Nabil EL LAMTI
S50561
Grande Ecole Program student at HEC Paris
Major: Finance

Thesis subject: **Are smart beta strategies really smart?**

Thesis directed by Professor Jean-Charles Bertrand

June 14, 2017
Jouy-en-Josas, France

ABSTRACT

Investors, throughout the ages and especially in recent times, have differed widely in their investment philosophies (market timing/asset and security selection and allocation, active/passive investing, selecting a particular time horizon) as well as in their investment styles (with some favouring an overall macroeconomic analysis of the impact of trends on certain asset classes, others opting for more empirical, quantitatively driven approaches and finally those who seek to combine both quantitative and qualitative analyses in their investments strategies). However, no matter how disparate the strategies employed by these investors are, they all share the same objective: to generate as much return on their investment (as well as an excess return, or what they refer to as "alpha") as possible all while minimizing the risk they have taken. This has led to the emergence of a wide range of investment strategies and portfolio construction methodologies amongst asset management funds. And while some strategies have thrived and survived the tests of time, financial empiricism and risk profile, others were either cast aside following their repeated failure to deliver on their promises or over-marketed and overhyped to appeal to investors. One such overly marketed strategy (or set of strategies) is smart beta.

In this thesis, we will go over the literature discussing and detailing smart beta strategies, analysing their growth and appeal over the last years as well as making the case for both the defenders and detractors of smart beta strategies. We will also attempt to conduct a quantitative exercise whereby we will compare the actual yields of smart beta ETF funds to what the academic theory suggests, ultimately leading us to a first answer to the question of whether smart beta strategies are indeed as smart as they are made to be.

Keywords: smart beta, investment strategies, returns, alpha, indexing, risk management, diversification, active management, passive management, portfolio construction, style factors, cost.

ACKNOWLEDGMENTS

The exercise of writing a thesis on a relatively recent concept is not an easy task and it would have been nigh impossible without the support and encouragement of the people who have helped me during these last three months.

Firstly, I would like to extend my heartfelt gratitude to Professor Jean-Charles Bertrand who not only assigned this extremely interesting subject, but also provided me with detailed guidance, reference articles to use for my research and took the time off from his extremely busy schedule at HSBC to thoroughly review each draft version I have sent him. Thanks to his guidance, I had fun writing this paper, despite the challenge it presented.

Secondly, I would like to thank Professor Olivier Bossard for his quick introductory session to Bloomberg. Having not interned/worked in a finance role before, I was not exposed to this tool and, as I worked on my thesis and needed data for the empirical exercise, I needed to learn the basics of using Bloomberg. Furthemore, his "Empirical Methods in Finance" class was absolutely instrumental in designing the risk analysis segment of the empirical exercise showcased in this paper.

Finally, I would like to express my eternal gratitude to my family, for their patience and their understanding (especially during periods when I neglected to call them because I was extremely busy with coursework, interviews and researching for my thesis). I would like to particularly thank my mother who had gone to extremely great lengths (and her own personal expense) to make me into the man I am today.

Glossary of the main terms used in this paper:

This section provides a brief definition of some of the major terms that will be utilized throughout this paper, with the aim of providing the reader with a first, basic understanding of their meaning in order for him to fully appreciate the concepts and ideas discussed in the paper.

Active fund management: Refers to a style of fund management where the human element is preponderant (i.e. having a manager or a team of managers to manage a fund's portfolio). This style of management places heavy emphasis on the manager's own judgement, business acumen and experience (in addition to empirical research and analysis) in making investment decisions. It is the opposite of passive fund management (also called index fund management).

Back-testing: Refers to the process of testing of an investment strategy on historical data in order to ascertain its viability before the investor actually invests capital in it. The main outcomes looked for in this process are returns and risks. The outcomes then serve as a benchmark to the investor of what his/her future yield will be if the back-tested strategy were to be applied in a timeframe similar to the one in which it was tested.

Bandwagon effect: Also called "herd mentality", this refers to a psychological phenomenon whereby individuals perform certain actions as a result of other people doing them, irrelevant of their own beliefs. This is primarily seen in consumer behaviour (through the emergence of fads), in politics as well as in finance (especially during bull markets and asset bubble growth periods).

Behavioural finance: Refers to branch of finance which seeks to explain market anomalies by studying the inherent behavioural characteristics of market participants.

Book value: Refers to the value at which an asset is recognized in a balance sheet. Calculation methodologies differ whether we refer to a single asset (in which case, its book value is equal to the cost of the asset minus the accumulated depreciation) or a company (in which case, its book value is equal to its total assets minus its intangibles and its liabilities).

Bull market: Refers to a state of the financial market whose securities' prices are either increasing or expected to increase. It is the opposite of a bear market, where securities' prices are either decreasing or expected to decrease, reflecting a state of pessimism from investors.

Exchange Traded Funds (ETF): Refers to a financial security which exhibits traits of an index fund, in that it tracks the performance of a benchmark index, commodity or a basket of assets. However, it can also be traded on a stock exchange like any other common stock, unlike mutual funds. As a result, ETFs experience price fluctuations on a daily basis and thus do not have a daily net asset value calculated.

Expense ratio: Refers to the measure of the cost incurred by an investment company to manage a mutual fund. It is annually calculated by taking the fund's overall operating expenses and dividing them by the average dollar value of the fund's assets under management.

Fundamental analysis: Refers to the analysis conducted in order to evaluate the intrinsic value of a given security by analysing several macroeconomic (economy state, industry growth), microeconomic (firm management, culture, financial state), financial, quantitative and qualitative factors. The intrinsic value obtained is then compared to the security's current price within the market which then allows an investor to judge whether the security is over or under-priced.

Growth stocks: Also called "glamour stocks", this refers to a share of a company whose growth prospects are or are expected to be above those of the market. These stocks do not usually pay a dividend as the companies that issue them usually reinvest their earnings in capital projects, thereby making them risky to an investor. An example of growth stocks is technological companies due to their nigh endless potential for innovation and advancement.

Index fund: Also called a "passively managed fund", this refers to a category of funds that are linked to (or indexed to) a stock index such as the S&P 500 and, therefore, do not require a manager. This is in stark contrast to "actively managed funds" where the managed portfolio is composed of stocks handpicked and managed by an investment manager.

Index investing: Refers to a form of passive investing whose objective is to achieve the same level of return as a benchmark market index. This is usually done through investment in an index fund or an exchange-traded fund which track and replicate the performance of the benchmark.

Information ratio: Also called "appraisal ratio", this refers to the ratio of the excess return of a portfolio relative to a benchmark to the standard deviation (volatility) of that return. It is used as a measure of a fund manager's performance in generating excess returns, with the higher the information ratio, the better the performance. It is calculated using the following formula:

$$Information\ ratio\ (IR) = \frac{E(R_p - R_b)}{\sqrt{Var(R_p - R_B)}}$$

Leverage: Refers to the level of debt a company has taken on in order to finance its assets and operations. A company is said to be highly leveraged if its level of debt greatly exceeds its total equity value.

Liquidity: From an accounting standpoint, a company's liquidity refers to its ability to meet its financial obligations and liabilities with the assets it has currently in both ownership and operation. Liquidity also refers to the ability of purchasing and selling an asset, stock or security easily and freely in a given market without significantly impacting its price.

Market efficiency: Refers to how security prices in a given market reflect all available information at a given time. Market efficiency is characterized by three forms: weak-form (where prices reflect all information in past trading), semistrong-form (where prices reflect all publicly available information) and strong-form (where prices reflect all relevant information, including private or inside information). Developed by Eugene Fama in 1970, this concept asserts that it is impossible for an investor to "beat the market" because all information is factored into the securities' prices.

Marketable securities: Refers to highly liquid financial securities that can be cheaply converted to cash. The high liquidity of these instruments has two sources: the very short maturities of these instruments (usually less than a year) and their rates which have little impact on their prices. Examples include: treasury bills, commercial papers and most money market instruments.

Mean reversion: Refers to the theory holding that prices and returns will revert to the average market or industry level. This is generally observed in stocks that have known extensive periods of sustained growth (usually over the span of several months or years) before reverting back to industry levels (sometimes in a sharp and unexpected manner).

Momentum: Refers to how quickly a security's price or trading volume increases. It is used in technical analysis to identify potential trends that can be used to help shape investment decisions. The term is derived from physics where the momentum of an object refers to the force or speed of movement.

Net Asset Value (NAV): Refers to the value per share of a given fund at a specific time. It is calculated using the following formula:

$$Net\ asset\ value = \frac{total\ assets - total\ liabilities}{number\ of\ shares\ outstanding}$$

Price-to-book value ratio (P/BV): Also called the "price-equity ratio", it refers to the ratio of the stock's market value to its book value. It is calculated using the following formula:

$$\frac{P}{BV} = \frac{Closing\ price\ of\ the\ stock}{Total\ assets - (Intangibles + Total\ liabilities)}$$

The P/BV ratio has various interpretations, the main ones being whether a stock is over or under-priced (signalling also the company's overall perception by the market) or whether an investor is overpaying for a company if it were to go bankrupt immediately.

Price-to-earnings ratio (P/E): Refers to the ratio of a company's current share price to its earnings per share. It is calculated using the following formula:

$$\frac{P}{E} = \frac{Current\ share\ price}{Earnings\ per\ share}$$

The P/E ratio is interpreted as the dollar amount an investor needs to invest in order to receive one dollar of the company's earnings.

Risk-free rate: Refers to the rate of return of a zero-risk investment. This is, in practice, impossible as even the safest investments have a small amount of risk. For U.S. based investors, the three-month U.S Treasury bill is used as a proxy for the risk free rate.

Risk premium: Refers to the excess return relative to the risk-free rate of a given investment. This risk premium reflects the compensation that investors obtain from taking on more risk compared to investing in a risk-free asset.

Sharpe ratio: Refers to a risk-adjusted return measure developed by Sharpe which takes the ex-ante excess return of a given portfolio and divides it by its standard deviation. It is calculated using the following formula:

$$Sharpe\ ratio = \frac{E(R_p - r_f)}{\sqrt{Var(R_p - r_f)}}$$

Short selling: Refers to the act of selling a security that is either not owned or borrowed. It is utilised as a speculative tool or a hedging tool against downward movements for the same security or a related one.

Technical analysis: Refers to the analysis performed in order to determine a value for securities as well as predict their future momentum. Unlike fundamental analysis which utilizes several quantitative and qualitative factors, technical analysis uses primarily statistical tools and chart analysis to forecast and evaluate a stock's momentum and value.

Tracking error: Refers to the standard deviation of the difference of returns between the portfolio and its benchmark. There are two variants: **ex-post tracking error,** which is calculated on the basis of realized returns, and **ex-ante tracking error**, which is calculated on the basis of expected returns.

Value stocks: Refers to a stock which is undervalued compared to its fundamental characteristics (such as earnings, dividends and so on). These stocks are characterised by a high dividend yield and either a low P/BV ratio or a low P/E ratio.

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1. Introduction

In this section of the paper, we will provide some insight on the motivation behind selecting "smart beta" as a thesis subject, discuss the current state of academic literature regarding it and outline the structure this paper will follow. Furthermore, we will detail the methodology and sources we intend to use as well as some issues and limitations we have encountered during the preparation of this paper.

1.1. Motivation:

The interest in studying smart beta strategies as a thesis subject stemmed from the inherent promise they offer: higher returns at lower costs and risk. Considering the current economic and financial situation, as well as factoring in the resulting monetary policies, this promise appears to be not only too good to be true, but also seems to be attracting more and more investors.

The observed growth in smart beta launches over the recent years does seem to give credence to the above-mentioned promise with the United States leading the pack and Europe slowly catching up. However, as smart beta strategies continue to get over-marketed and overhyped, many researchers, economists and scholars have made the case against them, calling them unsustainable, a temporary "fad" and even "dumb" (as in, they do not yield the high returns they promise through some breakthrough asset selection process but rather through very risky means and by considering certain punctual idiosyncrasies that may not be replicated in the long term, in contrast to the whole "smart beta" label they carry). Charles Aram, the head of the Research Affiliates EMEA branch, has put the researchers' fears and doubts in a much blunter manner. In the September 2016 issue of Fund Strategy, he states that: "If something [referencing smart beta strategies] has been "hot" recently, it risks performing badly […] If you overpay, no matter what the quality of the asset, you get a poor investment result. Investors need to look before they leap". Such a statement raises concerns regarding investors' behaviour towards this new concept as well as beg the question that lends this thesis its namesake "are smart beta strategies really smart?". It is a question that poses an interesting challenge and we will attempt to provide an answer to it in what will follow, to the best of our abilities.

1.2. Academic literature on smart beta strategies:

Smart beta strategies, as they are denominated, are still considered a new concept and, thus, academic research on smart beta strategies is scarce. However, considering that smart beta strategies exhibit characteristics of both active and passive fund management, some economists, fund managers, investors and researchers have leveraged the existing literature regarding them to begin analysing and understanding how smart beta strategies operate and how they contribute in terms of both risk and return to the average investor's portfolio.

As we will see in the "methodology" section, we will only limit ourselves to using research and academic papers that specifically discuss smart beta strategies, all while providing a small refresher on certain relevant economic theories and the basic characteristics of both active and passive fund management. This is done so as to help the reader in his/her understand of the subject and to encourage further research on it.

1.3. Structure, methodology and sources used

The thesis aims at providing a first answer to the question of whether smart beta strategies are truly "smart". To do so, we have elected to structure the paper as follows:

- Firstly, we will begin by providing the reader with basic definitions of certain economic concepts and theories that smart beta strategies are built upon. Such concepts include, but are not limited to, the Capital Asset Pricing Model, the concept of beta and alpha, the Fama-French Three-Factor model (and its extension, the Carhart Four-Factor model) and the main characteristics of active and passive fund management. While non-exhaustive, this section of the paper aims to prepare the reader for the discussion on smart beta strategies, to facilitate his/her understanding of the concept and to enable him/her to make their own judgement on whether smart beta strategies are indeed "smart".
- Secondly, we will introduce the concept of smart beta and proceed to a review of the relevant academic literature surrounding the concept. While smart beta does not have a universally accepted definition and is an umbrella term for various investment strategies, various definitions provided by scholars and researchers have common elements and thusly, we will provide them all while highlighting the significant differences that may arise. Regarding the academic literature review, we will limit ourselves to the relevant and most recent articles regarding smart beta, making the case for both the defendants and the detractors of the concept and summarizing their main findings and recommendations.
- Thirdly, we will present and summarize the findings of a quantitative exercise revolving around smart beta funds. The aim of this objective is to determine the source of return from these funds and whether they deserve to be called "smart". This exercise will consist mainly of a statistical analysis of the various components of the returns of these smart beta funds. The main financial data sources that will be used in this exercise are Bloomberg and Morningstar.
- Finally, we will conclude with an overall summary of our findings, provide our own opinion on whether smart beta strategies are indeed smart as well as provide guidelines and further references on portfolio construction using smart beta strategies and products.

We conclude this subsection by highlighting the main sources (online and offline) of information used throughout this paper, most of which are provided by the HEC Paris library. These sources are:

- The Journal of Portfolio Management
- The Journal of Financial Planning
- The Journal of Applied Finance
- Various financial publications, newspapers and periodicals such as: The Financial Times, The Wall Street Journal, Fund Strategy etc…
- Online financial resources and websites such as Investopedia, EDHEC Risk, Fama-French Tuck School of Business website etc…
- Financial data banks such as Bloomberg and Morningstar.

1.4. Issues and challenges:

As stated above, the main challenges encountered when writing this paper were twofold:

- Firstly, while articles regarding factor investing (whose concepts upon which smart beta strategies are based) are abundant, articles about smart beta as a standalone concept are rather scarce. This is due to two reasons:
    - "Smart beta" is a commercial denomination coined by various funds and investors, not an academic one;
    - Smart beta, as a concept, remains relatively new among investors despite, as we will see later in the paper, rapidly gaining ground.

Therefore, the main challenge was to wade through the massive variety of articles regarding factor investing and selecting those that are linked and relevant to smart beta strategies;

- Secondly, the difficulty of access to relevant financial data in order to construct the quantitative exercise to illustrate the sources of return for smart beta funds.

Furthermore, this paper relies on carefully selected publications which reflect their authors' opinions and, thusly, constitute in no shape or form a definitive or absolute stance on the subject. They are used as a reference to illustrate the advancements of academic research on the subject of smart beta and have been further analysed in order to highlight and compare their authors' arguments and opinions.

Finally, we have elected to approach the financial data used in this paper with caution and scepticism, especially data coming from product providers and from certain publications. This data has been cross-checked with other data providers such as Bloomberg and Morningstar, since they are considered objective by financial experts.

2. Financial and economic concepts review

To fully appreciate and understand the underlying theoretical concepts behind smart beta strategies as well as the views and opinions of the academic authors that have studied them, it is important to provide the reader with a basic introduction of some of the most relevant financial and economic theories which constitute not only the backbone of smart beta strategies but are widely and commonly used in almost all financial areas of expertise. The concepts covered in this section will also help shed some light on how smart beta strategies came to exist as some of the underlying ideas in these concepts have been challenged over time and many of their weaknesses have pushed investors and asset managers alike to seek out "alternative" ways to achieve higher returns.

We will discuss five essential concepts in this section: the capital asset pricing model, the Fama-French three-factor model, its upgraded versions the Carhart four-factor model and the Fama-French five-factor model, and the fundamentals of factor investing.

2.1. The Capital Asset Pricing Model (CAPM):

Born from the work of Harry Markowitz on portfolio theory and portfolio diversification, the Capital Asset Pricing Model was introduced by William Sharpe, among others[1], in 1964 in his paper "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk".

The CAPM is based on a set of assumptions that can be broken down into assumptions on the market and on its participants.

Market-wise, the CAPM assumes the following:

- The market does not have any intermediaries;
- There are no constraints on the positions held (i.e. no constraints on borrowing or short-selling);
- Supply and demand are immediately matched;
- There are no transaction costs.

Investor-wise, the CAPM assumes the following:

- Investors all seek to maximize their portfolio's value;
- Investors are rational, risk-averse, share the same beliefs and care only about the mean and variance;
- Investors have access to all available information at the same time;
- Investors only have a one-period investment horizon.

Under these assumptions, the CAPM provides an easy framework to understand the relationship between the return of a security/portfolio and its risk. This framework is illustrated by the following relationship:

$$E(r_A) = r_f + \beta_A \times (E(r_M) - r_f) \ (1)$$

Where:

- $E(r_A)$ is the expected return of the asset/portfolio;
- r_f is the risk-free rate;

[1] Sharpe was not the first one to leverage upon Markowitz's work to introduce the concept of CAPM. Treynor (1961, 1962), Lintner (1965) and Mossin (1966) have independently introduced the concept in their work. However, only Sharpe, alongside Markowitz and Merton were awarded the 1990 Nobel Memorial Prize in Economics for their work.

- β_A is the measure of the risk of the security/portfolio;
- $E(r_M)$ is the expected return of the market.

When measuring risk, the CAPM uses beta as a measure which is governed by the following relationship:

$$\beta_A = \frac{Cov(r_A; r_M)}{\sigma(r_M)^2} \quad (2)$$

Where:

- $Cov(r_A; r_M)$ is the covariance of the return of security/portfolio relative to the return of the market;
- $\sigma(r_M)^2$ is the variance of the market return.

There are two ways to interpret the beta used in the CAPM according to Fama and French (2004:28-29):

- **First interpretation:** According to (1), mathematically, beta can be viewed as the slope of the regression between the expected return of the security/portfolio and the market return. Thus, beta measures how sensitive the security/portfolio's return is compared to the market return;
- **Second interpretation:** According to (2), beta can be viewed as the risk each dollar invested in security/portfolio A contributes to the market portfolio. This is an economic interpretation that stems from observing that the risk of the market portfolio (measured by $\sigma(r_M)^2$) is a weighted average of the covariance risks of the assets within the market portfolio, thus making beta the measure of covariance risk of security/portfolio A relative to the variance of the market portfolio return. It is this interpretation that we will use throughout our paper when discussing smart beta strategies.

Furthermore, the CAPM distinguishes between two types of risk: systematic and specific. Systematic risk refers to the risk borne from the inherent market structure itself, its actors as well as any and all factors that cannot be diversified away such as monetary policy, political events, natural disasters and so on. In contrast, specific risk refers to the risk that is proper to a certain security/portfolio and, therefore, can be diversified away and hedged against. Because of this, the CAPM only reflects systematic risk through the beta measure, with the beta of the market being equal to 1, lower-risk securities/portfolios having a beta less than 1 and higher-risk securities/portfolios having a beta greater than 1.

Ultimately, the CAPM's main message is: When investing in a given security/portfolio, investors are doubly rewarded: once, through the effect of the time value of money (which is reflected by the risk-free component of the equation (1)) and once through the effect of taking on more risk.

However, the CAPM is not an empirically solid model and owes its failure to an overly simplistic set of assumptions as well as difficulties in implementing validating tests at the time when the model was first introduced (Fama and French, 2004:25). Thus, throughout the years, the CAPM has been revisited and upgraded to not only correct its shortcomings but also to reflect the financial and economic changes of the times. Sharpe (1990:313), in his review of the CAPM, has listed several examples of amendments brought forth by many economists and financial expert to his initial model.

Such examples include but are not limited to:

- Black, in 1972, introduced a CAPM version where no riskless asset existed;
- Merton presented two amendments to the CAPM framework, one in 1973 which dealt with future investment opportunities and one in 1987 which dealt with market segmentation;
- Markowitz, in 1990, presented a version of the CAPM framework which addressed the assumption on no constraints regarding short-selling.

One major review was done in 1993 by Fama and French who proposed an extension of the CAPM which adds two new factors to the market risk factor. It is this model that we will discuss in the next subsection.

2.2. The Fama-French Three-Factor model:

The Fama-French Three-Factor model was developed in 1993 by professors Eugene Fama and Kenneth French as a response to the incompleteness of the CAPM. It argues that returns from securities and portfolios are influenced by two additional factors, in addition to the market risk factor that is introduced by the CAPM: market capitalization (referred to as the "size" factor) and the book-to-market ratio (referred to as the "value" factor).

According to Fama and French, the main justification for the addition of these factors is that both size and book-to-market (BtM) ratios are linked to the economic fundamentals of the companies that issue the securities (Fama and French, 1993:7-8). They further elaborate that:

- Earnings and book-to-market ratios as negatively correlated, with firms with low BtM ratios presenting consistent higher earnings than firms with high BtM ratios;
- Size and average returns are negatively correlated due to a common risk factor. This stems from their observation of the evolution of earnings of small firms in the 1980s: they argue that small firms suffer longer periods of earnings depression than bigger firms should the economy in which they operate suffer from a recession. They have also observed that following the 1982 recession, smaller firms have not contributed to the economic growth of the mid and late 80s;
- Profitability is not only related to size but also to BtM and is a common risk factor that highlights and explains the positive correlation between BtM ratios and average returns.

As such, under the Fama-French Three-Factor model, the return of a security/portfolio becomes:

$$E(r_A) = r_f + \beta_A \times (E(r_M) - r_f) + \beta_S \times SMB + \beta_V \times HML + \alpha + \epsilon \ (3)$$

Where:

- $E(r_A)$ is the expected return of the asset/portfolio;
- r_f is the risk-free rate;
- β_A is the measure of the risk of the security/portfolio;
- $E(r_M)$ is the expected return of the market.
- β_S is the measure of the risk related to the size of the security/portfolio;
- β_V is the measure of the risk related to the value of the security/portfolio;
- SMB (which stands for "Small Minus Big") measures the difference in expected returns between small and big firms (in terms of market capitalization);
- HML (which stands for "High Minus Low") measures the difference in expected returns between value stocks and growth stocks;

- α is a regression intercept;
- ϵ is a measure of regression error.

Both SMB and HML are calculated by using both available historical data and a combination of portfolios that focus on size and value, respectively. These values are reported regularly by professor French on his personal website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html
Meanwhile, the betas for both the size and value factors are, alongside α, determined through linear regression and can have both positive and negative values.

The Fama-French Three-Factor model, however, is not without its shortcomings. One major issue with the model was highlighted by Griffin (2002: 786-798) where he argues that the Fama-French factors of value and size are more accurate in their explanation of return variations when applied locally as opposed to when they are applied globally. As a result, each of the factors should be considered on a per country basis (and it is currently done so on professor French's website, where he defines SMB and HML factors of each country such as the United Kingdom, France and so on).

While the Fama-French has indeed taken a step further than the CAPM to breakdown security returns, it remains an incomplete model and the interpretation of its new factors are geographically constrained. Efforts have been made throughout the years to further complete this model, with Fama and French introducing two other factors in 2015, namely profitability and investment strategy and other researchers such as Carhart (1997), who introduced a fourth factor, momentum, to the original Three-Factor model. It is this model that we will discuss in the next subsection.

2.3. The Carhart Four-Factor model:

As stated above, Mark Carhart introduced, in 1997, an extension of the Fama-French Three Factor model (1993) by adding a new factor: momentum.

Momentum is defined as the observed tendency for prices to keep increasing further after their initial increase or to keep decreasing further after their initial decrease. The very definition of momentum makes it somewhat of an anomaly as, according to the Efficient Market Hypothesis, there is no valid reason for security prices to keep increasing or decreasing after an initial shift in their value.

While traditional financial theory fails to clearly define what truly causes momentum to appear in some securities, behavioural finance offers some insights on why momentum exists; indeed, Chan, Jegadeesh and Lakonishok (1996) argue that momentum arises from most investors' inability to swiftly and immediately react to new information in the market and, thusly, integrate that information into security prices. This explanation highlights the irrationality of investors when it comes to their appraisal of the value of certain securities and to their investment choices.

Carhart's motivation for integrating the momentum factor in the Fama-French Three-Factor model stems from the model being unable to explain return variation when it comes to momentum-sorted portfolios (Fama and French, 1996 – Carhart 1997). As such, Carhart leveraged on Jegadeesh and Titman's (1993) one-year momentum variation and included it in his model.

Under the Carhart model, the return of a security or portfolio can be written as:

$$E(r_A) = r_f + \beta_A \times (E(r_M) - r_f) + \beta_S \times SMB + \beta_V \times HML + \beta_M \times UMD + \alpha + \epsilon \ (4)$$

The explanations of the factors in (4) are identical to those of (3) with the addition of the following:

- β_M is the measure of the risk related to the momentum factor of the security/portfolio;
- UMD (which stands for "Up Minus Down") measures the difference in expected returns between "winning" securities and "losing" securities (in terms of momentum).

As stated by Carhart in his paper, the four-factor model can be used in the same fashion as both the CAPM and the Fama-French Three-Factor in explaining the sources of the return of a given security/portfolio (Carhart, 1997). However, the model is mainly used in asset management to assess the performance of an actively managed portfolio as well as evaluate the overall performance of a mutual fund.

In this next section, we will discuss the recently updated Fama-French model, which adds two additional factors to the original three (market, size and value) in an attempt to further explain the returns observed of any given security.

2.4. The Fama-French Five-Factor model:

In 2014, Fama and French assert that the initial three-factor model that they have developed in 1993 does not fully explain certain irregularities observed in expected returns. As a result, Fama and French upgraded the three-factor model by incorporating two additional factors, namely profitability and investment.

The rationale for these two factors stems from the theoretical implications of the dividend discount model (DDM)[2] which asserts that profitability and investment further explain returns obtained from the HML factor in the initial model.

Surprisingly, the new Fama-French model does not include the momentum factor, as opposed to the Carhart model. This is mainly due to Fama's stance on momentum. While not disproving its existence, Fama believes that the level of risk carried by securities in an efficient market cannot change so abruptly and significantly that it justifies the need to acknowledge the momentum factor's role in it.

Under the Fama-French five-factor model, the return of any security is given by the following equation:

$$E(r_A) = r_f + \beta_A \times (E(r_M) - r_f) + \beta_S \times SMB + \beta_V \times HML + \beta_P \times RMW + \beta_I \times CMA + \alpha + \epsilon \ (5)$$

The explanations of the factors in (5) are identical to those of (3) with the addition of the following:

- β_M is the measure of the risk related to the profitability factor of the security/portfolio;
- RMW (which stands for "Robust Minus Weak") measures the difference in expected returns between securities that exhibit strong profitability levels (thus making them

[2] The dividend-discount model is a method of computing a security's price by calculating the present value of the expected dividend the underlying security's company will pay.

"robust") and securities that show inconsistent profitability levels (thus making them "weak");

- β_I is the measure of the risk related to the investment factor of the security/portfolio;
- CMA (which stands for "Conservative Minus Aggressive") measures the difference in expected returns between securities that engage in limited investment activities (thus making them "conservative") and securities that show high levels of investment activity (thus making them "aggressive").

To test the new model, Fama and French constructed several portfolios that are designed to exhibit large differences in returns caused by the size, value, profitability and investment factors. They have also performed two exercises:

- The first one is the regression of the returns of the portfolios constructed against the upgraded model. This was done to evaluate how much it explains the differences in returns observed in the selected portfolios;
- The second one is comparing the performance of the new model versus the three-factor one. This was done to highlight whether the new five-factor model explains the discrepancies in returns noted in the original three-factor model.

Fama and French summarize their findings regarding the new model as follows:

- In terms of structure, the HML factor becomes redundant as any value contribution within the return of a security can already be explained by the market, size, investment and profitability factors. Thusly, Fama and French encourage investors and academics to drop the HML factor if they are merely interested in explaining abnormal returns. However, they do advocate for the use of all five factors if the intent is to explain returns from portfolios that exhibit size, value, profitability and investment tilts;
- The model also manages to explain between 69% and 93% of the return discrepancies that were noted following the use of the previous three-factor model.

However, this new model is not without its shortcomings. In their 2016 paper "Five concerns with the Five-Factor model", Blitz, Hanauer, Vidojevic and van Vliet (henceforth known as BHVV), raised five issues with the new Fama-French five-factor model. While two of these issues are linked to some of the old factors present in the original Fama-French three factor model (mainly the continued existence within the model of the CAPM relationship between market risk and return, as well as, the overall acceptance by the academic community of the new model when some of the original factors are still being contested), some of the other issues are linked to how the model itself has been constructed. These issues being:

- The absence of the momentum factor;
- The lack of robustness of the new factors introduced. The concerns here are historical (i.e. will these factors be relevant for data points older than 1963) and whether these factors also work with other asset classes;
- The lack of sufficient empirical justification behind the introduction of these factors from Fama and French.

In this next section, we will discuss the main concept behind factor investing, which is the use of factors that reflect the fundamentals of a given market/security and, thusly, drive any return and risk obtained from it.

2.5. Fundamentals of factor investing:

The premise of factor investing, as we will see when discussing smart beta strategies, is that certain strategies are built around giving more importance to certain factors than others. While many popular smart beta ETFs use traditional factors such as Fama-French's three factors (market, size and value) as well as momentum, some strategies use exotic or more specialized factors in their construction.

The aim of this section is not to list every potential factor that exists, but offer to the reader an insight on the main existing categories of factors and how they are evaluated by researchers.

Harvey, Liu and Zhu (henceforth known as HLZ), in their 2016 paper "…and the Cross-Section of expected returns", analysed a considerable body of literature regarding expected returns, and how academics attempt to explain them using various factors. The aim of their paper was to provide a factor evaluation model that relies on statistical thresholds. If factors, old and new, cleared those thresholds, then the factor would be deemed relevant.

To do so, HLZ reviewed 313 papers covering 316 different factors. While they deem the number of factors reviewed limited, they argue, however, that these factors are listed in papers that either have been published in respected financial publications or are currently being reviewed. The factors reviewed were classified under two main groups:

- "Common" factors, which make up 36% of the factors listed, refer to factors that affect the returns of all securities/assets regardless of their inherent characteristics. Under these factors, we find market, investment, accounting standards and so on. **These factors are usually referred to as "systematic" factors and their effect on returns cannot be diversified away;**
- "Characteristics" factors, which make up 64% of the factors listed, refer to factors that are unique to each security/asset. **These factors are usually referred to as "idiosyncratic" factors and their effect on returns can be diversified away.**

In terms of how to evaluate these factors, HLZ argue that because data mining has become easier and less costly than in the past, the statistical threshold (namely, the "t-statistic") to consider any studied factor as relevant, should be raised. In statistics, the rule is that the higher the t-statistic, the higher the likelihood that the studied variable is statistically relevant.

Historically, the t-stat threshold was set to 2.0. However, HLZ suggest that any new factor introduced should have a t-stat of 3.0 to be considered viable. Furthermore, they assert that any factor that comes from a combination of previously tested factors should have a lower t-stat threshold to be considered relevant. However, HLZ point out that many of the recently discovered factors are false discoveries and that investors should only limit themselves to an extremely reduced number of factors, especially those that have withstood the test of time and empiricism.

In summary, the abovementioned concepts should provide the reader of this paper with a first understanding of the main financial theories used in many investment strategies in general, and in smart beta, in particular. We have elected to keep the definitions of these concepts brief and to focus on the main messages and some of their relevant shortcomings so as not to deviate from the main subject of this paper. We encourage the reader to refer to the "References" section of this paper, should he/she want to explore the abovementioned concepts deeper.

In what follows, we will attempt to give a first definition of smart beta strategies, provide an overview of the smart beta “industry” as well go over some of the recent academic literature regarding it.

3. Understanding smart beta strategies

In this section of the paper, we will introduce the concept of smart beta to the reader. To this end, we will adopt the following three-point structure: Firstly, we will attempt to define smart beta strategies as, per Burton Malkiel, "there is no universally accepted definition of smart beta strategies" (Malkiel, 2014:127). To do so, we will draw upon various definitions of smart beta used by researchers and funds and combine them into a cohesive whole. Secondly, we will discuss the smart beta market, its characteristics (namely growth, structure and distribution across asset classes) as well as some of the big players in the market and their performance. Thirdly, we will go over the recent literature regarding smart beta strategies, discussing mainly the various smart beta strategies that exist, the appraisal of their performance by academics and investors as well as their stance on whether smart beta strategies are indeed "smart".

3.1. Smart Beta – A tentative definition:

To help the reader reach a tentative definition of smart beta, we suggest reviewing some the definitions offered by investors and academics, identifying their commonalities and summarizing them into a usable definition.

Rob Arnott, chairman and founder of Research Affiliates, defines smart beta strategies as "approaches that can help achieve individual investment objectives by avoiding chasing what is popular and expensive" (Arnott, 2016:28). He warns, however, that the term smart beta is now being used to refer to any passive (or automated) strategy, arguing whether all of these strategies are indeed smart.

Echoing Arnott's definition of smart beta is Burton Malkiel who asserts that the common impression of smart beta strategies amongst investors is that they allow them to achieve greater-than-market returns by using passive management strategies that involve a similar risk level to that of investing into a low-cost total stock index fund. Avoiding the pitfall Arnott warns against above, Malkiel explains that achieving these returns is done through tilting (or "flavouring") the portfolio by using several factors such as value vs growth stocks, small vs large companies or other composite factors such as quality (which includes sales and earnings growth and low leverage levels), profitability, liquidity and dividend levels – making smart beta strategies akin to multifactor asset pricing models – all while not increasing the overall volatility of the portfolio and keeping the fees of such a portfolio below those charged by active managers (Malkiel, 2014:127).

Kahn and Lemmon further clarify what Malkiel has stated regarding smart beta strategies by defining them as having characteristics of both active strategies (through exposure to specific factors) and passive strategies (through the transparent and rules-based approach used to build smart beta portfolios). While Malkiel listed various factors that enter the composition of smart beta oriented portfolios, Kahn and Lemmon have focused specifically on factors that have performed well historically on average and which investors believe they will continue to do so. These factors being: value, momentum, size (with a focus on small caps), quality and volatility (mainly low-volatility/low-beta stocks). However, Kahn and Lemmon do warn that these factors, while they have performed well on average historically, have underperformed significantly over certain three- to five-year periods due to mean reversion. (Kahn and Lemmon, 2015:76).

From the above definitions, we can clearly see that there are three similarities in the definitions of smart beta suggested by academics and investors and reviewed above:

- Firstly, the premise of smart beta is to achieve higher returns than a benchmark market index, all while maintaining a risk level that is similar or lower to it as well as lower fees;

- Secondly, smart beta strategies are rule-based and focus on having exposure to certain factors that have performed historically well;
- Thirdly, the selected factors are all geared towards less expensive, less "popular" and less volatile stocks.

It is also important to highlight that the term "smart beta" may refer to not only the strategies that are implemented in given portfolios, but also to indices and to some specialized funds called exchange-traded funds or ETFs which are, at the most basic level, investment funds that are traded similarly to stocks on a stock exchange. ETFs may hold several asset classes such as stocks, commodities, bonds and so on and have several advantages over traditional funds such as: lower costs, flexible buying and selling conditions, transparency and ease of diversification. It is these conditions that make ETFs suitable platforms for smart beta strategies to be applied and for smart beta portfolios to be traded.

Thusly, taking into account the similarities between the definitions discussed above as well as the fact that smart beta strategies are usually applied in exchange-traded funds, we are able to formulate our own tentative definition of what smart beta strategies are:

Smart beta strategies are a set of investment strategies that aim to achieve higher returns than a benchmark market stock all while maintaining a low level of risk and management fees. Rules-based and transparent, smart beta strategies focus on having a portfolio of stocks that are exposed to a specific set of factors that have performed well historically on average, with the most popular ones being value, size, quality and volatility. Smart beta strategies are applied within specific funds called exchange-traded funds, with certain ETFs being entirely composed of smart beta portfolios. However, smart beta strategies are also prone to periods of underperformance, mainly due to mean reversion, meaning that investors have to be wary about market timing whenever they wish to implement smart beta strategies.

Now that we have defined the term "smart beta", in the next section, we will turn our attention to the smart beta market.

3.2. Overview of the Smart Beta market:

The purpose of this section is to provide the reader with a complete overview of the smart beta market, focusing on five characteristics: size, growth, main players, factors used and fees. While we will begin the section with describing the state of the worldwide smart beta market, we will later focus on the US and European markets since they both represent the largest and second-largest markets respectively.

According to Morningstar, the size of the global smart beta market is roughly $550.5 billion in assets under management and 1,123 smart beta ETFs as of June 30, 2016. The main leading markets are the US (89% market share) and Europe (7.4% market share), however, in terms of growth, both European and Asian-Pacific markets have experienced significant growth compared to the other markets, with a YoY change in assets under management of 25.4% and 47.5% respectively. The table below summarizes the various findings regarding the global smart beta market:

Table 1: Global smart beta market figures as of June 30th, 2016.

	AUM 2016 (in $ billions)	Global Market Share (%)	YoY Change (%)	# of Smart Beta ETFs	YoY Change (%)
U.S.	489.9	89.0%	4.1%	478	27.2%
Europe	40.7	7.4%	25.4%	233	15.0%
Asia-Pacific	10.5	1.9%	47.5%	97	34.0%
Canada	9.0	1.6%	9.2%	89	6.7%
Emerging Markets	0.5	0.1%	-33.9%	14	0.0%
Total	**550.6**	**100.0%**	**6.0%**	**911**	**23.3%**

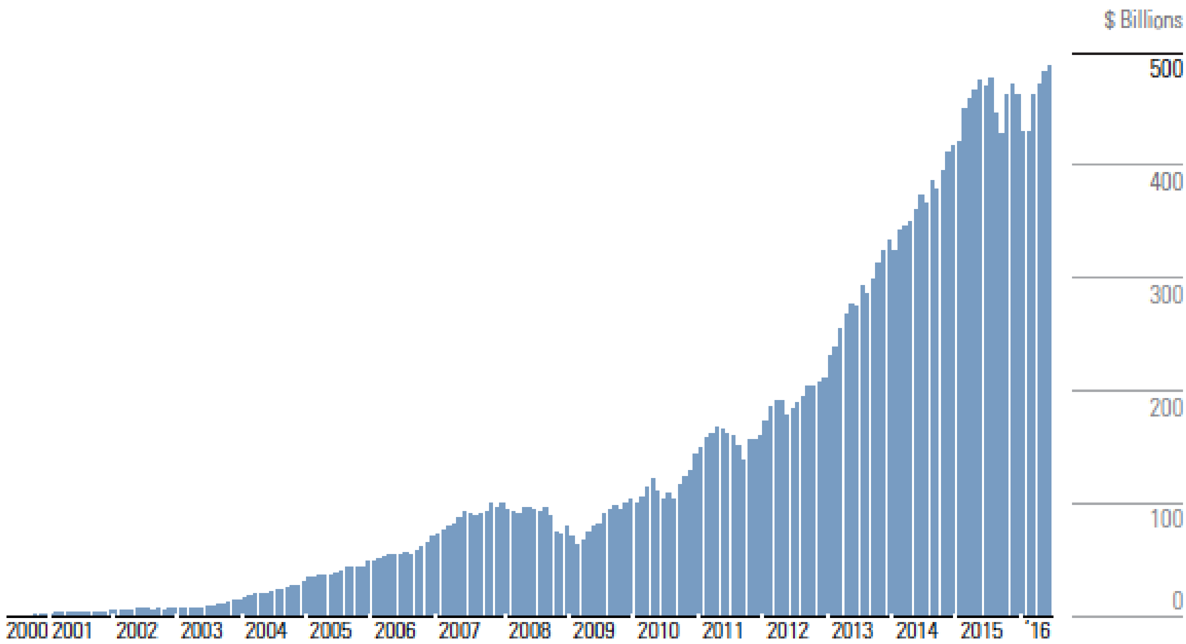
Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/09/16)
AUM = Assets Under Management

Since both the United States and Europe are the largest markets with respect to smart beta ETFs, we will focus on providing insights on these two markets in what follows.

- **The smart beta market in the U.S:**

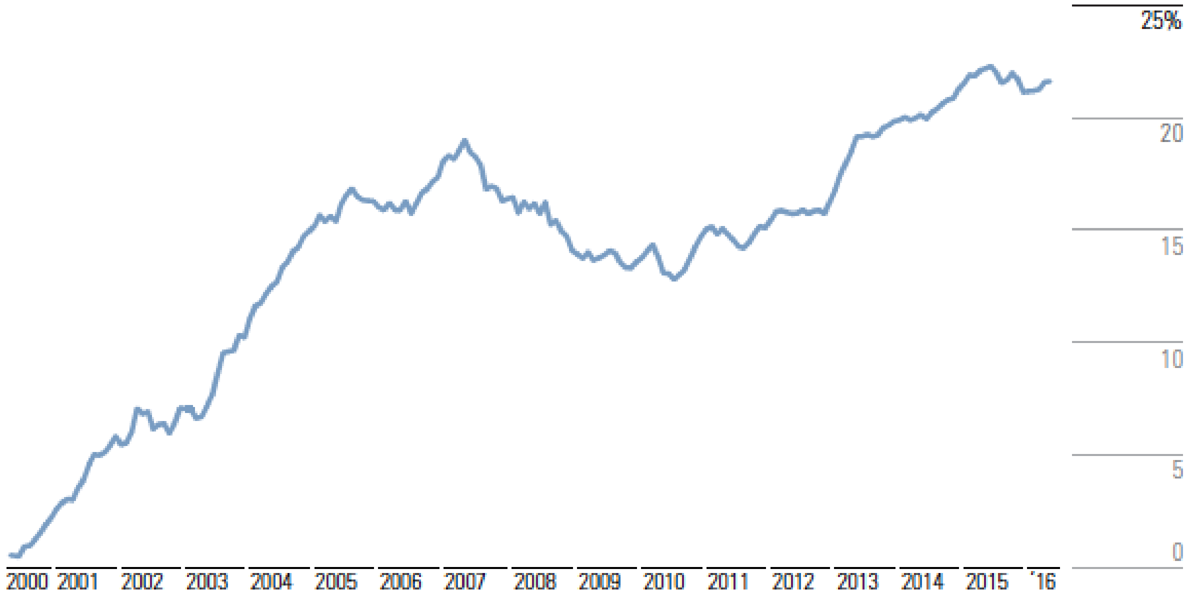
The U.S Smart Beta market is the oldest and the most mature market worldwide, with over 478 smart beta ETFs (54% of the total smart beta ETFs worldwide) and approximately $490 billion in assets under management. Smart Beta ETFs first appeared in May 2000 with both iShares Russell 1000 Growth IWF and iShares Russell 1000 Value IWD being the first and largest smart beta ETFs at the time. Since then, the U.S smart beta ETF market has been growing by leaps and bounds, not only in terms of assets under management but also in regards to its market share in the U.S ETF market, reaching almost 21% as of June 30th, 2016. The following graphs illustrate the growth of smart beta ETFs in the U.S:

Chart 1: Evolution of U.S Smart Beta ETFs assets under management as of June 30th, 2016.



Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/9/16, page 4)

Chart 2: U.S Smart Beta ETFs market share evolution in the U.S ETF market as of June 30th, 2016.



Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/09/16, page 6)

The surprising growth of smart beta ETFs in the U.S. is mainly attributed to new investors adopting smart beta strategies as a result of the current economic situation (where low interest rates and a seven-year post-crisis bullish market have made significant returns all but impossible). Quantitatively, the smart beta ETF growth in U.S. is broken down into growth due to net new inflows since May 2000 (representing 79%) and asset appreciation (representing 21%).

Factors-wise, smart beta ETFs offering exposure to standard and simple factors (such as value, growth, dividends and low-volatility/minimum-variance) dominate the market and represent 71% of the U.S smart beta ETFs total assets under management. Dividend-weighted strategies are especially popular amongst U.S. investors for reasons mentioned above, representing 27% of the total smart beta ETFs assets under management. The following table provides a breakdown of the smart beta factors used in the U.S:

Table 2: Breakdown of U.S. smart beta factors used as of June 30th, 2016.

Strategy	AUM ($ billion)	% of AUM	Strategy	AUM ($ billion)	% of AUM
Dividend-weighted	132.1	27.0%	Nontraditional fixed income	7.3	1.5%
Value	108.8	22.2%	Quality	4.4	0.9%
Growth	108.1	22.1%	Earnings-weighted	2.6	0.5%
Low-volatility/Minimum-variance	38.6	7.9%	Multiasset	1.6	0.3%
Equal weight	27.6	5.6%	Buyback/Shareholder Yield	1.6	0.3%
Multifactor	26.1	5.3%	Revenue-weighted	0.9	0.2%
Fundamentally weighted	11	2.2%	Risk-weighted	0.3	0.1%
Nontraditional commodity	9.5	1.9%	Expected returns	0.2	0.0%
Momentum	9	1.8%	Low/High Beta	0.1	0.0%

Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/09/16, page 8)

In terms of providers, iShares and Vanguard dominate the U.S. smart beta ETF providers with a 61.1% of the total U.S. smart beta assets under management, despite them only accounting for 15.4% in terms of number of smart beta ETFs in the U.S. Their position is a result of them providing smart beta solutions that follow the most popular strategies in the U.S. The following tables list the most popular providers of smart beta strategies in the U.S but also the most prominent funds as well:

Table 3: Smart beta strategies providers in the U.S. as of June 30th, 2016.

Smart beta providers	AUM ($ billion)	# ETFs	Market share
iShares	193.8	72	39.6%
Vanguard	105.7	22	21.6%
PowerShares	40	88	8.2%
State Street Global Advisors	36.7	53	7.5%
WisdomTree	36.6	63	7.5%
First Trust	25.4	58	5.2%
Guggenheim	17.1	30	3.5%
Schwab	11	9	2.2%
FlexShares	6.4	16	1.3%
ProShares	2.4	6	0.5%
Others	14.8	191	3.0%

Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/09/16, page 9)

Regarding smart beta ETFs, we have limited ourselves to the largest ETFs in the U.S. in terms of assets under management. Additional information provided includes the factors used in their smart beta strategies, their ticker as well as their expense ratios.

Table 4: Largest U.S. smart beta ETFs as of June 30th, 2016

Smart beta ETF	Ticker	Inception date	Smart beta factor used	Expense ratio	AUM ($ billions
iShares Russell 1000 Growth	IWF	22/05/2000	Growth	0.20%	29.3
iShares Russell 1000 Value	IWD	22/05/2000	Value	0.20%	28.6
Vanguard Value ETF	VTV	26/01/2004	Value	0.08%	21.8
Vanguard Dividend Appreciation ETF	VIG	21/04/2006	Dividend-weighted	0.09%	21.6
Vanguard Growth ETF	VUG	26/01/2004	Growth	0.08%	20.4
iShares Select Dividend	DVY	03/11/2003	Dividend-weighted	0.39%	15.7
iShares Edge MSCI Min Vol USA	USMV	18/10/2011	Low-volatility/Minimum variance	0.15%	14.6
Vanguard High Dividend Yield ETF	VYM	10/11/2006	Dividend-weighted	0.09%	14.5
SPDR S&P Dividend ETF	SDY	08/11/2005	Dividend-weighted	0.35%	14.0
iShares S&P 500 Growth	IVW	22/05/2000	Growth	0.18%	13.4

Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/09/16, page 10)

Fees-wise, on average, smart beta ETFs are priced competitively with other ETFs in the U.S. However, Morningstar does warn investors to consider fees at a case-by-case basis since there are smart beta ETFs that price higher than their peer group, with certain outliers averaging the fees charged by active managers. This is primarily due to the benchmark that the smart beta ETF is tracking. One such example is the expense ratios for Schwab US Broad Market ETF SCHB and Schwab Fundamental US Broad Market ETF FNDB. The former uses as a benchmark the Dow Jones U.S. Broad Stock Market Index weighted by market-capitalization and has an expense ratio of 0.03%. The latter uses as a benchmark the Russell Fundamental U.S. Index and has an expense ratio of 0.32%. Both are smart beta ETFs and both come from the same provider, yet they charge differently.

Overall, while performance is indeed important and keeping in mind the initial promise of smart beta strategies, in the U.S., investors have always opted for the least expensive options and Morningstar warns investors to always assess the performance of smart beta ETFs that charge higher fees, to see if it is worth paying the extra cent.

Finally, Morningstar points out that there is a decreasing tendency in fees in the U.S. smart beta market with examples from longstanding funds that have cut their expense ratios

(PowerShares FTSE RAFI and iShares Core) to recently launched funds such as Goldman Sachs ActiveBeta U.S. Large Cap Equity ETF GSLC, which charges a 0.09% expense ratio.

The following table provides a comparison of fees across all ETFs in the U.S., as well as across all asset classes:

Table 5: Comparative analysis of fees charged in U.S. ETFs as of June 30th, 2016

	Average	Combined	Equity	Fixed Income	Commodities	Alternatives
All ETFs	Weighted	0.25%	0.23%	0.22%	0.48%	0.98%
	Simple	0.57%	0.50%	0.34%	0.79%	0.90%
Non-smart beta ETFs	Weighted	0.24%	0.21%	0.22%	0.43%	0.98%
	Simple	0.61%	0.53%	0.35%	0.83%	0.89%
Smart beta ETFs	Weighted	0.29%	0.27%	0.39%	0.80%	0.97%
	Simple	0.50%	0.46%	0.33%	0.74%	1.15%

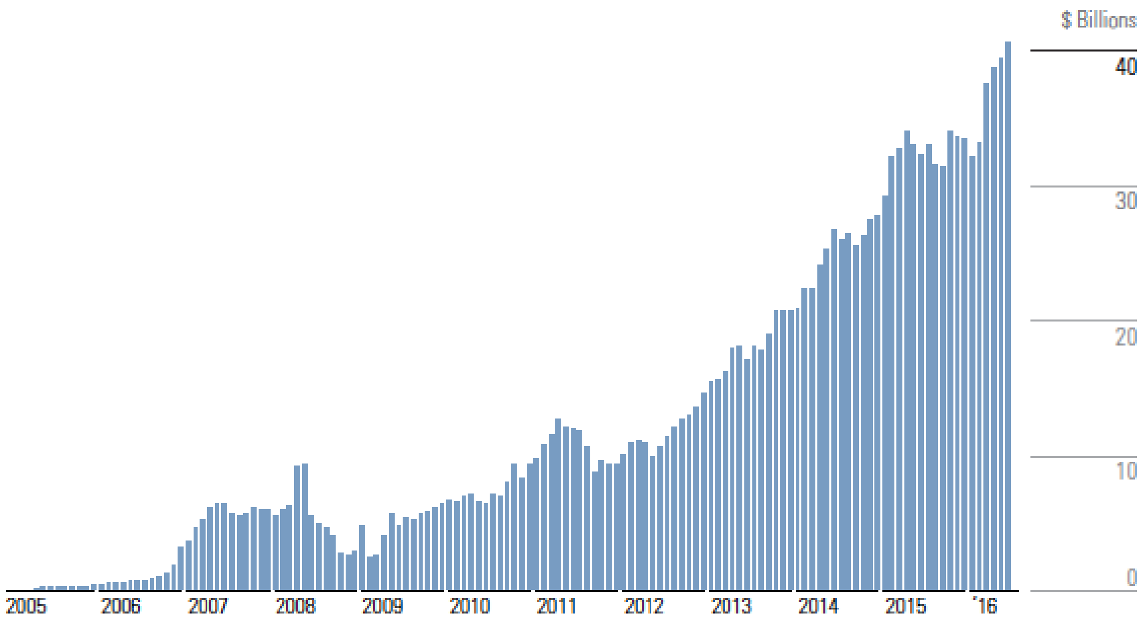
Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/09/16, page 11)

We will next provide an overview of the European market in the same manner as above, especially considering that the European smart beta market has been one of the fastest growing markets in recent years.

- **The smart beta market in Europe:**

The European smart beta ETF market is relatively younger than its American counterpart. Having been established in late 2005, it is now counts 268 smart beta ETFs and is valued at $40 billion in assets under management as of June 30th, 2016 (a 25% increase compared to last year's AUM figures and a four-times increase overall in four years). These figures make Europe the second fastest growing smart beta ETF market in the world, right behind the Asian-Pacific market.

Chart 3: Evolution of European Smart Beta ETFs assets under management as of June 30th, 2016.



Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/09/16, page 19)

Smart beta ETFs have had a rocky start in Europe, starting with a significant increase in market share between 2006 and 2007, before suddenly dropping in 2008. This is mainly attributed to the financial crisis having severely impacted high-dividend paying firms, thus having a severe effect on the performance of dividend-weighting smart beta ETFs due to investors removing their investments from them. However, from 2009 onward, smart beta ETFs have known a steady growth pace, reaching 7.5% in market share of the total ETF market in Europe, primarily due to consistent new smart beta ETFs launches and low-volatility oriented strategies gaining ground.

Chart 4: European Smart Beta ETFs market share evolution in the European ETF market as of June 30th, 2016.

Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/09/16, page 20)

Factors-wise, while dividend-weighted smart beta ETFs remain the most popular choice amongst investor due to the low interest rate environment (peaking at 43% of the total assets under management of the European market), their AUM value has stagnated over the last couple of years and their market share has been dwindling with every passing year. However, both low-volatility/minimum-variance and multifactor strategies have steadily been gaining ground, reaching 19% (vs 13% LY) and 13% (vs 7% LY) respectively. The growth of multifactor strategies is particularly interesting as it is a result of both funds increasing their investments (in both funds and marketing) to promote these strategies as well as the general market tendency in Europe towards more complexity.

However, it is important to note that fixed income oriented strategies have remained stagnant in their growth and the number of fund closures is doubling year-over-year, reaching 23 closed funds as of June 30th, 2016. The latter is interpreted by Morningstar as a sign of market maturity as surviving funds see their AUM increase and benefit from the approval of investors while funds that fail to draw in investors and assets have closed and will continue to do so.

Overall, factors-wise, the European smart beta ETF market is dominated by 3 main strategies that either echo the current economic environment (dividend-weighted, low-volatility) or a combination of current/future market tendencies and high marketing efforts (multifactor). Finally, it appears that the European market seems to be maturing rather rapidly, with well-performing funds thriving and others having their doors and activities unceremoniously shut down.

The following table summarises the various strategies used by European smart beta ETFs as of June 30th, 2016:

Table 6: Breakdown of European smart beta factors used as of June 30th, 2016.

Strategy	AUM ($ billion)	% of AUM	Strategy	AUM ($ billion)	% of AUM
Dividend-weighted	17.6	43.2%	Fundamentals-weighted	0.3	0.8%
Low-volatility/Minimum-variance	7.7	18.9%	Momentum	0.3	0.7%
Multifactor	5.2	12.7%	Growth	0.2	0.5%
Nontraditional commodity	2.9	7.2%	Expected returns	0.2	0.4%
Quality	2.4	5.8%	Buyback/Shareholder Yield	0.1	0.2%
Value	1.8	4.5%	Multiasset	0.1	0.1%
Equal-weighted	1.3	3.2%	Low/High Beta*	0	0.1%
Nontraditional fixed income	0.6	1.6%	Risk-weighted*	0	0.1%

Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/09/16, page 22)

Regarding providers, iShares holds the lion's share of the European smart beta ETF market at 44% in AUM with 70% of the largest European smart beta ETFs being provided by iShares. They are followed closely by SPDR and Source, the latter benefitting from the performance of the Goldman Sachs Equity Factor Europe ETF, a multifactor fund which has gathered around $500 million dollars in AUM as of June 30th, 2016. The following table lists the main smart beta providers in the European market:

Table 7: Smart beta strategies providers in Europe as of June 30th, 2016.

Smart beta providers	AUM ($ billion)	Market share
iShares	18.1	44.6%
SPDR	3.8	9.4%
Source	3.2	7.9%
Lyxor	2.4	5.9%
UBS	2.3	5.7%
db X-trackers	2.6	6.4%
Ossiam	2.1	5.2%
Amundi	2.0	4.9%
Think ETFs	0.7	1.7%
Invesco	0.7	1.7%
Others	2.7	6.7%

Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/09/16, page 22)

Regarding smart beta ETFs, as it was the case with the American market, we have limited ourselves with the largest ETFs in Europe in terms of assets under management. Additional information provided includes the factors used in their smart beta strategies, their ticker as well as their expense ratios.

Table 8: Largest European smart beta ETFs as of June 30th, 2016

Smart beta ETF	Ticker	Inception date	Smart beta factor used	Expense ratio	AUM ($ billions)
iShares Developed Markets Property Yield	IWF	20/10/2006	Dividend-weighted	0.59%	3.0
SPDR S&P US Dividend Aristocrats	IWD	14/10/2011	Dividend-weighted	0.35%	2.3
iShares Edge S&P 500 Minimum Volatility	VIG	30/11/2012	Low-volatility/Minimum variance	0.20%	2.1
iShares European Property Yield	VUG	04/11/2005	Dividend-weighted	0.40%	1.6
iShares Edge MSCI World Minimum Volatility	VTV	30/11/2012	Low-volatility/Minimum variance	0.30%	1.4
iShares Edge MSCI Europe Minimum Volatility	DVY	30/11/2012	Low-volatility/Minimum variance	0.25%	1.2
iShares STOXX Global Sel Div 100 (DE)	SDY	25/09/2009	Dividend-weighted	0.46%	1.1
iShares UK Dividend	DXJ	04/11/2005	Dividend-weighted	0.40%	1.0
SPDR S&P Euro Dividend Aristocrats	IVW	28/02/2012	Dividend-weighted	0.30%	0.8
Lyxor JPX-Nikkei 400 ETF DR	VYM	30/01/2015	Quality	0.25%	0.8

Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/09/16, page 23)

In regards to fees, there is a clear divide in the European smart beta ETF market with funds offering exposure to standard factors have seen their fees shrink while funds that offer strategies geared towards multifactor models and fixed-income strategies have charged a premium for their services. This has had the effect of levelling smart beta ETF fees and having them approach the fees charged by other non-smart beta ETFs. Finally, Morningstar predicts that fees will drop as the European market matures. The following table provides a comparison of fees across all ETFs in Europe, as well as across all asset classes:

Table 9: Comparative analysis of fees charged in U.S. ETFs as of June 30th, 2016

	Average	Combined	Equity	Fixed Income	Commodities	Alternatives
All ETFs	Weighted	0.31%	0.31%	0.27%	0.40%	0.50%
	Simple	0.48%	0.41%	0.23%	0.59%	0.77%
Non-smart beta ETFs	Weighted	0.31%	0.30%	0.29%	0.40%	0.50%
	Simple	0.48%	0.41%	0.22%	0.63%	0.77%
Smart beta ETFs	Weighted	0.39%	0.39%	0.46%	0.41%	N/A
	Simple	0.42%	0.40%	0.41%	0.47%	N/A

Source: Morningstar, A Global Guide to Strategic-Beta Exchange-Traded Products (30/09/16, page 24)

We have concluded our overview of the global smart beta ETF market as well as our focus on both the American and European markets. In the following section, we will further explore smart beta strategies, focusing on the different strategies possible as well as an appraisal of the concept of smart beta, as a whole, from various academics and investors. This section's goal is to provide the reader with a first academic and professional answer to the question of whether smart beta strategies are really smart.

3.3. Appraisal of smart beta strategies:

In this section, we will perform an appraisal of smart beta strategies as a whole by relying on the opinions and research of various academics and investors. The objective is to provide a first answer to the question "is smart beta really smart?". To do so, we will first start by introducing the main smart beta strategies used, next we will go over several researches and analysis from academics and investors regarding the use of smart beta strategies as way to enhance returns, making the case for both the defenders and the detractors of smart beta.

- **Overview of the main smart beta strategies:**

The main smart beta strategies used by practitioners and investors can be organized into three categories, each reflecting the main construction approaches used by smart beta funds: fundamental indexing, risk-based indexation and strategy/factor-based strategies.

- **Fundamental indexing strategies:**

The approach known as fundamental- indexing is based off the work of Arnott, Hsu, and Moore, namely their 2005 paper "Fundamental Indexation". The premise of this approach is that portfolios that are weighted using market-capitalization are not as close, performance-wise, to CAPM portfolios as many investors claim. However, Arnott, Hsu, and Moore argue that while these market-cap weighted portfolios do not perform as well as their CAPM counterparts, they do have present several advantages that any alternatively constructed strategy should conserve. These advantages are:

- Market-cap weighted portfolios require little to no rebalancing. This means that any holder/manager of such a portfolio does not need to engage frequently in trading the securities that make it up. The only known exceptions are when certain companies disappear due to mergers/bankruptcy or when certain companies become sufficiently large in size to warrant their inclusion in the market. Therefore, the trading costs and management fees of these portfolios are very minimal compared to actively-managed portfolios;

- Market-cap weighted portfolios allow investors to easily participate in the market since these portfolios assign the biggest weights to large market capitalization companies, which also happen to exhibit large performance metrics such as sales, available cash flow and so on;
- Market-cap weighted portfolios, by construction, will assign the highest weights to companies that are regularly traded (or highly liquid) in the market. This is due to the fact that size and liquidity are highly correlated. As a result, this further decreases the transaction costs of market-cap weighted portfolios.

With that in mind, Arnott, Hsu and Moor demonstrate in their paper than investors can achieve greater returns, lower tracking error and turnover compared to the market-capitalization weighted portfolios by weighing their portfolios using company fundamentals such as gross revenue, equity book value, gross sales, gross dividends, cash flow, and total employment (Arnott, Hsu, and Moore, 2005:83).

Construction-wise, fundamental-indexing uses a weight based on each fundamental discussed above, named "accounting-weight", which comprises the last five years-worth of sales, cash flows, dividends and book value of the companies selected. The resulting accounting-weight is defined as such:

$$x_{accounting\ size,i} = \frac{Accounting\ size_i}{\sum_{i=1}^{N} Accounting\ size_i}$$

The final fundamental-weighted portfolio is then obtained by averaging all fundamentally-weighted sub-portfolios created from each of the five fundamentals discussed above.

- **Risk-based indexation strategies:**

Risk-based smart beta strategies focus on, as their names imply, reducing/managing the overall risk of the portfolio all while maintaining a decent level of return. Under this category, we list: equal-weighting and its risk-cluster equivalent, diversified-weighting, minimum variance and maximum Sharpe ratio strategies.

- Equal-weighting:

Equal-weighting is a smart beta strategy that focuses on constructing a portfolio of securities that all have the same weight. Depending on the benchmark, the number of securities (N, in this instance) may vary, however, the selection process is based on ranking the securities by market capitalization in descending order and then applying an equal weight to all selected securities (namely, a weight of 1/N).

Chow, Hsu, Kalesnik and Little (henceforth denoted as CHKL) have noted in their paper "A Survey of Alternative Equity Index Strategies", that equal-weight portfolios see their return and volatility change depending on the number of securities chosen. In particular, they have noted that the equal-weighted portfolio based on the Russell 1000 Index has exhibited higher volatility and is highly exposed to small-cap companies.

- Risk-cluster equal-weighting:

The risk-cluster equal-weighting (RCEW) approach is a direct response to investors' claims that the equal-weighted approach discussed above was too simplistic, especially when it came to selecting the securities that would make up the portfolio. As such, the approach attributes weights based on risk clusters instead of the number of securities present in the portfolio.

The RCEW approach, as described by CHKL, borrows a lot from the QS Investors' Diversification Based Investing (DBI) methodology where it defines risk-clusters on the basis of a country/sector combination and, once it has identified all the combination required for the portfolio, then allocates an equal weight to them. CHKL, in their paper, defined these risk-clusters using correlations between all possible country/sector portfolios, with positively correlated portfolios being grouped together in one risk-cluster. Once all the clusters are defined (assuming that, in this instance, we have identified M clusters), then all of them are attributed an equal weight of 1/M.

Performance-wise, the RCEW approach fares better than the equal-weight one as CHKL have noted, for the same Russell 1000 Index benchmark, which in terms of returns and volatility, the RCEW portfolio exhibited a similar profile than the benchmark.

- Diversified-weighting:

The diversified-weighting approach draws on the research conducted by Robert Fernholz in his 1999 paper "On the diversity of equity markets". Fernholz defines stock market diversity as:

"Diversity in the distribution of capital is a prominent characteristic of equity markets; not all the capital is concentrated in a few companies. Markowitz's work on portfolio theory shows that risk averse investors will hold diversified portfolios and Sharpe's work on market equilibrium shows that this will lead to a diverse equity market. Market diversity is a weak stability condition compatible with forms of stationary economic equilibria […]. Market diversity allows for shifts of capital from company to company and from economic sector to economic sector, as long as concentration of all the capital in just a few companies is avoided. Diversity appears to be natural in actual equity markets" (Fernholz, 1999:393-394).

Quantitatively, Fernholz defined the following formula as an interpretation of stock market diversity using a market-capitalization weighted portfolio P_{market}:

$$D_p(P_{market}) = \left[\sum_{i=1}^{N} (x_{market,i})^p\right]^{1/p} \quad p \in (0,1)$$

with $x_{market,i}$ being the weight of the i-th stock in the portfolio and p, the desired tracking error level between the portfolio and its benchmark.

Diversified-weighted portfolios leverage on the work Fernholz to create portfolios that mix between equal-weighting and market-capitalization weighting through the following weight definition:

$$x_{diversity,i} = \frac{(x_{market,i})^p}{\sum_{i=1}^{N} (x_{market,i})^p}$$

It should be noted that for p=0, we end up with an equal-weighted portfolio, whereas for p=1, we end with a market-capitalization weighted portfolio.

The main application of the diversified-weighted method is to avoid the issues that investors have with the two other above methodologies, mainly regarding tracking error and portfolio turnover which are noted to be quite high.

- <u>Minimum-variance:</u>

Minimum-variance portfolios take their inspiration from the 1993 paper "The Effect of Errors in Means, Variances and Covariances on Optimal Portfolio Choice" by Chopra and Ziemba, who assert that portfolio returns and variances can be improved if we assume that all stocks exhibit the same expected returns. Thus, the optimal portfolio choice would be that of the minimum-variance portfolio. The assumption that forms Chopra and Ziemba's theory is due to the fact that forecasting returns is very tedious and is largely error-prone.

In practice, minimum-variance strategies seem to have some credibility as they have been shown to deliver better results than market-capitalization weighted portfolios in both returns (higher) and volatility (lower), according to Haugen and Baker (1991) and Clark, de Silva, and Thorley (2006).

Minimum-variance portfolios are constructed by weighting the securities within the portfolio by solving the following optimization problem:

$$\min X'\hat{\Sigma} X \; subject \; to \begin{cases} \sum_{i=1}^{N} x_i = 1 \\ l \leq x_i \leq u \end{cases}$$

where:

- X is the vector of the weights of the portfolio
- $\hat{\Sigma}$ is the covariance matrix
- l, u are the lower and upper bounds, respectively, of a given weight. To ensure that no short-selling is possible and that no security has predominance over another in the portfolio, l is set at 0 and u is set at 5%.

- <u>Maximal Sharpe-ratio:</u>

The assumption upon which minimum-variance portfolios are built (all stocks should have the same expected returns) is not possible practically. As a result, the Sharpe ratio of a minimum-variance portfolio will not be maximal. To remedy this issue, two methods are available:

- The first method draws upon the research of Choueifaty and Coignard (2008) who suggested that the expected excess return of a given security has a linear relationship with its volatility. Therefore, to maximize the Sharpe ratio, we need to build a portfolio in which the weights of the securities are the solution to the following optimization problem:

$$\max \frac{X'\hat{\sigma}}{\sqrt{X'\hat{\Sigma}X}} \; subject \; to \begin{cases} \sum_{i=1}^{N} x_i = 1 \\ l \leq x_i \leq u \end{cases}$$

where $\hat{\sigma}$ is the vector of the volatilities of expected returns of each security in the portfolio and the lower and upper bounds for the weights of the securities are set at 0 and 10% respectively.

- The second method draws upon the research Amenc, Goltz, Martellini, and Retkowsky (2010) who suggest that the expected return of a given security has a linear relationship with its "semi-volatility", particularly its downside variant as, according to behavioural finance, investors are much more interested in their portfolio's losses than they are in its gains. They defined the downside semi-volatility as:

$$\delta_i = \sqrt{E[\min(R_{i,t}; 0)^2]}$$

where $R_{i,t}$ is the return of stock i in a given time period t.

Thus, to build a portfolio that maximizes its Sharpe ratio, we need to choose the portfolio's securities weights from the solution of the following optimization problem:

$$\max \frac{X'\hat{\delta}}{\sqrt{X'\hat{\Sigma}X}} \; subject\ to \begin{cases} \sum_{i=1}^{N} x_i = 1 \\ l \leq x_i \leq u \end{cases}$$

where $\hat{\delta}$ is the vector of the downside semi-volatilities of expected returns of each security in the portfolio. The lower and upper bound constraints are not fixed, as opposed to the previous methods. However, Amenc et al. suggest setting the lower bound at 1/2N and the upper bound at 2/N (with N being the number of securities within the portfolio).

- **Strategy/factor based strategies:**

Strategy or factor based strategies are built on the selection of specific systematic factors whose effects have been strongly backed-up by both academic research and empirical exercises. The number of factors fluctuates but there are five main factors that are used in most factor-based smart beta strategies, many of which come from the Fama-French three factor model:

- **Market beta:** Which measures how sensitive a security's return to the return of the market in which it exists;
- **Value:** Which captures the returns generated by companies that are either value stocks or growth stocks. The usual measures used to capture value are book value, price-to-book ratio, sales and so on;
- **Quality:** Which captures the returns generated by companies that are known for their high quality in the eyes of investors. The usual measures used to capture quality are earnings stability, leverage and so on;
- **Size:** Which captures the returns generated by companies that are either large-cap or small-cap. The only measure used to capture size is market capitalization;
- **Momentum:** Which captures the returns generated by companies that are either market leaders or laggards. The usual measures used to capture momentum are past prices and the historical performance of the company's stock.

Smart beta ETFs using factor-based strategies either specialize in one specific factor or use two or more, depending on the objective that they want to achieve. Denomination-wise, ETFs that specialize exclusively in one factor are called "pure style" funds. Smart beta ETFs that use a maximum of two factors are said to have a "tilt" towards these factors, whereas ETFs that use more than two factors are called "multifactor" ETFs.

Finally, while the abovementioned factors are regularly used, additional factors such as yield, liquidity and so on, can be used by other funds. In addition, these factors' popularity is rather cyclical due to their performance, with one factor becoming popular one year, only to be unpopular the next, as shown by the chart below from Vanguard:

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Equity market returns		20.65%	9.57%	−40.33%	30.79%	12.34%	−5.02%	16.54%	27.37%	5.50%	−0.32%	8.15%
Factor returns (excess equity market)	Best performer	Value 10.4%	Momentum 10.3%	Low volatility 11.1%	Size 21.0%	Size 12.8%	Low volatility 13.1%	Liquidity 2.5%	Size 6.3%	Low volatility 6.6%	Low volatility 6.1%	Size 3.8%
		Liquidity 2.9%	Quality 7.2%	Quality 6.9%	Value 11.1%	Liquidity 7.1%	Momentum 9.8%	Size 0.7%	Value 5.3%	Quality 3.5%	Momentum 4.9%	Value 0.07%
		Low volatility 0.5%	Liquidity 0.7%	Momentum 0.4%	Liquidity 7.1%	Momentum 4.2%	Quality 9.4%	Value −1.5%	Momentum 2.9%	Momentum 1.5%	Quality 4.6%	Low volatility 0.0%
		Momentum −1.6%	Value 0.7%	Liquidity −1.7%	Quality 2.7%	Low volatility 0.4%	Size −3.8%	Momentum −1.8%	Quality 0.4%	Value -0.9%	Liquidity 2.6%	Liquidity −1.9%
		Size −3.8%	Low volatility −3.4%	Value −2.3%	Low volatility −13.6%	Quality −1.0%	Liquidity −5.7%	Quality −2.9%	Liquidity −2.8%	Size −1.8%	Size 0.9%	Quality −3.0%
	Worst performer	Quality −3.9%	Size −8.3%	Size −3.6%	Momentum −16.0%	Value −3.2%	Value −6.0%	Low volatility −7.7%	Low volatility −8.0%	Liquidity −4.5%	Value −2.4%	Momentum −3.4%

Notes: Returns are USD-denominated excess returns to the equity market. Excess returns are calculated relative to the MSCI World Total Return Index (USD). The liquidity factor is calculated using the FTSE Developed Illiquidity Factor Index; the momentum factor is calculated using the MSCI World Momentum Index; the quality factor is calculated using the MSCI World Quality Index; the size factor is calculated using the MSCI World Small Cap Index; the value factor is calculated using the MSCI World Enhanced Value Index; and the volatility factor is calculated using the MSCI World Minimum Volatility Index.

Source: "Cyclical nature of factor-based equity investing", Vanguard Canada (March 2017, page 1)

In the next section, we will perform a first appraisal of smart beta as a concept by reviewing the works of academics and investors and their opinions on whether smart beta is indeed smart.

- **<u>Making the case for smart beta strategies – literature review:</u>**

As seen in the smart beta market section, these strategies have been growing at a steady pace (whether it is due to new inflows to existing smart beta ETFs or due to new launches) and more and more investors are adopting them. While some scholars and investors have praised smart beta strategies for their performance and have qualified them as "truly smart", others remain doubtful and some have even stated that smart beta strategies do not work at all and are not considered smart. In this section, we will go over some of the academic articles and investor opinions that have studied smart beta, making the case for those who are against smart beta strategies and those who support it.

- The case against smart beta:

Prominent academics such as Burton Malkiel and Robert Dubil and investors such as Jack Bogle and Rob Arnott have openly expressed that smart beta strategies do not always work and should not be called "smart". The reasons differ but two common points between all their findings are apparent:

- Smart beta strategies' superior returns are either situational or obtained through taking on more risk;
- Smart beta strategies are heavily reliant on the valuations of the stocks at the time of the strategies' implementation.

We will perform a comparative review of the research conducted by both Malkiel and Dubil as well as the statements of both Bogle and Arnott regarding why smart beta is not truly smart in what follows.

- Burton Malkiel – "Is smart beta really smart?" (2014:127-134):

In this paper, Burton Malkiel performs an assessment of the performance of smart beta funds and compares the results obtained theoretically with those obtained using real capital.

He finds that the performance of smart beta strategies is not consistent and is highly dependent on the economic environment. Any excess return achieved by the funds implementing these strategies was, according to Malkiel, due to them assuming more risk. Malkiel illustrates this by analysing the performance of the RAFI (Research Affiliates) Fundamental Index portfolio during the 2009-2014 period, where it is shown that considerable weights were given to bank stocks and 15% of the portfolio's value was invested in two stocks, Citigroup and BoA – which were, at that time, under scrutiny by the U.S. treasury department in its attempt to mitigate the effects of the financial crisis and thus were heavily discounted in the market. Malkiel states that the stock selection performed by Research Affiliates in this instance is not so different from gambling and could have had catastrophic consequences if the market did not stabilize, thus the superior returns that the RAFI Fundamental Index obtained from 2009 onward are nothing short of luck.

Malkiel also asserts that, in addition to their need for regular rebalancing (which, thusly, increases their costs), smart beta portfolios are prone to long periods of underperformance due to the mean reversion effect following periods of high performance. This is especially true considering that the returns of smart beta portfolios are heavily reliant on market valuations (Malkiel provides an example of growth stocks that have benefitted greatly from the huge valuations after the dot-com bubble which, in turn, generated massive returns for smart beta strategies titled towards value).

Malkiel further provides an overall assessment of the existing smart beta strategies, stating that:

- In his analysis of the performance of the VVIAX value ETF and the VIGAX growth ETF over the 1992-2013 period, value/growth smart beta ETFs have demonstrated similar levels of performance relative to each other but, individually, they have exhibited fluctuations in their outperformance;
- Small-cap/large-cap titled smart beta ETFs have exhibited high levels of volatility as well as significant mean reversion, leading to extended periods of underperformance;
- Blended (or mixed) smart beta strategies have exhibited solid returns, however, Malkiel warns that this is counterbalanced by higher levels of risks;
- The results of fundamental indexing titled smart beta strategies are heavily reliant on market valuations as well as higher levels of risks;
- Equal-weighted smart beta strategies exhibit the same result profile as value/growth strategies, especially in terms fluctuations in outperformance periods and have been noted to produce larger annual returns.

Malkiel also states that, despite what it is marketed, smart beta strategies are quite expensive compared to market-capitalization weighted strategies. This is due to them not being priced at the fair value of their underlying stocks as well as the fact that some smart beta ETFs can only be purchased through an intermediary, which further increases their cost.

Finally, Malkiel asserts that smart beta strategies owe their popularity to marketing hype and claims that, as strategies become increasingly popular amongst investors, their results will eventually decrease (which, according to Malkiel, is especially true for value and small-cap tilted strategies).

- Robert Dubil – "How Dumb is Smart Beta? Analyzing the Growth of Fundamental Indexing" (2015:49-54):

In this paper, Robert Dubil performs a statistical analysis of the performance of certain smart beta ETFs in the U.S., regresses their returns against the Carhart Four-Factor model and performs a performance attribution analysis of them. The aim of this paper is twofold: firstly, to identify what are the actual risks taken by these funds and secondly, to identify what are the main factors in the Carhart model that contribute to the returns of the smart beta ETFs.

Regarding the statistical analysis of the performance of the funds, Dubil proceeded by calculating the compounded monthly total returns net of management fees for each of the funds before deriving the main portfolio statistics (mean, standard deviation and Sharpe ratios) across 3, 5, 7 and 10-year periods. The results obtained are shown in annex 1.

Dubil summarizes the main finding of his statistical analysis as such:

- Dividend-oriented strategies (yield and growth) seem to be producing better results than the other ETFs over the 3 and 5-year periods, evidenced by their lower standard deviations and higher Sharpe ratios;
- Market-capitalized strategies titled towards growth perform better than their other ETFs in their peer group, with the SPDR S&P 500 Growth SPYG ETF exhibiting a lower standard deviation (or second-lowest in certain cases) and higher Sharpe ratios during the 3, 5 and 7-year time periods;
- The remaining strategies show conflicting results across the different time periods.

The results of the regression of the returns of the smart beta ETFs compared to the Carhart Four-Factor model performed over a seven-year period are shown in annex 2 and their findings can be summarized as follows:

- All strategies have exhibited very small but positive intercepts. While the intercept is usually a regression byproduct and academics are at odds over how to interpret it, Dubil chooses to interpret the intercept as alpha. Therefore, all strategies have slightly beaten the market;
- Dividend-oriented strategies have exhibited betas that are lower than 1 compared to the other strategies. Since beta is a measure of systematic risk according to CAPM, this result proves that dividend-oriented strategies are less risky than the market. Furthermore, they have positive exposures to the HML and Momentum factors and a negative exposure to the SMB factor. This means that the risk from dividend-oriented strategies is derived from those of big-sized companies (negative SMB) that exhibit solid earnings and value (positive HML) and are market leaders/trend setters (positive Momentum);
- Equal-weight and pure style strategies have both exhibited betas that are higher than 1, significant positive exposure to the SMB factor and negative Momentum exposure. This means that both strategies are riskier than the market (beta > 1) and their risk comes mainly

from smaller companies (positive SMB) that are lagging compared to the market (negative Momentum);

- Fundamental-oriented strategies (book value, cash flow, sales and dividends) have a significant positive exposure to the HML factor all while being negatively exposed to the Momentum factor. This shows that the risk of fundamental-oriented strategies come from value stocks (positive HML) that are lagging compared to the market.

Finally, the results of the performance attribution analysis of the smart beta strategies (which can be seen in annex 3) can be summarized as follows:

- Based on the CAPM alpha, the main outperforming strategies are the equal-weight, pure style and fundamental-oriented strategies;
- The outperformance of the strategies mentioned in the first point can be broken down as such:
  - Equal-weight strategies' outperformance is explained at 0.27% by its exposure to market risk (0.13%) and its bias towards small-cap stocks (0.14%);
  - Pure style growth strategies derive almost half of their outperformance from exposure to market risk (0.27%) whereas pure style value strategies derive theirs from exposure to the HML factor (0.48%). However, a significant portion of their excess returns remains unexplained (0.19% for growth and 0.24% for value).
  - Fundamental-oriented strategies have over half of their excess returns explained by their exposure to the HML factor (0.18%) and only 0.07% of the excess returns remain unexplained.
  - Dividend-oriented strategies' returns remain somewhat enigmatic; they do not exhibit a significant alpha, however, looking at their exposure to other factors, we see that they benefit from a significant positive exposure to the HML factor which is largely offset by an equally significant but negative exposure to the market, however, a sizeable portion of its alpha remains unexplained.

The key takeaways from Dubil's paper is that the returns of smart beta strategies can be, for the most part, explained through the various factors that the Carhart four-factor models offer making them not as smart as they are put out to be:

- While some strategies such as pure style and dividend-oriented strategies do have a non-negligible portion of their excess returns unexplained, those obtained through equal-weight and fundamental-oriented strategies can be completely linked to exposure to certain key factors.
- And although dividend-oriented strategies are currently the go-to option for many investors, the fact remains that their popularity is not due to their excess returns (which Dubil proves are rather meager) but because they offer lower risk (beta < 1) and higher Sharpe ratios.

  - <u>Jack Bogle – "Smart Beta ETFs do not work" (2016):</u>

In an interview given to Morningstar as part of its Guide to Passive Investing, Jack Bogle who is the founder of the two oldest and largest smart beta ETFs – the Vanguard Growth and Value ETFs, claims that smart beta strategies do not work and have been misused on the following bases:

- He has noted that the funds he has created have delivered the exact same returns over a 25-year period and have experienced fluctuations based on the market. To Bogle, this proves that, in the case of his funds, no one can accurately predict how value and growth stocks will move, effectively reducing the strategies based on these stocks to a guessing game based on investor sentiment/market profile at that time. As Bogle, himself, puts it: "the investors in both funds did about half as well whether you are in the balanced fund or the growth fund because the money comes into the one when it looks good and goes out into the other one when it looks bad" (Bogle, 2016).

- Giving the example of Rob Arnott (founder of the RAFI Fundamental Index) and Jeremy Siegel (founder of WisdomTree, a fund focused on dividend-oriented strategies), Bogle shows that their returns, over 10 years, are almost identical to that of the S&P500.

Ultimately, Bogle claims that not only smart beta strategies do not work but it is easier to hold the market than to invest in complicated strategies that offer no guarantee of returns.

- Rob Arnott – "Dangers of performance chasing" (2016:28):

In the article "Smart beta: Fad or here to stay" (Fundstrategy, September 2016 issue), Rob Arnott, founder of Research Affiliates and of the RAFI Fundamental Index, delivers a column on the dangers of performance chasing specifically applied to smart beta strategies. The performance of an investment, be it smart beta or otherwise, is gauged using historical data. However, therein lies the problem, especially in situations where outstanding returns are noted. Arnott argues that, due to these "situational returns", the valuations of these strategies will increase, driving costs upwards, returns downwards and increasing the risk of mean reversion.

He proves this point through his fund's analysis of the performance of four factors (value, small cap, low beta and gross profitability) over the last 10 years: it is shown that the past performance of the funds basing their strategies from these factors are simply the result of the factors becoming expensive due to rising valuations.

Ultimately, Arnott summarizes the key takeaway from his column as follows:

"Quite simply – valuations matter. They cannot expand indefinitely and today's high valuations will likely be mean reverting valuations tomorrow, leading to negative future performance. As investors look to allocate into smart beta strategies, it is therefore vital they take valuations into consideration and look before they leap" (Arnott, 2016:28).

- The case for smart beta:

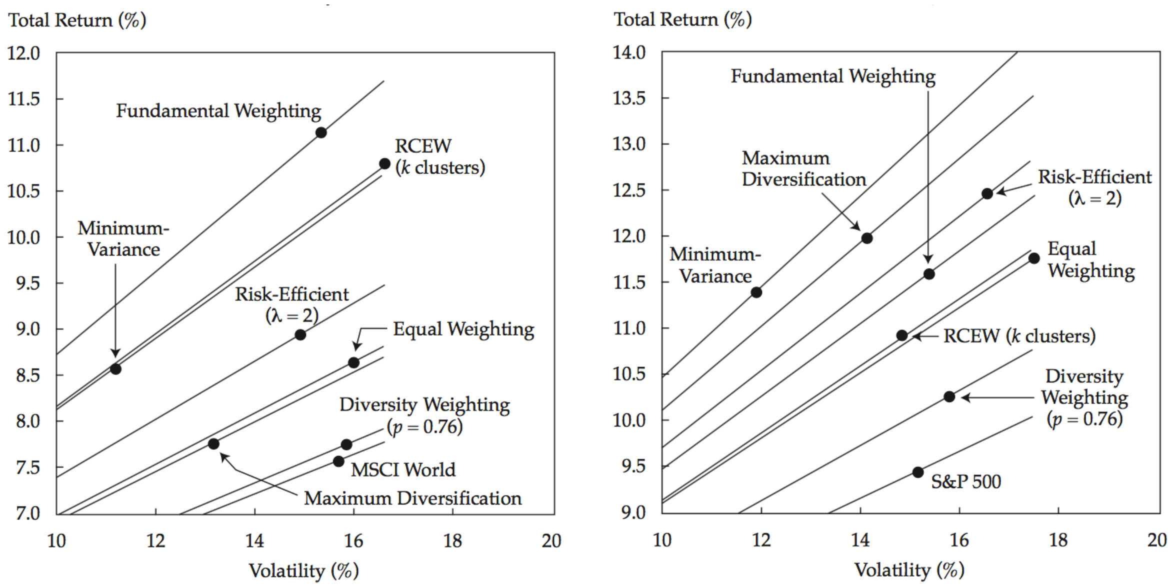
Excluding asset management firms and investment funds that promote smart beta strategies in their prospectus, certain academics and investors have praised smart beta strategies for their performance and their consistency. And while they have warned about some of the issues discussed above (mainly, investors' overenthusiasm for the strategies, valuation and high fees), they have quantitatively proven that smart beta strategies do indeed work. Therefore, in this section, we will cover the works of CHKL, Vadlamudi-Bouchey and Asness who have made the case for smart beta strategies.

- Chow, Hsu, Kalesnik and Little (CHKL) – "A Survey of Alternative Equity Index Strategies" (2011:37-57):

In this paper, CHKL have listed the main smart beta strategies that are used by investors and have proceeded to evaluate their performance quantitatively. To do so, CHKL proceeded with several back-tests on two portfolios (U.S. and Global) comprised of similar datasets and underlying stocks as their benchmarks (the S&P500 for the U.S. and MSCI for the Global portfolio) as well as a risk decomposition using a Carhart Four-Factor regression exercise. The U.S. portfolio is comprised of securities that are part of the CSRP universe. The CSRP universe is comprised of all stocks listed on the New York Stock Exchange, the American Exchange and the NASDAQ and excluded all ETFs, title records and ADRs[3]. The Global portfolio is comprised of stocks provided by the Thomson Reuters and Datastream databanks that fit the criteria of the MSCI index. The purpose of these back-tests was not to fully replicate the investment strategies provided by smart beta funds but rather to prove the solidity and consistency of the theory behind them. Finally, to avoid selection bias with respect to the results of the tests, CHKL proceeded with several supplementary back-tests, which consisted of varying the parameters involved in the construction of their portfolios.

The results of these back-tests, shown in appendixes 4 and 5, reveal that all smart beta strategies listed in the study outperform their respective benchmark on a return basis, however, certain strategies present better characteristics both on absolute (return and volatility) and relative bases (excess return and tracking error) than others.

Chart 5: Absolute performance of smart beta strategies applied to the global (left) and U.S. (right) portfolios.



Source: Chow, Hsu, Kalesnik and Little (CHKL) – "A Survey of Alternative Equity Index Strategies" (2011:43)

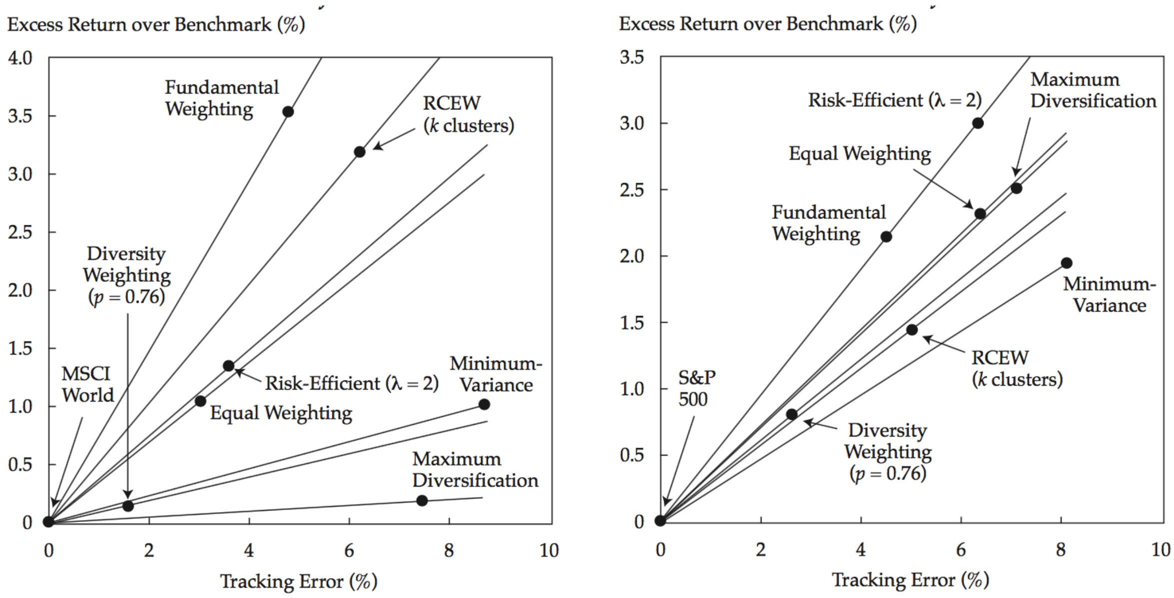
On an absolute basis, we see that:

- All strategies, for both the global and U.S. portfolios, outperform their respective benchmarks, return-wise;
- For the global portfolio, optimization-based strategies (minimum-variance, maximum diversification and risk-efficient) exhibit lower volatility-levels that heuristic-based ones;
- For the U.S. portfolio, optimization-based strategies, except for minimum-variance, exhibit the highest returns among all strategies. Volatility-wise, they offer the lowest volatility levels of the group except for risk-efficient strategies;

[3] Title records refer mainly to U.S. real estate titles of ownership that are listed on public records.
ADR stands for "American Depository Receipt" and refers to stocks that are traded on U.S. stock exchanges but which represent a set amount of shares in a foreign company.

- As expected and advertised by investment funds, minimum-variance strategies exhibit the lowest volatility levels compared to the other strategies, while fundamental weighting and risk-efficient (i.e. the second maximal Sharpe ratio strategy, as discussed above) strategies exhibit the highest total return for the global and U.S. portfolios respectively.

Chart 6: Relative performance of smart beta strategies applied to the global (left) and U.S. (right) portfolios.



Source: Chow, Hsu, Kalesnik and Little (CHKL) – "A Survey of Alternative Equity Index Strategies" (2011:43)

On a relative basis, we see that:

- For the global portfolio, optimization-based strategies, except for risk-efficient strategies, exhibit higher tracking-error levels and lower excess returns than heuristic-based ones;
- For the U.S. portfolio, optimization-based strategies exhibit the highest tracking error levels among all strategies. Excess-returns wise, risk-efficient strategies exhibit the largest excess-return levels while diversity-weighting lags compared to the rest of the strategies.

When combining tracking error with absolute returns, we see that optimization-based strategies, despite exhibiting lower volatility levels, are not an interesting choice for investors seeking higher returns compared to the benchmark. This is due to how tracking error is interpreted. Since tracking error is the standard deviation of the excess return obtained by an investment strategy compared to its benchmark, strategies that have high tracking errors but low average returns are not viable. Therefore, apart from risk-efficient strategies in the U.S., optimization-based strategies as smart beta strategies are not viable from a return-consistency point of view.

The Carhart four-factor regression exercise performed on all smart-beta strategies listed for both the global and U.S. portfolios allowed CHKL to decompose the risk of these strategies with respect to the traditional four factors (market, size, value and momentum). This allowed them to showcase the risk tilts of these strategies as well as any potential alpha obtained from them. The main findings (which are shown in appendix 6) can be summarized as follows:

- All smart beta strategies regressed have exhibited a sizeable positive exposure to the SMB and HML factors. This means that the main source of return and risk for the smart beta studied in the paper is the size and value tilt in their portfolios;

- All smart beta strategies, except for minimum-variance and maximum diversification, show market risk exposure levels that are close to 1. For minimum-variance and maximum diversification strategies, their exposure to market risk is lower than 1. This means that smart beta strategies possess risk levels similar to that of holding the market while minimum-variance and maximum diversification strategies exhibit a much lower risk level than that of the market;
- Momentum exposure for all smart beta strategies is very negligible. This means that the smart beta strategies studied in the paper are not affected by market movements and changes in securities prices;
- According to CHKL, the alphas shown in appendix 6 are not statistically significant. This is because the portfolios on which the strategies are based are constructed with respect to the semi-strong efficient market hypothesis form and thusly do not rely on information that has not already been made available.

CHKL conclude that smart beta strategies are indeed smart in two ways:

- In their ability to offer investors access to size and value tilts in a much more efficient way than by purchasing them directly;
- In their usefulness in improving a portfolio's characteristics (Sharpe ratio, excess return and information ratio).

The first claim is substantiated by CHKL by citing a study from Hsu, Kalesnik, and Surti (2010) who found that standard size and value indices have exhibited negative Fama-French alphas and thus are not the optimal choice for investors seeking exposure to those factors. They also point out that traditional "Fama–French factor portfolios are also difficult to invest in because they require shorting, experience high turnover at rebalancing, and contain many illiquid stocks".

Finally, CHKL add that, while smart beta strategies are cost-effective in allowing investors to gain access to size and value tilts in their portfolios, they remain rather costly to implement, mainly due to high turnover rates, low liquidity and investment capacity, which in turn eat away at the excess returns generated by these strategies. As such, CHKL advises investors to pay close attention to the cost side, rather the potential returns that can be gained, of the implementation of smart beta strategies before investing in them.

  - <u>Vadlamudi and Bouchey – "Is Smart Beta Still Smart After Taxes?" (2014:123-134):</u>

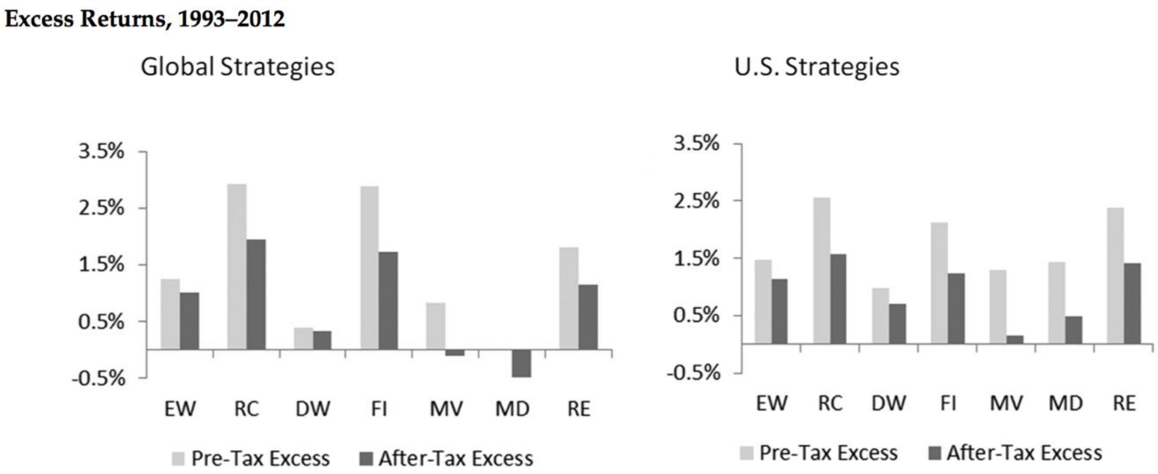
In this paper, Vadlamundi and Bouchey leverage on the findings of CHKL's study of smart beta strategies to test their viability from a taxation standpoint. While they do not challenge the findings of the CHKL paper in regards to the performance (from a portfolio standpoint) of the smart beta strategies listed, they do express interest on how tax systems impact these strategies and whether they can still be called smart after taxes. In short, Vadlamundi and Bouchey's study provides an answer to the question of the smartness of smart beta strategies from a real money perspective.

In terms of the methodology followed, Vadlamundi and Bouchey constructed two portfolios that are similar to those of CHKL and subjected them to the same smart beta strategies listed in their study, albeit on a more restricted timeframe. They rationalize their choice of the timeframe by stating that the tax systems of the last 20 years are significantly different from those of the past and it is simpler for them to explain the results they have obtained, from a return standpoint. Furthermore, in addition to performing the same back-test as CHKL with respect to performance measurement and assessing the direct impact of taxes on excess returns, they subjected the smart beta strategies to a second back-test where they implemented five tax management methods to reduce the simulated costs related to taxation.

The premise of this study is that, due to the high turnover rates of smart beta strategies compared to their traditional, market-capitalization weighted counterparts, they are costlier to implement and are exposed to further taxation. The effect of taxation is to significantly reduce any potential return obtained from the implementation of investment strategies, with those exhibiting higher turnover rates suffering from higher taxation levels. This is especially true in the case of active fund managers who are known to have lost any excess return they have generated to taxes (Jeffrey and Arnott [1993], Arnott et al. [2011]). Vadlamundi and Bouchey have compared the potential effect of taxes on the returns obtained from traditional market-capitalization weighted strategies and smart beta ones, with the former estimated to be reduced annually by 1% (equally split between dividend tax and capital gains tax) and the latter by 1.5 to 2.5%.

The graph below illustrates the difference in excess returns before and after tax. Excess returns have been calculated in the same fashion as those of the CHKL study, while after-tax returns have been calculated by applying tax rates of 15/35% and 33%/50% (the various tax levels have been chosen by Vadlamundi and Bouchey to assess the sensitivity of their results to the tax rate). Vadlamundi and Bouchey have also operated under the assumption that the tax systems are almost universal in their application.

Chart 7: Pre and Post Tax Excess Returns of smart beta strategies applied to the global and U.S. portfolios.



Source: Vadlamundi and Bouchey – "Is Smart Beta Still Smart After Taxes?" (2014:127)

With:

- EW: Equal-weighting
- RC: Risk-cluster equal weighting
- DW: Diversification-weighting
- FI: Fundamental indexing
- MV: Minimum-variance
- MD: Maximum diversity (Max Sharpe ratio strategy 1)
- RE: Risk-efficient (Max Sharpe ratio strategy 2)

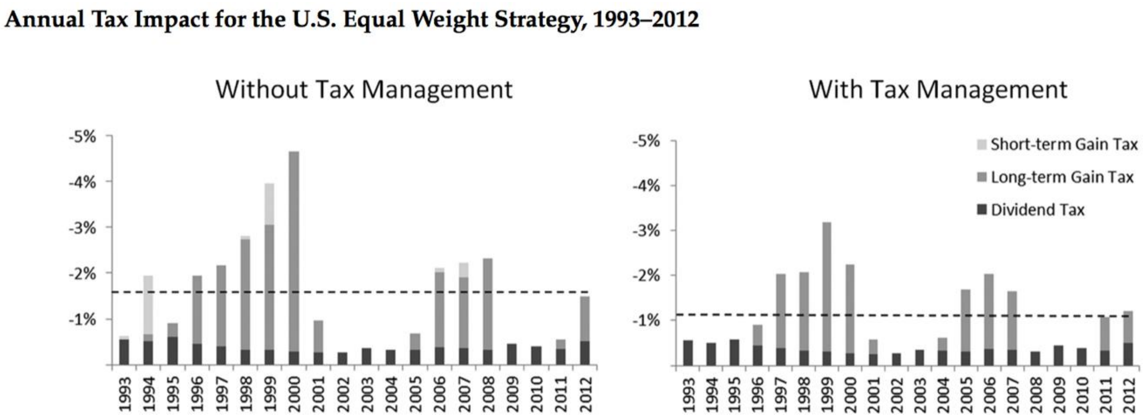
For both global and U.S. strategies, taxes have eroded much of the excess return generated by smart beta strategies (with minimum-variance and maximum diversity strategies displaying negative post tax returns). This is mainly due, as discussed above, to the high turnover rates of smart beta strategies. However, these turnover rates remain smaller than those of active management funds which adds to the appeal of smart beta strategies in their ability to retain excess returns even after taxes have been applied. Vadlamundi and Bouchey also point out that heuristic-based strategies (EW, RC, DW and FI) are less affected by tax than optimization-based strategies (MV, MD and RE), which is due to the former not requiring too much turnover compared to the latter.

Vadlamundi and Bouchey have also implemented five tax management methodologies in order to further reduce the tax impact on the excess returns generated by the smart beta strategies studied. These tax management methodologies are:

- Delaying the realization of gains from an asset's sale.
- Managing the holding period of an asset.
- Accumulating losses.
- Managing tax lots
- Avoiding wash sales (the repurchase of a security/asset within 30 days of its initial sale).

Vadlamundi and Bouchey initially applied the tax management methodologies to the equal-weight strategies at first, before applying them to the other smart beta strategies as well. The graph below showcases the differences of post-tax excess returns of the equal weight strategy applied to the U.S. portfolio, before and after the implementation of the tax management methods discussed above:

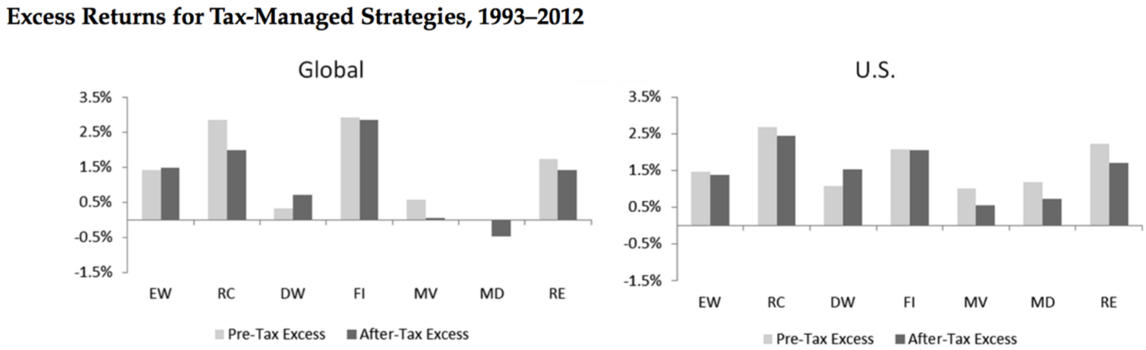
Chart 8: Post Tax Excess Returns of equal-weight strategies applied to the U.S. portfolio before and after tax management.



Source: Vadlamudi and Bouchey – "Is Smart Beta Still Smart After Taxes?" (2014:130)

The main finding is that the average tax impact on the excess returns of the equal weight strategy has decreased from -1.64% to -1.08% (a decrease of 56 basis points), which is quite significant. Vadlamundi and Bouchey also applied these tax management methods to the other strategies (results in annex 7) and have obtained a similar performance (with excess returns gains ranging from 40 to 90 basis points depending on the smart beta strategy). This is illustrated by the graph below:

Chart 9: Post Tax Excess Returns of smart beta strategies applied to the global and U.S. portfolios, before and after tax management.



Source: Vadlamudi and Bouchey – "Is Smart Beta Still Smart After Taxes?" (2014:133)

Vadlamundi and Bouchey's final verdict is that smart beta strategies are smart before taxes and remain smart after taxes if adequate tax management is applied to them to prevent the erosion of the excess returns gained. And while they warn that these tax management methodologies further increase the turnover rates for these portfolios (and, therefore, their overall cost), the benefits outweigh the costs.

- Cliff Asness – "My Factor Phillipic" (2016:1-30):

In this paper, Cliff Asness, who is the founder of the investment firm AQR Capital Management, opposes Rob Arnott's claim of valuation being the explaining factor behind some smart beta strategies' recent returns. In addition, Asness express his views on how investors should approach smart beta strategies as well as his stance on value investing.

As seen in his Fundstrategy September 2016 column, Arnott asserts that multifactor-based smart beta strategies (especially those that rely on size, beta, value and profitability) owe their excellent performance, over the last 10 years, to rising valuations which have made these factors more expensive. Furthermore, Arnott, Beck, Kalesnik and West (known as ABKW), have argued in their 2016 paper "How Can Smart Beta Go Horribly Wrong?" that rising valuations may lead to some level of predictability in the future returns generated by smart beta strategies that rely on these factors.

Asness, however, counters this statement by stating that valuations, in general, are not excellent predictors of future returns. And while he agrees with Arnott that there is a risk of mean reversion in the future (Asness refers to it as a "crash" in his paper), it is extremely difficult to predict based on valuations alone.

To substantiate his claim, Asness performs a statistical analysis of four factors, value, momentum, profitability and beta, focusing on companies that have large market capitalization. The aim of the analysis was to answer the questions of whether factors are expensive and whether valuations are excellent predictors of the performance of factors and the risk of mean reversion.

On the question of the price of factors, Asness computed the value spread for each factor. The value spread is defined by Asness as the "ratio of the valuation of each factor's long portfolio divided by the valuation of its short portfolio" (Asness, 2016:6). Asness also computed the value spread using both the book-to-price and the sales-to-price ratios.

The results show that, from 1968 to 2016, Asness agrees with Arnott that factors have indeed become expensive, however he disagrees on the magnitude of such an increase. For example, ABKW argue that the value factor is getting extremely cheaper. Asness, on the other hand, proves that, while value tilted strategies are among the most popular strategies used by investors, they are not as cheap as ABKW have made them to be. The only factors that seemed to have gotten more expensive are the momentum and beta factors. However, Asness dismisses these factors as predictors for future returns as well as points out their lack of viability in explaining realized returns.

On the question of whether valuations are excellent predictors of both performance and mean reversion, Asness studied the methodology used by ABKW to prove their stance on the question, which is looking at "R-squared and t-statistics from regressing overlapping 5-year factor returns on starting valuation levels which rely on full-sample information to judge valuations" (Asness, 2016:9).

Asness states that the results obtained by ABKW are not only statistically weak (due to the t-statistic being barely above 2 for most of the studied factors) but the approach itself is flawed, as the regression used by ABKW should only be done for portfolios that have a low turnover rate (which is the opposite for portfolios that rely on the four factors mentioned above). This means that valuations are poor predictors of future performance.

Furthemore, regarding the likelihood of mean reversions (or "crashes"), while Asness agrees with ABKW on the potential risk of a mean reversion occurring, he believes it for different reasons than ABKW. In September 2007, Asness published a note called "The August of our Discontent" where he highlighted how the field of quantitative investing had suffered a crash during August 2007, only to rebound back a month later. Asness further adds that there were no significant changes in the valuations of those strategies that suggested that a crash was en-route. Asness concludes that mean reversion occur, not because certain factors become more expensive or cheaper, but they occur due to how well acquainted investors become with the strategies they implement.

Ultimately, Asness belives that smart beta strategies that rely on the factors studied above are still viable and investors, looking to put their money in them, should do so by:

- Investing in the strategies they believe in and modify them based on how the market is moving;
- Accept the fact that the market will eventually crash, that no one can easily predict when it will occur and necessary precautions are needed to mitigate its effects.

3.4. First answer to the question "is smart beta really smart?"

The literature review has allowed us to gain insight on where academics and investors alike stand regarding the question of whether smart beta strategies are smart. Moreover, while both sides have resorted to quantitative exercises and implementation experiences to provide an answer to that question, it still borders on uncertainty.

Smart beta strategies have proven to be smart from a theoretical point of view as showcased by CHKL and, with proper tax management, they can retain much of the excess returns generated as proven by Vadlamundi and Bouchey. However, the warnings of both Malkiel and Dubil come to mind, which is that past information is not a solid indicator of the validity of a given strategy. As they have proven, the outperformance of smart beta strategies can be situational, some even relying on sheer luck and are highly influenced by current valuations. Furthermore, the excessive costs they entail compared to the returns they generate are not sufficiently attractive to the wellread investor and therefore, one is best off holding the market than investing in these alternative strategies, as Bogle points out.

For what it is worth, the Morningstar reports on the smart beta ETF market show that these strategies are rapidly gaining ground, which adds to their merit as alternative ways to generate high returns with low levels of risks in a difficult market environment. However, as Arnott points out, it is important to remain prudent towards these strategies as the overenthusiasm of investors might overshadow the shortcomings of smart beta strategies and lower both their appeal and their returns.

We believe there is value to be made through smart beta but not just through it. Smart beta strategies should not become a crutch on which investors should fully lean on, but they should be an additional arc to their bow when hunting for returns. It is important that investors fully understand what these strategies entail, what are their underlying fundamentals and to keep a very close eye on the market. In addition, tempering one's enthusiasm, coupled with a proper understanding of the costs of these strategies and the tax management methodologies available will help investors retain much of the returns they are seeking. Only then, can smart beta strategies can be truly called "smart".

In the next section, we will perform an appraisal of some of the main smart beta ETFs traded on European exchanges using data provided from Morningstar and Bloomberg.

4. Analysis – Performance and risks of European Smart Beta ETFs

In this section, we will evaluate the performance and the risk sources of some of the main European ETFs. Having covered mainly US ETFs in the literature review (mainly due to the fact that the US smart beta market is older, bigger in terms of AUM and significantly more mature than the European one), it is necessary to perform an early appraisal of how these strategies perform and see whether smart beta strategies are really smart in Europe.

To do so, we will adopt the following structure: Firstly, we will list the universe of European smart beta ETFs, explaining the rationale behind the choices as well as the methodology followed. Secondly, we will highlight the results of both the performance analysis of the selected ETFs as well as those of the Carhart Four-Factor model regression. Finally, we will conclude this section by providing our personal opinion on the viability of smart beta strategies in Europe.

4.1. Universe selection and methodology:

In order to gain a first idea on the performance of smart beta ETFs in Europe, it is necessary to not only evaluate the performances of these funds on both a standalone and a relative bases, but also to subject these funds to a risk assessment to understand from where the risk in holding these ETFs comes from.

To do so, we created a fund universe composed of ten European smart beta ETFs that exhibit the following characteristics:

- The funds' selected should **be traded on the main European exchanges** such as Euronext Paris (XPAR), the London Stock Exhange (LSEx) and the the Deutsche Börse Group (XTER);
- The funds selected should **use one of the top 10 most popular smart beta strategies** (in terms of assets under management) in Europe as listed by the 2016 Morningstar report;
- The funds' **assets under management should amount to at least €50 million**;
- The funds' should have **existed for at least 5 years**. This is done to ensure that sufficient data points are available in order to assess their performance properly.[4]

Table 10 lists the selected smart beta ETFs for this exercise. Furthermore, we provide for each ETF, in each smart beta category, a mini factsheet that includes the ETF's ticker (including the number of holdings within the fund), relative benchmark, recommended holding period, construction method and country/sector compositions for either the fund or the benchmark (based on their availability). All figures shown are from the most recent dates (either May 2017 or April 2017).

Understanding the selected ETFs construction method and country/sector compositions is essential in order to assess properly the performance of these funds. This is due to two reasons:

- Firstly, since ETFs use specific smart beta strategies such as dividend-weighting or minimum variance, it will be interesting to see whether the way these funds are constructed is identical to funds studied in academic research or if they diverge in some form or another. Depending on the outcome, this might change our interpretation of the performance results;

[4] An exception was made to this rule regarding multifactor smart beta ETFs. As multifactor strategies have gained in popularity in 2016 due to the increasing complexity of the European market, we have selected two multifactor ETFs that have less than 5 years of existence. As such, in our analyses of both performance and risk decomposition, we have limited our calculations to the latest data point available for each of those two funds.

- Secondly, in addition to the construction methodology, having access to the asset/sector compositions is important in fine-tuning our interpretation of the results of the risk decomposition analysis.

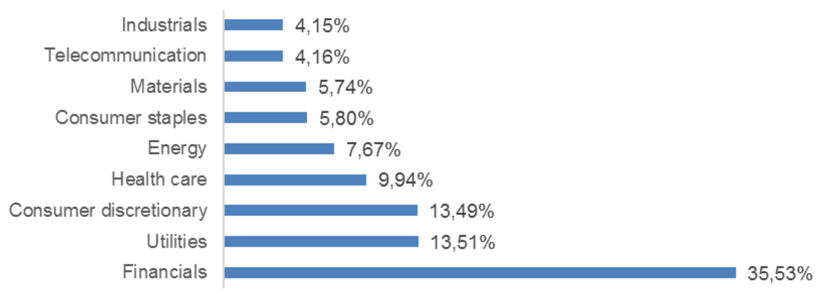
Table 10: Selected European smart beta ETFs for performance and risk analysis:

Ticker	ETF Name	Creation date	Main exchange	Morningstar Style	AUM (in millions)
Dividend-Weighted					
CD9	Amundi ETF MSCI Europe High Dividend	26/02/2009	XPAR	Large Value	57,58 €
IQQA	iShares Euro Dividend UCITS ETF EUR (Dist)	28/10/2005	XTER	Large Value	846,48 €
EUDI	SPDR® S&P Euro Dividend Aristocrats UCITS ETF	28/02/2012	LSEx	Large Value	1 256,31 €
Minimum Variance/Low Volatility					
EUMV	Ossiam iSTOXX™ Europe Minimum Variance NR	21/06/2011	LSEx	N/A	319,49 €
MIVO	Amundi ETF MSCI Europe Minimum Volatility Factor	26/02/2009	XPAR	Large Blend	155,70 €
Multifactor					
LYX5	Lyxor J.P. Morgan Multi-factor Europe Index	30/09/2015	XTER	N/A	85,00 €
IFSE	iShares Edge MSCI Europe Multifactor	04/09/2015	LSEx	Large Blend	265,16 €
Pure style (Quality, Value)					
IQQV	iShares Euro Total Market Value Large	04/11/2005	XTER	Large Value	73,62 €
VAL	Lyxor MSCI EMU Value ETF A/I	13/04/2005	XPAR	Large Value	231,05 €
Equal-weight					
S6EW	Ossiam STOXX® Europe 600 Equal Weight NR	16/05/2011	LSEx	Large Blend	72,64 €

Source: Morningstar

4.1.1. Dividend-weighted ETFs mini factsheets:

- **Amundi ETF MSCI Europe High Dividend Factor ETF (CD9):**

Ticker	CD9
ETF Name	Amundi ETF MSCI Europe High Dividend Factor (22 holdings)
Benchmark	MSCI Europe High Dividend Yield Strategy Index
Benchmark description	Index composed of 70 companies, spanning 16 European markets and paying the highest dividends in each of these markets.
Investment horizon	Greater than 5 years
ETF Construction methodology	Unfunded total return swap: the ETF buys a basket of securities using cash (effectively owning them) and swaps their performance for that of the benchmark. In this case, the swap was done by BNP Paribas at a percentage of -0,1% of the fund's NAV.
Benchmark sector breakdown	

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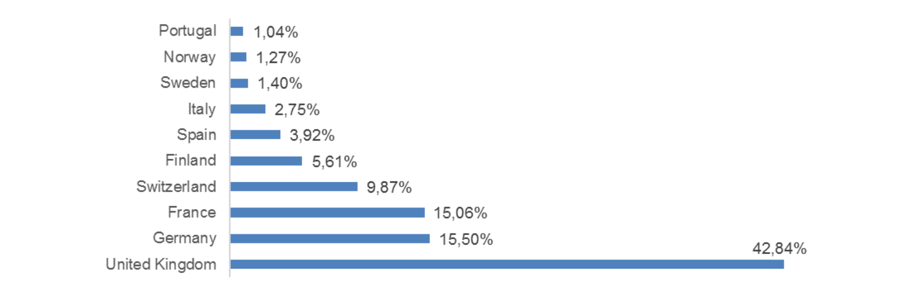
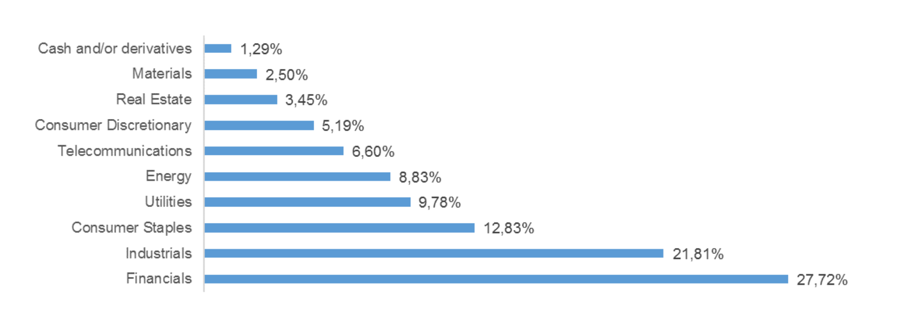
<tr><td>Benchmark country breakdown</td><td>
</td></tr>
</table>

Source: Amundi

- **<u>iShares Euro Dividend UCITS ETF EUR (IQQA/IDVY):</u>**

<table>
<tr><td>Ticker</td><td>IQQA/IDVY</td></tr>
<tr><td>ETF Name</td><td>iShares Euro Dividend UCITS ETF EUR (Dist) (30 holdings)</td></tr>
<tr><td>Benchmark</td><td>EURO STOXX® Select Dividend 30 Index</td></tr>
<tr><td>Benchmark description</td><td>Index composed of 30 securities of companies operating in Eurozone countries and that are known for high dividend yields</td></tr>
<tr><td>Investment horizon</td><td>Greater than 5 years</td></tr>
<tr><td>ETF Construction methodology</td><td>Physical replication of the benchmark: the ETF holds the same securities as the benchmark and weighing them simirarly to the index (weighting based on net dividend yield and capped at 15%)</td></tr>
<tr><td>ETF sector breakdown</td><td>
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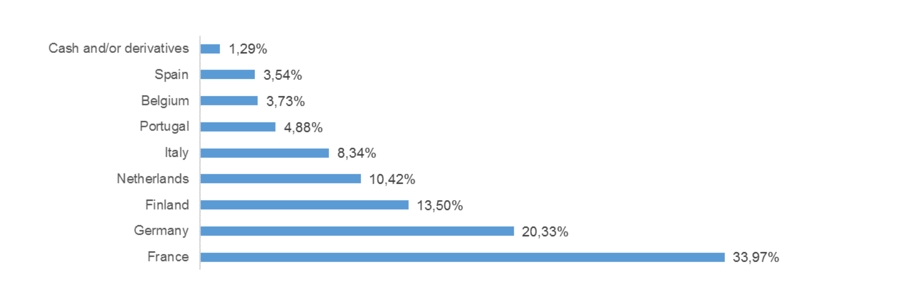
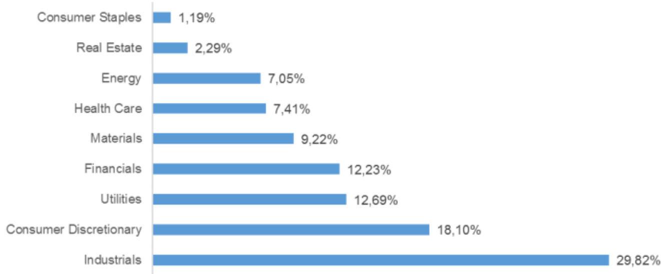
<tr><td>ETF country breakdown</td><td>
</td></tr>
</table>

Source: iShares/Blackrock

- **<u>SPDR® S&P Euro Dividend Aristocrats UCITS ETF (EUDI/EUDV):</u>**

Ticker	EUDI/EUDV
ETF Name	SPDR® S&P Euro Dividend Aristocrats UCITS ETF (39 holdings)
Benchmark	S&P Euro High Yield Dividend Aristocrats Index
Benchmark description	Index composed of the top 40 companies operating in the Eurozone in terms of dividend yield and which are part of the S&P Europe Broad Market Index
Investment horizon	Greater than 5 years

<table>
<tr><td>ETF Construction methodology</td><td>Physical replication of the benchmark: the ETF holds the same securities as the benchmark and weighing them simirarly to the index according to dividend yield</td></tr>
<tr><td>ETF sector breakdown</td><td>
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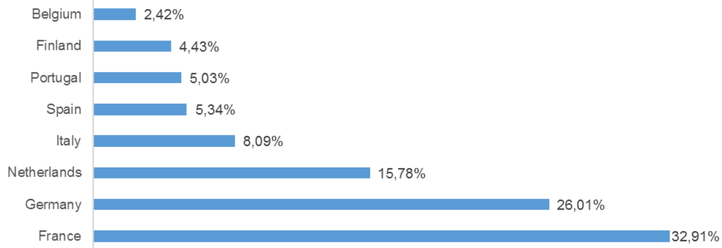
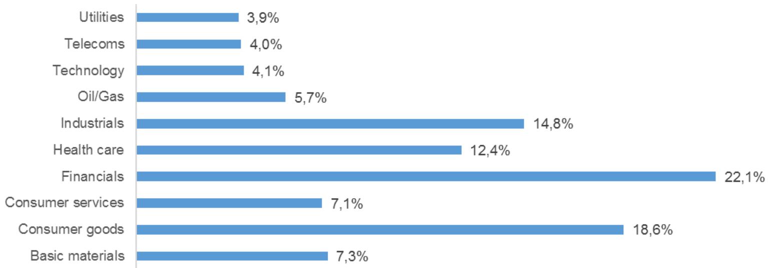
<tr><td>ETF country breakdown</td><td>
</td></tr>
</table>

Source: SPDR

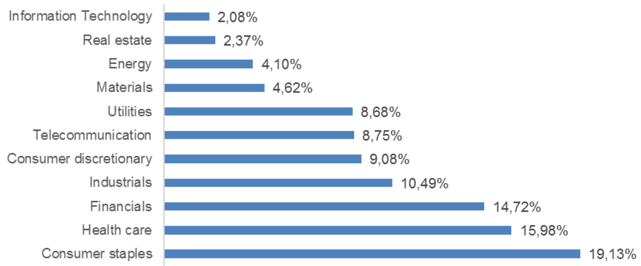
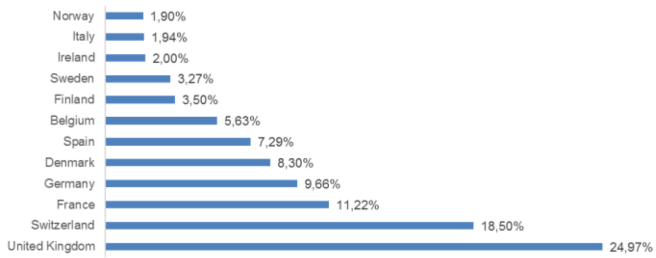
4.1.2. Minimum variance/Low Volatility ETFs mini factsheets:

- **Ossiam iSTOXX™ Europe Minimum Variance NR (EUMV):**

<table>
<tr><td>Ticker</td><td>EUMV</td></tr>
<tr><td>ETF Name</td><td>Ossiam iSTOXX™ Europe Minimum Variance NR (50 holdings)</td></tr>
<tr><td>Benchmark</td><td>iSTOXX® Europe Minimum Variance Index Net Return</td></tr>
<tr><td>Benchmark description</td><td>Index comprised of the 300 most liquid stocks from the STOXX® Europe 600 Index. The stocks are weighted according to the standard minimum variance optimization process.</td></tr>
<tr><td>Investment horizon</td><td>5 years</td></tr>
<tr><td>ETF Construction methodology</td><td>Unfunded total return swap: the ETF buys a basket of securities using cash (effectively owning them) and swaps their performance for that of the benchmark. In this case, the swap is done with Morgan Stanley.</td></tr>
<tr><td>ETF sector breakdown</td><td>
</td></tr>
</table>

Source: Ossiam

- **<u>Amundi ETF MSCI Europe Minimum Volatility Factor (MIVO):</u>**

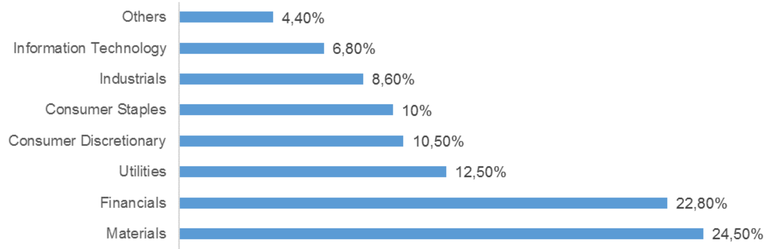
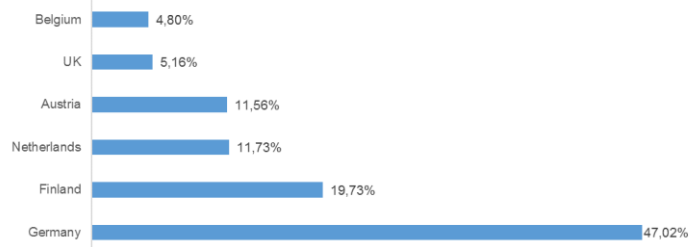
Ticker	MIVO
ETF Name	Amundi ETF MSCI Europe Minimum Volatility Factor (21 holdings)
Benchmark	MSCI Europe Minimum Volatility Strategy Index
Benchmark description	Index composed of stocks selected based on the MSCI Barra Optimizer model and that make up the MSCI Europe Index. The minimal volatility of the index is obtained through the diversification of predefined risks such as min/max weighting of securities, sectors/countries in the MSCI Europe Index.
Investment horizon	Greater than 5 years
ETF Construction methodology	Unfunded total return swap: the ETF buys a basket of securities using cash (effectively owning them) and swaps their performance for that of the benchmark. In this case, the swap was done by BNP Paribas at a percentage of 0,1% of the fund's NAV.
Benchmark sector breakdown	
Benchmark country breakdown	

Source: Amundi

4.1.3. Multifactor ETFs mini factsheets:

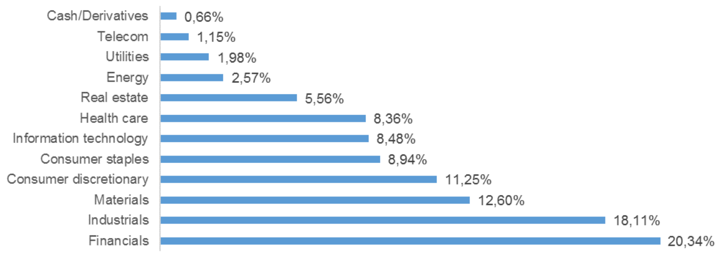
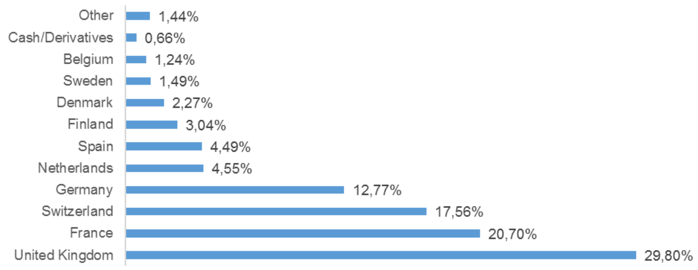
- **<u>Lyxor J.P. Morgan Multi-factor Europe Index (LYX5):</u>**

Ticker	LYX5
ETF Name	Lyxor J.P. Morgan Multi-factor Europe Index (25 holdings)
Benchmark	J.P. Morgan Multi-factor Europe Index
Benchmark description	Index comprised of 200 stocks, broken down into 5 sub-indices (ERPF indices) which are each reflective of a given factor (low beta, size, momentum, quality and value). Each of the sub-indices is equally weighted (20%) within the J.P.Morgan Multi-factor Europe Index and each stock within the sub-index is also equally weighted.
Investment horizon	Greater than 5 years
ETF Construction methodology	Unfunded total return swap: the ETF buys a basket of securities using cash (effectively owning them) and swaps their performance for that of the benchmark. In this case, the swap was done by J.P Morgan at a percentage of -0,04% of the fund's AUM.

<table>
<tr><td>ETF sector breakdown</td><td>
</td></tr>
<tr><td>ETF country breakdown</td><td>
</td></tr>
</table>

Source: Lyxor

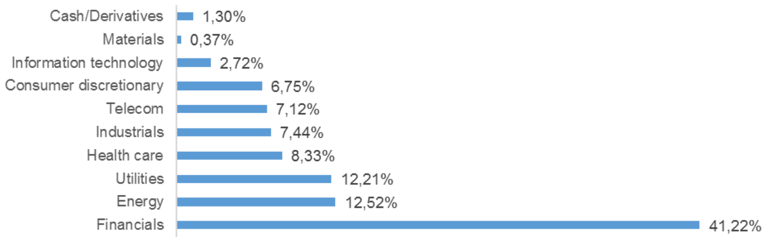
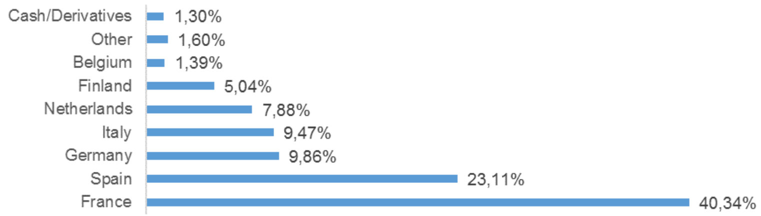
- **<u>iShares Edge MSCI Europe Multifactor ETF (IFSE):</u>**

<table>
<tr><td>Ticker</td><td>IFSE</td></tr>
<tr><td>ETF Name</td><td>iShares Edge MSCI Europe Multifactor (112 holdings)</td></tr>
<tr><td>Benchmark</td><td>MSCI Europe Diversified Multiple-Factor Index</td></tr>
<tr><td>Benchmark description</td><td>Index comprised of securities taken from the MSCI Europe Index that have exhibited the highest aggregate exposure to four factors namely value, momentum, size and quality.</td></tr>
<tr><td>Investment horizon</td><td>Greater than 5 years</td></tr>
<tr><td>ETF Construction methodology</td><td>Sampling: the ETF is built around a selection (or all, in some cases) of the stocks from the benchmark and are weighted based on the fund's proprietary methods. The aim is to achieve similar return levels to the benchmark. It should be noted that the ETF might sometimes hold securities that are not part of the benchmark.</td></tr>
<tr><td>ETF sector breakdown</td><td>
</td></tr>
<tr><td>ETF country breakdown</td><td>
</td></tr>
</table>

Source: iShares/Blackrock

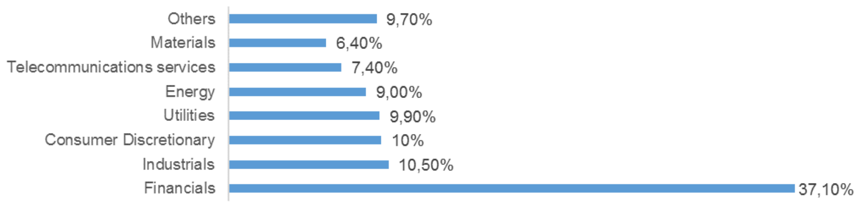
4.1.4. Pure Style ETFs mini factsheets:

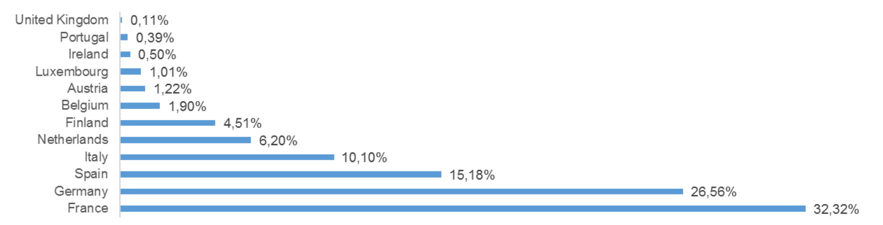
- **iShares Euro Total Market Value Large UCITS ETF (IQQV/IDJV):**

Ticker	IQQV/IDJV
ETF Name	iShares Euro Total Market Value Large UCITS ETF EUR (45 holdings)
Benchmark	EURO STOXX® Total Market Value Large Index
Benchmark description	Index composed of stocks of companies that are part of the Economic and Monetary Union of the EU, are large-cap and are value-tilted.
Investment horizon	Greater than 5 years
ETF Construction methodology	Physical replication of the benchmark: the ETF holds the same securities as the benchmark and weighing them simirarly to the benchmark.
ETF sector breakdown	
ETF country breakdown	

Source: iShares/Blackrock

- **Lyxor MSCI EMU Value ETF A/I (VAL):**

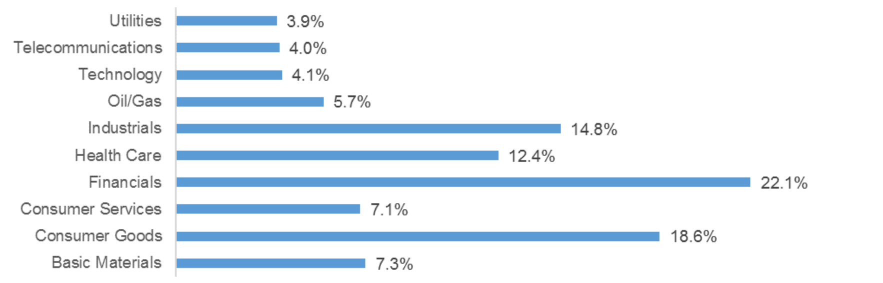
Ticker	VAL
ETF Name	Lyxor MSCI EMU Value ETF A/I (122 holdings)
Benchmark	MSCI EMU Net Total Return Index
Benchmark description	Index composed of 241 stocks of large and mid-cap companies operating in Developed Europe and who exhibit a value tilt.
Investment horizon	Greater than 5 years
ETF Construction methodology	Sampling: the ETF is built around a selection (or all, in some cases) of the stocks from the benchmark and are weighted based on the fund's proprietary methods. The aim is to achieve similar return levels to the benchmark. It should be noted that the ETF might sometimes hold securities that are not part of the benchmark.
ETF sector breakdown	

ETF country breakdown	

Source: Lyxor

4.1.5. Equal weighted ETF mini factsheet:

- **Ossiam STOXX® Europe 600 Equal Weight NR UCITS ETF (S6EW):**

Ticker	S6EW
ETF Name	Ossiam STOXX® Europe 600 Equal Weight NR UCITS ETF (27 holdings)
Benchmark	STOXX® Europe 600 Equal Weight NR
Benchmark description	Index comprised of all STOXX® Europe 600 stocks but constructed so that all securities have an equal weight (approximately 0.2%) within the index.
Investment horizon	Greater than 5 years
ETF Construction methodology	Unfunded total return swap: the ETF buys a basket of securities using cash (effectively owning them) and swaps their performance for that of the benchmark. In this case, the swap is done with Deutsche Bank.
ETF sector breakdown	

Source: Ossiam

Before moving on to the methodology section, it is important to point out that five of the studied funds are synthetic ETFs as opposed to physical ones[5]. This will be taken into consideration when we interpret the results obtained from our analyses.

A synthetic smart beta ETF uses a total return swap with a counterparty (in practice, large financial institutions such as Morgan Stanley) to swap the performance of the benchmark with that of the ETF's selection of securities. Furthermore, there are two types of synthetic ETFs:

- "Unfunded" (the ones we are studying in this paper) ETFs that use cash from investors to buy the securities used in the swap;
- "Funded" where the ETF transfers the cash from investors directly to the counterparty.

[5] Physical ETFs use the same securities that make up their benchmarks and weigh them according to specific rules that fit the strategy the ETF is aiming for. The weighing can be nearly identical to that of the benchmark or can rely on optimization processes or particular factors such as dividend yield, as it is the case for both IQQA and EUDI.

In short, synthetic ETFs allow the investor to obtain directly the actual return of the benchmark at a much lower cost than investing in it directly (especially if the benchmark is not easily accessible). However, they have some drawbacks:

- The choice of the securities used in the swap is severely constrained by UCITS regulations that require that their total value to be greater than or equal to 90% of the ETF's NAV. Should the securities' total value drop below that threshold, the ETF issuers asks the swap counterparty to issue new securities to compensate for the lost value. This procedure is called a "swap reset". But doing so increases the costs incurred by the ETF issuers and is negatively reflected in the return of the ETF;
- The construction methodology is rarely evident and available for investors. However, recent stricter regulatory requirements have pushed more and more providers to be transparent in this regard;
- In addition to being exposed to the index risk, the investor is also exposed to counterparty risk since the ETF relies on the counterparty to deliver the return of the benchmark. Usually this is mitigated by having the counterparty being a financial institution with a strong financial footprint.

4.1.6. Methodology:

To evaluate the performance and attractiveness of the ten European smart beta ETFs we have chosen, we have done two exercises: a **portfolio performance analysis and risk factor decomposition analysis against Fama-French's three factors plus momentum.**

- **Portfolio performance analysis methodology:**

We collected the monthly closing prices of the smart beta ETFs that make up our universe as well as their respective benchmarks using Bloomberg over a period of five years. The reasoning behind such a timeframe is two-fold: firstly, as mentioned in the funds' mini-factsheets above, the recommended investment horizon is of at least five years. Secondly, Bloomberg only has records of the prices of some of these ETFs up until January 31, 2012, limiting any metric calculation beyond five years.

The prices were collected in both Euro and USD currencies. The Euro-denominated prices were used in the performance analysis whereas the USD-denominated prices were used in the risk factor decomposition analysis.

Once the prices were collected, monthly returns were computed for both the ETFs and their benchmarks and total compounded returns over six periods (3-month, 6-month, 9-month, 1-year, 3-year and 5-year) were calculated. We opted for compounded returns instead of geometrical/arithmetic average returns because, unlike the latter, compounded returns reflect an investor's actual gains or losses over an extended period of time. This is also done to reflect the recommendations of the issuers of the ETFs of holding them for extended periods.

Excess returns for each ETF have been calculated by subtracting the compounded returns for each ETF in each of the given six periods from the compounded returns of their respective benchmarks. This is done to illustrate whether investing in a smart beta ETF is better than investing in its benchmark.

Annualized standard deviation figures for these ETFs were also computed to reflect the volatility of their returns over three periods (1-year, 3-year and 5-year). This was done by computing the standard deviation of the monthly returns of each ETFs and multiplying it by the square root of the number of observations for each period (12 for 1- year, 36 for 3-year and 60 for 5-year).

Finally, portfolio performance metrics such as the Sharpe and information ratios and tracking error were collected from the performance analysis reports for each fund using Bloomberg, calculated over the period between the first observable data point and April 28, 2017.

- **<u>Risk factor decomposition analysis methodology:</u>**

The aim of this exercise is to breakdown the risk that these smart beta ETFs carry across Fama-French's traditional three factors (market, size and value) as well as the momentum factor. This allows us to obtain a first idea of the source of the risk that each ETF carry.

To do so, USD denominated monthly prices of each ETF were collected using Bloomberg, and monthly returns were computed. The currency choice is due to the European Fama-French and momentum factors being denominated in USD. The monthly factors for Europe were taken from Professor Kenneth French's Darmouth website.

Finally, using Excel's Data Analysis Toolpack, a multivariate regression for each ETF's monthly return series against Fama-French's three factors plus momentum was performed. We chose a 95% confidence level for the regression and we reviewed each resulting parameter's p-value to determine whether it is statistically significant and, therefore, relevant to the regression model. As an additional sanity check, we performed the regression twice over; once using the multivariate regression methodology taught by Professor Olivier Bossard in his "Empirical Methods in Finance" class at HEC Paris, and once using the LINEST Excel function that professor Dubil used in his smart beta papers. We obtained identical results for all three methods.

In the next section, we will discuss the results obtained from these exercises, which will help us draw our first conclusions regarding the performance of smart beta ETFs in Europe.

4.2. Empirical results and discussion:

4.2.1 Portfolio performance analysis:

Table 11 shows the results of the portfolio performance analysis on the selected smart beta ETFs:

Table 11: Portfolio performance results of European Smart Beta ETFs:

		Dividend-weighted			Min Variance/Low Vol		Multifactor		Pure Style		Eq. Weight
Metrics and timeframe		CD9	IQQA	EUDI	EUMV	MIVO	LYX5***	IFSE***	IQQV	VAL	S6EW
Return behavior*	# Wins	38	34	35	41	43	10	13	38	38	43
	# Losses	24	28	25	21	19	7	5	24	24	19
Total Returns	3-month	4,56%	5,10%	6,42%	5,97%	6,04%	6,00%	6,84%	7,36%	6,56%	7,26%
	6-month	9,96%	15,90%	9,62%	3,34%	5,09%	10,77%	12,68%	22,16%	20,16%	13,12%
	9-month	13,59%	22,41%	14,58%	5,94%	6,52%	16,14%	19,99%	26,32%	21,96%	20,59%
	1-year	13,55%	15,78%	12,91%	6,02%	7,86%	12,40%	15,08%	22,10%	18,38%	15,56%
	3-year	23,58%	19,19%	17,72%	22,17%	32,28%			5,83%	4,04%	26,56%
	5-year	65,02%	40,63%	50,08%	65,82%	81,53%			38,96%	36,52%	78,07%
Excess total return vs benchmark	3-month	0,58%	0,10%	-0,14%	0,03%	0,31%	-0,12%	0,41%	0,93%	0,15%	0,25%
	6-month	0,27%	-0,11%	-0,35%	-0,21%	0,05%	-0,19%	0,08%	0,55%	-0,39%	0,28%
	9-month	0,76%	-0,74%	-3,54%	-0,14%	0,57%	-0,06%	0,39%	-0,60%	-6,33%	0,51%
	1-year	0,35%	-4,17%	-3,28%	-0,33%	0,28%	-0,42%	-0,02%	-2,51%	-5,20%	0,20%
	3-year	0,15%	-12,57%	-11,16%	-1,62%	0,46%			-8,81%	-12,95%	-0,16%
	5-year	0,03%	-30,58%	-26,42%	-2,36%	9,04%			-23,93%	-29,42%	-0,62%
Standard Deviation	1-year	8,94%	13,60%	11,38%	8,05%	8,34%	10,41%	11,83%	14,97%	13,25%	11,54%
	3-year	21,84%	23,72%	22,96%	19,63%	19,96%			27,28%	27,24%	23,11%
	5-year	26,30%	30,67%	27,50%	22,41%	28,26%			37,10%	35,32%	28,12%
Performance metrics**	1-year Sharpe Ratio	0,74	1,22	1,55	0,91	0,73	1,05	1,54	1,23	1,25	1,44
	Information Ratio	-0,04	0,30	0,16	-0,14	0,06	0,03	0,05	0,11	0,23	0,06
	Tracking Error	0,59%	2,09%	0,88%	1,57%	10,34%	1,96%	1,04%	8,02%	1,56%	1,00%

Source: Prices and performance metrics provided by Bloomberg. Calculations performed by Nabil EL LAMTI

*: The return behaviour is evaluated over a 5-year period between 28/02/2012 and 31/03/2017

**: The performance metrics highlighted in this table are taken from the Bloomberg-provided historical performance report of each fund

***: Calculations have been limited for both LYX5 and IFSE as they have less than 2 years of existence

For the sake of structure, we have decided to separate the return behavior metric from the rest, as it is relatively straightforward and quicker to analyze. Furthermore, analysis of returns and excess returns is meaningless without factoring in risk and performance measures. As such, we opted to analyze the performance of the funds, first from an absolute basis and second by each smart beta strategy.

It is important to note that our analysis takes into consideration the construction methodology of the ETF studied. As seen in the mini-factsheets above, half of the funds studied are synthetic ETFs that rely on total return swaps. This is important to keep in mind as synthetic ETFs exhibit different characteristics than physical ETFs, mainly in terms of risk profiles and returns.

Finally, a cautious approach was taken when analyzing the results of the multifactor ETFs as they have less than two years of existence. As stated above, their selection was mainly due to their surge in popularity in 2016 and, as a result of the limited number of observations, our interpretation of the results obtained are not robust enough to declare these funds viable. Therefore, we encourage the reader to undertake the exercise again once a considerable amount of time has passed in order to assess properly the performance of these funds.

- **Return behavior:**

The purpose of this metric is to count the number of instances when, at a given month, investing in a given smart beta ETF will lead the investor to earn (positive return aka "a win") or to lose money (negative return aka "a loss). This gives us a first idea on how consistent the performance of the fund is.

On an absolute basis, all funds in all smart beta categories have delivered more wins than losses. However, on a relative basis, some categories outshine others:

- Minimum Variance and Equal Weight strategies perform better than the other categories in this regard, with an observable percentage of winning returns of 67.7% and 69.4% respectively;
- While still recent, multifactor funds also deliver more wins than losses. However, it should be noted that, as opposed to IFSE, the LYX5 fund has shown a balanced proportion of wins and losses throughout its ongoing lifetime. As stated above, it is too early to draw conclusions for both of these funds. It will be interesting to observe the return behavior of these funds once 5 years have passed to see whether the proportion of wins and losses has improved or not;
- On average, Pure Style strategies show a higher proportion of winning returns compared to Dividend-Weighted, however, as we will see in the next section, this impression is marred by the total return figures of Pure Style strategies especially between the 1-year and 3-year periods where we notice a sharp decrease. This indicates that, while there are more positive returns than negative ones, numbers-wise, the magnitude of negative returns is quite significant.

- **Overall fund performance:**

On an absolute basis, on the observed 5-year period, best in class performance (in terms of returns and risk) was demonstrated by Minimum Variance and Equal Weight strategies. Whereas the worst performance was demonstrated by Pure Style strategies.

On a smart beta strategy basis, we observe the following:

- Dividend-weighted strategies:

Amundi's CD9 smart beta ETF delivered a significantly better performance than its iShares and State Street counterparts, both in 5-year total returns (65.02% vs 40.63% and 50.08% respectively) but also in excess return, where it is the only fund to have delivered a slightly positive excess return against its benchmark (0.03% vs -30.58% and -26.42%). These results are especially interesting if we take into consideration how these funds were constructed:

- Amundi's CD9 functioned as intended of a synthetic ETF and allowed its investors to obtain the return of its benchmark with a +3bps markup;
- IQQA and EUDI significantly underperformed compared to their benchmark. Moreover, given how they are constructed, this casts doubts on the viability of the construction methodology in and of itself. Coupled with higher standard deviation figures compared to Amundi's CD9 (26,30% vs 30,67% and 27,50% respectively) and lower tracking errors (0,59% vs 2,09% and 0,88% respectively), one can conclude that an investor is better off investing in a synthetic ETF than a physical one when it comes to dividend-weighted strategies in Europe.

- Minimum Variance/Low volatility strategies:

Arguably the best performing strategies in the studied universe (in terms of both return and, as we will see later, risk), Ossiam's EUMV and Amundi's MIVO have delivered two of the highest observed 5-year total returns at 65.82% and 81.53% respectively.

However, Amundi's MIVO shows a higher and positive excess return than Ossiam's EUMV (9.04% vs -2.36% respectively). This situation is interesting since both of these funds are synthetic ETFs and are designed to fully capture the actual return of the benchmark. Therefore, we need to understand what is causing such a discrepancy.

The answer lies in the tracking error of these two funds. As mentioned in the glossary, the tracking error is the standard deviation of the excess returns between the ETF and the benchmark and, therefore, measures by how closely a fund is tracking its benchmark. Low tracking errors (less than 5%) usually mean that a fund is closely tracking its benchmark while high tracking errors (5% and above) convey the opposite. In this instance:

- The tracking error of Ossiam's EUMV is 1.57%, which indicates that it closely follows its benchmark (as it should, given its nature as a synthetic ETF). Thus, the -2,36% underperformance can be explained by additional costs incurred by the ETF provider such as taxes or, as discussed above, any swap resets that might have occurred during the 5-year observation period;
- However, Amundi's MIVO outperformance of 9.04%, coupled with a tracking error of 10.34% shows that the ETF is largely deviating from its benchmark. One potential explanation could be due to dividend tax management techniques employed by the counterparty of ETF issuer, which is done through the lending of certain securities to other counterparties located in countries that are known for lax tax requirements at dividend due dates. The results obtained from such a practice are then transferred in part to the ETF and is reflected in its returns.

Finally and unsurprisingly, the standard deviation figures for both of these funds are, on average, the lowest compared to the rest of the universe studied.

- Multifactor strategies:

These newcomer strategies have benefitted from a surge in popularity in 2016, namely due to investors' concerns regarding the complexity of the modern markets. On a 1-year basis, both the LYX5 and the IFSE have delivered a total return of 12.40% and 15.08% respectively. Both multifactor ETFs also boast standard deviation figures that are on the low end compared to the other funds, for the same timeframe, at 10.41% and 11.83% respectively.

An interesting point to note is the construction methodologies of these two funds, with LYX5 being a synthetic ETF and the IFSE being a physical ETF that relies on sampling. As seen above, we would expect that the outperformance/underperformance of the ETF compared to the benchmark be minimal for the synthetic ETF. However, looking at the results, we notice that the LYX5 falls further short than its benchmark as opposed to IFSE, by -42 bps and -2bps respectively. Tracking error-wise, the same remark can be made for both funds, with LYX5 showing a higher figure than IFSE, at 1.96% and 1.04% respectively.

Overall, does this mean that sampling delivers better results than swaps for European multifactor ETFs? At this stage and with the lack of data, we cannot ascertain anything. We can note, however, that, performance-wise and after just a year, these two funds show promise and it will be interesting to revisit them once more time has passed.

- Pure style strategies:

Both of the pure style funds studied, IQQV and VAL, are physical ETFs that give priority to securities that exhibit a value and size tilt. Performance-wise, on a 5-year period, IQQV and VAL delivered returns of 38.96% and 36.52% respectively. These 5-year returns are the lowest among the ETFs studied and this is primarily due to the sharp drop seen in the 3-year returns, going from an average 1-year return of 20.24% to an average 3-year return of 4.93%.

The sharp drop is explained by a succession of small positive monthly returns and moderately high negative ones between 2014 and 2015, which itself is due to a drop in the prices of the funds. Considering that these funds are either complete replicates of (IQQV) or sample securities (VAL) from their benchmarks, this leads us to believe that the underlying securities making up these benchmarks must have suffered from a temporary decline in their value between 2014 and 2015.

Both funds also severely underperform against their benchmark, with a 5-year underperformance of -23.93% and -29.42% for both IQQV and VAL respectively. Whereas their standard deviation is the highest of the ETFs studied at 37.10% and 35.32% respectively.

However, when looking at the tracking error for both funds and factoring in their construction methodology, our performance assessment of the funds changes:

- IQQV physically replicates the benchmark it tracks by investing in the same securities and in similar proportions. Yet, when looking at its tracking error, we see a value of 8.02%, which indicates that the returns of the fund deviate from those of the benchmark. This shows that the replication method used by the fund is either not consistent or is not updated regularly to take into account the changes in the market in which the benchmark operates. To the IQQV fund's defense, however, the increase in its underperformance is not as significant as that of VAL. This shows that the underperformance issues is more to do with updating the ETF's composition than an actual inconsistency with the construction method;

- VAL uses a sampling approach in its construction, where it selects a few of the benchmark's securities and pairs them with other securities in an effort to track its performance as closely as possible, which is backed up by the fund's low tracking error of 1.53%. However, the underperformance of the fund is quite significant. This shows that, while the variation in excess returns is low, the magnitude of the excess returns is quite high. This can be explained by the performance/weight of the securities that do not make up the benchmark and that are chosen to be part of the fund.

In summary, pure style strategies are heavily exposed to market valuations, which can severely affect the total returns they generate, as seen with the case of both IQQV and VAL. It is also important for investors to understand how such funds are constructed, especially in the case of physical ETFs, and whether their weighting/composition are updated to reflect the changes in the market.

- Equal Weight strategies:

Equal Weight strategies are one of the two best performing strategies studied in this universe alongside Minimum Variance. On a 5-year period, the S6EW fund delivered a 78.07% total return and, given its nature as a synthetic ETF, slightly fell short of its benchmark by -62bps all while keeping a tracking error of 1%. This shows that S6EW's performance, as a synthetic ETF, is commendable. Risk-wise, its 5-year standard deviation of 28.12% makes it a mid-tier fund in terms of risk compared to the other funds.

Unfortunately, due our fund selection constraints and given the fact that equal-weight strategies are not significantly popular in Europe according to Morningstar's market report, it was not possible to select a fund that respected our criteria and offered a different construction methodology than the one used by S6EW.

- **Portfolio performance analysis conclusion:**

The portfolio performance analysis allowed us to compute, compare and interpret various metrics to determine the attractiveness of some of the most popular smart beta strategies in Europe. The main takeaways of this exercise are twofold:

  - From a smart beta strategy perspective, minimum variance and equal weight strategies seem to deliver the best outcomes on a risk/return basis, followed closely by dividend-weighted strategies. Pure style ETFs are at the mercy of market valuations and, given unstable market conditions and increasing market complexity, leads them to exhibit poor performances compared to the other ETFs. Finally, multifactor strategies, although promising, are still too recent to be properly evaluated;
  - From a construction methodology perspective, synthetic ETFs deliver consistent performances and they generally fare better than physical ETFs. However, in addition to the risks related to the benchmark they are tracking, they also carry counterparty risk. Furthermore, as seen in the case of the MIVO fund, certain synthetic ETFs exhibit very high tracking errors, which can lead to either high outperformances or underperformances depending on the benchmark.

In the next section, we will discuss our findings regarding the risk decomposition analysis of the smart beta ETFs selected against Fama-French's three factors and the momentum factor.

4.2.2 Risk factor decomposition analysis:

Table 12 shows the results of the risk factor decomposition analysis on the selected smart beta ETFs:

Table 12: Risk factor regression analysis of European Smart Beta ETFs against Fama-French's three factor + MOM model:

		Four-Factor Risk Decomposition of European Smart Beta ETFs†						
	Name of fund	Alpha	Alpha p-value	Market (Mkt-Rf)	Size (SMB)	Value (HML)	Momentum (MOM)	R^2
Dividend-Weighted								
CD9	Amundi ETF MSCI Europe High Dividend	0,08%	0,5999	0,9297	-0,3140	-0,0551	-0,0771	0,94
IQQA	iShares Euro Dividend UCITS ETF EUR (Dist)	-0,12%	0,6694	0,9859	-0,2013	0,1431	-0,1555	0,86
EUDI	SPDR® S&P Euro Dividend Aristocrats UCITS ETF	-0,05%	0,8298	0,9642	-0,1112	-0,0211	-0,1162	0,88
Minimum-Variance/Low Volatility								
EUMV	Ossiam iSTOXX™ Europe Minimum Variance NR	-0,10%	0,5244	0,8776	-0,1453	-0,3171	0,1143	0,91
MIVO	Amundi ETF MSCI Europe Minimum Volatility Factor	0,24%	0,4091	1,0200	-0,1789	-0,4190	-0,0230	0,81
Multifactor								
LYX5*	Lyxor J.P. Morgan Multi-factor Europe Index	-0,13%	0,4929	1,0564	0,2212	-0,1763	-0,1831	0,98
IFSE*	iShares Edge MSCI Europe Multifactor	0,09%	0,7572	0,9379	0,5003	-0,2866	-0,2623	0,94
Pure Style (Quality, Value)								
IQQV	iShares Euro Total Market Value Large	-0,19%	0,4219	1,0355	-0,4786	0,6901	-0,0291	0,93
VAL	Lyxor MSCI EMU Value ETF A/I	-0,10%	0,6554	1,0023	-0,2739	0,5514	-0,1646	0,92
Equal-Weight								
S6EW	Ossiam STOXX® Europe 600 Equal Weight NR	-0,06%	0,6270	1,1092	0,2864	-0,1114	-0,0087	0,97

Sources: Fama/French European Factors and Momentum Factor provided by Kenneth French's data library, prices provided by Bloomberg

Calculations performed by Nabil EL LAMTI

*: Regressions were limited for both of LYX5 and IFSE as they have less than 2 years of existence

†: Risk factor loadings are all computed at the 95% confidence level. Values that are highlighted in green are statistically significant at the 5% level

For the sake of structure, we will approach the analysis of the results of these exercises by focusing on each factor at a time. An exception will be made for the interpretation of both the alpha factor and the goodness of fit coefficient, as they are relatively straightforward.

Furthermore, while we will briefly describe the results obtained for each factor, our interpretation will only focus on factors, which are statistically significant. This is done by observing the p-value of each factor and comparing it to the significance level (in this case, 5%) of the model. If the p-value greater than 5%, then the factor is considered not statistically significant. With this, it will be easier for the reader to:

- Understand what are the factors that contribute to each fund's risk;
- Clarify whether these findings are aligned with the funds' construction methodology;
- Understand what the potential implications for an investor are.

- **<u>Goodness of fit and alpha:</u>**

In a regression exercise, the goodness of fit of a given statistical model, measured by R^2, indicates whether it is capable of fully explaining a given set of observations. The general rule is the closer R^2 is to one, the better the model fits the observations.

In our case, all of the funds R^2 values are greater than 0.8, which indicates that the Fama-French three-factor + momentum model is a good fit for the funds' returns. This is especially true for the CD9 and the S6EW funds, which exhibit R^2 values of 0.94 and 0.97 respectively.

The alpha (or intercept) parameter has no set interpretation and, in asset management, it is usually interpreted as any active (or additional) return that a fund generates. In our model, all alpha values are extremely small, with seven values out of the ten obtained being negative. Furthermore, none of the alpha values shown in table 12 are statistically significant, meaning that none of the funds generate active returns. This is in-line with the fact that that our universe comprises synthetic ETFs and funds that totally or partially replicate their benchmarks.

- **<u>Market risk:</u>**

Regarding market risk, not only is it statistically significant for all the funds studied, but also all the values shown (except for the EUMV and S6EW funds, with betas of 0.8776 and 1.1092 respectively) are close to or equal to one. This means that, in terms of market risk, holding the studied smart beta ETFs presents just as much risk as holding the market portfolio (which, by definition, has a beta of 1). This is expected as smart beta ETFs usually carry risk levels that are closer to/slightly lower than that of the market.

EUMV shows a market risk beta of 0.8776, making it 12-13% less risky than the market. This is explained by both the fund tracking a minimum variance index and the index's composition (which is made up of the 300 most liquid stocks of the STOXX® Europe 600 Index). As mentioned in the glossary, the liquidity of a stock refers to how easy and how frequently it is bought and sold in the market. Highly liquid stocks are safer and less prone to price swings but they also yield lower returns. Given how the EUMV fund is constructed, it comes as no surprise why it shows a market beta lower than one.

S6EW shows a market risk beta of 1.1092, making it 11% riskier than the market. Considering that S6EW is a synthetic ETF that tracks an equal-weighted version of the STOXX® Europe 600 Index, then such a high beta is not surprising. Giving an equal weight to all the components of an index has the adverse effect of putting both volatile and less volatile stocks on equal footing, which then increases the risk of the index.

- **Size (SMB):**

The size factor allows us to determine whether a portion of the return and risk of the funds studied is due to a size tilt, with a positive SMB factor meaning that the fund's return and risk come from small companies and the opposite for a negative SMB factor.

The results show that seven of the ten funds studied exhibit a large size tilt (evidenced by the negative factors) while the remaining three seem to favor small companies. In terms of magnitude, with the exception of IFSE, IQQV and VAL, all factors obtained are relatively small, which suggest that there really is not a significant domination of one size over the other.

However, if we factor in statistical significance, then only five funds have exhibited a size tilt, these being CD9, IFSE, IQQV, VAL and S6EW. To be more precise:

- CD9 and S6EW, both being synthetic ETFs, exhibit a large (-0.3140) and small size (0.2864) tilt respectively. For the CD9 fund, this is explained by its benchmark being composed mainly of large companies that pay high dividends. For the S6EW fund, the small size tilt comes from the benchmark's equal weighted approach, giving the same level of importance to small companies compared to the large ones that make up the index;
- IFSE exhibits a small size tilt, evidence by its positive factor of 0.5003. This can be explained by its construction methodology, which is based on sampling its benchmark's securities (which gives importance to small sized companies, in addition to other factors);
- IQQV and VAL have both exhibited a large size tilt, with factors of -0.4786 and -0.2739 respectively. This is not surprising since, by construction, these funds not only physically replicate their benchmark, but they favor large-sized companies in their security selection.

- **Value (HML):**

The value factor allows us to determine whether a portion of the return and risk of the funds studied is due to a value or growth tilt, with a positive HML factor meaning that the fund's return and risk come from value stocks or from growth stocks in the case of a negative factor.

The results show that seven of the ten funds studied exhibit a growth tilt (evidenced by the negative factors) while the remaining three seem to favor value stocks. In terms of magnitude, with the exception of EUMV, MIVO, IQQV and VAL, all factors obtained are relatively small, which suggest that there really is not a significant domination of value or growth stocks.

However, if we factor in statistical significance, then only four funds have exhibited a value/growth tilt, these being EUMV, MIVO, IQQV and VAL. To be more precise:

- EUMV and MIVO both exhibit a growth tilt, which can come off as surprising at first, since growth stocks are riskier than value stocks. However, growth stocks deliver higher returns and if we factor in the construction methodology of the benchmarks that these two synthetic ETFs track, then the risk impact of these growth stocks is minimized;

- IQQV and VAL both exhibit a value tilt, as evidenced by the positive HML factors they exhibit. This is not surprising since, by construction and similarly to the size factor case, the funds not only physically replicate their benchmark, but they favor value stocks in their security selection.

- **Momentum (MOM):**

The momentum factor allows us to determine whether a portion of the return and risk of the funds studied is due to the fund being made up of market leaders ("winners") or laggards ("losers"), with a positive MOM factor meaning that the fund's return and risk come from winning stocks or from losing stocks in the case of a negative factor.

The results show that, with the exception of EUMV, all funds exhibited a laggard tilt (evidenced by the negative factors). Magnitude-wise, these factors are very small which indicate that any tilt observed is due to a slight over-representation of either lagging stocks (for 9 funds) or winning stocks for EUMV.

However, in terms of statistical significance, only LYX5 exhibits an actual momentum (laggard) tilt. Considering that LYX5 is a synthetic ETF that tracks the performance of a multifactor index, which itself favors momentum among its factor, then it not surprising for LYX5 to exhibit such a tilt.

- **Risk factor decomposition analysis conclusion:**

This exercise allowed us to shed light on the sources of risk and returns of each of the selected smart beta ETFs using the Fama-French three factor + momentum model. The main takeaway from this exercise is that smart beta ETFs in Europe exhibit the characteristics an investor can expect of them, given their construction methodology.

The results shown above all confirm that smart beta ETFs not only present similar, if not slightly lower, risk than the market/index, but also present certain tilts that are aligned with how they were constructed, as well as do not deliver any active returns or alpha (as evidenced by the lack of statistical significance of the values obtained).

4.3. Performance and risks of European Smart Beta ETFs - Conclusion:

The aim of this section was to assess the viability of European smart beta ETFs that are constructed around the most popular strategies, according to the Morningstar report. While the European Smart Beta market is lacking in maturity, as opposed to its American counterpart, the rising adoption of smart beta ETFs by European investors is an indicator of the market's growth and the positive performance of these ETFs.

The two analyses performed on the selected European smart beta ETFs do give some credence to the abovementioned statement. Performance-wise, they have exhibited solid return and standard deviation figures. Risk-wise, they have lived up to their status as smart beta ETFs by delivering low betas and, in the case of some funds, exhibiting certain tilts towards certain factors (which were aligned with how these ETFs were constructed to begin with).

However, for an investor, who is considering smart beta ETFs as an investment tool, there are three issues that he/she should not ignore:

- Firstly, synthetic ETFs perform better than physical ETFs since synthetic ETFs truly capture the return generated by their benchmarks. Furthermore, synthetic ETFs allow access to hard-to-obtain/reach benchmarks and or markets, which might be beneficial to an investor seeking to diversify his/her holdings. However, according to Morningstar's 2017 coverage of the European ETF markets, synthetic ETFs are declining, reaching 23% of the total European offering in 2016. This is due to them being very risky since synthetic ETFs take on counterparty risk on top of the index risk. As a result, and following increased regulatory requirements, many ETF providers are creating more and more physical ETFs to keep attracting investors. Therefore, it is essential for an investor seeking to use smart beta ETFs in his/her portfolio to thoroughly analyze the performance of these new physical ETFs and assess whether they are worth including in their holdings;
- Secondly, the selection of high performing smart beta strategies remains limited. As seen above, dividend-weighted and low variance/minimum volatility strategies represent 62.1% of the assets under managements for the European smart beta market, while the rest is split across the remaining strategies. This could be an obstacle to an investor seeking to diversify his/her holdings as the performance of funds that are not using the top 5/10 strategies is not as well documented by investors and academics as their American counterparts. Therefore, the investor might not have a solid point of reference to use while selecting smart beta ETFs to use in his/her portfolio;
- Finally, and as mentioned in the beginning of this section, the European smart beta ETF market is still immature and ETF providers are still gaining experience in developing and constructing smart beta products that are adequate to satisfy not only the investors, but the regulators as well.

Ultimately, however, our selection of European smart beta ETFs show that this market is headed towards the right direction, with solid performing products and an excellent growth momentum. So long as the curious investor remains aware of the issues listed and so long as ETF providers remain motivated to satisfy their clients' (both investors and regulators) needs with their products, then it is safe to say that the European smart beta market will be a strong contender in the future. Not only for local investors seeking to enter it, but also for foreign ones seeking new markets and new ways to diversify their holdings.

5. Thesis conclusion: Are smart beta strategies really smart?

This paper's objective was to provide a first answer to the question of whether smart beta strategies are really smart. To do so, we have adopted a threefold structure: firstly, we provided a brief reminder of the main economic and financial concepts that underlie these strategies. Secondly, we have discussed the structure of the smart beta markets for both the U.S. and Europe, covered the main smart beta strategies that are utilized by investors and provided a summary of the research done on smart beta, making the case for both its defenders and sceptics. Finally, we concluded the paper with an empirical exercise, aimed at analysing the performance of European smart beta ETFs that focus on the most popular strategies used in Europe.

From what have learned thus far, smart beta strategies have demonstrated mixed results, with some singing their praises and others vilifying them. The main criticism behind smart beta strategies is their situational nature: the returns obtained from the implementation of these strategies are heavily reliant on valuations (as claimed by Arnott) and on market timing (evidenced by how certain U.S. based smart beta ETFs favoured certain types of stocks/securities at a specific time). Some academics, such as Malkiel, claimed that smart beta strategies are nothing short of a gamble, while others, such as Dubil, asserted that the returns of smart beta strategies come from statistical manipulation. Leading investors, such as Bogle, flat out claimed that smart beta strategies do not work and that investors, seeking to obtain decent returns at lower risk levels, are better off investing in a standard market index.

However, other academics have made the case for smart beta strategies, with CHKL reviewing all standard smart beta strategies and concluding that they do add value to the investor through solid returns and acceptable risk levels, effectively making them "smart" from an academic standpoint. Vadlamundy and Bouchey confirmed the findings of CHKL and showed that smart beta strategies remain "smart" after taxes, provided, of course, that investors implement tax management strategies to prevent their returns from being eroded. Finally, Asness challenged Arnott's claim that smart beta returns are a byproduct of rising valuations and proved that smart beta strategies are still viable, in and of themselves.

Our analysis of European smart beta ETFs has painted an interesting image of the European smart beta market. While the funds studied did show robust performance metrics, both return and risk-wise, the fact remains that the European smart beta market is still immature, ETF providers are still learning the intricacies of the smart beta practice and the offer of smart beta ETFs is severely restricted to a few strategies that monopolize well over half of Europe's smart beta AUM.

Overall, are smart beta strategies really smart? As mentioned in our first conclusion, smart beta strategies on their own are not smart. However, when combined with other strategies and securities in a given portfolio, they are a formidable tool that investors can use to manage risk, enhance returns and diversify their portfolio's holdings.

Ultimately, smart beta strategies are a double-edged sword and, with their rise in popularity across all markets, it is easy for investors to blindly rely on them and ignore their shortcomings. As mentioned before, investors need to temper their enthusiasm, properly study the ins and outs of each smart beta strategy and implement proper tax management tools to their smart beta-enhanced portfolios. In short, as Arnott points out, investors should "look before they leap". It is only then that smart beta strategies can truly, and effectively, be called smart.

Annexes

Annex 1: Annualized statistical analysis of the performance of U.S. based smart beta ETFs

		3-Year			5-Year			7-Year			10-Year		
Ticker	**Name**	**Mean**	**St Dev**	**Sharpe**	**Mean**	**St Dev**	**Sharpe**	**Mean**	**St Dev**	**Sharpe**	**Mean**	**St Dev**	**Sharpe**
Cap-Weighted													
VOO*	Vanguard S&P 500	13.34%	12.22%	1.09	16.37%	11.99%	1.36						
SPY	SPDR S&P 500	13.28%	12.24%	1.08	20.58%	14.08%	1.46	6.09%	17.13%	0.31	6.84%	14.86%	0.36
MDY	SPDR S&P MidCap 400	12.99%	15.12%	0.86	23.34%	16.81%	1.38	8.14%	20.27%	0.36	9.27%	17.86%	0.43
SPYG	SPDR S&P 500 Growth	14.47%	11.40%	1.26	21.54%	14.09%	1.52	8.07%	17.36%	0.42	7.10%	15.31%	0.36
SPYV	SPDR S&P 500 Value	11.92%	13.64%	0.87	19.38%	14.45%	1.33	3.99%	17.71%	0.18	5.99%	15.24%	0.29
Equal-Weighted													
RSP	Guggenheim S&P 500 Equal Weight	13.91%	14.10%	0.98	24.87%	17.00%	1.46	7.37%	20.56%	0.32	8.60%	17.88%	0.40
EWRM*	Guggenheim Russell MidCap Equal Weight	14.20%	14.85%	0.95	15.43%	14.55%	1.05						
Pure Style													
RPG	Guggenheim S&P 500 Pure Growth	17.01%	15.02%	1.13	26.93%	16.96%	1.58	10.88%	20.19%	0.50	10.21%	19.22%	0.45
RPV	Guggenheim S&P 500 Pure Value	17.66%	16.35%	1.08	32.45%	22.21%	1.46	7.18%	27.15%	0.24	8.05%	25.75%	0.25
Book Value, Cash Flow, Sales, Dividends													
PRF	PowerShares FTSE RAFI US 1000	13.32%	13.01%	1.02	24.37%	17.18%	1.41	6.63%	20.18%	0.29	7.76%	18.79%	0.33
Dividend Yield													
DVY	iShares Select Dividend	14.79%	9.53%	1.55	21.50%	12.03%	1.78	3.63%	17.59%	0.16	5.71%	15.15%	0.28
VYM	Vanguard High Dividend Yield Index	14.29%	10.14%	1.40	20.91%	12.96%	1.61	5.70%	16.77%	0.29	5.69%	16.51%	0.25
Dividend Growth													
SDY	SPDR S&P Dividend	13.66%	10.36%	1.31	21.08%	13.40%	1.57	5.90%	17.44%	0.29	7.12%	16.16%	0.35
VIG	Vanguard Dividend Appreciation Index	12.41%	11.12%	1.11	18.42%	12.25%	1.50	6.81%	14.68%	0.41	7.37%	14.03%	0.42

* Based on data since inception in 2010.

Source: Dubil, "How Dumb is Smart Beta? Analyzing the Growth of Fundamental Indexing" (2015:51)

Annex 2: Regression results of U.S. based smart beta ETFs against Carhart's Four-Factor model

		CAPM		Four-Factor: FF+MOM				
Ticker	**Name**	**Beta**	**Intercept**	**MOM**	**HML**	**SMB**	**Rm-Rf**	**Intercept**
Cap-Weighted								
VOO*	Vanguard S&P 500	0.9977	0.0018	0.0067	0.0135	−0.1599	0.9855	−0.0009
SPY	SPDR S&P 500	0.9934	0.0018	0.0062	0.0439	−0.1472	1.0022	−0.0015
MDY	SPDR S&P MidCap 400	1.1518	0.0004	0.0931	0.0422	0.4180	1.0450	−0.0027
SPYG	SPDR S&P 500 Growth	0.9812	0.0035	−0.0955	−0.3069	0.0960	1.0392	−0.0012
SPYV	SPDR S&P 500 Value	1.0109	0.0000	0.1246	0.3514	−0.2931	0.9757	−0.0023
Equal-Weighted								
RSP	Guggenheim S&P 500 Equal Weight	1.1678	0.0024	−0.0742	0.0967	0.1406	1.0723	−0.0016
EWRM*	Guggenheim Russell MidCap Equal Weight	1.1588	0.0009	0.0353	0.0505	0.3273	1.0481	−0.0013
Pure Style								
RPG	Guggenheim S&P 500 Pure Growth	1.1209	0.0054	−0.1188	−0.3149	0.2674	1.1439	0.0000
RPV	Guggenheim S&P 500 Pure Value	1.4214	0.0015	−0.0291	0.8272	0.1156	1.0635	−0.0007
Book Value, Cash Flow, Sales, Dividends								
PRF	PowerShares FTSE RAFI US 1000	1.1373	0.0018	−0.0162	0.3363	−0.0765	1.0122	−0.0009
Dividend Yield								
DVY	iShares Select Dividend	0.8723	0.0000	0.3275	0.8881	−0.2037	0.6927	−0.0004
VYM	Vanguard High Dividend Yield Index	0.9310	0.0016	0.1506	0.4807	−0.3220	0.8570	0.0001
Dividend Growth								
SDY	SPDR S&P Dividend	0.8642	0.0020	0.2379	0.7712	−0.0661	0.6697	0.0012
VIG	Vanguard Dividend Appreciation Index	0.8300	0.0028	0.0986	0.1674	−0.1796	0.8335	0.0004

*Based on data since inception in 2010. All other regressions based on seven years of monthly returns.
Note: SMB means "small-minus-big" beta; HML means "high-minus-low" beta.

Source: Dubil, "How Dumb is Smart Beta? Analyzing the Growth of Fundamental Indexing" (2015:52)

Annex 3: Performance attribution analysis of U.S. based smart beta ETFs against Carhart's Four-Factor model

		CAPM		Four-Factor: FF+MOM				
Ticker	**Name**	**Alpha**	**Unexpl**	**Intercept**	**Rm-Rf**	**SMB**	**HML**	**MOM**
Cap-Weighted								
SPY	SPDR S&P 500	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MDY	SPDR S&P MidCap 400	0.23%	0.06%	−0.12%	0.08%	0.27%	0.00%	−0.06%
SPYG	SPDR S&P 500 Growth	0.08%	0.01%	0.03%	0.07%	0.12%	−0.21%	0.07%
SPYV	SPDR S&P 500 Value	−0.10%	−0.01%	−0.08%	−0.05%	−0.07%	0.19%	−0.08%
Equal-Weighted								
RSP	Guggenheim S&P 500 Equal Weight	0.36%	0.01%	−0.01%	0.13%	0.14%	0.03%	0.06%
EWRM*	Guggenheim Russell MidCap Equal Weight	0.08%	−0.05%	0.02%	0.06%	0.04%	0.00%	0.01%
Pure Style								
RPG	Guggenheim S&P 500 Pure Growth	0.53%	0.04%	0.15%	0.27%	0.20%	−0.22%	0.09%
RPV	Guggenheim S&P 500 Pure Value	0.99%	0.16%	0.08%	0.12%	0.12%	0.48%	0.03%
Book Value, Cash Flow, Sales, Dividends								
PRF	PowerShares FTSE RAFI US 1000	0.32%	0.01%	0.06%	0.02%	0.03%	0.18%	0.02%
Dividend Yield								
DVY	iShares Select Dividend	0.08%	0.29%	0.12%	−0.59%	−0.03%	0.51%	−0.23%
VYM	Vanguard High Dividend Yield Index	0.03%	0.06%	0.16%	−0.28%	−0.08%	0.27%	−0.10%
Dividend Growth								
SDY	SPDR S&P Dividend	0.04%	0.09%	0.27%	−0.63%	0.04%	0.44%	−0.17%
VIG	Vanguard Dividend Appreciation Index	−0.18%	−0.05%	0.19%	−0.32%	−0.02%	0.08%	−0.07%

* Based on three years only.
Note: SMB means "small-minus-big" beta; HML means "high-minus-low" beta.

Source: Dubil, "How Dumb is Smart Beta? Analyzing the Growth of Fundamental Indexing" (2015:53)

Annex 4: Portfolio characteristics of smart beta strategies applied on global selected stocks between 1987-2009

Strategy	Total Return	Volatility	Sharpe Ratio	Excess Return over Benchmark	Tracking Error	Information Ratio	One-Way Turnover
MSCI World Index[a]	7.58%	15.65%	0.22	—	—	—	8.36%
Heuristic-based weighting							
Equal weighting	8.64%	15.94%	0.28	1.05%	3.02%	0.35	21.78%
RCEW (*k* clusters)	10.78	16.57	0.40	3.20	6.18	0.52	32.33
Diversity weighting ($p = 0.76$)	7.75	15.80	0.22	0.16	1.60	0.10	10.39
Fundamental weighting	11.13	15.30	0.45	3.54	4.77	0.74	14.93
Optimization-based weighting							
Minimum-variance	8.59%	11.19%	0.39	1.01%	8.66%	0.12	51.95%
Maximum diversification	7.77	13.16	0.27	0.18	7.41	0.02	59.72
Risk-efficient ($\lambda = 2$)	8.94	14.90	0.32	1.35	3.58	0.38	36.40

Source: Chow, Hsu, Kalesnik and Little (CHKL) – "A Survey of Alternative Equity Index Strategies" (2011:42)
a: The turnover of the MSCI index is reported on December 31.

Annex 5: Portfolio characteristics of smart beta strategies applied on U.S. selected stocks between 1964-2009

Strategy	Total Return	Volatility	Sharpe Ratio	Excess Return over Benchmark	Tracking Error	Information Ratio	One-Way Turnover
S&P 500[a]	9.46%	15.13%	0.26	—	—	—	6.69%
Heuristic-based weighting							
Equal weighting	11.78%	17.47%	0.36	2.31%	6.37%	0.36	22.64%
RCEW (*k* clusters)	10.91	14.84	0.36	1.45	4.98	0.29	25.43
Diversity weighting (p = 0.76)	10.27	15.77	0.30	0.81	2.63	0.31	8.91
Fundamental weighting	11.60	15.38	0.39	2.14	4.50	0.47	13.60
Optimization-based weighting							
Minimum-variance	11.40%	11.87%	0.49	1.94%	8.08%	0.24	48.45%
Maximum diversification	11.99	14.11	0.45	2.52	7.06	0.36	56.02
Risk-efficient (λ = 2)	12.46	16.54	0.42	3.00	6.29	0.48	34.19

Source: Chow, Hsu, Kalesnik and Little (CHKL) – "A Survey of Alternative Equity Index Strategies" (2011:42)
a: The turnover of the S&P 500 index is reported on December 31.

Annex 6: Regression results of smart beta strategies for both global and U.S portfolios against Carhart's Four-Factor model

Strategy	Annual Alpha	Alpha p-Value	Market ($Mkt - R_f$)	Size (SMB)	Value (HML)	Momentum (MOM)	R^2
Annually rebalanced global strategies for 1,000 stocks, 1987–2009							
MSCI World Index	0.00%	—	1.000	0.000	0.000	0.000	1.00
Equal weighting	0.77	(0.131)	1.015**	0.259**	0.025*	–0.008	0.98
RCEW (*k* clusters)	0.68	(0.547)	1.071**	0.338**	0.232**	0.045**	0.90
Diversity weighting (p = 0.76)	0.38	(0.173)	1.001**	0.087**	–0.058**	0.011*	0.99
Fundamental weighting	2.18	(0.000)	0.970**	0.040*	0.332**	–0.090**	0.97
Minimum-variance	1.25	(0.329)	0.628**	0.001	0.138**	–0.013	0.73
Maximum diversification	0.49	(0.716)	0.760**	0.097*	0.004	0.029	0.78
Risk-efficient (λ = 2)	0.97	(0.154)	0.947**	0.176*	0.056**	–0.003	0.96
Annually rebalanced U.S. strategies for 1,000 stocks, 1964–2009							
S&P 500	0.00%	—	1.000	0.000	0.000	0.000	1.00
Equal weighting	0.15	(0.786)	1.043**	0.482**	0.144**	–0.012	0.96
RCEW (*k* clusters)	–0.13	(0.846)	0.954**	0.116**	0.185**	0.040**	0.91
Diversity weighting (p = 0.76)	0.07	(0.798)	1.012**	0.173**	0.029**	0.002	0.99
Fundamental weighting	0.50	(0.193)	1.010**	0.128**	0.338**	–0.076**	0.97
Minimum-variance	0.30	(0.713)	0.708**	0.198**	0.344**	0.011	0.81
Maximum diversification	–0.02	(0.977)	0.844**	0.342**	0.264**	0.061**	0.87
Risk-efficient (λ = 2)	0.19	(0.732)	1.002**	0.465**	0.250**	0.004	0.95

Source: Chow, Hsu, Kalesnik and Little (CHKL) – "A Survey of Alternative Equity Index Strategies" (2011:46)
**: Significant at 10%
*: Significant at 1%

Annex 7: Post-tax returns of smart beta strategies implemented on the global and U.S. portfolios after tax management.

After-Tax Returns for Tax-Managed Strategies, 1993–2012

	Global						U.S.					
Strategy	After-Tax Return	Post Liquidation Return	After-Tax Excess	Tax Impact	Liquidation Impact	Change in Tax Impact	After-Tax Return	Post Liquidation Return	After-Tax Excess	Tax Impact	Liquidation Impact	Change in Tax Impact
CW	6.76%	6.06%	0.42%	–0.55%	–0.71%	0.39%	8.19%	7.28%	0.74%	–0.46%	–0.91%	0.53%
Heuristic												
EW	7.83%	7.24%	1.48%	–0.86%	–0.60%	0.61%	8.83%	8.19%	1.38%	–1.08%	–0.65%	0.56%
RC	8.34%	8.34%	2.00%	–1.80%	0.00%	0.70%	9.88%	9.10%	2.43%	–1.24%	–0.78%	0.75%
DW	7.06%	6.31%	0.71%	–0.54%	–0.75%	0.50%	8.99%	8.05%	1.54%	–0.52%	–0.94%	0.70%
FI	9.20%	8.53%	2.86%	–1.01%	–0.67%	0.90%	9.49%	8.74%	2.04%	–1.01%	–0.75%	0.75%
Optimization												
MV	6.41%	6.30%	0.06%	–1.44%	–0.11%	0.71%	7.99%	7.66%	0.54%	–1.45%	–0.33%	0.86%
MD	5.88%	5.88%	–0.47%	–1.38%	0.00%	0.66%	8.18%	7.83%	0.73%	–1.43%	–0.35%	0.78%
RE	7.77%	7.39%	1.42%	–1.25%	–0.38%	0.60%	9.16%	8.66%	1.71%	–1.51%	–0.50%	0.54%

Source: Vadlamudi and Bouchey – "Is Smart Beta Still Smart After Taxes?" (2014:132)

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