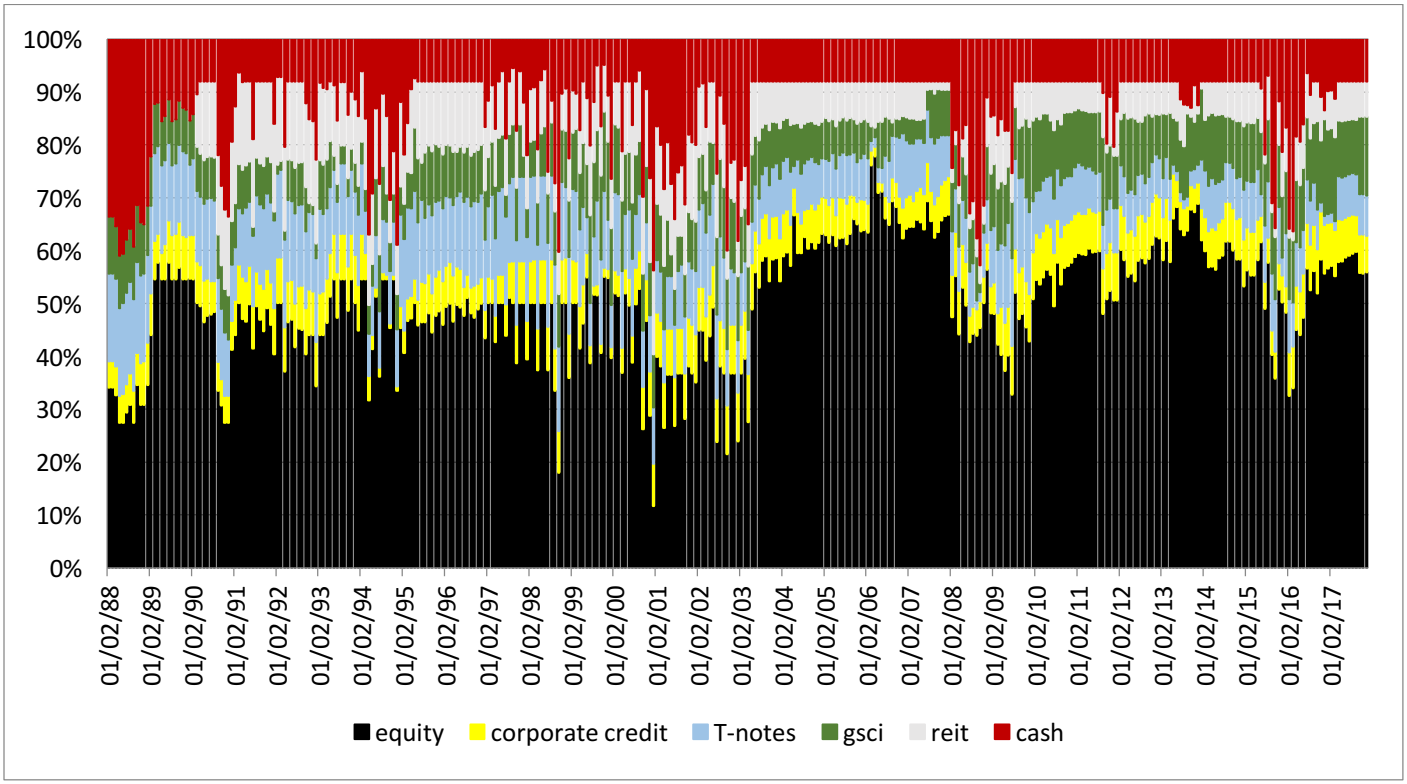

Figure 2.6: "Global" Portfolio Buy and Hold + Value + Momentum overlay 1988 to 2017.

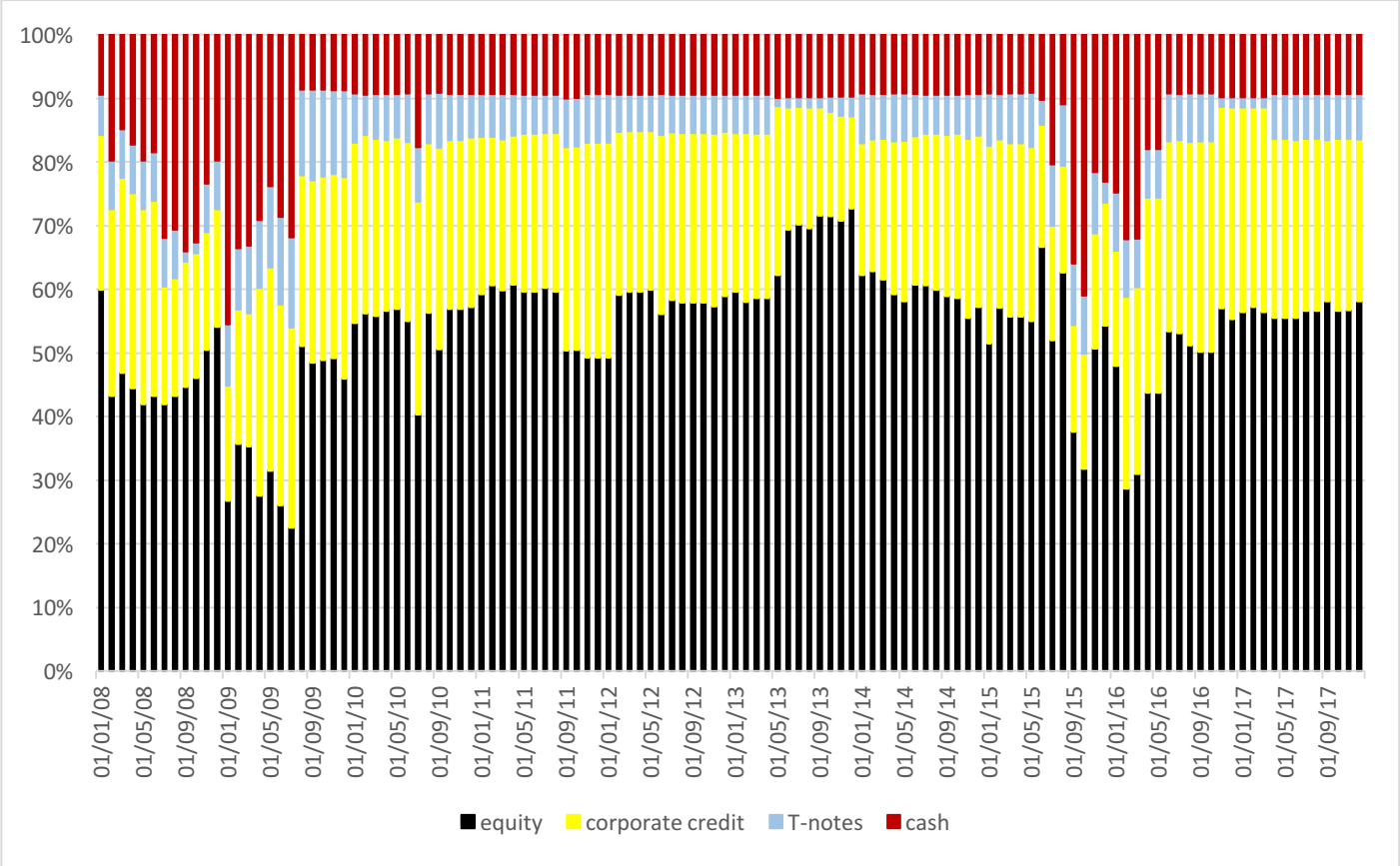

Figure 2.7: "Core Domestic" Portfolio Buy and Hold + Value + Momentum overlay 2008 to 2017.

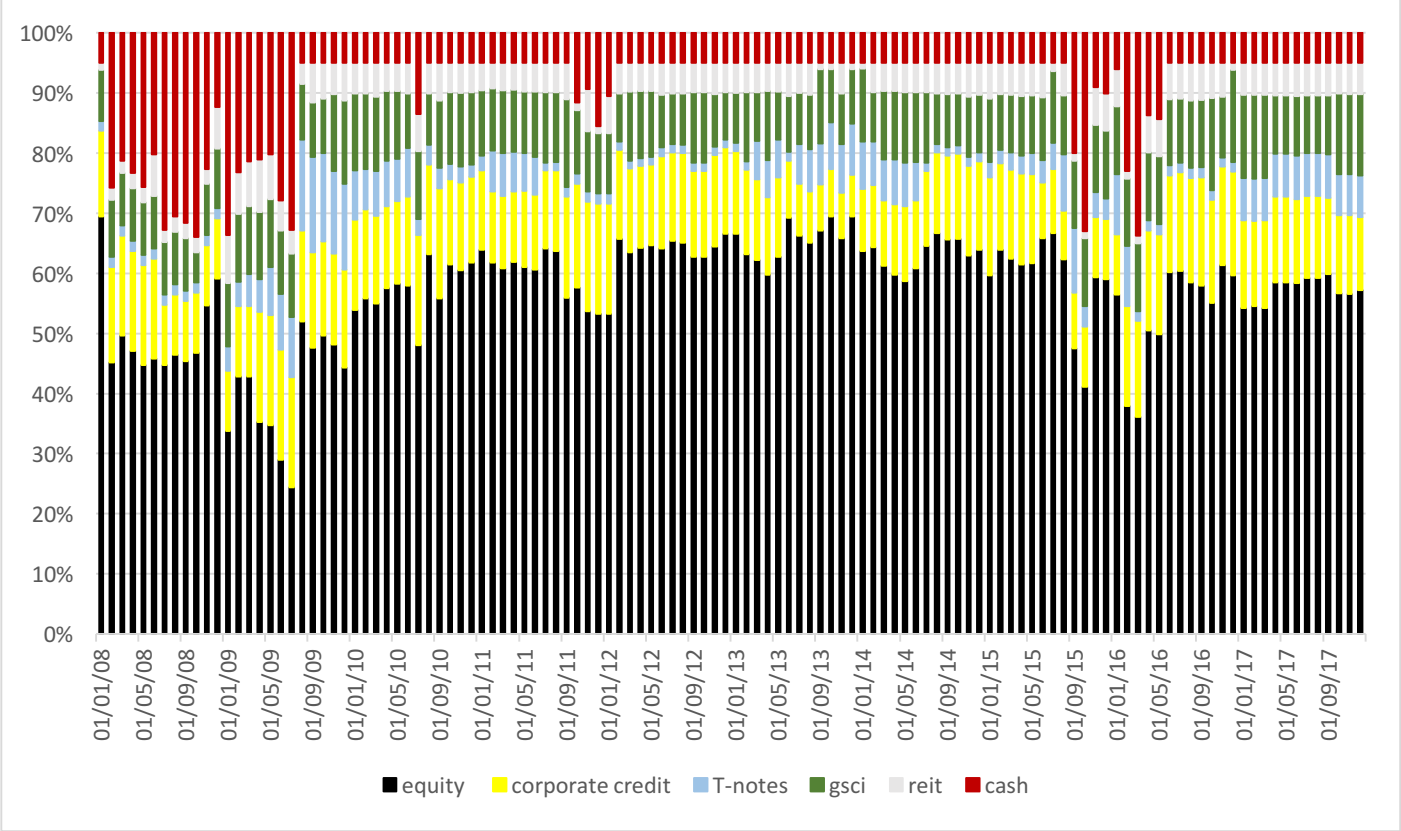

Figure 2.8: "Core plus Satellite" Portfolio Buy and Hold + Value + Momentum overlay 2008 to 2017.

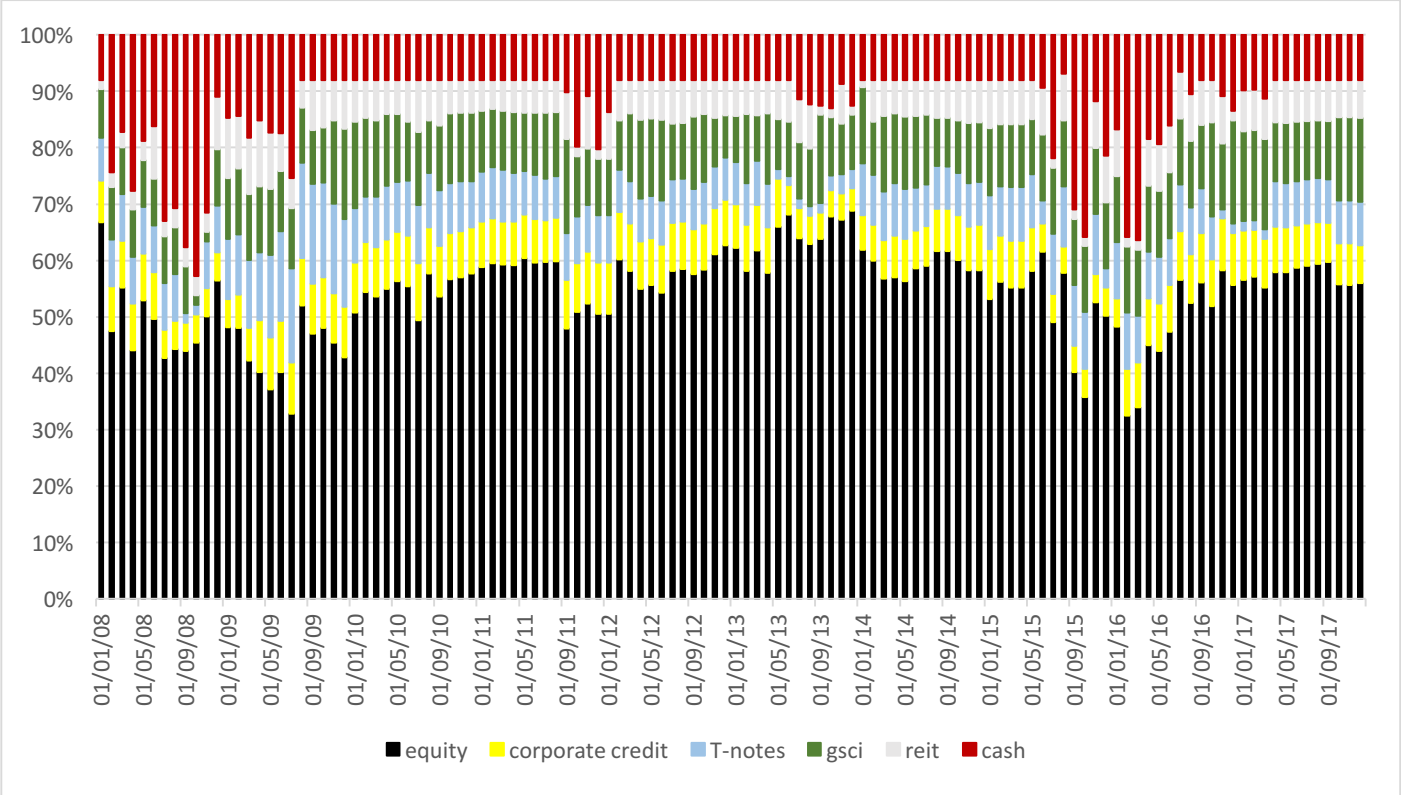

Figure 2.9: "Global" Portfolio Balanced Buy and Hold + Value + Momentum overlay 2008 to 2017.

All portfolio asset allocation based on value and momentum strategy have a coherent composition with what is happened during recent financial crisis or even more recent high return. Indeed, during financial crisis as 2008, the percentage invested in Equities is very low, otherwise during recent year of positive performance it as a gradually higher adjustment following the evolution of return.

1.2 Measures of value

In this section I explain how to compute step two of the mechanics[5], for each of our asset classes, the simple valuation metric that are used are as follows:

1) Equity markets: P/E where P is the current stock market index level, and where E is the average of the past 10 years of inflation adjusted corporate earnings on that index.
2) US 10-year Treasury notes: the expected 10 year real return, which is the difference between the next 10 years' forecasted inflation and the current yield of the 10 year Treasury note. There is not a more direct measure of the long term expected real return than this; it is in a sense the definition of the long term expected real return.
3) US Investment Grade Corporate bonds: the yield spread, which is the difference in yield between the index of corporate bonds and the yield on a maturity matched portfolio of US treasury bonds. We are using a relative measure (i.e. the spread to Treasuries) because we want to determine how much of the total interest rate risk we want in the portfolio, as determined by the metric on US 10 year notes, is to be in the form of corporate bonds.
4) US Real Estate (REIT Index): the dividend yield based on the prior year's dividends on the REIT index.
5) Commodities (GSCI index): today's price relative to the average inflation adjusted price over the past 10 years.
6) Value equities: in each market we look at the subset of the broad market with the cheapest valuation measures, known as the "value" segment of the market. MSCI, the data vendor, splits each broad equity index into Value and Growth sectors and reports total returns for each. Our measure of value in the analysis of Value stocks is simply the recent historical outperformance or underperformance of value stocks versus the broad equity index over the most recent three years. As with corporate bonds, above, we are using a relative measure of cheapness for Value equities because, in the construction of the portfolio, we are going to use this metric to decide how much of our total equity exposure in a given market is to be held in the form of the Value sector[6].

[5] Value factor calculation as be computed as in the study of Haghani giving the same valuation metric to each asset classes.
[6] I also test another measure of Value Stock value factor that is the recent historical outperformance or underperformance of value stocks versus the Growth equity index over the most recent three years. Portfolio weight adjusted to this factor achieve a bit higher return than with value vs broad and with less standard deviation.

In the table below we show the mapping from each measure to the cardinal values of 0 to 10:

Asset -->	Equities	US 10yr T-note	US corp bonds	US REITs	Commodities	Value equities
Valuation Metric -->	Shiller P/E (past 10yr real avg)	expected 10 year real rate (10 yr nom yld - expected 10 yr infl)	spread to Treasury bonds	dividend yield	current price / 10 year real avg price	annual return of Value vs Broad equity index over past 3 years
0	> 32	< 1%	< 0.75%	< 5%	> 1.625	> 5.25%
1	28 to 32	1.0% to 1.5%	0.75% to 1%	5% to 5.5%	1.5 to 1.625	4% to 5.25%
2	24 to 28	1.5% to 2.0%	1.0% to 1.3%	5.5% to 6%	1.375 to 1.5	2.75% to 4%
3	20 to 24	2.0% to 2.5%	1.3% to 1.5%	6% to 6.5%	1.25 to 1.5	1.5% to 2.75%
4	18 to 20	2.5% to 2.8%	1.5% to 1.7%	6.5% to 7%	1.2 to 1.3	0.8% to 1.5%
5	16 to 18	2.8% to 3.2%	1.7% to 1.8%	7% to 7.5%	1.1 to 1.2	0.2% to 0.8%
6	14 to 16	3.2% to 3.5%	1.8% to 2.0%	7.5% to 8%	1.0 to 1.1	-0.5% to 0.2%
7	12 to 14	3.5% to 4.3%	2.0% to 2.5%	8% to 9%	0.9 to 1.0	-1.8% to -0.5%
8	10 to 12	4.3% to 5.0%	2.5% to 3.0%	9% to 10%	0.7 to 0.8	-3.0% to -1.8%
9	8 to 10	5.0% to 5.8%	3.0% to 3.5%	10% to 11%	0.8 to 0.9	-4.3% to -3.0%
10	< 8	> 5.75%	> 3.5%	> 11%	< 0.8	< -4.25%

Table 2.1: Valuation Metric for asset classes analysed in this study.

Each month, for each asset class was calculate the corresponding valuation metric.
The value metrics for the second type of value equities value factor are calculate with the same method.

Next charts explore the relevance of these valuation metric in the long run:

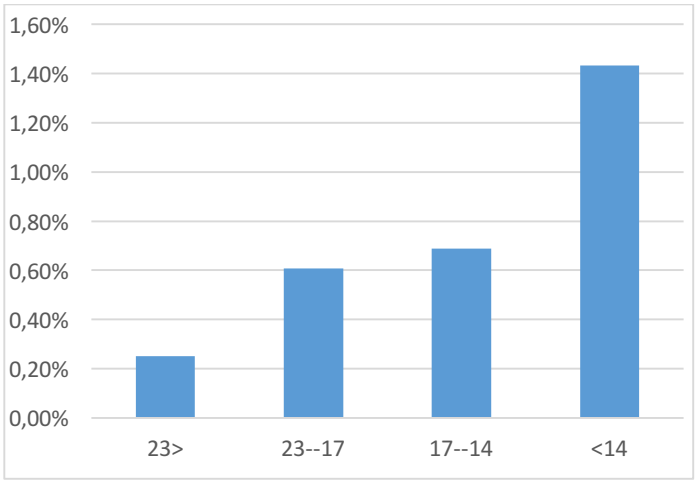

Figure 2.10: Average US Equities monthly return as a function of normalized P/E (1988-2017).

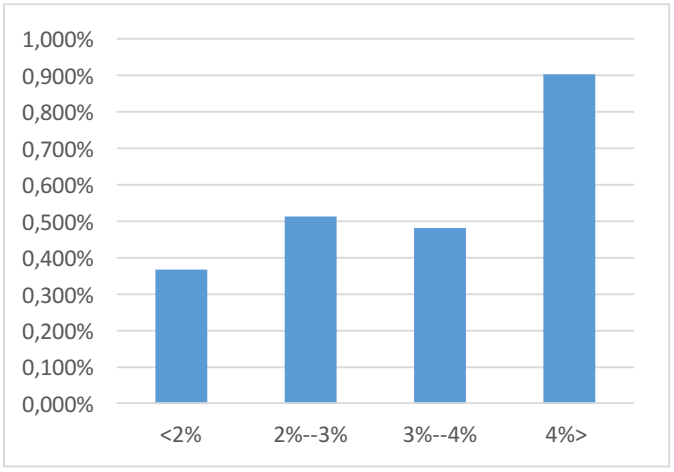

Figure 2.11: Average US T-notes monthly return as a function of yield over Expected Inflation (1988-2017).

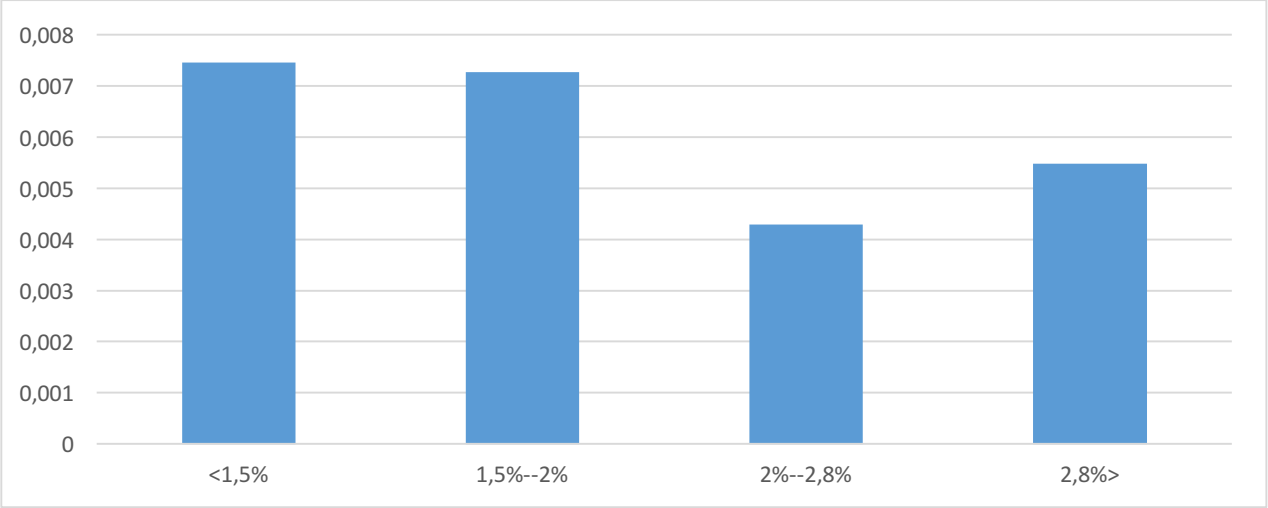

Figure 2.12: Average US Investment Grade Corporate Bond monthly return as a function of spread to US Treasuries (1988-2017).

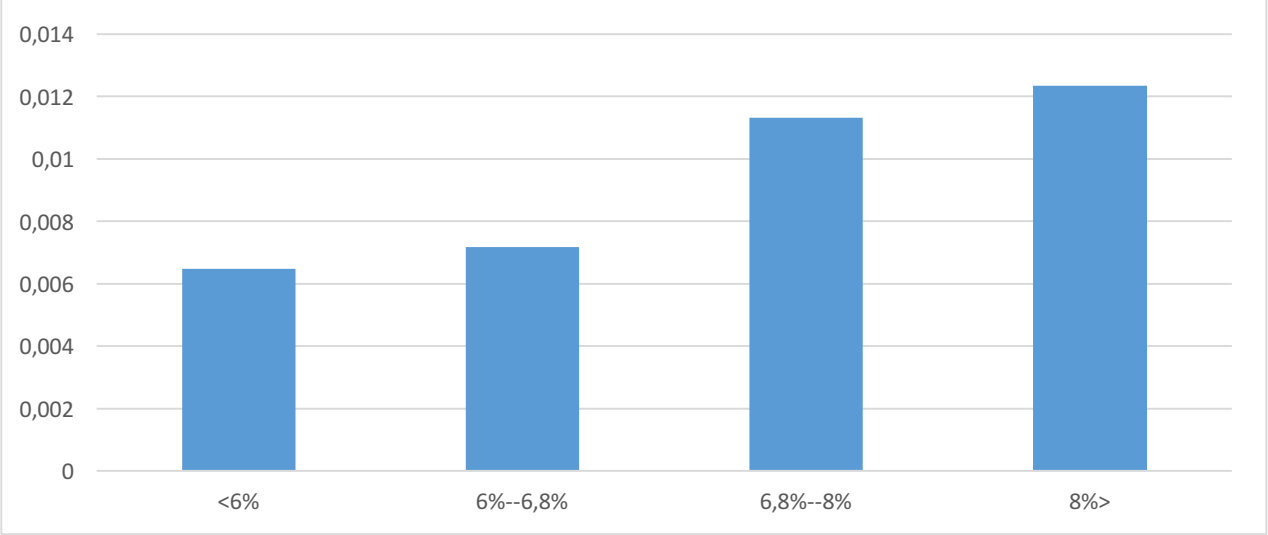

Figure 2.13: Average US Real Estate (REITs) as a function of Dividend Yield (1988-2017).

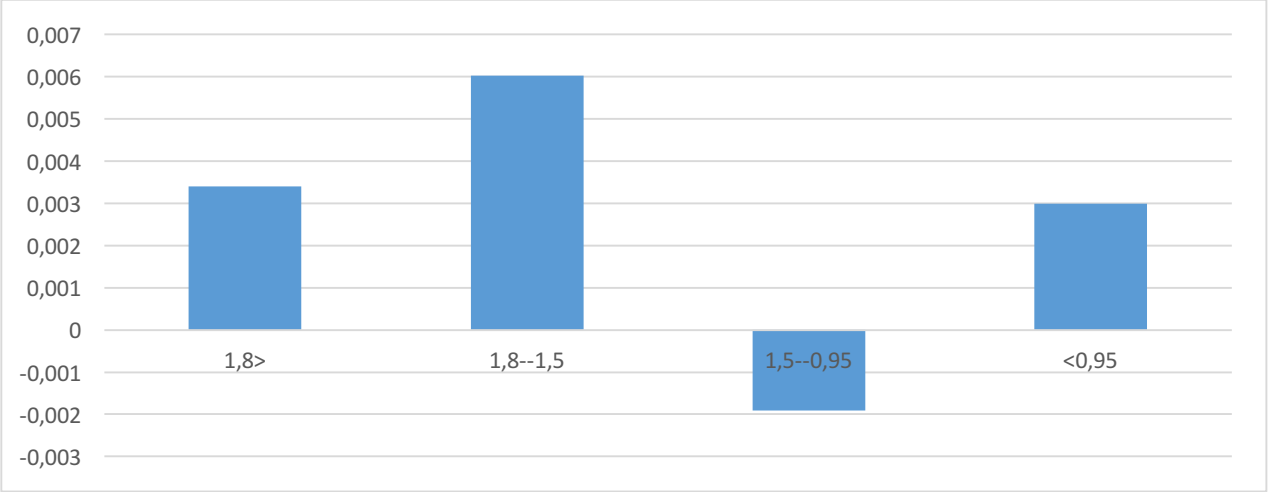

Figure 2.14: Average Commodities monthly return as a function of current price compared to 10-year average real price (1988-2017).

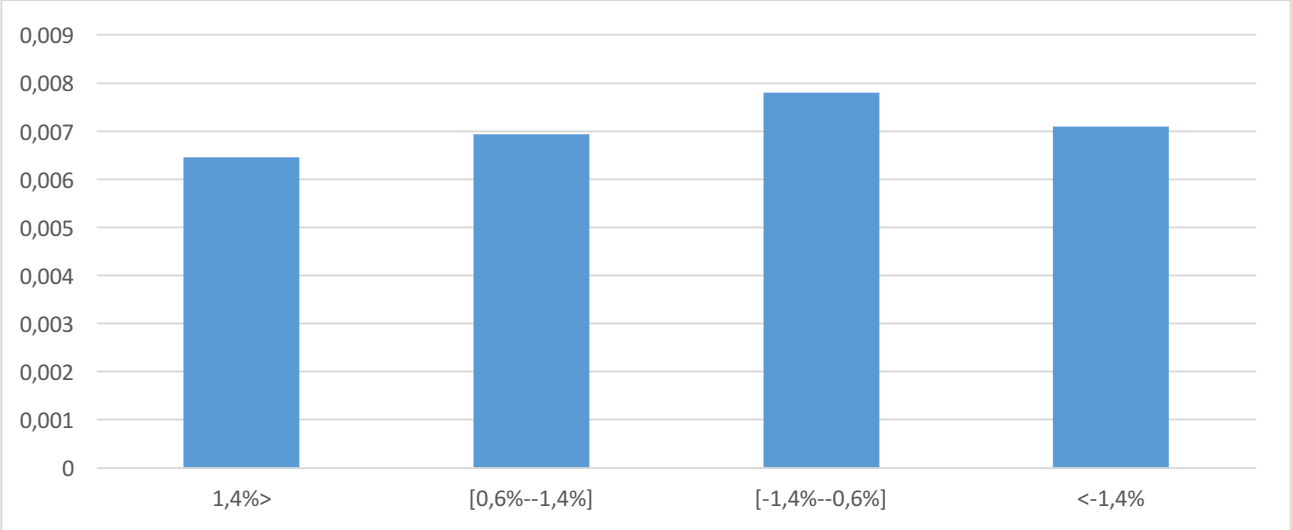

Figure 2.15: Average monthly return of US Value Stocks relative to US Broad equity index as a function of past 3 year outperformance of Value stocks (1995-2017).

The Value Factor are all good predictor for the respective asset classes, the only exception for Commodities since is evident in figure above that GSCI current price relative to 10 year Real average price produce unresonable prediction.

1.3 Measure of Momentum

In some ways, investing based on trend following is the antithesis of investing based on value. A leading professional trend following investment manager recently remarked: "Value based investing makes a lot of sense, but it doesn't work; trend following makes little sense, but it delivers". After so many years of observing the markets exhibit trends, we must recognize the possibility that momentum is as much a permanent feature of the market landscape as bubbles and crashes. In fact, many practitioners and theoreticians believe that momentum is an integral part of the process which gives us those booms and busts[7]. There are a number of explanations of why momentum is a fixed feature of financial markets. These explanations generally draw on a body of academic research called "behaviorial finance" and include well documented human behaviorial characteristics such as anchoring, the disposition effect, herding and confirmation bias. In addition, it seems that some elements of market structure, such as the effect of government intervention and VaR based risk management regimes, may also play a role in causing, or allowing, trends to exist8. We tend to favor the explanations that are based on feedback loops- what George Soros has explained at length in his books as "reflexivity".

The momentum metric used is the difference between today's price and the average inflation adjusted price over the past year. If the current price is above the average inflation adjusted price over the past year we assign a value of 1, otherwise 0.

Next chart show how predictive are Momentum signal calculating average monthly return as a function of positive momentum or negative momentum:

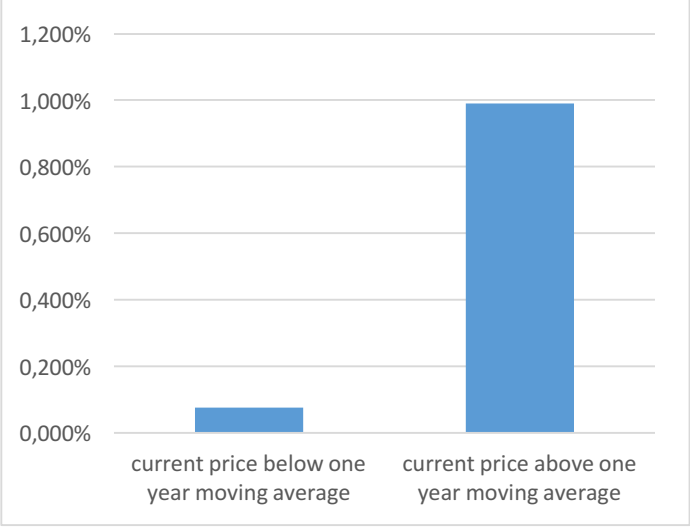

Figure 2.16: Avg US equities monthly return as a function of momentum signal.

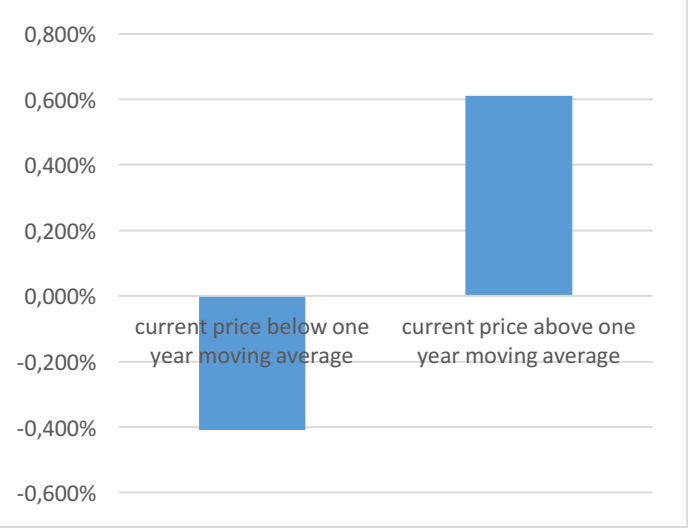

Figure 2.17: Avg US T-bond monthly return as a function of momentum signal.

[7] George Soros' reflexivity, Irving Fisher, Hyman Minsky, JM Keynes, and many others.

[8] See various AQR/Assness research for discussions of this area.

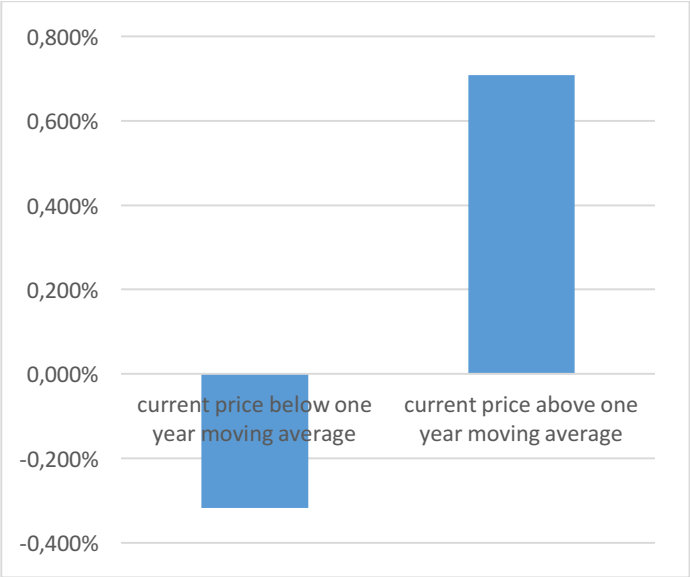

Figure 2.18: Avg US Investment Grade bond monthly Return as a function of momentum signal.

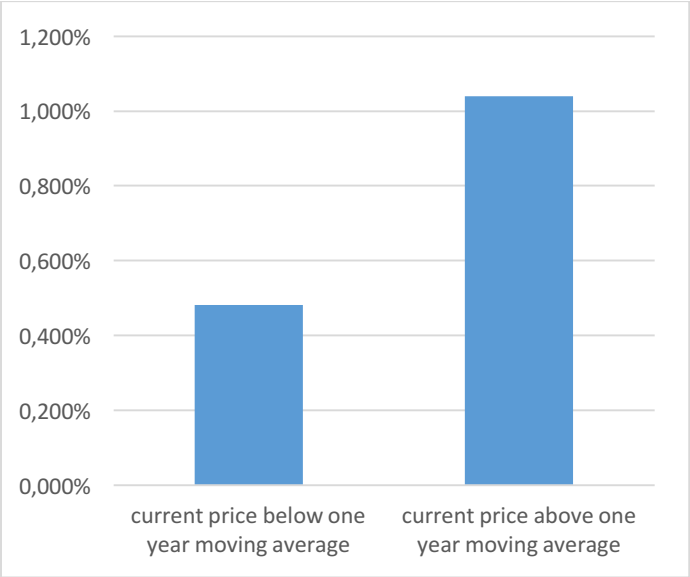

Figure 2.19: Avg US REIT monthly return as a function of momentum signal.

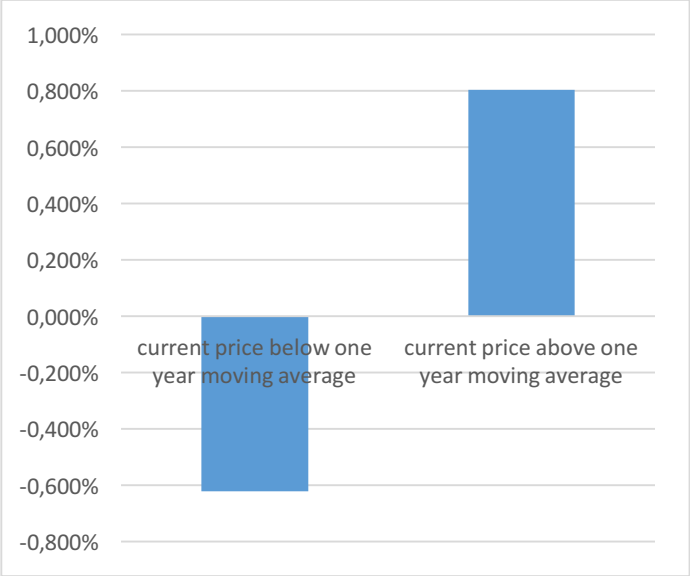

Figure 2.20: Avg GSCI monthly return as a function momentum signal.

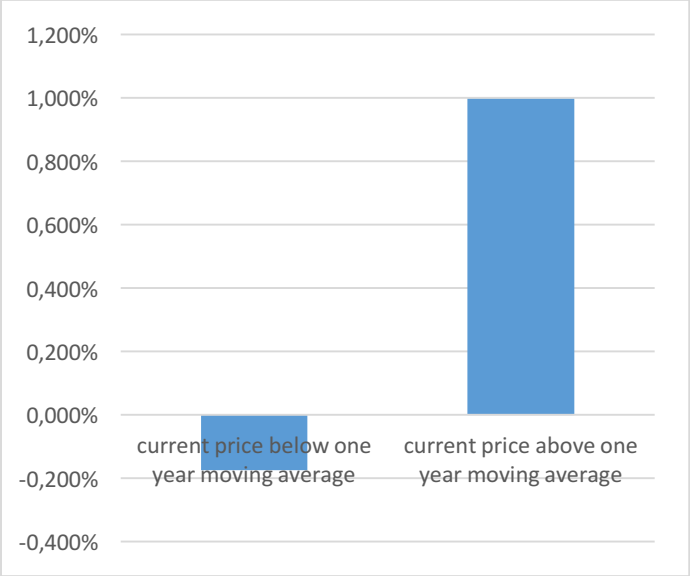

Figure 2.21: Avg US Value stock monthly return as a function of momentum signal.

CHAPTER 2

Results and Portfolio performance

2.1 Total Return Index Portfolio Performance

In this chapter I implement the strategies for the Baseline Portfolios adjusting weight for Value and Momentum factor, next table explain again what are fixed weight of Buy and Hold Baseline portfolios (detailed explanation of Baseline Portfolio Composition in Section 1.1):

	Baseline portfolio	
Core Domestic	Core plus Satellite	Global
30% US equities	15% US equities	10% US broad equities
20% UK equities £	15% US value equities	10% US value equities
10% Japan equities ¥	15% UK equities £	4,5% europe broad eq.
10% US corporate bond	10% Japan equities ¥	4,5% europe value eq.
10% high yield bond	5% em.mkt equities	2,5% UK broad eq. £
10% US 10 y T-notes	7,5% commodities	2,5% UK value eq. £
10% US 3 month T-bills	7,5% Real Estate US	3,5% Japan broad eq. ¥
	5% US corporate bonds	3,5% Japan value eq. ¥
	5% high yield bond	2% Pacific ex Japan broad
	10% US 10 y T-notes	2% Pacific ex japan value
	5% US 3 month T-bills	1% Canada broad eq.
		1% Canada value eq.
		8% em.mkt equities
		10% commodities
		10% Real Estate US
		2,5% US corporate bonds
		2,5% high yield bond
		10% US 10 y T-notes
		10% US 3 month T-bills

Table 3.1: Baseline Portfolios and weight of this study.

Here below are summarised Baseline portfolio asset allocation.

	Core Domestic	Core plus Satellite	Global
Equities	60%	60%	55%
Corporate Bond	20%	10%	5%
Treasury Bond	10%	10%	10%
Cash	10%	5%	10%
Commodities		7,50%	10%
Real Estate		7,50%	10%

Table 3.2: Baseline portfolio asset classes allocation of this study.

The studies show a number of interesting results related to the interaction of value and momentum factors in our portfolios. Scaling based on value or momentum alone or in combination, offers higher returns and Sharpe ratios than the static-weight Baseline portfolio.

The results of Buy and Hold, BH plus value and BH plus value plus momentum overlay are summarized in the Table below: the first one focus on annual Real return, standard deviation and Sharpe Ratio of Baseline Index Portfolio for the historical studies from 1988-2017 and 1999-2017[9]; the second one show standard deviation and Sharpe ratio of this Index Portfolios over the period 2008-2017 and 2012-2017.

"Core Domestic" Portfolio 1988-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	4,76%	5,3%	6,53%
standard deviation	8,59%	8,6%	8,42%
Sharpe ratio	0,21	0,27	0,43

"Core Domestic" Portfolio 1999-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	3,04%	3,3%	4,79%
standard deviation	8,66%	8,6%	8,01%
Sharpe ratio	0,12	0,16	0,35

"Core plus Satellite" Portfolio 1988-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	3,94%	4,3%	5,44%
standard deviation	9,25%	9,3%	8,93%
Sharpe ratio	0,11	0,15	0,28

"Core plus Satellite" Portfolio 1999-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	3,18%	2,9%	4,25%
standard deviation	10,3%	10%	9,45%
Sharpe ratio	0,12	0,09	0,24

"Global" Portfolio 1988-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	3,36%	4,2%	5,75%
standard deviation	10,88 %	11%	11,19%
Sharpe ratio	0,04	0,11	0,25

"Global" Portfolio 1999-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	3,18%	2,9%	4,67%
standard deviation	11,3%	11%	10,32%
Sharpe ratio	0,11	0,09	0,26

Table 3.3: Annualised Real Index Baseline Portfolio Returns, standard deviation and Sharpe ratio 1988 to 2017-1999 to 2017.

Return reported in the tables above are the sum of real annual geometric US dollar return, UK pound return, and Japanese Yen since FTSE100 and TOPIX/MSCI JAPAN are subscribed respectively in pound and yen. All three portfolio in each of the two studies in table above produce higher value Real return and Value plus momentum Real return than Buy and Hold portfolio.

Standard deviation and Sharpe Ratio are lower than Buy and Hold strategy only in the case of value plus momentum portfolios, otherwise in case of value portfolio are higher.

[9] All historical returns in this paper are geometric returns, not arithmetic averages of the annual returns

"Core Domestic" Portfolio 2008-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	4,07%	3,8%	5,17%
standard deviation	9,56%	9,9%	9,00%
Sharpe ratio	0,29	0,25	0,43

"Core Domestic" Portfolio 2012-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	7,89%	7,8%	8,37%
standard deviation	5,97%	5,7%	6,12%
Sharpe ratio	1,38	1,42	1,43

"Core plus settled yet" Portfolio 2008-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	2,29%	1,3%	1,76%
standard deviation	12,10 %	11%	11,01%
Sharpe ratio	0,08	0	0,04

"Core plus settled yet" Portfolio 2012-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	6,88%	5,7%	6,08%
standard deviation	7,00%	6,9%	7,82%
Sharpe ratio	1,04	0,88	0,82

"Global" Portfolio 2008-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	0,51%	-0,3%	0,94%
standard deviation	13,23 %	13%	11,85%
Sharpe ratio	-0,06	-0,13	-0,03

"Global" Portfolio 2012-2017	Buy and Hold	BH + value	BH + value + mom
Real Return	5,00%	3,8%	4,67%
standard deviation	7,54%	7,8%	7,66%
Sharpe ratio	0,71	0,54	0,66

Table 3.4: Annualised Real Index Baseline Portfolio Returns, standard deviation and Sharpe ratio 2002 to 2017-2012 to 2017.

As in the table before Core Domestic Portfolio show higher return with value plus momentum portfolio then Buy and Hold. This is not the case, in this recent historical studies, for Core plus Satellite and Global portfolios that produce higher return with Buy and Hold strategies. Here is evident how the value metric for GSCI is a bad predictor of Commodities return (Section 1.2), also because with REITs is the only difference in portfolios composition.

The historical returns presented above have all been index returns, without any subtraction for transactions costs. In practice, an investor will bear transaction costs in the form of fees, commissions and bid-offer spreads. In Section 3.1 will be specified the precise impact of transaction cost, the bulk of a portfolio would consist of funds an ETFs with annual fees less than 0.2%, although there would be some component of the portfolio with annual fees as high as 0.8%. It is felt that transaction cost in total would subtract less than 0.3% per annum from that returns that would be generated in the absence of all transactions costs.

In next charts are shown the evolution of a capital amount invested at start of 1988 in each of the Baseline Index portfolios and in each of the three strategies, Buy and Hold (BBH), Buy and Hold plus Value and Buy and Hold plus Value plus Momentum. The evolution is represented by the monthly Net Asset Value of the Baseline Index Portfolios.

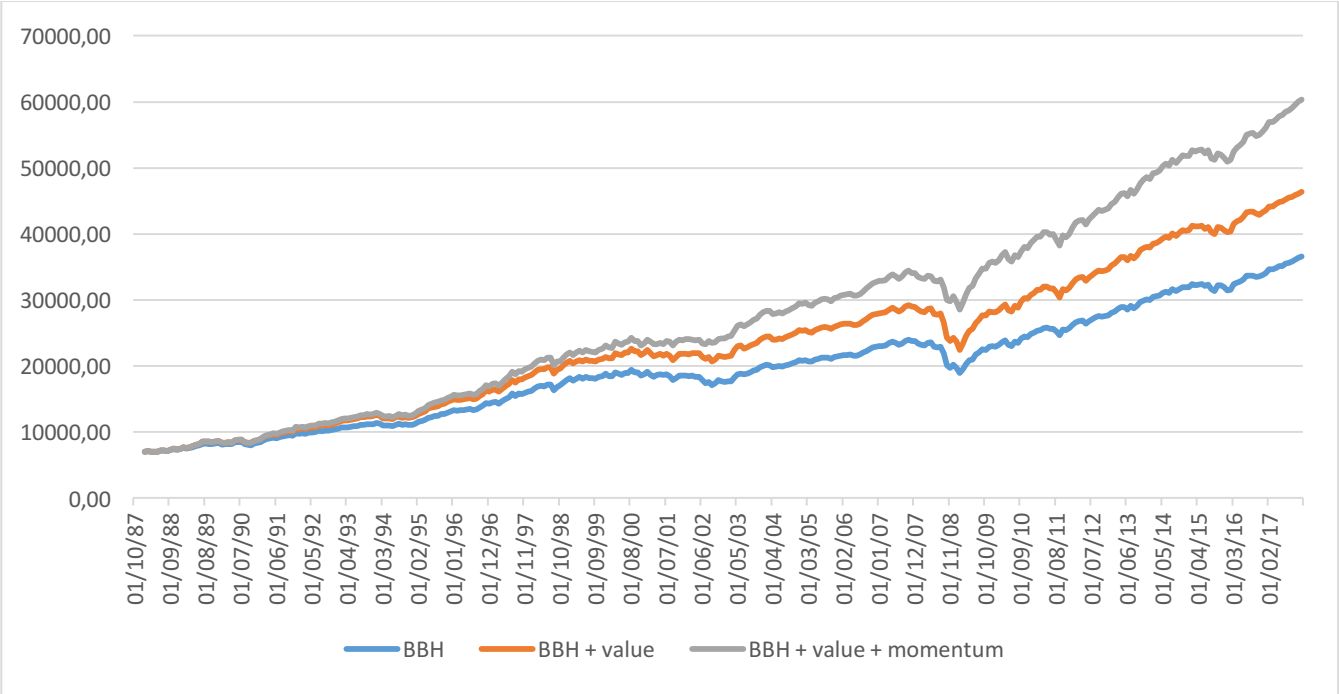

Figure 3.1: NAV of "Core Domestic" Portfolio strategies Buy and Hold, BH + Value, BH+ Value + Momentum 1988-2017 (dollar evolution).

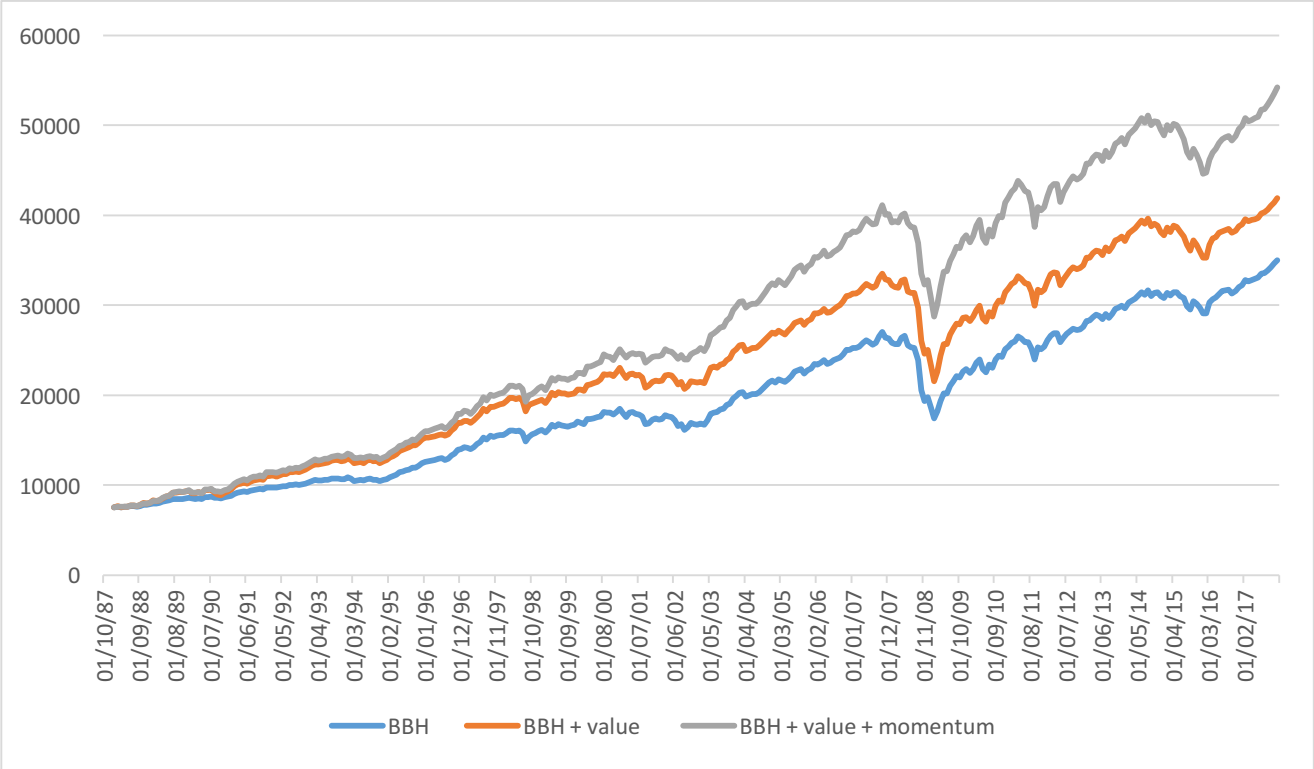

Figure 3.2: NAV of "Core plus Satellite" Portfolio strategies Buy and Hold, BH + Value, BH+ Value + Momentum 1988-2017 (dollar evolution).

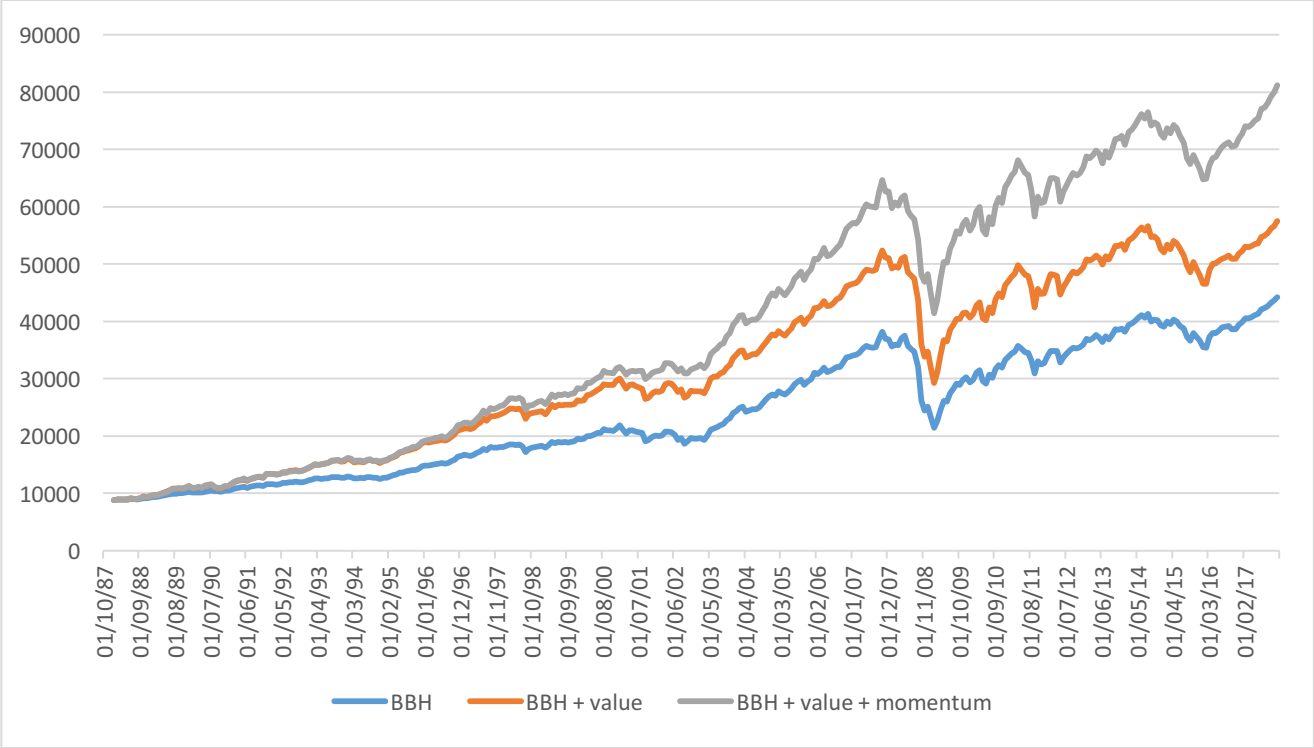

Figure 3.3: NAV of "Global" Portfolio strategies Buy and Hold, BH + Value, BH+ Value + Momentum 1988-2017 (dollar evolution).

In each of the portfolios analysed the Buy and Hold plus Value plus Momentum Strategy have over performed the simple Buy and Hold and the Buy and Hold plus Value from 1988 to 2017. Also other shorter historical time window performances (not reported here) show this positive trend of Value and Momentum returns. The Portfolio that reached higher return is Portfolio 1 that remark the particular negative effect of Diversification to Portfolio returns.

2.2 Relationship between Value and Momentum

In order to analyse relationship between Value and Momentum measure it was calculate correlation of the two series of signal. The correlation coefficents are summarized in this table:

Asset	Correlation coefficent
US equities	-0,17
UK equities	0,11
Europe ex UK Equities	0,09
Japan Equities	0,20
Pacific ex Japan Equities	0,10
Canada Equities	0,00
Emerging Market Equities	0,09
US REITs	-0,26
Commodities GSCI	-0,47
US Nominal Treasuries	0,04
US Credit	0,18

Table 3.5: Correlation of Value and Momentum Signal, Portfolio 3 (1988-2017).

For Equities Value Signal we have less data since P/E before 2008 are available only on quarterly frequency. For this reason they are almost uncorrelated, if we calculate monthly P/E form quarterly and again the correlation, Equities assets have negative correlation as other assets. The negative correlation of signal could be cover the risk of negative performance during downturns periods.

The other relationship is shown in the three charts below show the average monthly return for US Equities, US T-notes, and Real Estate when Value and Momentum are giving the same signal, in this case they tend to be more strongly predictive than either is on its own unconditionally. The second and fourth column represent average return when we consider positive or negative momentum irrespective of value.

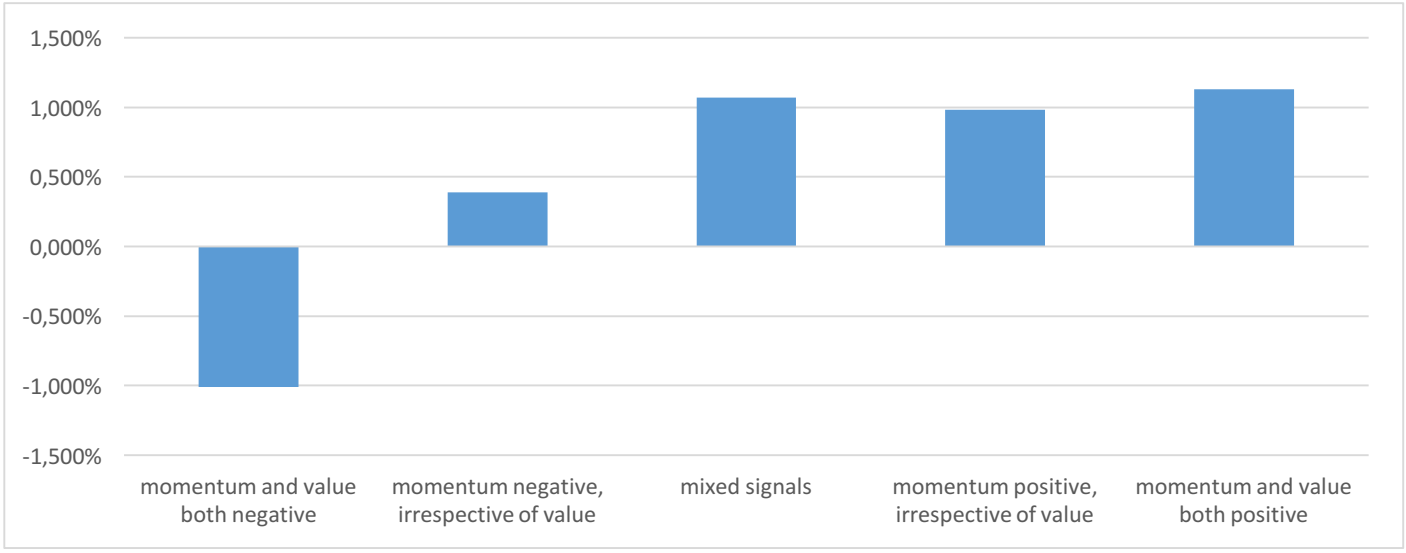

Figure 3.4: Average US Equities monthly return as a function of the value of the signal.

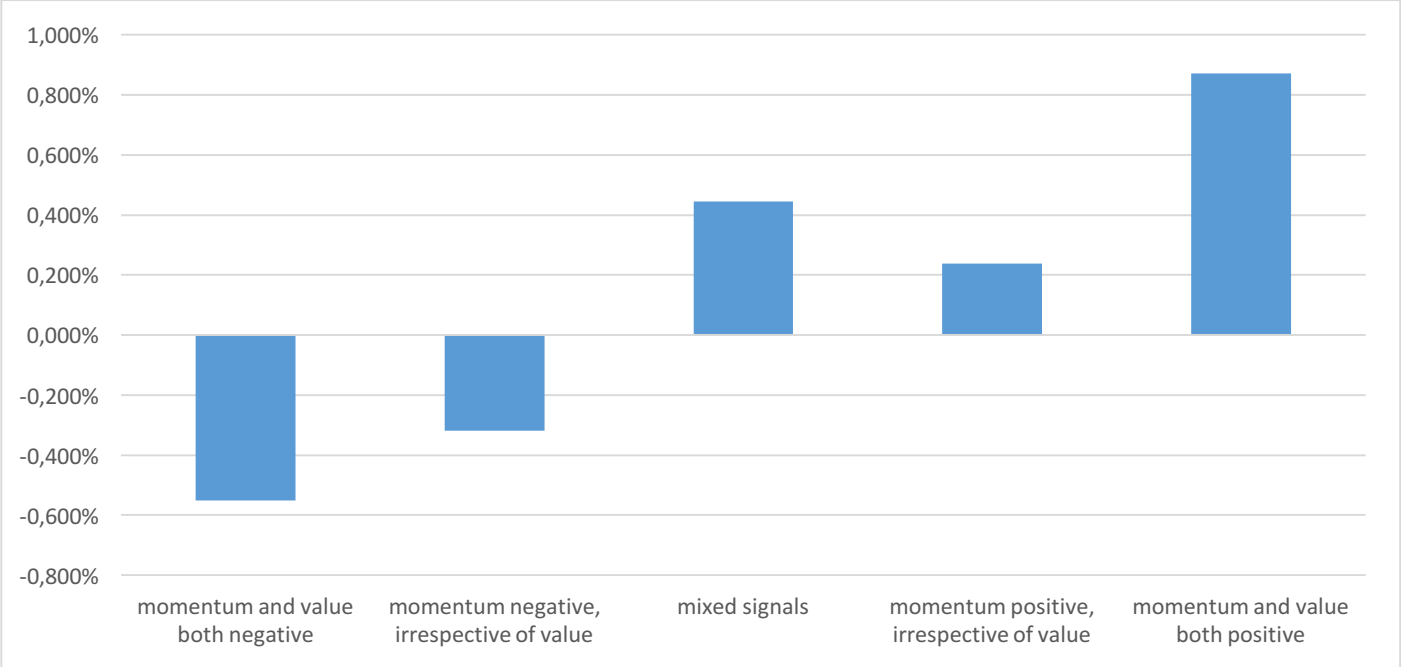

Figure 3.5: Average US T-notes monthly return as a function of the value of the signal.

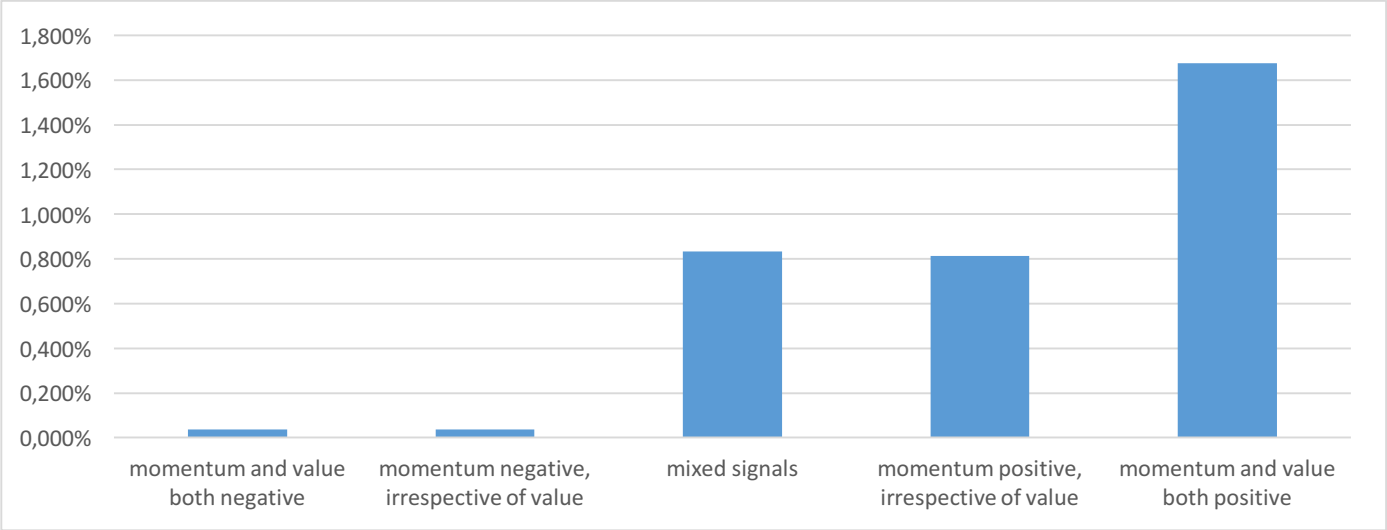

Figure 3.6: Average US REITs monthly return as a function of the value of the signal.

Each of the relationships between value and momentum factor evidence that when value and momentum signal are positively aligned securities performance experienced superior returns (last column of each graphs).

CHAPTER 3

Replication Strategy with ETFs

3.1 ETF Total Return

In order to replicate Total Return Index portfolios I take the weight of Index Portfolio and with this weight calculate ETFs portfolio return and Standard deviation.

To calculate portfolios returns it was chosen ETFs Total Return that take into account for Dividend.

What I do in this Section is try to replicate the series of ETFs Total Return starting from the non Total Return series and adding periodically the dividend yield of the fun analysed.

Next charts show the evolution of the series of price for VTI ETF TR, ISF LN ETF TR, IEF US ETF TR (red line) and VTI ETF, ISF LN ETF, IEF US ETF with periodically adjustment for dividend (blue line).

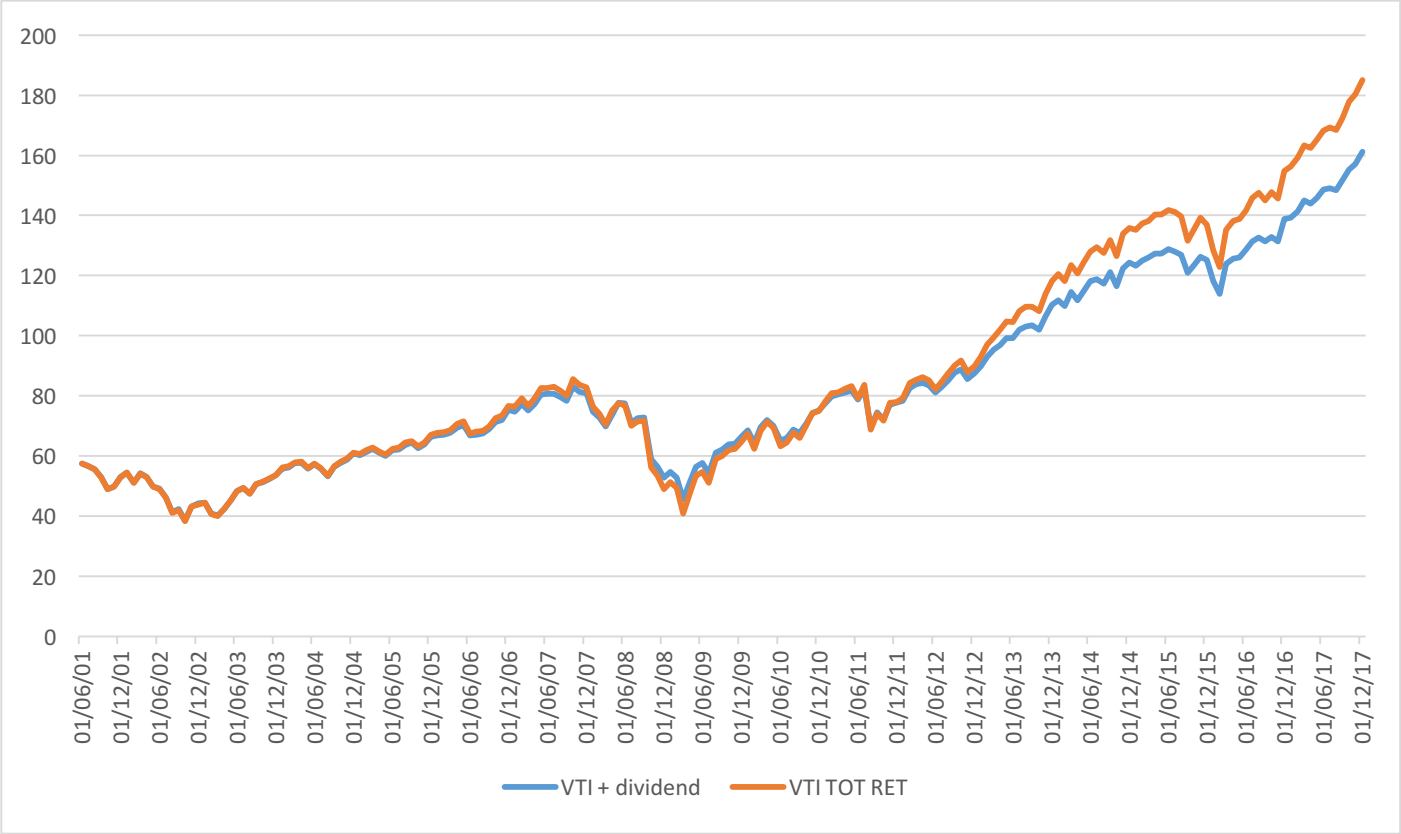

Figure 4.1: Evolution of VTI ETF Total Return relate to VTI ETF plus dividend.

For VTI ETF and ISF LN ETF the dividend arise on a quarterly basis, IEF US ETF on a monthly basis.

The Total Return ETFs series are for a 10% greater than the ETFs plus dividend in each of the three ETFs analysed. This difference can be explained by the fact that the ETFs plus Dividend does not consider the reinvestment of dividend in the ETFs but only summed to prior dividend ETFs price[10] giving the ETF adjusted price. What a long horizon trader has to do when receive Dividend Is to reinvest it so our consideration of ETFs series are the Total Return as with Index Portfolios.

[10] See Appendix for a more detailed explanation of estime.

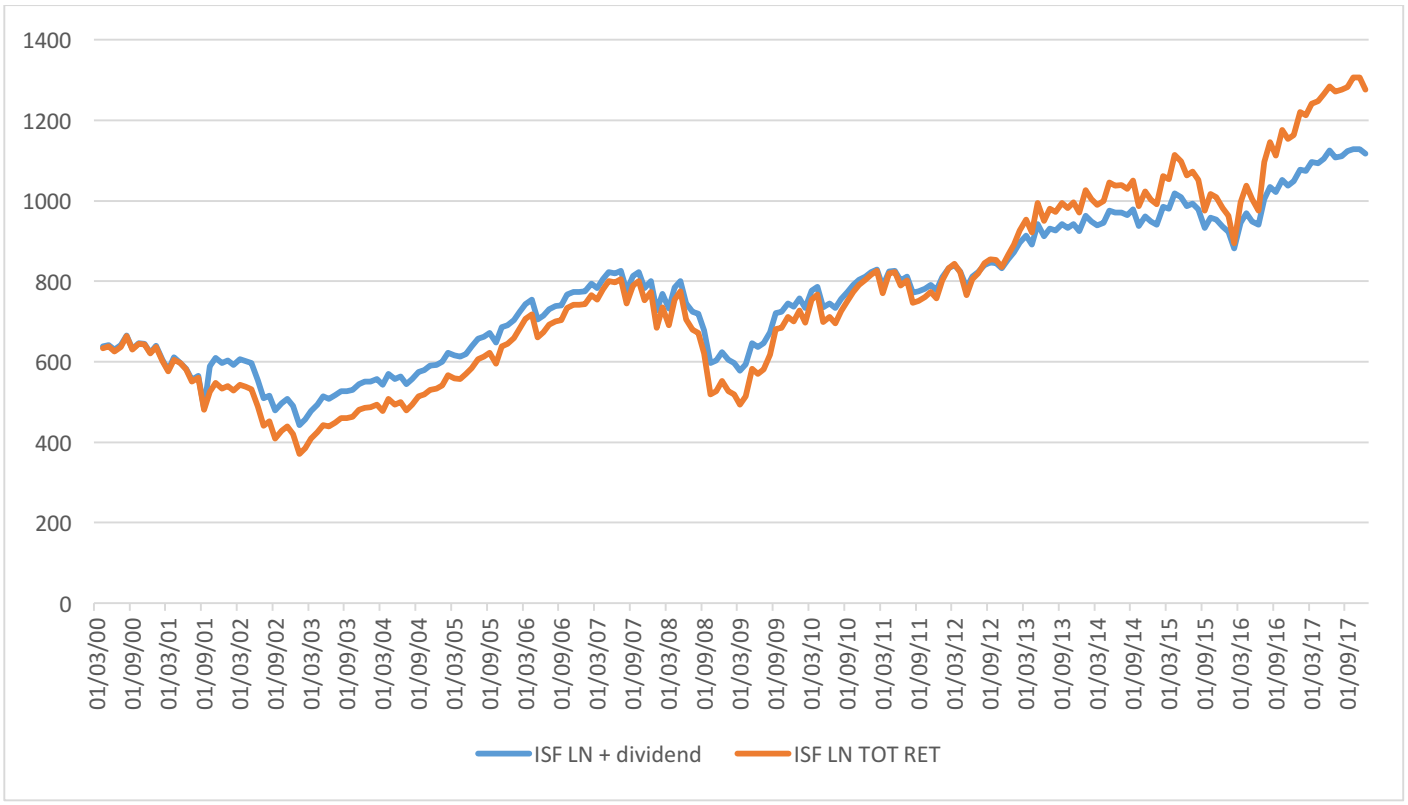

Figure 4.2: Evolution of ISF LN ETF Total Return relate to ISF LN ETF plus dividend.

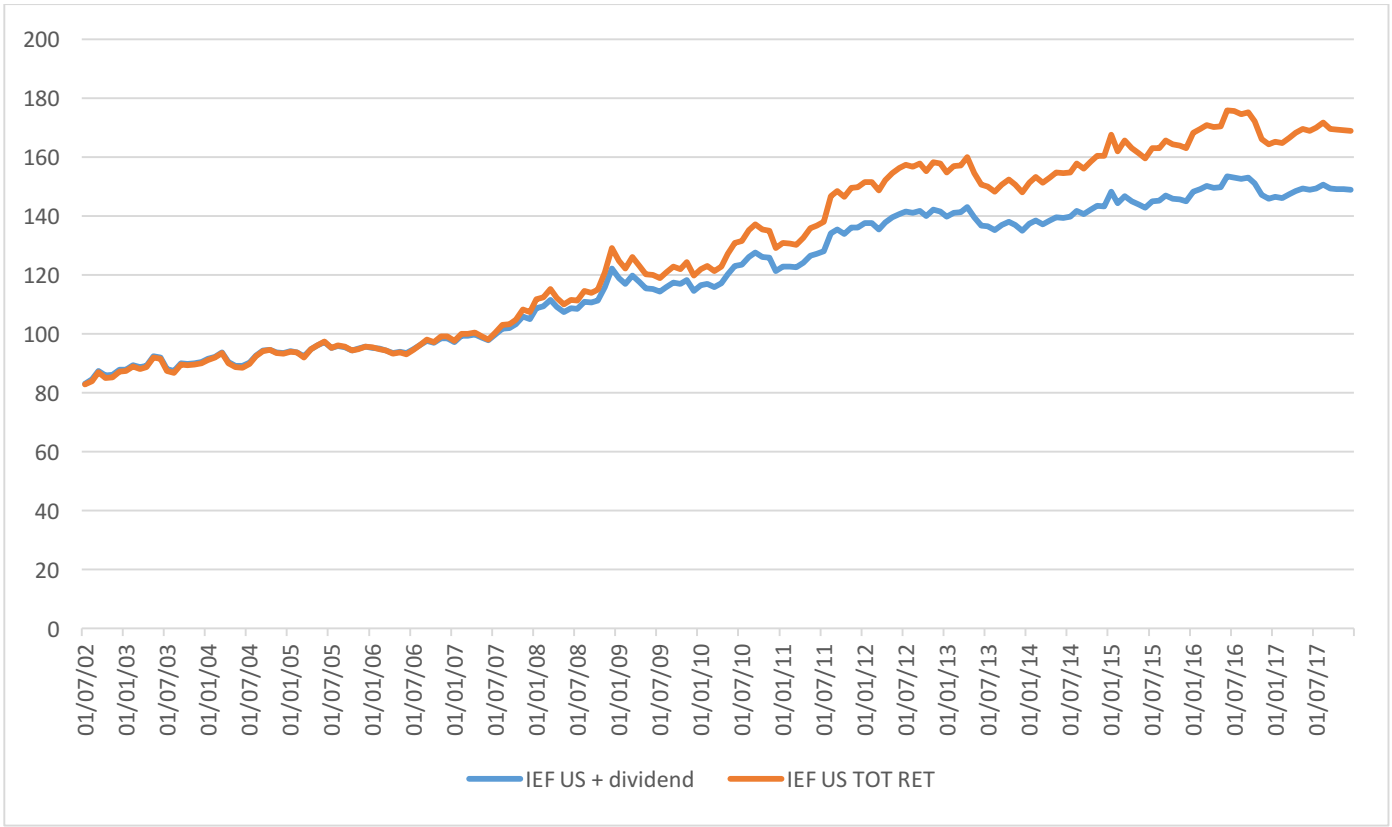

Figure 4.3: Evolution of IEF US ETF Total Return relate to IEF US ETF plus dividend.

Below is a list (as of December 2017) of a set of Exchange traded funds which are used to replicate the total return index portfolio strategies in this study. Annual fees and transaction costs in general on these investments is very low, and has been falling over the recent past as more assets have gravited towards these vehicles, resulting in economies of scale in terms of management fees. Also, the performance of these funds versus their benchmark indices have been improving as the managers become more savvy in following strategies to reduce or eliminate transaction cost.

TICKER	NAME	annual fees
VTI US Equity	VANGUARD TOTAL STOCK MKT ETF	0.07%
VGK US Equity	VANGUARD FTSE EUROPE ETF	0.16%
ISF LN Equity £	ISHARES CORE FTSE 100	0.4%
EWJ US Equity ¥	ISHARES MSCI JAPAN ETF	0.16%
EPP US Equity	ISHARES MSCI PACIFIC EX JAPA	0.5%
EWC US Equity	ISHARES MSCI CANADA ETF	0.53%
EEM US Equity	ISHARES MSCI EMERGING MARKET	0.27%
GSCIUSD SW Equity	S&P GSCI THEAM EASY UCITSETF	0.75%
VNQ US Equity	VANGUARD REIT ETF	0.13%
LQD US Equity	ISHARES IBOXX INVESTMENT GRADE	0.12%
VWEAX US Equity	VANGUARD HI YLD CORP-ADM	0.15%
IEF US Equity	ISHARES 7-10 YEAR TREASURY B	0.11%
IVE US Equity	ISHARES S&P 500 VALUE ETF	0.14%
VTRIX US Equity	VANGUARD INTERNATIONAL VALUE	0.45%

Table 4.1: ETFs used to replicate strategies.

In this study was excluded alternative asset for some reason: Investing in alternatives requires a commitment of quite a lot of resources to identify, or get access to, the successful managers. Paying someone else to perform those functions, such as a fund of funds, has not produced very attractive returns.

Historical data on alternative assets is not readily available prior to 1990 and the quality of the data is notorious for overestimated returns due to various biases in the construction of the databases, such as backfill and survivorship bias.

Historical returns for hedge funds, private equity and venture capital as overall asset classes, do not look very attractive on a historical basis, although there does seem to be some persistence in returns for funds that have

been successful in the past[11]. Getting direct access to those top performing funds is difficult and/or costly, and not practical for most investors.

It may be that a good part of the special returns generated by alternative investments are captured by the approach outlined in this paper. For instance, exposure to value stocks and momentum are two relatively common sources of return in the alternative space.

Creating a diversified portfolio of alternative assets, without relying on fund of funds, requires a large amount of capital, as most funds have fairly significant minimum investment requirements.

[11] Sandhill Econometrics has some data, and Dow Jones may be publishing it.

3.2 Replication Portfolio Return and Risk

In this Section it is highlighted how our replication strategy has worked in time with respect to Index Portoflios. What it is done to replicate Total Return Index portfolios is to take the weight of Index Portfolio and with this weight calculate ETFs portfolio return and Standard deviation.

Next Table contain Real return for ETFs Portfolio, standard deviation and Sharpe ratio:

"Core Domestic" Portfolio 2002-2017	BH	BH + V	BH + V + M
Real Return	4,18%	4,03%	5,21%
standard deviation	8,56%	8,89%	8,36%
Sharpe ratio	0,26	0,24	0,39

"Core plus Satellite" Portfolio 2002-2017	BH	BH + V	BH + V + M
Real Return	3,67%	2,90%	4,80%
standard deviation	9,21%	9,29%	8,77%
Sharpe ratio	0,19	0,1	0,33

"Global" Portfolio 2002-2017	BH	BH + V	BH + V + M
Real Return	3,34%	1,95%	4,52%
standard deviation	10,68%	10,16%	9,68%
Sharpe ratio	0,13	0	0,27

Table 4.2: Annualised Real ETFs Baseline Portfolio Returns 2002 to 2017.

"Core Domestic" Portfolio 2008-2017	BH	BH + V	BH + V + M
Real Return	3,69%	3,03%	4,26%
standard deviation	9,71%	10,11%	9,42%
Sharpe ratio	0,24	0,17	0,31

"Core plus Satellite" Portfolio 2008-2017	BH	BH + V	BH + V + M
Real Return	2,36%	1,16%	2,93%
standard deviation	10,66%	10,81%	9,99%
Sharpe ratio	0,1	-0,02	0,16

"Global" Portfolio 2008-2017	BH	BH + V	BH + V + M
Real Return	0,78%	-0,65%	1,45%
standard deviation	11,95%	11,53%	10,65%
Sharpe ratio	-0,05	-0,17	0,01

Table 4.3: Annualised Real ETFs Baseline Portfolio Returns 2008 to 2017.

"Core Domestic" Portfolio 2012-2017	BH	BH + V	BH + V + M
Real Return	7,49%	7,24%	8,32%
standard deviation	5,88%	5,44%	5,44%
Sharpe ratio	1,33	1,4	1,6

"Core plus Satellite" Portfolio 2012-2017	BH	BH + V	BH + V + M
Real Return	6,81%	5,80%	7,18%
standard deviation	5,82%	5,63%	6,35%
Sharpe ratio	1,23	1,09	1,19

"Global" Portfolio 2012-2017	BH	BH + V	BH + V + M
Real Return	5,05%	3,08%	4,97%
standard deviation	6,28%	5,96%	6,35%
Sharpe ratio	0,86	0,58	0,84

Table 4.4: Annualised Real ETFs Baseline Portfolio Returns 2012 to 2017.

Also in this case, as with Index Portfolio returns, ETFs Portfolio 1 over performed the others in each of the historical periods analysed.

3.4 Bottom up approach to replication strategy

My Portfolio construction is based on a top down approach of asset selection. Indeed, value and momentum factor are on Macro Index and not on particular value and momentum stock inside different markets. This second strategy is tipically of a bottom up approach that in this study is not implemented but it could be through the use of particular ETF that follow value and momentum investment strategy inside Stock market.
What I do in my study is to use Value Stock ETFs to capture value factor but I don't use momentum Stock ETFs as AMOMX ETF or AIMOX ETF (AQR fund) that could capture momentum factor among value stock but since since was emitted in 2009 does not permit a significant valuation.

Chapter 4

Replication Strategy Performance

4.1 ETFs Portfolio versus Index Portfolio evolution of capital

In this Chapter I want to show if for a retail investor is possible to replicate strategies discussed in this study and if do it is profitable as with Index.

Next charts plot the evolution of a capital amount invested in the Baseline Index Portfolios (blu lines) in relationship with the evolution of a capital amount (same amount) invested in a Baseline ETFs Portfolios (red lines).

The Index and ETF Portfolios NAV are based only on the dollar return and not considering returns of UK and Japan ETF.

What practically I do is to take Baseline Index Portfolios as benchmark and see if ETFs Portfolios reached the same performance. In each Figure is highlighted also excess return.

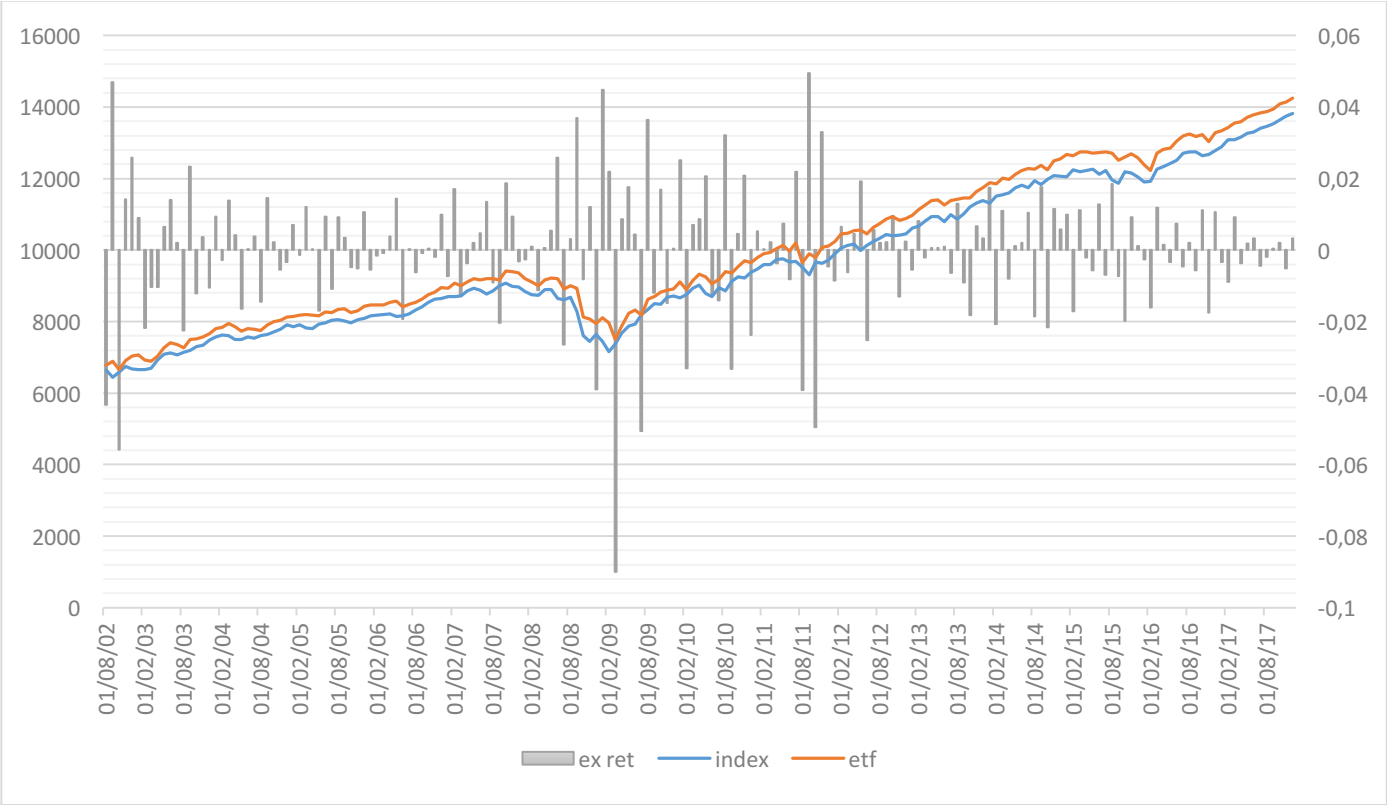

Figure 5.1: Index "Core Domestic" Portfolio NAV relate to ETFs "Core Domestic" Portfolio NAV, Baseline Buy and Hold (2002-2017).

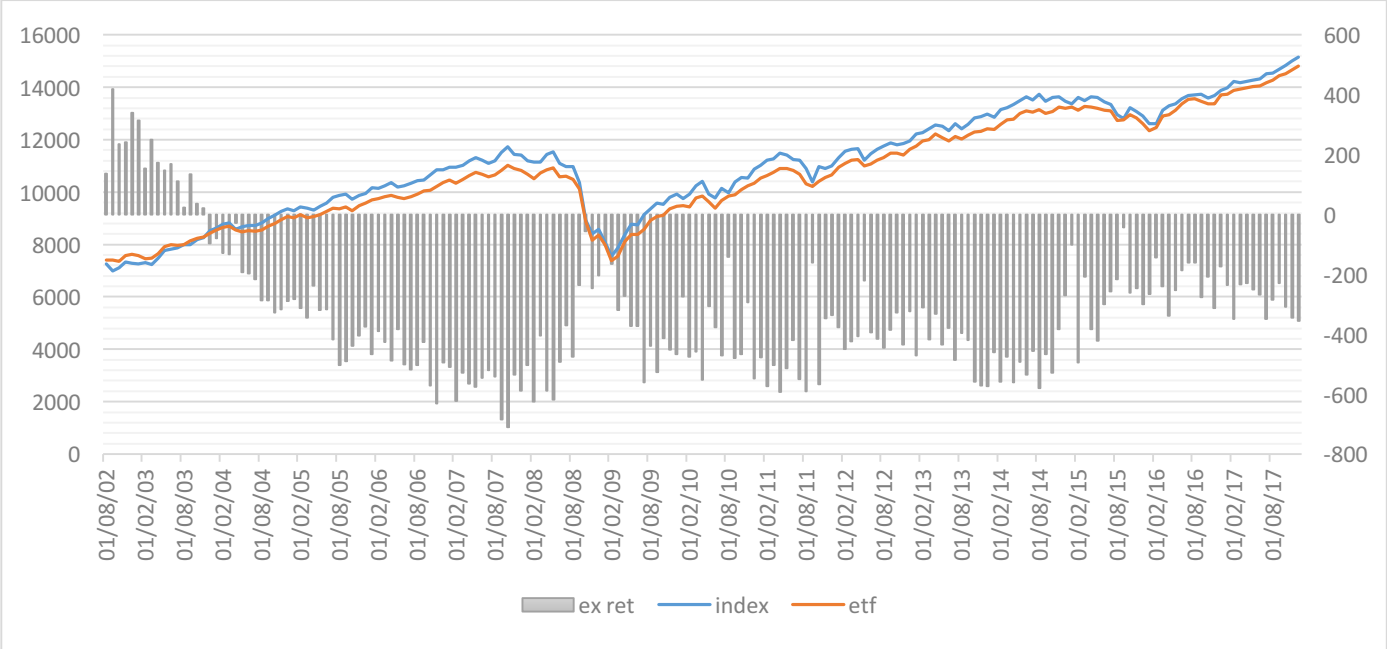

Figure 5.2: Index "Core plus Satellite" Portfolio NAV relate to ETFs "Core plus Satellite" Portfolio NAV, Baseline Buy and Hold (2002-2017).

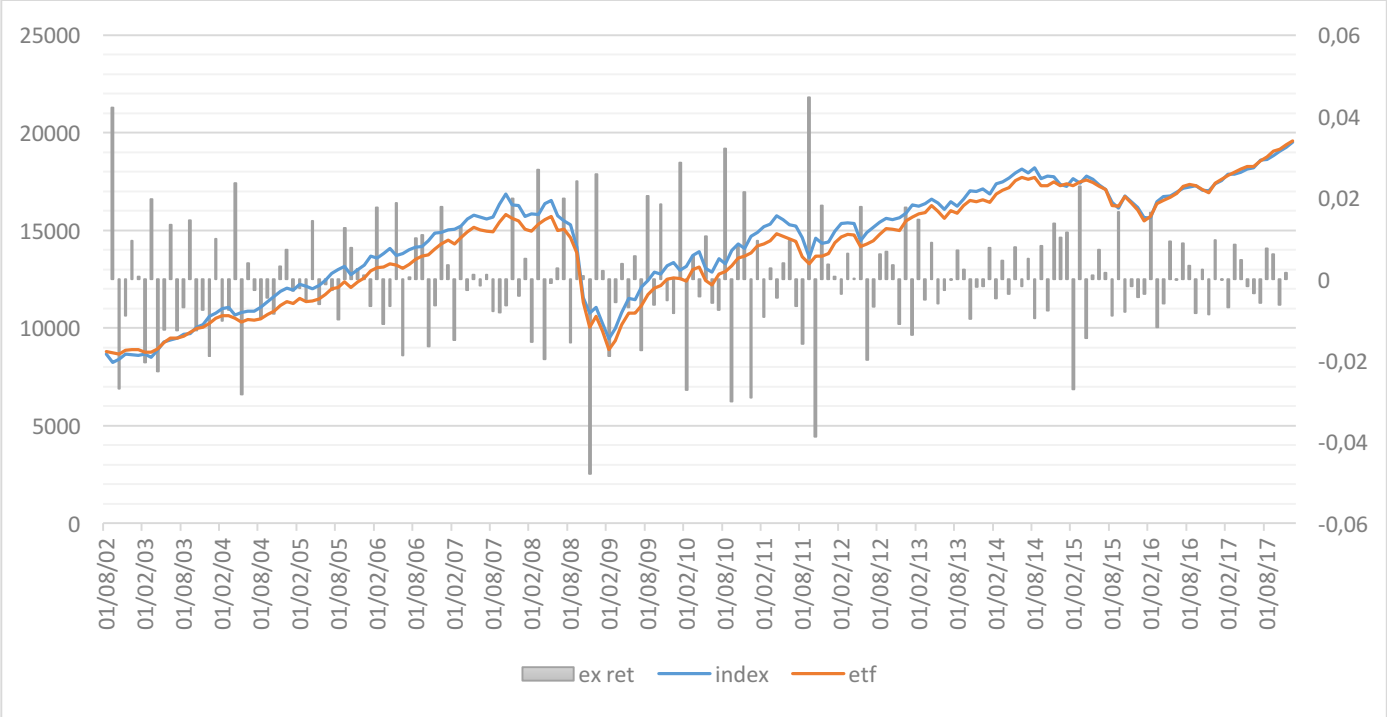

Figure 5.3: Index "Global" Portfolio NAV relate to ETFs "Global" Portfolio NAV, Baseline Buy and Hold (2002-2017).

This last charts show the evolution of a dollar amount invested in Index and ETFs Portfolios rebalanced to value signal only and to value and momentum together. What is relevant is that applying the same value and momentum weight of Index Portfolio strategies is possible to replicate passively the performance of those Portfolios strategies and in some case is possible to achieve extra performance.

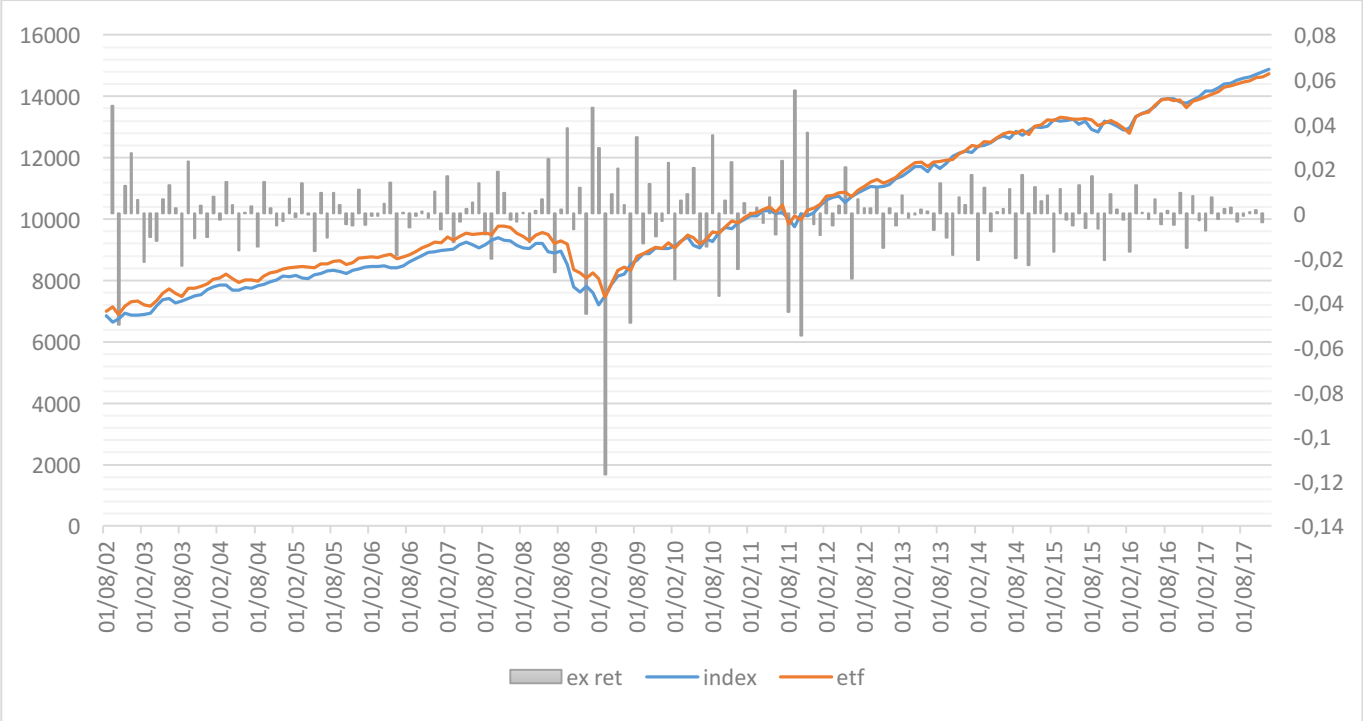

Figure 5.4: Index "Core Domestic" Portfolio NAV relate to ETFs "Core Domestic" Portfolio NAV BBH + Value (2002-2017).

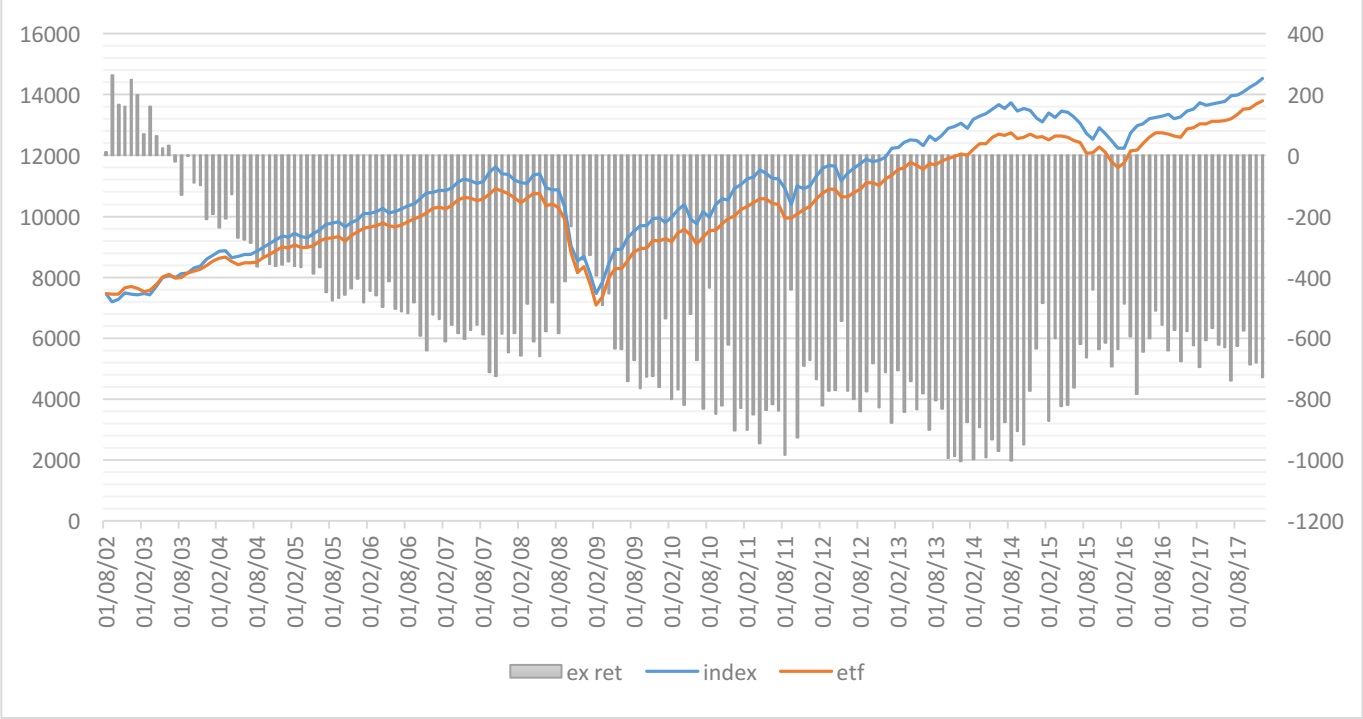

Figure 5.5: Index "Core plus Satellite" Portfolio NAV relate to ETFs "Core plus Satellite" Portfolio NAV, BBH + Value (2002-2017).

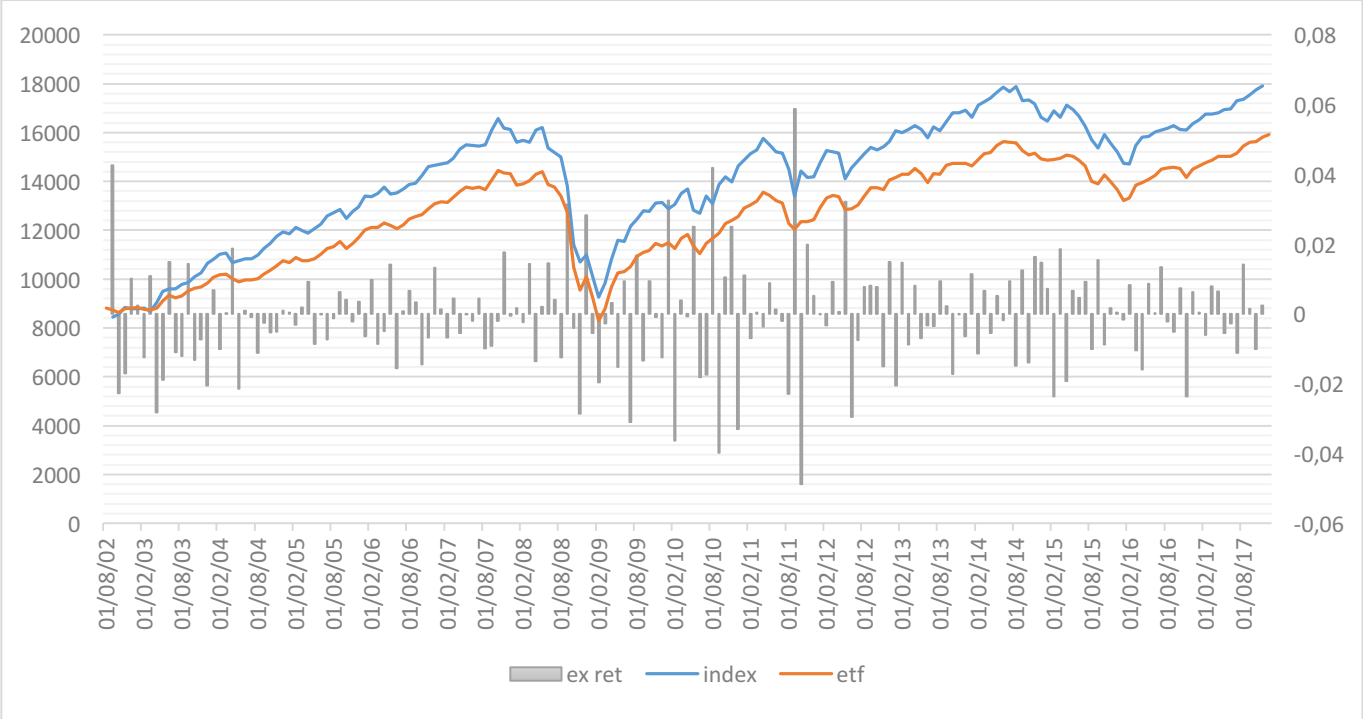

Figure 5.6: Index "Global" Portfolio NAV relate to ETFs "Global" Portfolio NAV, BBH + Value (2002-2017).

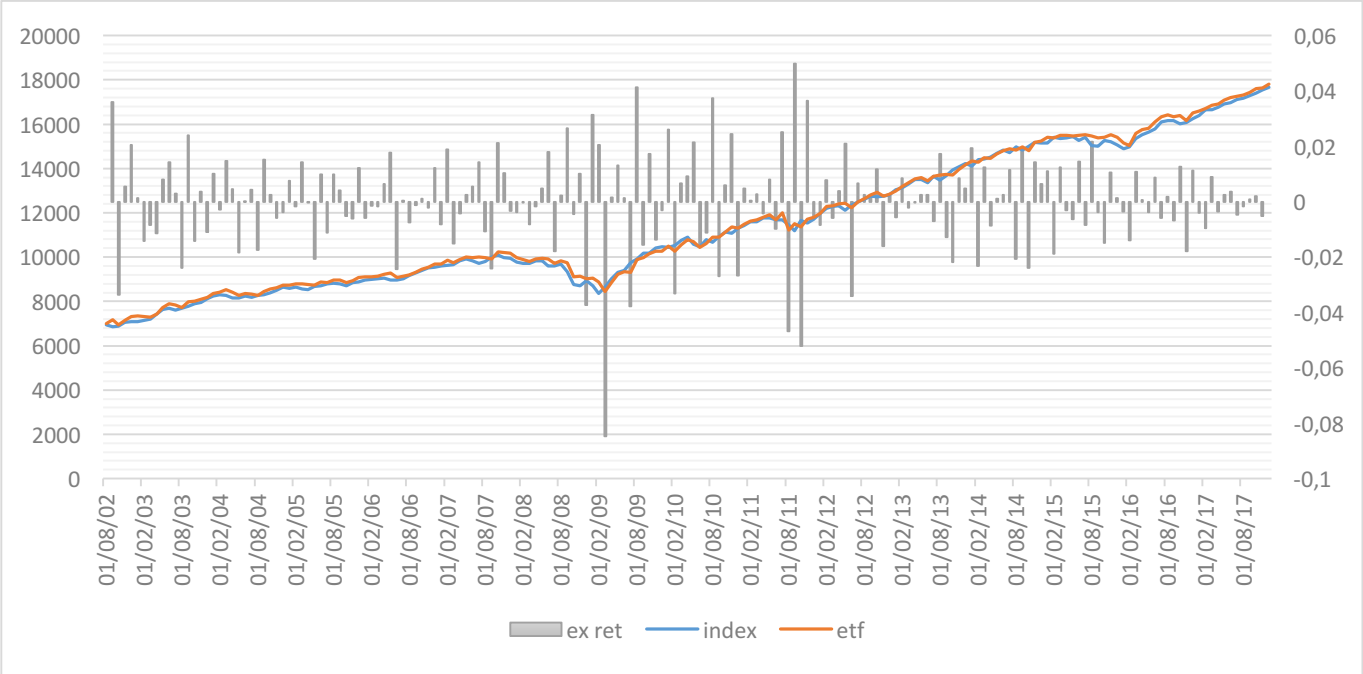

Figure 5.7: Index "Core Domestic" Portfolio NAV relate to ETFs "Core Domestic" Portfolio NAV, BBH + Value + Momentum (2002-2017).

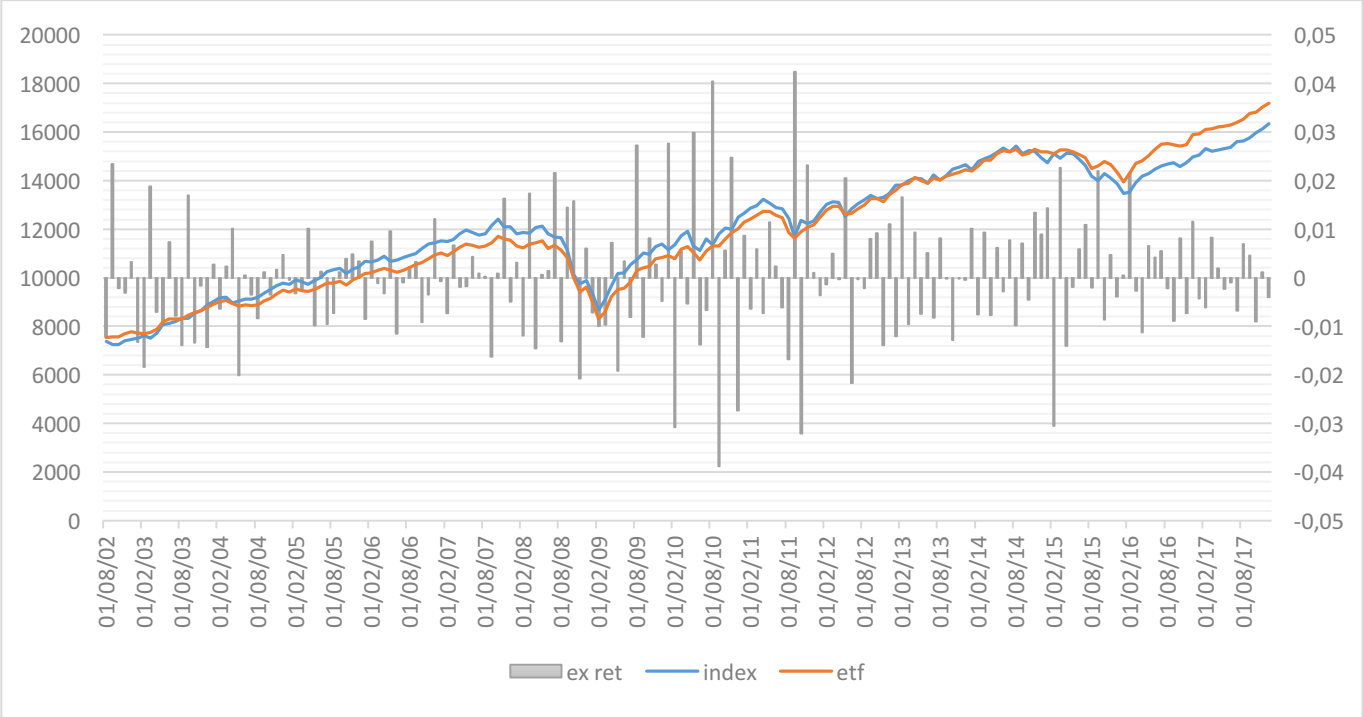

Figure 5.8: Index "Core plus Satellite" Portfolio NAV relate to ETFs "Core plus Satellite" Portfolio NAV, BBH + Value + Momentum (2002-2017).

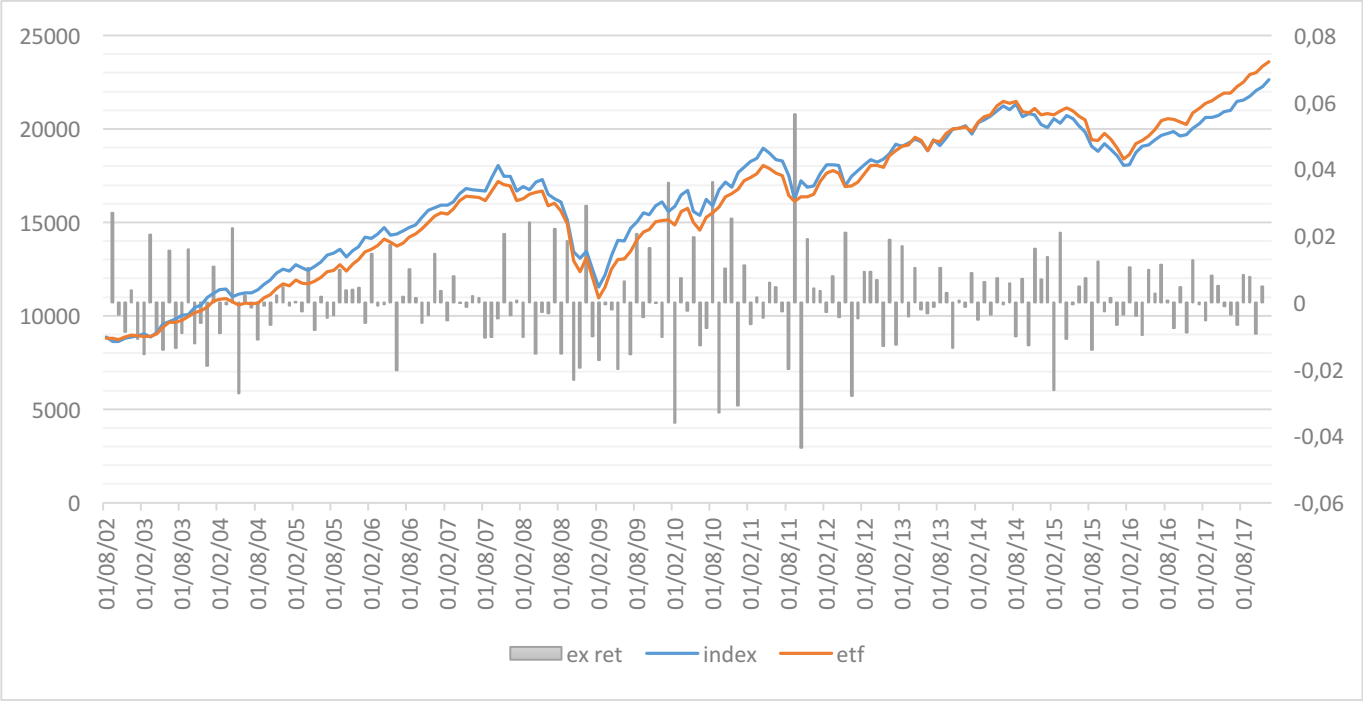

Figure 5.9: Index "Global" Portfolio NAV relate to ETFs "Global" Portfolio NAV, BBH + Value + Momentum (2002-2017).

The charts contained in this Section show the relevance of the replicability of Buy and Hold, Buy and Hold plus Value and Buy and Hold plus Value plus Momentum strategies with ETFs Portfolio.
The Index portfolios analysed are replicable almost perfectly with ETFs, especially Buy and Hold and Buy and Hold plus Value plus Momentum have a replication strategy that historically give higher return than Index Portfolios strategies.

3.4 Tracking Error Volatility and Information ratio "Global" Portfolio

In this last Section I analysed for the "Global" Portfolio the Tracking Error, Tracking Error Volatility and Information Ratio. Those are measure of efficiency of management. In this case I want to show that in particular IR are near the zero in order to have perfect passive replication strategy of Index Portfolio.
This measure of efficiency are summarized in next table.

Global 2002-2017	Buy and Hold	BH + V	BH + V + M
TE	-0,33%	-1,13%	-0,54%
TEV	3,22%	4,06%	2,92%
IR	-0,10	-0,28	-0,18

Global 2008-2017	Buy and Hold	BH + V	BH + V + M
TE	0,27%	-0,29%	0,50%
TEV	2,03%	3,90%	1,96%
IR	0,13	-0,07	0,26

Global 2012-2017	Buy and Hold	BH + V	BH + V + M
TE	0,06%	-0,80%	0,30%
TEV	1,73%	2,56%	1,57%
IR	0,03	-0,31	0,19

Table 5.1: TE, TEV, IR for "Global" Portfolio.

The "Global" Portfolio is not the best solution in terms of return and standard deviation so also measure of efficiency do not evidence a perfect replication strategy.

Conclusion

Using crude measures of value and momentum to directly allocate investments across asset classes has historically produced superior returns and lower risk than the other simple investment strategies we considered. This research is distinctive in that we have explored these effects at the level of asset classes, rather than the more prevalent existing body of research which has focused on value and momentum at the level of individual securities within asset classes, and usually would require investors to use leverage and short positions in a high turnover strategy.

The crude but intuitive metrics we use for value allocations allow investors to avoid allocating to assets that are in extreme cases of overvaluation or "bubbles" while giving investors confidence in holding assets that are undervalued when panic reigns in the markets.

Similarly, our simple metric for momentum allows investors to capture the long observed benefits of momentum that have appeared across assets and time periods. This momentum overlay imparts a kind of stop-loss discipline to the investment process. It is fascinating to note that many successful traders and risk managers rank a stop-loss approach (taking losses quickly and letting profits run) as the single most important ingredient in long term investment success[12.]

We find that value and momentum provide the best returns when used in combination. This is due to the negative correlation and general complementary nature of value and momentum[13]. However we still find that either value or momentum used alone provides better investment results over a long horizon than using a buy and hold strategy.

Results show that value and momentum decrease the risk in each portfolio. Across all of historical studies strategy incorporating a dynamic allocation to assets based on value always produces a better reward to risk trade off than a buy and hold strategy. Employing momentum and value was historically much more effective than using value alone in all of the studies. This positive correlation between returns and value plus momentum adjustment persist always in most recent "Core Domestic" Portfolio performance highlighting the usefulness of this simple investment strategies.

Most recent years Buy and Hold Portfolio performance, especially for "Global" Portfolio, are higher than value and momentum strategy, this fact is probably due to the bad performance relative to GSCI Index Value factor estimation (Section 1.2) that affect Portfolio performance.

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[12] See Jack Schwager's classic interviews with prominent investment managers in Market Wizards (1989) and New Market Wizards (1992).

[13] Again, see Asness, Moskowitz, Pederson 2008.

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