Factor Investing: a Stock Selection System for the European Equity Market

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Abstract

This paper uses the universe of European corporate data for the 1991-2016 period to demonstrate that systematic portfolio active management based on the identification of value, profitability and momentum factors is able to outperform the market benchmark. While factor investment strategies have received significant attention in the literature in the U.S. market, their application to European data is highly limited. Using an exclusive data set, we are able to construct different systematic investment strategies combining the three factors. We therefore offer a novel factor approach to portfolio management. We additionally address the relevance of currency risk in factor portfolio decision making and analyze the effects of the Euro introduction in 2002 in portfolio performance.

Keywords: Factor Investing, Value, Profitability, Momentum, Alpha, Active Investing.

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1. Introduction

It has been known to market participants that since 2010, the percentage of actively managed portfolios underperforming their market benchmarks has increased over time. An analysis published by Standard and Poors[1] on the 25th of September of 2017, found that, over the past ten years, 87.4% of the European Equity funds investing in European equities did not manage to beat the market. This underperformance has been one of the key drivers of a very significant flow out of active and into passively managed funds over the last decade.[2] This change in the nature of global equity flows suggests that "stock picking" and hence paying

[1] See SPIVA® Europe Scorecard (Mid-Year 2017).

[2] Source: EDFR Global and Bernstein analysis. Available at www.rwcdr.co.uk/Docs/17.02_RWC_Equity_Income_Investor_Letter_-_Q1 2017. See also See "Passive Investing: Active Fund Managers start to fight back." Financial Times, 4th October 2017.

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higher fees for active management is becoming a less attractive option for institutional and retail investors.

The underperformance of active portfolio management has been extensively addressed in the mutual fund industry (see Gennaioli, Shleifer and Vishny, 2015 and references therein). In a related paper Cremers, Ferreira, Matos and Starks (2015) use a multi-country sample of equity mutual funds and ETFs to demonstrate empirically that actively managed funds are more active and charge lower fees when they face more competitive pressure from low cost explicitly indexed funds.

Traditional active management techniques base portfolio selection on the analysis of company fundamentals. In this context, following the work of Graham and Dodd (1934) and the seminal work on systematic investing of Fama and French (1992), company ratio analysis has been a key methodology used by academics and practitioners.[3] Under these frameworks, financial ratios and other market metrics, such as past relative returns, are used to identify investment opportunities capable of outperforming consistently the reference market index. In this paper, we empirically assess whether systematic active management practices based on fundamental ratio and momentum factors remain successful in delivering long-term profitability.

We concentrate our analysis in the European market to assess the impact of different policy regimes in long run business risk and profitability. This is particularly relevant at the time of writing since, as it is underlined by Anker (2017), Europe faces a challenging situation of economic and political uncertainty. Assessing the extent to which fundamental and market based analysis is profitable in the long term is important in a context where corporates operate without clear guidance from regulatory or legal frameworks.[4]

The application of factor investing criteria to the U.S. market is extensive, the empirical evidence for the European markets is highly limited. This is partially explained by the absence of a sufficiently detailed and robust database incorporating: a) the unified long run series of accounting information required for the computation of selected financial ratios and b) a complete series of market data to analyze past relative returns and pre-filtering the stocks according to pre-defined market criteria. In this paper we exploit Factset, a dataset frequently used by investment firms, to contribute to the literature by addressing the underlined problems.

This paper focuses on the joint application of value, profitability and momentum investment strategies over a span of European companies, to obtain sustainable excess returns in

[3] Note that the present value model (see for instance Campbell and Shiller, 1987) has also been used extensive for Investment decision making. Under such frameworks valuation is also dependent on fundamentals such as the stock dividend.
[4] See Anker (2017) for a detailed discussion on current business challenges faced in Europe.

the long term. We propose a series of algorithms based on financial and market ratios that eliminate the human bias arising from stock picking and demonstrate consistent long term profitability.

The investment universe is defined to include the 600 non-financial, non-dual listed, European companies that exhibit the largest market capitalization when portfolios are rebalanced (30th of June), over the period ranging from 1991 to 2016. Our initial sample, thus, incorporates data on 1.830 different companies from 29 countries and 19 different economic sectors, adding up to 16.200 registries.[5]

The concept of value investing was initially introduced by Graham and Dodd (1934).[6] This methodology focuses on investing in companies whose price is substantially lower than its intrinsic value (undervalued companies). The value factor has been extensively studied by academic researchers, mainly using the book-to-market ratio as the key measure to segregate value from growth stocks (Fama and French, 1992). Investment strategies based on a profitability factor were introduced in the academic literature by Novy-Marx (2013). Profitability relates to the company's ability to generate profits in relation to its asset base. Momentum strategies are used in the literature to address the influence of past relative returns in portfolio performance. Jegadeesh and Titman (1993) identified the existence of positive persistence in stock returns that can be exploited to generate positive additional abnormal returns in the future. Momentum was considered by Fama and French (2008) as the "premier anomaly" and is now one of the most extensively studied factor in the literature.

As it is documented in the literature, investment strategies based exclusively on individual factors are able to outperform the market on a risk-adjusted basis on the long term (see Fama and French, 1992). Other academic articles (see Asness, Moskowitz and Pedersen, 2013) studied the positive performance in terms of risk-adjusted returns of strategies that combine single factors (value and momentum) to create portfolios. Novy-Marx (2013) argued that the incorporation of gross profitability into a strategy of value and momentum increases gross returns while decreasing transaction costs by reducing portfolio turnover and tail risk. Previously, Greenblatt (2005 and 2010) developed a quantitative investment strategy based on applying value and profitability criteria simultaneously.

In this paper we contribute to the literature by using an exclusive data set to provide new evidence that long-only equity portfolios composed by European stocks and built combining, in

[5] A detailed list of the accounting data used in this study, along with the expressions used for the computation of ratios, could be found in Appendix A.

association, value, profitability and momentum factors provide sustainable and superior risk-adjusted returns.

Portfolios are combined using first value as a criteria and then profitability followed by momentum. Thus the “buy cheap” condition is imposed in the first place. Out of the selected “cheap” companies we proceed to select the most profitable. The third filter that we apply is momentum, which selects the companies that exhibited highest returns over the recent history. The ordering of criteria that we use in our methodology is also consistent with the literature.

We measure value, profitability and momentum factors through different metrics. This allows testing for robustness as well as finding the best performing metric per factor.

We additionally address the impact of the introduction of the Euro in the Eurozone in 2002[7] by splitting the sample into two sub-periods (1991-2001 and 2002-2016). We provide some evidence suggesting that there is a structural break that affected investment decisions of European based companies, as well as the information impounded in their balance sheet and income statements, making those more comparable among peers. We therefore address some of the positive effects brought by globalization.

We also contribute by isolating the impact of each metric in portfolio’s performance using Z-scores. Z scores were first applied by Altman (1968) to assess the performance of different financial ratios for bankruptcy prediction purposes (see also Duchin and Sosyura, 2014.) In a related context, Urionabarrenetxea et al., (2017) use an index to detect extreme zombie firms applying firm sensitivities to different normalized index factors. In this paper, a factor analysis is conducted to find the determinants of portfolio profitability. We conduct a z-score analysis for the 1991-2016 period as well as for two subsamples that arise before and after the Euro introduction. This allows us to determine the role of different fundamental factors in portfolio profitability as means of developing novel active portfolio management strategies.

The rest of the paper is organized as follows. Section 2 discusses data collection and methodology. Section 3 discusses results. Conclusions are described in section 4.

[7] The Euro came into existence the 1st of January of 1999, but notes and coins began to circulate the 1st of January of 2002.

2. Data and methodology

2.1. Data

The process of data collection is an important contribution of this paper. One of the main difficulties that arise when analyzing long spans of European accounting and financial market data is the lack of homogeneity, especially before the introduction of the Euro. To address this problem, the data preparation process has been carefully designed to select a robust set of data for the largest possible number of European corporates during the longest available time period.

The main tool of our data collection process is provided by the Alpha Testing function included in the Factset terminal. This tool allowed us to obtain homogeneous and robust accounting information on annual frequency from balance sheet and income statements, for a wide variety of companies within the European investment universe. The Factset terminal also provided us with monthly market data on total stock returns, both on local currency and US dollars.[8] The dollar measure is provided to make company based performance results comparable between different countries within and outside Europe.

The investment universe includes the largest 600 European based companies, by market capitalization, listed on European stock exchanges. Tables I and II in Appendix A show the number of companies across the time frame considered per sector and per country. Companies are distributed across 19 sectors and 29 countries.

Selection is made on the basis of market capitalization with portfolio rebalancing taking place on the 30th of June. We exclude banks, insurance, REITS, financial holdings and dual listed companies. Accounting and financial data are measured in domestic currency. Market cap is measured in US dollars.

Our data set covers the 1991 to 2016 sample period. Prior to 1990, the financial and market information available was insufficient to complete a robust set of information on 600 companies. After we select 600 companies on the basis of market capitalization a second filter is applied that guarantees the practical implementation of the value, profitability and momentum strategies outlined in the analysis. This leaves us with an average of 576 companies selected annually.[9] This allows a maximum representativeness covering approximately 90% of the total

[8] US dollar returns after 1994 are obtained by converting stock prices using the WM/Reuters 4:00 PM GMT spot exchange rate. Before 1994, and on holiday dates, price series are converted through 11:00 AM GMT Interactive Data rates.

[9] Out of the 600 largest companies, we only incorporate to the universe yearly those stocks for which the data is accessible in order to calculate all the value, profitability and momentum metrics. This means that, on average, our universe is actually composed of 576 stocks.

market cap of the European investment universe. Note that this threshold is considered in the literature as the frontier to separate the large cap universe from the rest (see Novy-Marx, 2013).

2.2 Methodology

The goal of this paper is to analyze the extent to which a European equity benchmark can be outperformed using a systematic investment strategy that selects the stocks in the portfolio through an algorithm based on value, profitability and momentum factors.

2.2.1 Portfolio composition

We consider different measures of factor metrics to guarantee robustness in our analysis. This also allows us to find the best performing metric per factor.

We use four different metrics to measure value: 1) Book-to-market ratio. This is the most common ratio used in the academic literature to define value (see Fama and French, 1992 and Lakonishok et al.,1994). 2) Price-to-earnings (PER) was described by Graham and Dodd (1934) and Graham (1949) as the sixth out of his seven "quality and quantity criteria." According to this principle “Moderate price-to-earnings ratios, should typically not exceed 15”. 3) Total enterprise to EBIT ratio used by Greenblatt (2005 and 2010), Gray and Vogel (2012) and Gray and Carlisle (2012) with superior results to both BTM and PER. 4) Total enterprise to EBITDA ratio (EV/EBITDA) used by Gray and Vogel (2012) and Gray and Carlisle (2012) with superior results to both BTM and PER. Note that all the metrics analyzed are also extensively applied by practitioners in both public and private equity markets[10].

Three different metrics are applied to measure profitability. 1) Gross profit on total assets (GPA). This is the most commonly used ratio to measure profitability in the academic literature. As shown by Novy-Marx (2013), it is the best metric to achieve sustainable risk-adjusted excess returns when applying a single profitability factor to create long-short portfolios. 2) Return on capital (ROC_G), as defined by Greenblatt (2010). This excludes intangible assets from its computation and is frequently used by institutional investors. 3) Return on capital (ROC_D) including intangible assets. While this metric has received limited attention in the academic research, is widely used by institutional investors. Including intangible assets provides greater transparency on the assessment of how corporates use their financial resources and a more precise analysis on their return on capital. As documented in the literature (see Urionabarrenetxea et al. 2017), the intensive presence of intangibles increases corporate risk and the probability of corporate default. We quantify the extent to which including intangibles delivers superior performance in the proposed strategies.

[10] Including research published by sell-side analysts and quarterly and annual reports published by mutual funds, among others.

Finally, we use one measure for momentum and select stocks according to accumulated past 12 months total performance. Following Lehmann (1990), Jegadeesh (1990) and Jegadeesh and Titman (1993) we exclude the most recent month ("12_1 momentum"). Their finding suggests that the inclusion of short term momentum has a reversal effect so that previous winners, measured over the past month, perform poorly over the next month.

Each of these single factor (value, profitability and momentum) metrics are, then, used to perform an initial division of our 600 stocks universe in quintile portfolios (denoted as "pure" in our study).

The analysis we perform on this paper and the steps followed are described below:

1. We rank companies on a yearly basis according to the following criteria: when using a value metric, companies are ranked from cheaper to more expensive; when we use a profitability metric, companies are ranked from higher to lower profitability. Finally, the momentum ranking is obtained by sorting, for each year, companies from higher to lower accumulated returns.
2. We next review each factor according to the different metrics, test the robustness of those metrics and find the best performing factor metric.
3. We determine a set of rankings (denoted as "mixed") by adding, and sorting in a descending order, each value ranking combined with a profitability/momentum ranking. This type of analysis was previously used by Greenblatt (2010), and Novy-Marx (2013) among others.
4. An additional set of rankings (denoted as "conditional") is obtained by iteratively classifying stocks according to value, then profitability and then momentum indicators. This requires us to combine the three factors into a single portfolio, following the spirit of Gray and Carlisle (2012) combining value and quality. Conditional value-based (pure) sub-portfolios are split according to each quality/momentum metric and, further, decomposed according to the momentum indicator. For example, we create portfolios of thirty stocks using the following procedure: out of the 600 stocks universe, we select the first quintile (top 20%) by a metric of value (120 stocks), subsequently, we select the top 50% by a metric of quality (60 stocks) and finally we choose the top 50% by momentum to select a thirty stock portfolio.

Therefore, the total number of different rankings considered in this study amount to 40: 8 pure rankings, 16 mixed rankings and 16 conditional rankings[11].

Unlike most of the previous literature on investment anomalies we rely only on long-only portfolios rather than focusing on long-short portfolios. The main reason that explains our choice lies on the short selling limitations that have prevailed in the European market (unlike the U.S. market). These restrictions were even stronger prior to the introduction of the Euro currency.

In order to investigate the performance of the proposed active management strategies we construct a Benchmark portfolio that illustrates passive management profitability. For this purpose we create a portfolio that includes the entire universe of 600 European companies. Note that natural passive portfolio benchmark could be the Stoxx Europe 600 Total Return. However this index includes banks, REITS, and dual listed and financial companies. Moreover, it does not cover our full sample period. We therefore construct a benchmark portfolio with the 600 highest market capitalization companies prevailing over our sample period.

Our investment portfolios and the 600 stock Benchmark are equally weighted and rebalanced every 30th of June. They are therefore held for one year until the next rebalancing. On that date, our different metrics are computed, using published accounting information (balance sheet and income statement) as of previous year-end (December) statements and current market data, following Asness and Frazzini (2013). As discussed in the literature, the use of June as a rebalancing month guarantees data availability, so that financial information can be accessed by market participants.

Finally, the entire analysis has been performed both in local currency and in US dollars to study the currency impact on factors and investment strategies when different currency measures are applied.

2.2.2 Characterizing the impact of Value, Profitability and Momentum Strategies: the Z-score

In order to evaluate the performance of each factor individually over our sample period, we quantify the effect of value, profitability and momentum on portfolio performance in a context where each factor metric is considered in isolation. The purpose is to determine the

[11] Pure rankings (8): created using the single metrics of value (4), profitability (3) and momentum (1).
Mixed rankings (16): created combining each metric of value with those of profitability (4x3=12) and momentum (4x1=4).
Conditional rankings (16): A) Created selecting the first quintile of each metric of value, then the top 50% by each metric of profitability and then the top 50% by momentum (4x3x1=12). Each portfolio holds 30 stocks. B) Created selecting the first quintile of each metric of value and then the top 25% by momentum (4x1=4). We select the top 25% to create comparable portfolios of 30 stocks for all the conditional rankings.

main drivers of excess returns. The procedure is conducted as follows: first, for each company, *j*, in the sample, the Z-score corresponding to each the factor metric, *i*, and year, *t*, is generated as:

$$Z_{i,j,t} = \frac{V_{j,i,t} - \bar{V}_{i,t}}{\sigma_{i,t}} \qquad (1)$$

Where $V_{j,i,t} - \bar{V}_{i,t}$ corresponds to the distance from its mean of each specific criterion, and $\sigma_{i,t}$ denotes the yearly dispersion (standard deviation) of the values of that criterion. Factor data are therefore standardized to deliver scores with zero mean and unit standard deviation.

We perform a panel data analysis according to the following methodology. Conditional portfolios, as described above, are generated according to each of the factor metric iteratively. In order to avoid sampling bias, all the feasible combinations of metrics are considered: we initially divide on a yearly basis the full universe of companies in five quintiles (120 stocks) according to one of the 8 metrics (4 value, 3 profitability and 1 momentum). The resulting portfolios are, then, separated in two according to the same, or an alternative metric. This allows us to obtain portfolios that include a 10% of the original universe (60 stocks). Finally, these portfolios are decomposed in two according to any of the factor metrics. Hence, each final portfolio incorporates 5% of the original universe (30 stocks). The total number of portfolios generated following this methodology amounts to 10.240 ($20x8^3$) and constitutes the number of different observations in our panel data analysis.

For each of those sub-portfolios, each Z-score, $\bar{Z}_{i,t}$, and yearly returns are obtained as the simple average of company values. As 26 years are considered, our dataset includes 266.240 (26x10.240) registries.

Next, yearly returns on 1Y Libor are subtracted from those observed in the Benchmark portfolio, and each of the previously defined each sub-portfolio to obtain the corresponding risk premium, $E_t^b, E_{m,t}$.

A time series-panel data regression is then used to estimate the coefficients of the following equation:

$$E_{m,t} = \bar{\alpha}_m + \sum_{w=0}^{t} \beta_w E_{t-w}^b + \sum_{i=1}^{8} \gamma_i \bar{Z}_{i,t-1} + u_{m,t} \qquad (2)$$

The Z-score loadings, γ_i, and the drift parameter, $\bar{\alpha}_m$, represent the extent to which each metric generates excess returns and the excess return generated by the stock selection for each sub-portfolio class respectively. Sub-portfolio class excess returns, in this context, are defined as those obtained when ordering and pooling together portfolios that represent the same portion (5%; 30 stocks) of the total universe.

3. Results

In what follows, we present results delivered by the proposed strategies. We first consider pure measures as well as mixed rank performance. We then follow Gray and Carlisle (2012), to analyze the capacity of conditional rankings to improve the stock selection process. Finally, a panel data approach is utilized to quantify individually the impact of value, quality and momentum components and metrics in portfolio excess returns.

In order to test the robustness of the metrics that we use to define the value, profitability and momentum factors we split our investment universe in quintiles (20% portfolios; 120 stocks), as Novy Marx (2013), using "pure" factors. The first requirement when building portfolios in this context is that the metric applied for selection purposes delivers an ordered structure of portfolio performance. This implies that the first quintile outperforms the second and that the process repeats consecutively. A detailed analysis of optimality, which can be provided upon request, demonstrates that the minimum portfolio threshold that provides robustness is 20%. This guarantees an ordered structure and a sufficiently large size to allow for diversification.

3.1 The Value of Systematic Factor Investing

Table 1 presents descriptive statistics, both in local currency and US dollars, of the first and fifth quintile portfolios (quintile 1 and quintile 5 thereafter). Analyzing the performance of the quintile 1 and quintile 5 portfolios has important consequences for portfolio management purposes as a full picture of portfolio winners and losers is provided. Reported figures show results based on pure rankings of value, quality and momentum under two main measures: [12] a) final value achieved by an investment index with an initial value equal to one (corresponding to the initial investment allocated to a given portfolio, and b) average portfolio returns compounded annually. The following points should be highlighted about the results reported in Tables 1. First quintile 1 outperforms the market benchmark based on the two performance measures (final value and annualized compounded returns) under all reported factor metrics. As expected, quintile 5 underperforms the market benchmark under all strategies. However, the average quintile (constructed as the average between quintile 1 and quintile 5) performance measures remain above the market benchmark. Second, there are important differences in

[12] The statistics corresponding to all the portfolios generated under the mixed and conditional approaches described in section 2.2. are available upon request from the authors.

performance arising due to currency measurements: the local currency and the common U.S. dollar. Indeed portfolio performance is significantly higher when returns are measured in local currency reflecting the existence of currency risk which is quantified in the last row of table 1. Measuring profitability in dollars reflects the underlying currency risk that the investor faces when investing in a foreign currency denominated asset. When currency risk is taken into account, losses in portfolio final values range between 60% and 70%. The strategies that minimize losses in final portfolio values due to currency risk are the ROC Green and ROC_D with the later outperforming the former. This highlights the importance of including intangibles in return on capital measures. Reduction in profitability due to currency risk is less pronounced when performance is recorded as means of annualized compounded returns. However returns reported for the quintile 1 and quintile 5 portfolios remain consistently higher than the benchmark. The analysis of currency premium reported in the last panel of table 1 shows annual compounded return differences between local and common currency measures. Reported figures demonstrate that the highest currency premium arises under momentum followed by EVEBIT strategies.

Table 1: Descriptive Statistics for the Best and Worst portfolios

	Benchmark	Book To Market	PER	EVEBIT	EVEBITDA	GPA	ROC Green	ROC Det.	Momentum
Final Index Value Best (Quintile 1) Quintile (Local)		15.45	19.16	19.16	17.44	18.59	14.62	16.21	21.32
Final Index Value Worst (Quintile 5) Quintile (Local)	11.38	8.84	5.00	6.02	5.47	6.73	6.35	6.10	4.98
Final Index Value (Mean Quintiles 1 and 5) (local)		12.14	12.08	12.74	11.46	12.66	10.49	11.16	13.15
Final Index Value Best (Quintile 1) Quintile (USD)		5.61	7.44	6.16	5.83	8.40	5.72	7.37	6.45
Final Index Value Worst (Quintile 5) Quintile (USD)	4.649	3.57	1.64	1.75	1.69	2.20	2.23	2.02	2.20
Final Index Value (Mean Quintiles 1 and 5) (USD)		4.59	4.54	3.96	3.76	5.30	3.98	4.70	4.32
Annualized Compounded Return Best (Quintile 1) Quintile (Local)		11.25%	12.18%	12.18%	11.77%	12.05%	11.01%	11.46%	12.65%
Annualized Compounded Return Worst (Quintile 5) Quintile (Local)	5.05%	8.86%	6.47%	7.24%	6.84%	7.70%	7.46%	7.30%	6.45%
Annualized Compounded Return (Mean Quintiles 1 and 5) (Local)		10.05%	9.33%	9.71%	9.31%	9.88%	9.24%	9.38%	9.55%
Annualized Compounded Return Best (Quintile 1) Quintile (USD)		6.94%	8.13%	7.34%	7.11%	8.64%	7.03%	8.09%	7.53%
Annualized Compounded Return Worst (Quintile 5) Quintile (USD)	3.54%	5.08%	1.95%	2.21%	2.07%	3.12%	3.18%	2.78%	3.11%
Annualized Compounded Return (Mean Quintiles 1 and 5) (USD)		6.01%	5.04%	4.77%	4.59%	5.88%	5.10%	5.43%	5.32%
Currency Premium Quintile 1 (Annualized Compounded Return Local - USD)	1.51%	4.30%	4.06%	4.85%	4.67%	3.41%	3.98%	3.37%	5.12%
Currency Premium Quintile 5 (Annualized Compounded Return Local - USD)		3.77%	4.52%	5.03%	4.78%	4.59%	4.29%	4.52%	3.34%

Mean Currency Premium (Annualized Compounded Return Local - USD)		4.04%	4.29%	4.94%	4.72%	4.00%	4.13%	3.94%	4.23%

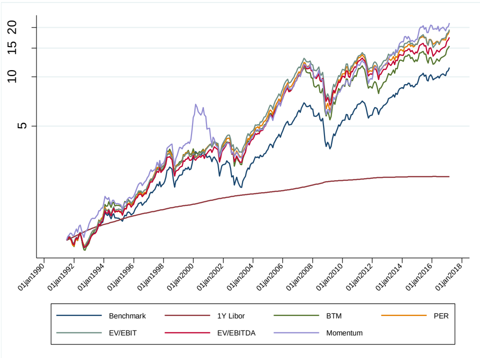
This table presents Final Index Values, Annualized Compounded Returns and Currency premiums, in local currency and US dollars, over the 1991-2017 period, for upper and lower 20% portfolios generated according to each of the pure metrics. Portfolios are rebalanced on a yearly basis and strategies are performed out of sample.

3.2. Pure and mixed rankings.

The main purpose is the selection of the preferred metric per factor. As previously discussed, we focus our analysis in the portfolio that incorporates the upper 20% of companies (quintile 1 portfolio) according to each metric.

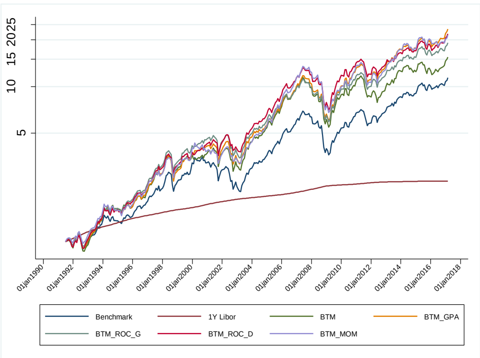
Figure 1: Return Evolution of Tier 1 Portfolios (pure and mixed) in local currency

(a) Value and Momentum

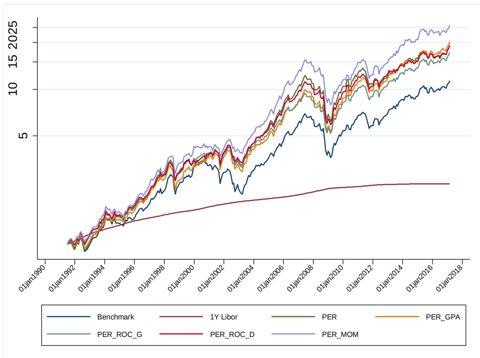


(b) Profitability Portfolios

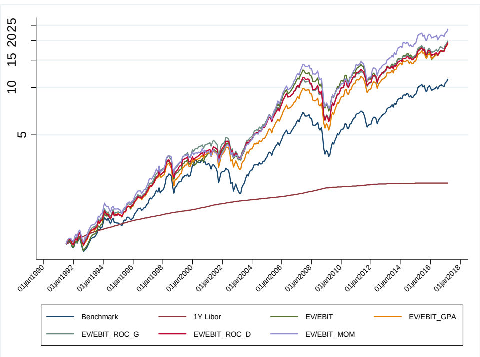
(c) BTM: Profitability and Mom.



(d) PER: Profitability and Mom.



(e) EV/EBIT: Profitability and Mom.



(f) EV/EBITDA: Profitability and Mom.

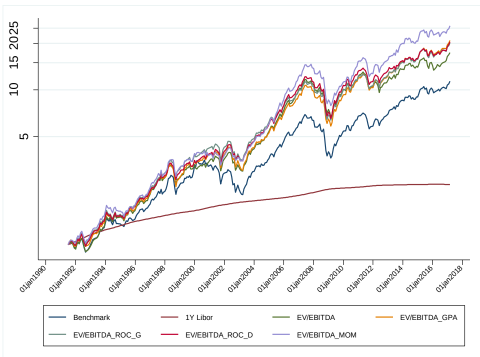


Fig 1 depicts cummulative returns of a standardized measure of performance that takes the value of 1 at the start of the investment period reflecting the initial investment.

We start by analyzing the performance of quintile 1 portfolios generated in local currency. Figures 1 (a)-(f) present the evolution of cumulative returns for each of the constructed Tier 1 portfolios and the benchmark portfolio. Note that the cumulative performance is standardized so that one is the initial value. A final figure of 25 observed for some of the mixed momentum strategies implies that the value of the initial investment multiplies by 25 times during the investment period. As means of completeness, we also construct the accumulated return for a risk free investor.[13] Results corresponding to value and momentum portfolios are presented in 1(a). Returns for profitability portfolios are reported in 1(b). Finally, figs 1(c) to 1(f) illustrate results on mixed portfolios.

Figure 1 illustrates the efficiency of value, profitability and momentum investing criteria for the stock selection process. Each quintile 1 portfolio shows higher accumulated returns than the 600 stock Benchmark and the risk free strategy. Table 2 reports annualized compounded returns and performance measures for pure and mixed tier 1 portfolios. On average, quintile 1 portfolios deliver a premium over the benchmark (risk free) equal to 160 bps (430 bps). While that increase is also paired with an average rise on volatility, of 70 bps, the final impact is positive in terms of risk remuneration and Sharpe ratio improves by +3.6%.

Also, Figure 1 presents graphical evidence on the existence of return outperformance of momentum based portfolios when compared to the best pure value and profitability portfolios. It is noted however that profitability metrics do also exhibit a solid performance when compared to the Benchmark.[14] This is important given that the study of such measures has been less extensive than value and momentum measures in the literature.

Table 2: Performance Ratios for the quintil 1 pure and mixed portfolios

	1Y Libor	**Benchmark**	**PER**	**GPA**	**Momentum**	**BTM_GPA**	**PER_Mom**
Annualized Compounded Return (Final)	3.56%	9.930%	12.184%	12.051%	12.650%	13.064%	13.521%
Annualized Compounded Return (Mean)	2.51%	5.237%	6.807%	6.331%	7.044%	6.959%	7.524%
Annualized compunded Return Volatility	4.80%	14.155%	18.261%	16.891%	17.599%	18.855%	19.773%
Sharpe Ratio		0.482	0.606	0.610	0.565	0.630	0.707
Sortino Ratio		0.603	0.790	0.811	0.710	0.786	0.890

[13] When returns are presented on a local currency basis we consider the risk free returns those obtained by the continuous investment on a 1 year EUR Libor. For the case of US dollars measured returns, the 1 year USD Libor is used, instead.
[14] The full collection of results is available upon request from the authors.

CAPM Beta			96.500%	95.300%	109.900%	105.200%	93.600%
CAPM Beta (Std. Dev.)			9.353%	8.660%	13.856%	7.275%	9.007%
Jensen's Alpha			2.352%	2.244%	2.268%	2.664%	3.660%
Jensen's Alpha (Std. Dev.)			1.015%	0.812%	1.524%	0.842%	0.959%

This table reports average annualized compounded returns, standard deviations, Sharpe and Sortino Ratios and Jensen's Alphas, for the different portfolios formed on the basis of value, profitability and momentum metrics over the 1991-2017 period. Portfolios are rebalanced on a yearly basis and strategies are performed out of sample.

Table 2 reports results for the best performing portfolios within each sub-group (pure, mixed value-quality and mixed value-momentum).

Figures reported on the 9th row of table 2 show that investment strategies based on value criteria not only outperform in terms of annualized returns. They also deliver a significant annualized CAPM alphas ranging between 220-375 bps.

Reported results also demonstrate that while annualized volatility of returns reported is between 50 and 100 bps higher than the market Benchmark, portfolios outperform in terms of Sharpe and Sortino ratios by 30%. Further evidence is presented when looking at CAPM betas. Those are all significant and smaller than one, except for the case of Momentum and BTM-GPA strategies. These results are important for active portfolio management, as they demonstrate that the proposed stock selection methods generate systematic risk-adjusted returns without the involvement of levered strategies as suggested CAPM betas.

3.2.1 Measuring performance using the US dollar as common currency base

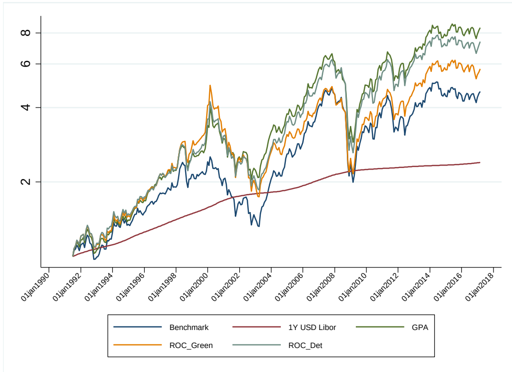
In this section we address in detail the effects of currency distortions. As previously discussed, different currency measures deliver strong disparity in portfolio performance. This motivates us to address the effect of currency measurement in greater detail. Figure 2 presents the evolution of accumulated returns in Tier 1 portfolios when returns are measured in US dollars. This illustrates that Tier 1 portfolios measured in a common currency on average also out-perform both the Benchmark and the risk free strategy for the whole sample period. However, while local currency portfolios out-perform the benchmark every year over the sample period, that is not the case for all of them when equity returns are measured in US dollars. This suggest that currency specific risk vanishes part of the profitability obtained from the proposed ratio based strategies for the period considered.

As illustrated in (2a), and to a lesser extent in (2c)-(2e), value based portfolios exhibited a behavior similar to the market benchmark up to 2002. However, (2a) and (2b) shows a systematic out-performance of profitability and momentum based portfolios over the entire period. Since 2002, and especially prior to the burst of the subprime crisis, value based portfolios significantly beat the market. On average, pure value, profitability and momentum portfolios multiplied their value by 5.0, 7.4 and 5.3 respectively. Mixed portfolios increased in value by a seven-fold while the market benchmark only raised by a four-fold.

Figure 2: Return Evolution of Tier 1 Portfolios (pure and mixed) in US dollars

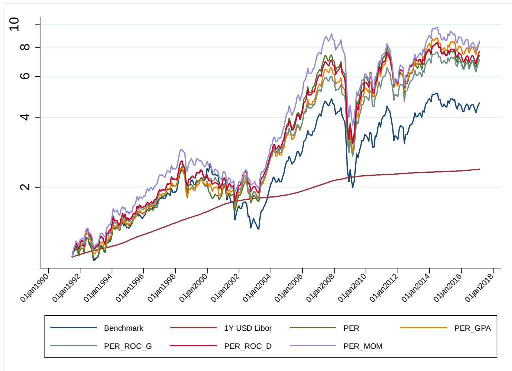
(a) Value and Momentum

(b) Profitability Portfolios



(c) BTM: Profitability and Mom.

(d) PER: Profitability and Mom



(e) EV/EBIT: Profitability and Mom.

(f) EV/EBITDA: Profitability and Mom.

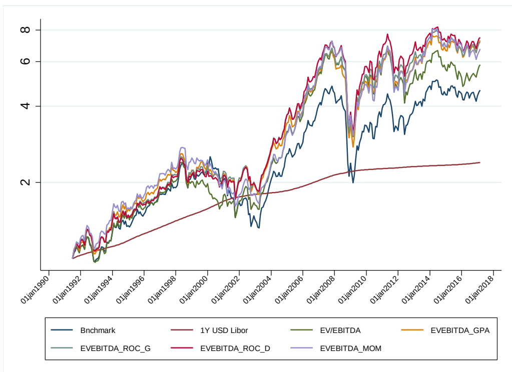


Fig 2 depicts cummulative returns in US dollars of a sdandardized measure of final performance that takes the value of 1 at the start of the investment period reflecting the initial investment.

Table 3 reports performance results for the best performing USD portfolios. We can see that, as it is for the case of local currency based portfolios, Tier 1 Portfolios deliver an increase of risk adjusted returns with respect to the market Benchmark ranging between 25% and 57%, when overall volatility is considered. We can also see that the performance measures arising from CAPM factors exhibit a similar behavior to those reported for the local currency case.

Table 3: Performance Ratios for Best USD Performing Portfolios

	1Y Libor	Benchmark	PER	GPA	Momentum	BTM_GPA	PER_Mom
Annualized Compounded Return (Final)	3.46%	6.15%	8.13%	8.64%	7.53%	8.90%	8.72%
Annualized Compounded Return (Mean)	2.28%	3.65%	4.75%	5.04%	4.94%	4.96%	5.34%
Annualized compunded Return Volatility	5.28%	9.70%	14.10%	12.68%	11.16%	14.12%	13.97%
Sharpe Ratio		0.236	0.336	0.371	0.294	0.367	0.367
Sortino Ratio		0.308	0.447	0.492	0.374	0.492	0.485
CAPM Beta			99.90%	94.80%	108.30%	103.90%	98.10%
CAPM Beta (Std. Dev.)			26.40%	22.80%	36.00%	21.60%	25.20%
Jensen's Alpha			1.99%	2.48%	1.49%	2.64%	2.56%
Jensen's Alpha (Std. Dev.)			1.07%	0.94%	1.43%	0.96%	1.05%

This table reports average annualized returns, standard deviations, Sharpe and Sortino Ratios and Jensen's Alphas, in US dollars for the different portfolios formed on the basis of value, quality and momentum criteria over the 1991-2017 period. Portfolios are rebalanced on a yearly basis and strategies are performed out of sample.

As it is the case under the local currency measure, the best performing pure value and profitability portfolios in terms of final index value are those based on PER and GPA. The former portfolio increased its value by a 7.4 fold, while the later did so by a 8.4 fold. Similarly, the momentum, BTM-GPA and PER-Momentum portfolios multiplied their value by 6.4, 8.9 and 8.5, respectively.

As shown in Table 3, equity premiums of top performers (or Tier 1) portfolios measured in US dollars for the full sample range from 140 to 260 bps with respect to the market Benchmark. They also exhibit a premium of 270 bps with respect to the riskless strategy. Common currency based portfolios also exhibit on average lower correlation with the market benchmark and therefore lower market risk. In this sense equity premiums are reduced in all but the pure value strategy (PER). Average abnormal returns are lower than the local currency counterparts except from the case of profitability based strategies.

Table 4: Impact of Currency Risks in Performance

	Benchmark	PER	GPA	Momentum	BTM_GPA	PER_Mom
Currency Risk Premium (Final)	3.78%	4.06%	3.41%	5.12%	4.16%	4.80%
Currency Risk Premium (Mean)	1.59%	2.06%	1.30%	2.11%	2.00%	2.19%
Volatility Impact (%)	-31.48%	-22.80%	-24.90%	-36.60%	-25.10%	-29.36%
Sharpe ratio variation (%)	-51.08%	-44.57%	-39.20%	-47.85%	-41.76%	-48.04%
Sortino Ratio variation (%)	-48.85%	-43.42%	-39.32%	-47.32%	-37.44%	-45.53%
Leverage Impact (Beta Variation)		3.52%	-0.52%	-1.46%	-1.24%	4.81%
Alpha Impact		-15.31%	10.70%	-34.39%	-0.90%	-30.16%

This table reports the impact of currency risks on average annualized returns, standard deviations, Sharpe and Sortino Ratios and Jensen's Alphas, for the different portfolios formed on the basis of value, quality and momentum criteria over the 1991-2017 period. Portfolios are rebalanced on a yearly basis and strategies are performed out of sample.

Moreover, measuring returns in a common base currency also impacts the choice of the best stock selection measure among pure and mixed portfolios. While in the case of local currency there is a clear preference for the mixed PER-Momentum strategy, the optimal allocation outcome under the common currency base is that which arises from the BTM-GPA strategy.

An important implication of this analysis for active management purposes is that the best performing portfolios in US dollars are related but not equal to those reported under the local currency metric. This is somehow expected as when the investor selects a foreign currency denominated stock he remains exposed to the stock price fundamental as well as to currency risk.

Table 4 summarizes relative performance of local and USD portfolios. The decrease in performance as measured by Sharpe Ratio changes ranges from 36% (momentum) and 41,7% (BTM-GPA). This illustrates that currency considerations are highly important for portfolio management purposes.

The discrepancies in the preferred allocation criteria between local and common currency based portfolios are further analyzed within the next section, where we address explicitly the effects of the introduction of the common European currency in January 2002.

3.2.2. The 2002 Effect

The introduction of the Euro in January 2002 constituted one of the major political and financial events of the past century. The existence of a common currency in the Eurozone has led to the elimination of currency related risk and probably a reduction in risk aversion.

This has affected the investment decisions of European based companies, as well as the information impounded in their balance sheets and income statements, making those homogeneous and comparable among peers.

In what follows we address explicitly the effects of the introduction of the Euro by illustrating in Figure 3 the evolution of our top performing pure and mixed portfolios in local (a) and USD (b), along with the Benchmark, under a scenario where investment strategies are placed on the 1st of January of 2002. Results are reported in Table 5.

Figure 3: Evolution of Best Performing Portfolios (2002-2016)

(a) Local (b) USD

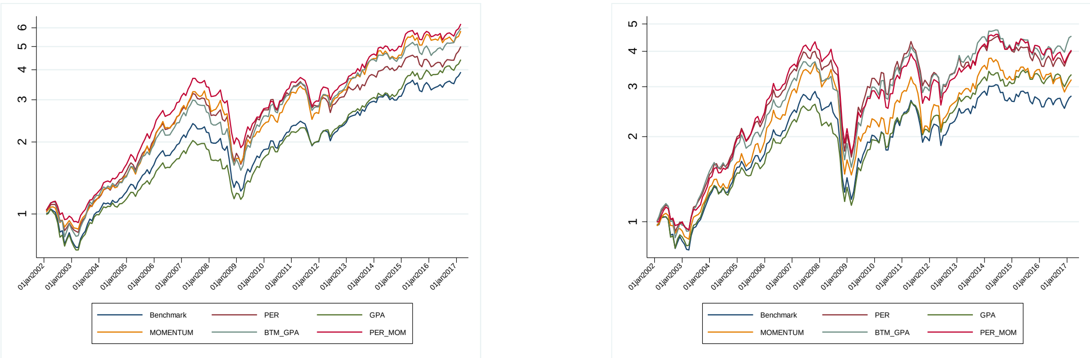


Fig 4 depicts cummulative returns of a sdandardized measure of final performance that takes the value of 1 at the start of the investment period for Tier 1 portfolios generated according to pure and mixed strategies. Results are presented in local currency and US dollars.

Figure 4(a) shows results obtained under the 2002-2016 sample period are consistent with those obtained in our full sample analysis. [15] There is only one important difference which is observed in the quality-based (GPA) portfolio, which only over-performs the market Benchmark since 2015 (in local currency) and 2011 (in US dollars). While the Benchmark portfolio multiplied its value by around 4 times, both value and momentum pure portfolios rose by a 6 fold therefore systematically beating the market Benchmark. Also, as reported for the full sample period, the best performing portfolios are those based on mixed selection strategies, with the value-momentum criterion (PER-MOM) yielding the best performance, among all considered indicators, over the 2002-2007 and 2012-2016 sample periods.

The systematic outperformance of these portfolios over the market Benchmark is further illustrated when comparing the results presented in Table 5 with those presented in Tables 2 and 3. Since 2002, the annual returns of the winning portfolios and the Benchmark outperform full sample estimates by 75% irrespective of the currency measurement applied. Such increase in annual return averages is not paired with an equivalent increase in volatility. Over the full

[15] These portfolios are the top performing pure and mixed portfolios for the full sample period (1991-2017) but not necessarily for the period between 2002 and 2017. The key ratios for all the pure and mixed portfolios are available upon request from the authors.

sample period, the volatility of the Benchmark measured in local (US dollars) currency increased 18% (39%) while the average volatility increase in the Tier 1 portfolio was 12% (26%). This therefore quantifies the reduction in volatility and overall risk that emerged in the European stock universe brought by the introduction of the Euro.

Table 5: Returns and Standard Deviations of Best Portfolios (2002-2016)

	Benchmark	PER	GPA	MOM	BTM_GPA	PER_MOM
Annualized Compounded Return (Local)	17.38%	21.49%	21.24%	22.34%	23.10%	23.95%
Annualized Compounded Return (USD)	10.64%	14.14%	15.06%	13.07%	15.53%	15.20%
Annualized Compounded Return (Mean, Local)	11.98%	15.95%	14.54%	15.91%	16.28%	17.59%
Annualized Compounded Return (Mean, USD)	8.06%	11.24%	11.26%	10.52%	11.57%	12.19%
Annualized Compounded Return (Std. Dev., Local)	16.77%	19.16%	19.02%	21.41%	21.10%	21.38%
Annualized Compounded Return (Std. Dev., USD)	13.49%	17.01%	15.41%	15.67%	17.60%	17.54%
Mean-Volatility Ratio (Local)	0.714	0.833	0.764	0.743	0.772	0.823
Mean-Volatility Ratio (USD)	0.598	0.661	0.731	0.671	0.657	0.695

This table reports Annualized Compounded returns, standard deviations and mean-volatility ratios for the different portfolios over the 2002-2017 period. Portfolios are rebalanced on a yearly basis and strategies are performed out of sample.

The analysis also suggests that there is robustness in the performance of the proposed stock selection procedure. The results reported in terms of annualized compounded returns demonstrate prevalence in the outperformance of value-momentum (PER-MOM) mixed criterion under the common US currency measure, and the prevalence of the value-quality (BTM-GPA) mix under the local currency measurement.

Fig 1 in Appendix C presents the evolution of Jensen's Alpha under the local currency measurement. This illustrates positive excess returns arising in all strategies. Overall, while the first subsample (1991- 2002 period) is characterized by the lack of statistical significance in the reported alpha, for all but the PER-MOM, GPA and Momentum strategies, the statistical significance is increased over the second sample period, where the reported alpha becomes positive and statistically significant. It is however observed that around the same date, estimated alphas, for GPA and Momentum strategies, became insignificant signaling weaker performance for those investment criteria. This evidence does, therefore, suggest that the introduction of the euro led to a structural break that affected global risk and the performance of the proposed investment criteria. The active portfolio manager should rebalance investment strategies accordingly.

3.3. Conditional rankings

In this section we analyze portfolio performance when quality and momentum criteria are used iteratively, in the stock selection process. This further discriminates between the cheapest stocks according to BTM and PER criteria. In what follows, we report results under the local currency measure.

Fig 4a depicts portfolio performance when a quality factor is applied through a conditional ranking for value companies. The procedure used to form these portfolios is described as follows: we select the top 20% companies (120 stocks) using BTM. Then the upper and lower 10% (60 stocks each) are selected by GPA. Fig 4(b) presents the results iterative value and qualitative rankings with an additional momentum based filter. We therefore split the best performer portfolio in 4(a) into the upper and lower 5% (30 stocks each) by momentum.

Figure 5: Conditional on GPA and Momentum TIER 1 BTM portfolios

(a) BTM|GPA (b) BTM|GPA|MOM

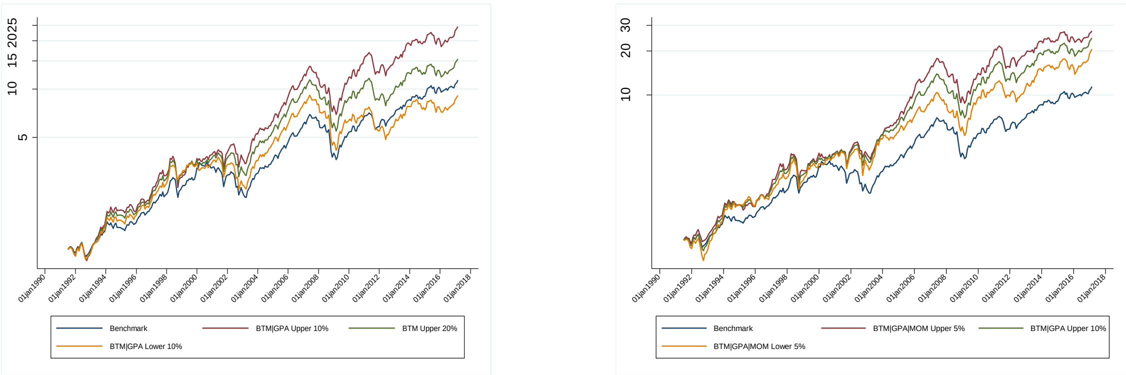


Fig 5 depicts cummulative returns of a sdandardized measure of final performance that takes the value of 1 at the start of the investment period for conditional BTM portfolios.

Fig 4(a) shows that while the Tier 1 BTM selected portfolio obtained in previous section, increased its value by 15 fold when additional 50% filtering by GPA is applied, an improvement in returns of roughly 61% is achieved. As described in fig 4(a) the best resulting portfolio multiplied its value by a 25 fold while the portfolio composed by the worst profitable companies multiplied its value by a 9-fold.

Fig 4(b) [16] shows that applying a momentum-based criterion to a value-then-quality selected portfolio can further increase returns. For the BTM|GPA portfolio considered, applying this additional filter leads to 10% increase in the final value of the best portfolio. Complete performance results, available upon request, demonstrate that similar improvements in terms of returns are achieved when applying conditional rankings regardless of the metric used to define value and profitability.

Following the results in the previous section, where PER-Momentum and BTM-GPA are the best performing mixed portfolios, we apply to these strategies the iterative selection procedure. Table 6 provides summary statistics of the best portfolios generated combining PER

[16] Note that 30 stocks is the minimum size required to guarantee portfolio diversification.

and BTM value portfolios with each quality and momentum metric. Results show that, on average, conditional portfolios present an increase in annualized returns of 242 (234) bps over their corresponding pure BTM (PER) portfolios when the full sample period is considered.

Table 6: BTM and PER, profitability and momentum Conditional Tier 1 Portfolios in local currency

	Benchmark	BTM|GPA	BTM|ROC_G	BTM|ROC_D	BTM|MOM	PER|GPA	PER|ROC_G	PER|ROC_D	PER|MOM
Annualized Compounded Return (Final)	9.93%	13.77%	13.93%	13.35%	13.50%	13.66%	14.22%	15.56%	14.68%
Annualized Compounded Return (Mean)	5.24%	7.80%	7.64%	7.63%	7.62%	7.28%	8.30%	8.96%	7.92%
Annualized compunded Return Volatility	14.16%	21.37%	20.68%	20.43%	19.65%	20.44%	21.50%	23.52%	22.95%
Sharpe Ratio	0.482	0.624	0.703	0.651	0.620	0.665	0.717	0.783	0.707
Sortino Ratio	0.603	0.866	0.966	0.887	0.869	0.908	0.960	1.029	0.980
CAPM Beta		110.00%	90.50%	93.40%	105.60%	97.60%	89.70%	89.50%	98.10%
CAPM Beta (Std. Dev.)		37.20%	42.00%	44.40%	37.20%	40.80%	45.60%	48.00%	44.40%
Jensen's Alpha		3.20%	4.34%	3.72%	3.22%	3.71%	4.68%	5.90%	4.66%
Jensen's Alpha (Std. Dev.)		1.36%	1.43%	1.54%	1.44%	1.37%	1.57%	1.68%	1.58%

This table reports average annualized returns, standard deviations, Sharpe and Sortino Ratios and Jensen's Alphas for the different conditional portfolios formed on the basis of value, quality and momentum criteria over the 1991-2017 period. Portfolios are rebalanced on a yearly basis and strategies are performed out of sample.

Note that the figures reported for Sharpe and Sortino ratios present average improvements of 42% and 55% with respect to their pure counterparts. That improvement in risk remuneration is not, however, homogeneous across value metrics. While the average improvement for PER portfolios amounts to a 49%, the BTM portfolios improve in lesser extent, 34%. The reported increase in returns is therefore significantly higher than the reported increase in volatility.

The reported Jensen's alpha for conditional portfolios is significant in all cases, and ranges from 324 and 600 bps. These numbers imply positive outperformance when compared to those reported in Table 2 where excess returns for pure and mixed portfolios ranged between 224 and 366 bps. Conditional portfolios lead then to excess return improvements. This is coupled with leverage (CAPM beta) coefficients significantly lower than those presented in Table 2.

The results presented in table 6 also show that there is prevalence in performance under the iterative use of PER, ROC_D and Momentum criteria. The portfolio selected under that criterion increased its value by 41 times over the sample period. The outperformance observed under the ROC_D iterative portfolios highlights the importance of including intangibles in the ROC_D measure, an observation that was not previously documented in the literature. Figure 2 in appendix C depicts the evolution of Jensen's alpha for the 8 iterative portfolios. This shows that the selected criteria render significant and stable excess returns only after 2002, (with the exception of PER-ROC_D-Mom based portfolios). As discussed in the previous section, this highlights the existence of a structural change following the introduction of the Euro that lead to a reduction in European equity risk.

Interestingly, under the PER-ROC_D-Mom based criteria, the estimated alpha becomes significant in 1996, prior to the dot-com bubble and remains significant over the whole sample period. Moreover, the capacity of PER-ROC_D-Mom criteria to exhibit excess returns decays over time. That is in line with prior literature findings based on the US market (Calluzzo et al., 2015; McLean and Pontiff, 2016) where it is shown that the capacity of factor investing to extract returns decayed after the academic publication of relevant studies including such factors.

3.3.1 The impact of using the US dollar as a common currency for returns

We address the impact of currency risk by calculating the performance of iterative portfolios with returns measured under the common dollar based measurement.

Table 7: BTM and PER, profitability and momentum Conditional Tier 1 Portfolios in US Dollars

	Benchmark	BTM|GPA	BTM|ROC_G	BTM|ROC_D	BTM|MOM	PER|GPA	PER|ROC_G	PER|ROC_D	PER|MOM
Annualized Compounded Return (Final)	6.15%	8.15%	7.25%	7.31%	6.51%	9.34%	8.84%	9.80%	9.86%
Annualized Compounded Return (Mean)	3.65%	4.86%	4.51%	4.66%	3.96%	4.69%	5.03%	5.58%	5.59%
Annualized compunded Return Volatility	9.70%	15.71%	12.30%	13.28%	12.06%	16.94%	15.47%	17.65%	17.59%
Sharpe Ratio	0.236	0.32	0.28	0.28	0.25	0.38	0.36	0.41	0.39
Sortino Ratio	0.308	0.46	0.42	0.41	0.36	0.52	0.49	0.54	0.55
CAPM Beta		109.30%	95.50%	98.90%	108.70%	102.20%	97.90%	96.80%	107.50%
CAPM Beta (Std. Dev.)		30.23%	33.87%	32.83%	28.66%	26.58%	31.79%	33.35%	31.27%
Jensen's Alpha		2.16%	1.50%	1.55%	0.64%	3.25%	2.94%	3.86%	3.74%
Jensen's Alpha (Std. Dev.)		1.74%	1.82%	1.88%	1.75%	1.58%	1.80%	1.88%	1.72%

This table reports average annualized returns, standard deviations, Sharpe and Sortino Ratios and Jensen's Alphas, in US dollars, for the different conditional portfolios formed on the basis of value, quality and momentum criteria over the 1991-2017 period. Portfolios are rebalanced on a yearly basis and strategies are performed out of sample.

Our results show that while currency risks distorted the selection of the preferred selection criterion when pure and mixed portfolios were considered, that is not the case for conditional portfolios as the successive use of PER, ROC_D and Momentum is presented as the preferred allocation mechanism under the tier 1 portfolios

The portfolio generated according to the underlined criteria increased its value by 11 times over the sample period. This is equivalent to a 30% improvement with respect to the best mixed portfolio. Moreover, the improvement in excess returns is similar to that presented for local currency portfolios and amounts to 100 bps (or 50%). Active management strategies should therefore give priority to iterative PER, ROC_D and Momentum strategies.

3.4. Results for Z-score regressions

In what follows, we quantify the contribution of each of the investment value, quality and momentum factors to portfolio outperformance. We report results in local and USD currencies, and consider the effects of the 2002 structural break by analyzing two subsamples as well as the whole sample period.

Table 8: Z-score analysis for the full sample, 1991-2001 and 2002-2016 periods both in local currency and US dollars

	Local (full period)		Local (1991-2001)	Local (2002-2016)	USD (full period)		USD (1991-2001)	USD (2002-2016)
Variable	*R_Port-R_BMK*	*R_Port-RF*	*R_Port-RF*	*R_Port-RF*	*R_Port-R_BMK*	*R_Port-RF*	*R_Port-RF*	*R_Port-RF*
Z_BTM	0.0352***	0.0330***	0.0322***	0.0314***	0.0292***	0.0279***	0.0254***	0.0341***
	(0.0004)	(0.0004)	(0.0006)	(0.0006)	(0.0004)	(0.0005)	(0.0007)	(0.0007)
Z_PER	-0.0140***	-0.0119***	-0.0250***	-0.0057***	0.0247***	0.0272***	0.0531***	0.0037***
	(0.0011)	(0.0011)	(0.0024)	(0.0011)	(0.0012)	(0.0012)	(0.0021)	(0.0012)
Z_EVEBIT	-0.0135***	-0.0102***	-0.0276***	-0.0134***	0.0054***	0.0071***	-0.0005	0.0014
	(0.0010)	(0.0010)	(0.0019)	(0.0011)	(0.0010)	(0.0010)	(0.0018)	(0.0013)
Z_EVEBITDA	-0.0316***	-0.0277***	0.0069***	-0.0352***	-0.0776***	-0.0721***	-0.0970***	-0.0458***
	(0.0009)	(0.0009)	(0.0023)	(0.0014)	(0.0016)	(0.0015)	(0.0023)	(0.0016)
Z_GPA	0.0178***	0.0165***	0.0222***	0.0183***	0.0283***	0.0268***	0.0329***	0.0290***
	(0.0004)	(0.0004)	(0.0007)	(0.0005)	(0.0004)	(0.0005)	(0.0008)	(0.0006)
Z_ROC_G	0.0269***	0.0258***	0.1376***	-0.0414***	0.0217***	0.0196***	0.1080***	-0.0345***
	(0.0010)	(0.0010)	(0.0028)	(0.0010)	(0.0010)	(0.0010)	(0.0026)	(0.0011)
Z_ROC_D	0.0156***	0.0130***	-0.0665***	0.0160***	0.0045***	0.0035***	-0.0520***	0.0080***
	(0.0007)	(0.0006)	(0.0021)	(0.0007)	(0.0011)	(0.0011)	(0.0025)	(0.0010)
Z_MOMENTUM	0.0361***	0.0346***	0.0234***	0.0375***	0.0300***	0.0286***	0.0312***	0.0250***
	(0.0004)	(0.0004)	(0.0007)	(0.0005)	(0.0004)	(0.0004)	(0.0006)	(0.0005)
R_BMK-RF (upper 5% portfolio)		-0.0134**	-0.0053	-0.0125**		0.0019	-0.0925***	0.0318***
		(0.0053)	(0.0165)	(0.0055)		(0.0051)	(-0.0123)	(0.0055)
R_BMK-RF (upper 10% to 35% portfolios)		-0.0030	-0.0398	0.0070***		0.0096***	-0.0326***	0.0261***
		(0.0025)	-0.0088	(0.0024)		(0.0023)	(0.0059)	(0.0026)
R_BMK-RF (mid 30% to 65% portfolios)		0.974***	0.9181***	0.9864***		0.9754**	0.9586***	0.9750***
		(0.0017)	(-0.0055)	(0.0015)		(0.0015)	(0.0035)	(0.0016)
R_BMK-RF (lower 30% portfolios)		0.0928***	0.3154***	0.0405***		0.0721***	0.1859***	0.0518***
		(0.0027)	(0.0085)	(0.0027)		(0.0026)	(0.0054)	(0.0030)
Alpha Increase (upper 5% portfolio)		0.0048***	0.0252***	-0.0043***		-0.0092***	-0.0182***	-0.0054***
		(0.0009)	(0.0014)	(0.0010)		(0.0007)	(0.0012)	(0.0011)
Alpha Increase (upper 10% to 35% portfolios)		-0.0024***	0.0069***	-0.0063***		-0.0024***	0.0016***	-0.0072***
		(0.0004)	(0.0007)	(0.0005)		(0.0004)	(0.0006)	(0.0005)
Alpha (mid 30% to 65%)	0	0.0051***	-0.0005	0.0092***	0	0.0060***	-0.0008**	0.0112***
	(0.0001)	(0.0002)	(0.0005)	(0.0003)	(0.0001)	(0.0002)	(0.0004)	(0.0003)
Alpha Increase (lower 30% portfolios)		-0.0155***	-0.0096***	-0.0236***		-0.0159***	0.0041***	-0.0292***
		(0.0004)	(0.0008)	(0.0006)		(0.0005)	(0.0007)	(0.0006)
R-sq: within	0.0346	0.7911	0.5978	0.8894	0.0357	0.8259	0.6828	0.8963
R-sq: between	0.6781	0.6997	0.5684	0.523	0.5714	0.6068	0.5204	0.4698
R-sq: overall	0.0768	0.7897	0.5964	0.8838	0.704	0.8232	0.6773	0.8898

This table reports Generalized Least Squares Random Effects panel data factor augmented CAPM estimates, over the 1991-2017 period. Z_"YYY" denotes Z-score for the "YYY" pure metric. R_BMK-RF and R_Port-RF denote respectively benchmark and portfolio excess returns. Clustered Robust standard errors in parenthesis. *** Significant at 99.9%. ** Significant at 99%. * Significant at 95%

Columns 1 and 5 present results when Z-scores are considered solely to explain the differences between portfolio and Benchmark returns, while remaining columns focus on the analysis of excess returns, as characterized by the CAPM equation.

Consequently, column 1 shows estimated coefficients reflecting impact of each single metric Z-score on returns against the Benchmark under the local currency measurement. Reported coefficients exhibit the expected sign so that one standard deviation from sample average values for BTM, GPA, ROC_G, ROC_D and Momentum Z-scores leads to improvements in returns, while the same variation in PER, EV/EBIT and EV/EBITDA Z-scores exhibit a negative effect on performance. [17] Column 5 in table 8, presents further evidence supporting the existence of a distorting effect arising from currency risks. Currency risks have the effect of inverting the relation between portfolio returns and PER as well as EV/EBIT Z-scores. The result is that one standard deviation increase from average values leads to higher returns when those are computed under a common currency basis.

Columns 2, 3, 4, 6, 7 and 8 results from estimating the extended CAPM equation (2) which relates excess returns and each of the analyzed Z. The first panel presents beta coefficient estimates corresponding to the relationship between excess returns and factor Z-scores for different subsamples and two currency metrics. We find significant differences in the estimated coefficients for the pre- and post-Euro periods as presented in Columns 3 and 4. We also find significant discrepancies in the relationship between benchmark excess returns and the conditional portfolios under different tiers as reported by the CAPM alpha estimates in panels 2, 3, and 4. For example, prior to the introduction of the Euro, a one standard deviation in the EV/EBITDA Z-score increased excess returns in 69 bps, while upper 5% portfolios exhibited excess returns 252 bps higher than those of the benchmark. After the introduction of the Euro the same increase in the EV/EBITDA Z-score leads to a reduction in excess returns of 352 bps and a reduction of excess returns in the top tier portfolio of 49 bps.

Results therefore suggest that the influence of different factor metrics on portfolio performance significantly changes over time. In fact, we demonstrate that the 2002 introduction of the euro played a determinant role in profitability determination. This has important implications for portfolio management purposes and may explain why some active portfolio management strategies may not currently be as profitable as the used to.

[17] Contrarily to BTM, the lower the PER, EV/EBIT and EV/EBITDA ratios (as long as they are not negative), the cheaper the stock.

4. Conclusions

In this paper we analyze whether systematic active portfolio management strategies based on factor investing criteria have been profitable over the past 26 years in Europe. The purpose is to quantify the extent to which long term factor strategies remain profitable during important shifts in the political and economic environment. In doing this, we also address whether the currently observed decrease in active management profitability can be explained by a decay of the performance in traditional management practices.

We propose a novel factor based approach to long term investing which involves a simultaneous combination of value, quality and momentum metrics. Applied to a long span of European equity data, we show that the proposed strategies consistently beat the market benchmark. Different metrics are used to measure the proposed factors. We show that these are robust when the investment universe is split in quintiles so that the order of delivered performance is consistent with the imposed quintile structure.

We demonstrate that risk-adjusted returns achieved by individual factors can be improved by the combination of factors into single portfolios. Top performing mixed portfolios, composed of two different factors (value + profitability/momentum), deliver significant premium in both in terms of annualized compound returns and risk-adjusted returns. We also show how the investor can iteratively combine profitability and momentum factors in top quintile value portfolios to increasingly improve the risk-adjusted returns of those portfolios. Those portfolios that incorporate the three factors iteratively (value first, profitability second and momentum third) are able to outperform mixed and single portfolios. This result is robust regardless the metric used to define the factors (excluding BTM).

We further contribute by quantifying currency risk and demonstrating that it is an important risk source to be considered when using factor investing in Europe. Our results demonstrate that portfolio performance is highly influenced by currency considerations. Thus, returns reported under local currency portfolios are consistently higher than those reported under a common US dollar measure for the period considered. The implication for portfolio management is that performance under smart stock selection is strongly conditioned by the applied currency measure. While mixed strategies based on value-quality and value-momentum selection variables are preferred when currency risks are absent, pure quality strategies outperform when those risks are significant. Iterative portfolios are however robust to currency consideration

We further show that all single, mixed and iterative strategies are strongly affected by the introduction of the euro which leads to a structural break characterized by lower risk and improved portfolio performance.

Important lines of future research include the use of z-score regressions to optimize portfolio creation and the improvement of factor investment strategies by early detection of market downturns through the use of macro variables and trend-following techniques.

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Appendix A

Table 1: Companies by Sector and Year

	Year																											
Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Commercial Services	25	25	18	19	20	17	16	16	23	27	32	32	35	34	31	33	29	27	28	26	25	25	27	27	31	32	29	709
Communications	11	11	10	11	13	13	18	21	26	30	37	35	35	33	35	32	31	31	32	32	32	31	31	28	31	34	32	716
Consumer Durables	30	32	30	31	32	34	30	27	26	24	20	25	27	29	31	31	29	30	21	25	23	26	29	31	32	35	33	773
Consumer Non-Durables	66	60	62	60	53	54	55	57	56	52	47	57	58	61	58	59	57	53	51	51	50	47	51	50	50	50	53	1478
Consumer Services	36	34	38	42	40	40	42	45	52	56	62	59	52	54	55	56	59	52	42	38	38	38	36	40	41	42	40	1229
Distribution Services	19	19	19	19	16	15	15	13	11	12	14	11	12	11	12	10	10	9	5	6	8	7	9	9	8	9	9	317
Electronic Technology	26	24	25	25	26	23	25	21	25	27	37	30	27	23	28	23	25	23	20	26	24	25	30	28	27	32	30	705
Energy Minerals	18	18	16	15	14	16	19	22	19	16	13	16	15	19	17	24	28	29	35	36	33	31	34	32	27	22	22	606
Health Services			2	1	1	3	3	4	3	4	4	4	4	4	4	4	6	3	3	4	4	4	5	5	6	5	6	96
Health Technology	22	23	27	30	24	24	27	27	26	28	35	36	38	39	38	38	35	41	38	43	38	37	37	40	41	41	47	920
Industrial Services	34	31	31	30	32	29	25	31	31	27	20	25	26	26	25	33	37	39	49	44	44	44	46	41	40	37	30	907
Miscellaneous																						1						1
Non-Energy Minerals	40	40	36	34	38	37	37	38	35	36	29	32	34	31	35	35	36	40	47	40	45	49	41	34	30	26	26	981
Process Industries	73	73	68	62	69	72	67	59	55	45	39	34	41	37	34	33	34	32	33	35	40	38	42	49	43	42	40	1289
Producer Manufacturing	94	86	86	78	76	78	72	73	67	58	52	54	52	53	52	46	56	62	63	60	61	61	52	58	65	63	70	1748
Retail Trade	45	45	51	55	52	52	58	57	49	52	45	44	49	47	45	38	33	33	30	30	33	34	32	38	40	41	39	1167
Technology Services	9	7	6	8	7	6	14	16	21	27	41	26	17	16	20	17	13	13	13	17	17	16	18	17	15	16	24	437
Transportation	18	23	24	23	20	22	19	21	25	25	23	30	30	32	31	37	31	33	38	32	31	32	33	29	30	34	32	758
Utilities	34	49	51	57	67	65	58	52	50	54	50	50	48	51	49	51	51	50	52	55	54	54	47	44	43	39	38	1363
Total	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	16200

This table describes the year over year evolution in the total number of companies included in each industrial sector over the 1990-2016 period.

Table 2: Data by Year and Country of Origin

	Year																											
Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
AUSTRIA	9	8	5	5	7	7	7	7	7	7	5	6	7	9	7	10	10	9	14	12	12	11	11	10	10	9	12	233
BELGIUM	20	18	15	16	19	18	18	17	16	19	14	12	15	13	14	13	14	14	12	13	12	13	13	14	14	14	18	408
CROATIA																			1	2	2	2	2	1	1	1	1	13
CYPRUS																	1				1	1	3	3				9
CZECH REPUBLIC									1	3	3	2	2	3	3	4	3	3	3	2	2	3	4	2	2	1	2	48
DENMARK	13	11	10	10	14	13	11	11	11	14	12	13	14	13	14	17	15	17	15	15	17	15	14	15	19	19	22	384
FINLAND	15	9	7	12	15	16	17	21	22	17	15	16	19	17	22	22	20	20	19	20	21	21	17	18	17	16	16	467
FRANCE	102	93	94	94	95	95	90	92	91	86	83	88	85	80	81	81	83	81	82	82	81	83	80	84	92	88	88	2354
GERMANY	83	91	87	86	91	86	78	74	78	77	80	73	73	75	70	68	70	72	74	79	72	76	77	81	77	72	84	2104
GIBRALTAR																	1											1
GREECE	1		1			1	1	4	5	7	9	8	12	11	11	9	11	10	11	12	7	5	3	3	6	2	2	152
HUNGARY							1	2	3	2	3	3	3	3	3	3	3	3	2	3	3	3	3	2	2	2	2	54
ICELAND														1	1	1	1	1										5
IRELAND	3	5	5	6	3	6	5	8	9	6	6	10	8	8	9	11	11	13	10	8	10	11	9	12	11	12	11	226
ITALY	42	34	30	31	28	24	22	20	33	33	39	41	37	42	37	39	35	39	33	35	29	29	25	27	30	30	31	875
KAZAKHSTAN																		1	1	1	1	1	1	1	1	1	1	10
LUXEMBOURG		1	1	1	1	1	1	1	1	2	2	4	3	5	7	7	6	6	6	5	5	6	7	8	8	8	8	111
MALTA																											1	1
NETHERLANDS	33	31	31	30	29	32	34	36	34	33	37	32	28	24	26	30	33	31	27	25	24	26	26	24	25	25	25	791
NORWAY	15	8	8	5	8	12	10	14	12	9	8	7	10	7	9	14	14	13	16	12	13	14	15	14	10	9	10	296
POLAND										2	3	3	2	3	4	4	4	5	7	8	9	11	13	12	10	9	6	115
PORTUGAL	5	2		1	2	5	5	7	8	8	10	8	8	8	8	8	7	8	8	9	9	8	7	7	8	6	4	174
ROMANIA																		2	1	1	1	1	1	1	2	2	2	14
SLOVENIA															1	1	1	2	2	2	1	1	1	1	1	1	1	16
SPAIN	33	34	27	25	26	24	22	27	35	35	31	37	40	41	39	41	37	43	42	40	33	32	29	28	34	34	31	900
SWEDEN	17	22	25	25	27	28	36	38	35	30	27	31	28	28	28	27	33	31	27	30	33	32	33	35	37	38	43	824
SWITZERLAND	36	36	33	31	34	39	35	31	31	35	41	41	45	41	43	40	41	43	45	42	46	50	44	42	42	44	47	1078
TURKEY						2	1	4	4	3	10	7	5	10	8	10	10	11	12	15	22	20	20	22	16	18	17	247
UKRAINE																			8	3	9	4	2	3				29
UNITED KINGDOM	173	197	221	222	201	191	206	186	164	172	162	158	156	158	155	140	136	122	122	124	125	121	140	130	125	139	115	4261
Total	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	16200

This table describes the year over year evolution in the total number of companies included in our sample by country of origin over the 1990-2016 period.

Appendix B: Definitions

$$Book\ to\ Market = \frac{Total\ Equity + Tax\ Deferred\ Assets - Preferred\ Stocks}{Market\ Value\ of\ Equity}$$

$$PER = \frac{Market\ Value\ of\ Equity}{Net\ Income}$$

$$Enterprise\ Value = Market\ Value\ Of\ Equity + Total\ Financial\ Debt + Minoritary\ Interests + Preferred\ Stock + Pension\ Fund\ Deficit\ - Cash\ and\ equivalents$$

$$EV/EBIT = \frac{Enterprise\ Value}{EBIT}$$

$$EV/EBITDA = \frac{Enterprise\ Value}{EBITDA}$$

$$Working\ Capital = Net\ Account\ Receivables - Net\ Account\ Payables + Total\ Inventories$$

$$GPA = \frac{Net\ Sales - Cost\ of\ Goods\ Sold}{Total\ Assets}$$

$$ROC\_Greenblatt\ = \frac{EBIT}{Working\ Capital + Net\ Plant\ Property\ and\ Equipment}$$

$$ROC\_Detailed\ = \frac{EBIT}{Working\ Capital + Net\ Plant\ Property\ and\ Equipment + Intangible\ Assets}$$

Appendix C

Figure 1c: Evolution of Annualized Jensen's Alpha

(a) PER

(b) GPA

(c) PER_MOM

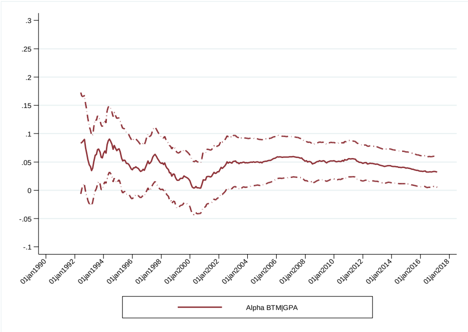
(d) BTM_GPA

(e) Momentum

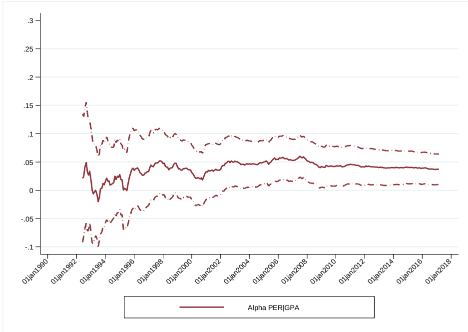
Fig 1c depicts the evolution of annualized Jensen's alpha and benchmark index over the 1991-2016 period for best in class portfolios computed in domestic currency.

Figure 2c: Evolution of Conditional Portfolios Jensen's Alpha

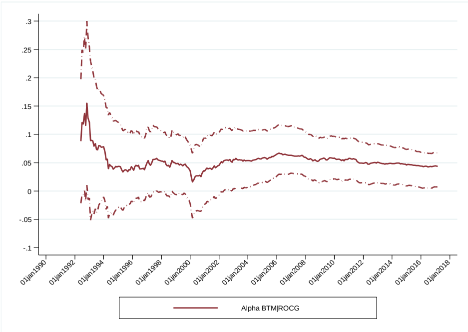
(a) BTM GPA



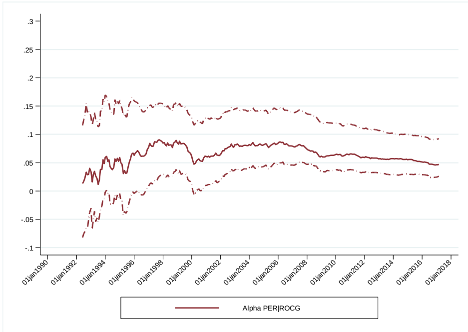
(b) PER GPA



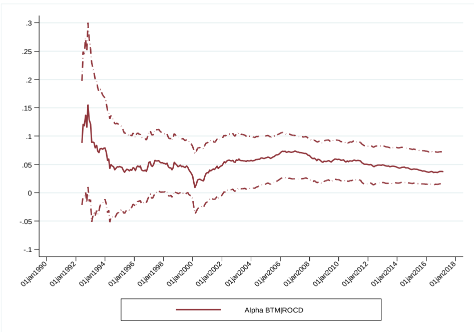
(c) BTM ROC_G



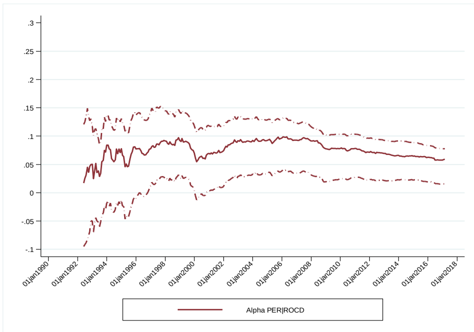
(d) PER ROC_G



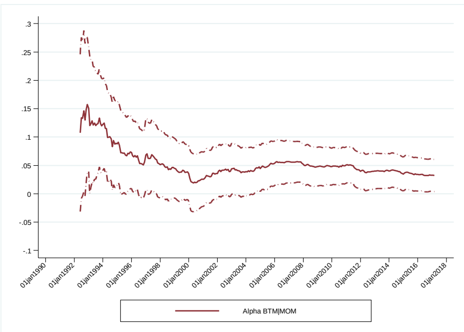
(e) BTM ROC_D



(f) PER ROC_D



(g) BTM MOM



(h) PER MOM

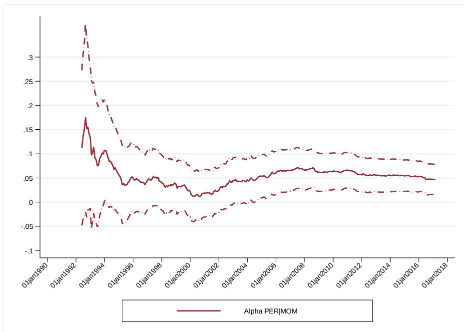


Fig 2c depicts the evolution of annualized Jensen's alpha for BTM and PER conditional portfolios computed in domestic currency over the 1991-2016 period for best in class portfolios.