EVIDENCE ON SIZE, VALUE, OPERATING PROFITABILITY AND INVESTMENT IN THE FRENCH MARKET

Marc DESBAN[a]
[a] *University Paris-Est, IRG (EA 2354)*
E-mail: marc.desban@u-pec.fr

Souad LAJILI JARJIR[b]
[b] *University Paris-Est, IRG (EA 2354)*
E-mail: souad.lajili-jarjir@u-pec.fr

Revised January 2017

Abstract. Unlike U.S. firms, French companies with high asset growth rates outperform more conservative ones. There is evidence on *value, operating profitability, investment* and a remarkable *size* effect on the French market from January 1990 to July 2016. Like Fama and French (2016), small stock returns remain harder to explain whatever the model used. The *size* factor seems redundant in the data. An alternative orthogonal five-factor model specifically designed for the French market better describes stock returns than previous asset pricing models. We bring some insights on the French specificities through a large sample comprising 1,163 firms such as the lower volatility of the small caps.

Introduction

The relation between the expected rate of return of an asset and its risk dates back sixty years but remains one of the most fundamental assumptions made in finance. Following the seminal work by Markowitz (1952) [39], finance knows a substantial development since the outbreak of the first Capital Asset Pricing Model presented by Sharpe (1964) [47]. The CAPM proposes to compute the sensitivity of an asset's returns relatively to its systematic risk, measured by its *beta*. The model becomes known widely, Bruner et al. (1998) [12] report that the "*CAPM is currently the preferred model for estimating the cost of equity*" (p.26). Despite this success, a large body of research criticizes the single factor model, unsatisfying to explain securities past returns as it relies on an unobservable market portfolio (Roll, 1977 [45]). A few years later, Levy and Roll (2010) [37] attests that [...] "*many conventional market proxies could be perfectly consistent with the CAPM and useful for estimating expected returns.*" (p.2464). Numerous works and studies underline some unexpected results assuming additional risk factors to be relevant. Without being exhaustive, Basu (1977) [8], Banz (1981) [6], Fama and French (1992) [21], Novy-Marx (2013) [42] and Aharoni *et al.* (2013) [1] respectively show that average returns also covary with *earnings-to-price, market capitalization, book-to-market, profitability* and *investment* even after controlling market betas. Fama and French (1993) [22] propose a three-factor model by integrating both *value* and *size*

Key words and phrases. Asset Pricing, Size effect, Value premium, Risk factors, Three factor Model, Five factor Model and Market anomalies. JEL classification: G12 .

effects to the original CAPM to summarize the cross section of average stock returns. Notwithstanding this, their three-factor model fails to explain a growing number of market *anomalies* (Aharoni *et al.* 2013 [1] ; Novy-Marx, 2013 [42]). A large body of accounting research reports several relations between accounting information and stock returns. With the benefit of hindsight, they only explains a weak proportion of the variation in stock returns. For instance, Lev (1989) shows that earnings is not able to explain more than 10% of the variation in stock returns and call into question their usefulness for investors. Other researchers remain careful about *anomalies* and question the robustness of their relations with returns arguing that they might result in extensive *data-snooping* (Black, 1993 [10] and Mackinlay, 1995 [38]). Barber and Lyon (1997) [7], corroborate the relations described by Fama and French on the U.S. market from July 1973 to December 1994 on financial firms. They also point out that *size* and *book-to-market* premiums are neither explained by *selection biases* nor *data-snooping*. It is therefore considered in the light of the overall financial observations that previous asset pricing models fail to fully explain stock returns. Paradoxically, research in finance have "[...]*more questions and empirical puzzles than at the start of its modern development*" (Merton, 1987 [40], p.483).

In this paper, we investigate the ability of an orthogonal five-factor to describe average stock returns on the French market from January 1990 to July 2016. Our model relies on investment-based asset pricing (Aharoni *et al.* 2013 [1]) and on profitability-based approach of Novy-Marx (2013) [42]. To evaluate its performance, we start with a wide sample of 1,163 French firms. We investigate the persistence of four market anomalies through 66 different strategies. We seek to identify if they produce abnormal returns even after using our alternative pricing model.

Our paper contributes another piece to the puzzle bringing new hindsights on the French market. First, our findings shed lights on the determinants of French stock returns. We show that conversely to the U.S. market, firms with high asset growth rates outperform more conservatives ones. Moreover, stocks with high *operating profitability* ratios have on average higher returns than firms with weak ratios. Finding persistent abnormal returns related to new market anomalies leads us to challenge current pricing models and to propose innovative alternatives. Second, we reconcile conflicting evidence from former research on the relation between size and stock returns (Dichev, 1998 [19]). Our results suggest that *size* is the main determinant of stock returns after the systematic risk. Third, Fama and French (2012) [24] run tests on an international sample and report that local models outperform global ones. Their definition of "*local*" is scaled at a European level while we work at a country level constituting another originality. As such, our study joins the expanding financial literature that looks at international evidence for different forms of stock return initially documented on the U.S. market.

This paper proceeds as follows: Section I gives a theoretical background of the pricing models. Section II introduces the data sets used and the applied methodology. Section III summaries results of empirical tests and section IV presents conclusions.

1. Literature review

Creating an asset pricing model fully describing stocks returns will probably stay one of the hardest challenges in finance. The huge body of the empirical work on the Capital Asset Pricing Model remains usually inconclusive and fails to rationalize market anomalies not explained by the plain vanilla CAPM (since there are several versions). Among all the critics, the most celebrated one is the work by Fama and French (1993) [22] who, in a series of papers, propose to consider the existence of additional risk factors as a consistent hypothesis. They integrate *value* and *size* effects to the original Capital Asset Pricing Model expecting to summarize the cross section of average stock returns.

1.1. **The book-to-market effect.** One of the central questions posed by the financial community is to know if some market anomalies correspond to new unknown risk factors or new evidence of mispricing related to investors' over [under] reaction to news. Lakonishok *et al.* (1994) [36] attest that low [high] stocks with *book-to-market* ratio are on average over [under] priced. Strategies based on purchasing *value* stocks and simultaneously short selling *growth* stocks should thus be an interesting method for exploiting misvaluations in the cross section questioning indirectly the efficient theory for some. Unlike glamour firms, *value* stocks are illustrated with low *past-sales growth*, high *book-to-market*, high *earnings-to-price* and high *cash flow-to-price* among other. The huge interest for those stocks is quite old (Graham and Dodd, 1934 [28] and Williams, 1938 [51]) and is explained by their capacity to earn persistent positive returns. Basu (1977) [8] finds that firms with high *earnings-to-price* ratios have higher risk-adjusted returns than low *earnings-to-price* stocks shedding light on the difficulty to find a satisfying proxy of the *value* effect. Moreover, while the effect appears robust over the time, academics remain divided on the underlying economic reason. Lakonishok et al. (1994) [36] document a behavioral explanation related to investors' over or under-reactions. Operators may be excessively optimistic about *glamour* stocks or may be excessively pessimistic about *value* firms. An alternative explanation (supported by Fama and French, 1992 [21], 1993 [22]) is that *value* firms have persitent positive abnormal returns because they are simply riskier. "*...if assets are priced rationally, variables that are related to average returns, such as size* [market capitalization] *and book-to-market equity, must proxy for sensitivity to common* [...] *risk factors in returns*" (FF, 1993 [22] p.4). They thus conclude that *value* effect is a compensation for risk. Dichev (1998) [19] document that the highest 10% bankruptcy risk firms have also the lower *book-to-market* ratio (0.38 for NYSE-AMEX firms from 1981 to 1995[1]) but a high market value. He explains that "*...unlike market value, book value of the most distressed firms is often completely wiped out by losses or is even negative. Thus, even if firms with high bankruptcy risk have higher returns, the nonmonotonic relation between bankruptcy risk and book-to-market suggests that a distress explanation is unlikely to account for the book-to-market effect*" (p. 1139). Despite the well-developed literature on that subject, there is still no consensus on the underlying economic explanation. Kothari *et al.* (1995) [33] attest that the *value* effect might be due to *data-snooping* or *survivor-bias*. Barber and Lyon (1997) [7] document both a *value* and a *size* effect on the U.S. market from July 1973 to December 1994 including also financial firms. Their central message is that *size* and *book-to-market* premiums are neither explained by *selection biases* nor *data-snooping*.

1.2. **The size effect.** Prevalent theory in modern finance argues smaller firms are riskier than larger firms, *citeris paribus*. Banz (1981) [6] documents that small stocks (measured by market capitalization) have, on average, higher risk-adjusted returns than the common stock of large firms between 1936 to 1975 on the U.S. market. He names it "the *size* effect" and reports that: "*It is not known whether size per se is responsible for the effect or whether size is just a proxy for one or more true unknown factors correlated with size*" (p.3). In the same year, Reinganum (1981) [44] studies a sample comprising 566 U.S. stocks from 1975 to 1977 and corroborates that the 10% smallest firms outperform the biggest 10% by +19.20% *per annum*. Schwert (1983) [46] attests that "*...the statistical association between the 'size' of the firm and average stock returns is comparable to the association between average return and risk*" (p.4). Dichev (1998) [19] investigates the role of the distress risk to explain both *size* and *book-to-market* effects. He proxies distress risk by *probability of bankruptcy*. Altman (1993) [3] documents that the most *high-yielding bonds* (considered as the most distressed firms of the sample) underperform on average. From those observations, Dichev (1998) [19] concludes that surprisingly, bankruptcy risk is negatively related to systematic risk which appears counterintuitive. Opler and Titman (1994) [43] and Asquith *et al.* (1994) [4] find a good trade-off by jointly reporting that bankruptcy risk remains mostly explained by idiosyncratic causes deleting all potential relation with the systematic risk. Further investigations on that question drive to mixed results. Campbell, Hilscher, and Szilagyi (2008) [13] report that "*stocks with a high risk of bankruptcy tend to deliver anomalously low average returns*[...]*This result is a significant challenge to the conjecture that the value and size effects are proxies for a distress premium*". The message of Dichev (1998) [19] (p. 1132) is that "*bankruptcy risk is not rewarded by higher returns*". Secondarily, "*...distressed firms generally have high book-to-market but the most distressed firms have lower book-to-market*". Dichev (1998) [19] reports that

[1]Dichev (1998) [19], p.1139, table III: Firms are monthly assigned into decile portfolios relatively to their probability of bankruptcy noted Z. A higher Z coefficient means higher probability of bankruptcy (Altman (1968) [2]).

the *size* effect "*...has virtually disappeared since 1980*". Crain (2011) [18] attests that it "*has diminished or disappeared since the 1980's in the U.S., UK, and elsewhere following Banz's announcement and launches of small-cap funds*" (p.1). Empirical results are inconclusive on the *size* effect. It seems to vary over time which is problematic for a risk factor-based-approach. Having said that, research still matters because the underlying economic explanations are still not known. Furthermore, the effect seems to exist only among the 5% smallest stocks (Crain, 2011 [18]). Horowitz et al. (2000) [30] observe that deleting stocks of the sample with less than $5 million in market capitalization makes it disappear. Since microcaps are poorly liquid, researchers call into question the consistence of long strategies on microcaps net of trading costs. Brennan, Chordia and Subrahmanyam (1997) [11] warns that the effect could be an indirect proxy of a hidden liquidity effect. Small firms are supposed less liquid and therefore must provide a higher return to offset their costs of transactions. Chan *et al.* (1985) [15] observe that small companies can over-react in front of economic environment changes. Kothari *et al.* (1995) [33] report that the average *size* and *book-to-market* returns documented by Fama and French are upward biased since they use the database COMPUSTAT. Fama and French [23] argue that the bias could not be able to describe the month-by-month *size* and *book-to-market* risk factors in returns. It "*seems unlikely that survivor bias necessarily produces intercepts close to 0.0 in the three-factor asset-pricing regressions*" (p.146). Even if the bias exists, it does not explain the good specification of the time series regressions.

1.3. **The operating profitability effect.** Novy-Marx (2012) [41] reports that when the *book-to-market* ratio of a firm is high [low], an investor can buy a large [small] quantity of book value for each Euro spent which is a kind of leverage effect. Usual "*value*" strategies are long-short equity strategies. They finance an acquisition of under-valued assets by selling over-valued assets. He concludes that a *profitability* strategy is a *different dimensions of value.* This dimension is based on financing the acquisition not on under-valued assets but on productive assets by selling unproductive assets. As stated by the author, those two effects are closely related. Berk (1995) [9] reports that firms with high expected returns are lower priced increasing *de facto* their *book-to-market* ratios. In a similar way, firms with productive assets should be yielding higher. They seem to be counter-intuitive because they are priced like firms with unproductive firms (the role of the discount rate is crucial). That being said, profitable stocks are expected to generate higher average returns legitimating why the *return-to-asset* ratio is often retained as an additional risk factor.

1.4. **The asset growth or investment effect.** Previous studies document a negative relationship between several forms of investments and stock returns. "*...Firms experiencing rapid growth by raising external financing and making capital investments subsequently have low stock returns, whereas firms experiencing contraction via divestiture, share repurchase, and debt retirement enjoy high future returns.*" (Watanabe et al, 2013 [50], p. 529). Cooper *et al.* (2008) [17] mention *capital investment, accruals, sales growth rates*, and *capital raising* as investment factors negatively correlated with expected returns. Their study suggests "*that corporate events associated with asset expansion tend to be followed by periods of abnormally low returns*" (p.1609) on the U.S. market between 1968 to 2003. They sort stocks in function of their previous-year growth and find that annualized return of the value-scaled portfolio in the lowest growth decile is +18%, while firms in the highest perform much lower (+5%). Based on those observations, they run two long-short strategies by being both long on *low-growth* stocks and short *high-growth* ones. The first strategy uses equi-weighted portfolios while the second one uses value-scaled ones. In the first case the *zero-cost* investment return is 1.59% per month and is 1.05% for value-scaled portfolios. Watanabe et al, 2013 [50] study 43 equity markets and report mixed results. In line with the financial literature, they observe a negative relation between growth and stock return for 30 out of 43 countries (including the U.S. market). Once again, academics stay divided on the economic explanation. Various justifications are proposed to explain that negative relation. One is based on "*overinvestment*": Managers might invest in projects with negative net present values driving to reduce subsequently the firm value. Titman *et al.* (2004) [48] make a trade-off by assimilating managers to investors. They actually may over (under) value a firm with large (low) investments by over (under) valuing its forecasted cash-flows. The final low return is thus a direct consequence of a natural market correction. Another possible explanation may lie with "*market timing behavior in financing decisions*". Corporate manager have better information relatively to their business and are able to make a better estimation of the firm's value. Starting from this, they may be tempted to raise equity when the stock price is over-priced or *vice-versa* buy back shares when the firm is under-priced (Baker and Wurgler, 2002 [5]). "*If investors do not fully take such opportunistic corporate behavior into account when they value stocks, this leads to a negative relation between corporate financing and subsequent stock returns*" (Watanabe et al, 2013 [50] p. 533). According to this hypothesis, it is not surprising to expect a negative relation between investment and stock returns and especially when the firm asset growth policy is driven by external financing (Cooper et al. 2008 [17]). That being said, before raising external financing, managers can falsify reported earnings upward to adjust favourably their financing terms leading external investors to overprice (Teoh *et al.* 1998 [49]). In line with Lakonishok *et al.* (1994) [36], investors may also over-price a firm's value based on its past growth. Even if this bias is initially proposed to explain the past-sales-growth anomaly, Cooper *et al.* (2008) [17] state that it could also justify the persistence of an investment effect. Fama and French (2015) [25] show significant abnormal returns for long-short strategies on *operating profitability* and *investment* even after controlling for *size*, *value*. They thus propose a second extension of the original CAPM by integrating them as new risk factors. "*Available evidence suggests that much of the variation in average returns related to profitability and investment is left explained by the three-factor model*" (p.2).

In respect of the efficient theory[2], diffusion of public information is expected to be immediately done and integrated among investors. Merton (1987) [40] reports that information diffusion rates vary considerably due to their sources. Empirically, academic information are integrated slower than earnings or dividends announcement for instance. From this observation, Merton (1987) [40] makes the trade-off with market anomalies by suggesting that their persistence may result from a time lag and from a bad communication. If a specific anomaly exists among a set of securities, a large number of investors would make it disappear through an arbitrage. Merton (1987) [40] take a very concrete example with the *size* effect and attests that "*that six years have passed since publication of the first study on the "small-firm effect", and we in academic finance have yet to agree on whether it even exists*" (p.486). Merton does not thus suggest that market anomalies are risk factors. If a market anomaly is detected, an arbitrage would be done immediately only if diffusion rates are optimal which is definitively not the case regarding the source of information. Moreover, an investor aware of a given market anomaly revealed by academics at time t has to wonder whether past observations are likely to happen in the future. Regarding to this literature review, we propose in the next section an empirical study about asset pricing models in the French context. Our objective is to give insights about the French market.

2. Data and variables

2.1. **Database.** We study monthly past returns on the French market from January 1990 to July 2016 (318 months). We use DATASTREAM to extract and construct our data base. Like Fama and French, financial firms and stocks with negative *book-to-market* ratio are eliminated from the sample comprising *in fine* 1163 firms listed on Euronext Stock Exchange market. We retain firms listed at least for three years. Regarding the survivor bias described by Kothari *et al.*(1995) [33], using DATASTREAM remains a solid test to see whether their argument holds through another market and over different periods. Moreover, we include delisting returns when available. Subsequently, we independently sort our sample to assign stocks to two *size* groups and to three *book-to-market* (Panel A), *operating profitability* (Panel B), and *investment* groups (Panel C)[3]. We label these portfolios with two letters: The first letter describes the *size* (*small* [S] and *big* [B]). The second describes the *book-to-market* (*high* [H], *neutral* [N] and *low* [L]), *operating profitability* (*robust* [R], *neutral* [N] and *weak* [W]) and *investment* (*conservative* [C], *neutral* [N] and *aggressive* [A]). Like Fama and French (1992) [21], we form our variables at the end of July in year t by using information from fiscal year-end $t-1$ from DATASTREAM. The different strategies tested are monthly value-scaled. To

[2]Fama (1970) [20] reports *that "a market in which prices always "fully reflect" available information is called efficient"* (p.383).

[3]*book-to-market* ratio is obtained by inverting *market-to-book* [MTBV]. Revenues minus cost of goods sold, minus selling, general, and administrative expenses [EBITDA: WC18198], minus interest expense [WC01251] all divided by book equity [WC05491] constitute our *operating profitability* ratio. Finally, *investment* is defined as the annual change in gross property, plant, and equipment added of the annual change in inventories [Total Asset: WC02999] between $t-2$ and $t-1$ all divided by the lagged book value of total assets of $t-2$.

test them, we consider a holding period return from the beginning of June of year t to the end of July of year $t+1$. Allocation of portfolios is annually updated.

2.2. **Explanatory variables.** Five explanatory variables are used in our time series regressions:

- ***The Market Premium*** $[R_M - R_f]$ is the excess return of the portfolio M net of the 3 month-EURIBOR rate. R_M corresponds to the value-weighted monthly returns of the full sample[4].
- ***The Small Minus Big*** portfolio $[SMB]$ corresponds to the difference between the average monthly stock returns of the three portfolios of small capitalizations (SL, SM and SH) and the three with big capitalizations (BL, BM and BH)[5].
- ***The High Minus Low*** portfolio $[HML]$ corresponds to the difference between the average monthly stock returns of the two portfolios with the highest *book-to-market* ratios (SH and BH) and the two with the lowest ratios (SL and BL)[6].
- ***The Robust Minus Weak*** portfolio $[RMW]$ corresponds to the difference between the average monthly stock returns of the two highest profitable portfolios (SR and BR) and the the two lowest (SW and BW)[7]. We retain the definition of the *operating profitability* ratio of Hou, Xue and Zhang (2015) [32] and Fama and French (2015) [25][8].
- ***The Aggressive Minus Conservative*** portfolio $[AMC]$ corresponds to the difference of the average monthly returns on portfolios with high asset growth rates, designated *agressive* (SA and BA) and portfolios with *conservative* firms (SC and BC)[9]. Like Chen and Zhang (2010) [16], Hou, Xue and Zhang (2015) [32] and Fama and French (2015) [25] the *investment* proxy is the annual change in gross property, plant, and equipment added of the annual change in inventories between $t-2$ and $t-1$ all divided by the lagged book value of total assets of $t-2$.

We consider past-returns of diversified value-weighted portfolios with:

(1) ***The original Capital Asset Pricing Model*** (1964) which explains monthly-excess returns with the market portfolio:

$$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + \epsilon_{i_t} \tag{2.1}$$

[4] $R_{M_t} = \sum_{t=1}^{t=n} w_{pi_t} R_{i_t}$ where R_{i_t} is the monthly return of the stock i and w_{pi_t} is the ratio of market value of the stock i on the total market value of portfolio M ; n is the number of existing stocks comprised in the portfolio M at time t.

[5] $SMB = \{(SL + SM + SH) - (BL + BM + BH)\}/3$

[6] $HML = \{(SH + BH) - (SL + BL)\}/2$

[7] $RMW = \{(SR + BR) - (SW + BW)\}/2$

[8] It corresponds to the revenues minus cost of goods sold, minus selling, general, and administrative expenses, minus interest expense all divided by book equity. The definition given by Novy-Marx (2012) [41] and Chen and Zhang (2010) [16] is respectively measured by the gross profits (revenues minus cost of goods sold) to its assets and by the income before extraordinary divided by last quarter's total assets. Those different definitions constitute robustness tests driving us to select the Fama and French definition on a statistical basis for the French market.

[9] $AMC = \{(SA + BA) - (SC + BC)\}/2$

(2) ***The Fama and French three-factor model*** (1993) adding the *size* and the *value* factors to the CAPM:

$$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + s_i(R_{SMB_t}) + h_i(R_{HML_t}) + \epsilon_{i_t} \tag{2.2}$$

(3) ***The Fama and French five-factor model*** (2015) adding the last two market anomalies bringing the original three-factor model to five.

$$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + s_i(R_{SMB_t}) + h_i(R_{HML_t}) + r_i(R_{RMW_t}) + c_i(R_{AMC_t}) + \epsilon_{i_t} \tag{2.3}$$

(4) ***An alternative orthogonal five-factor model*** (2016) substituting the *size* factor by its orthogonal version:

$$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + s_i(R_{SMB_t^{\perp}}) + h_i(R_{HML_t}) + r_i(R_{RMW_t}) + c_i(R_{AMC_t}) + \epsilon_{i_t} \tag{2.4}$$

Three different versions of the five-factor model are proposed by Fama and French (2015, [25]) regarding the breakpoints $[2 \times 3]$, $[2 \times 2]$ and $[2 \times 2 \times 2 \times 2]$. "*The three versions of the factors also produce much the same descriptions of average returns*" (p.12). We retain the $[2 \times 3]$ sort also comparable with their original three-factor model (1993) [10].

2.3. **Dependant variables.** Six sets of portfolios are used as dependant variables. They correspond to the *Left Hand Side* (*LHS*) of the equation. The first three sets correspond to the panels *A*, *B* and *C* previously described. Those first three sets allow to construct our explanatory variables and are value-weighted portfolios. Subsequently, we construct three other panels (D, E and F). Each of them comprises 16 diversified portfolios and is respectively constructed on *book-to-market*, *operating profitability* and *investment* ratios:

- **Panel D** comprises 16 value-scaled portfolios constructed from independent sorts of stocks into four *size* groups and four *book-to-market* groups.
- **Panel E** corresponds to the average monthly excess returns for 16 value-weighted portfolios from independent sorts of stocks into four *size* and four *operating profitability* groups.
- **Panel F** comprises 16 value-scaled portfolios constructed from independent sorts of stocks into four *size* groups and four *investment* groups.

[10] Trying to control for more factors would be in the French case problematic. Adding for instance *momentum* (Carhart, 1997 [14]) would drive in poor diversification of our portfolios utilized to construct factors.

2.4. **Summary statistics.** Ideally, we would like to examine the relation between our three market anomalies and average returns separately. Firstly, we document a negative relation between market value and average returns as stated by Banz (1981) [6]. The relation can be seen in every panel (A to F). Controlling strategies for firm capitalization appears not only consistent but empirically necessary.

2.4.1. ***Descriptive statistics of the three panels A, B and C.*** The table 1 summarizes descriptive statistics of the strategies replicated in the panels A, B and C. They are formed on a double and independent classification: *size* and *book-to-market* (panel A), *size* and *operating profitability* (panel B), *size* and *investment* (panel C). In line with the literature, we observe that long strategies on small stocks always outperform on average long strategies on big firms for the panel A, B and C (respectively 1.94% vs. 0.85%; 1.90% vs. 0.84% and 1.88% vs. 0.83%). Surprisingly, they are also less volatile regarding their annualized risk (17.62% vs. 22.11%; 17.88% vs. 20.82% and 16.46% vs. 19.87%). Seeking to describe performances on monthly average of strategies related to *book-to-market*, *operating profitability* and *investment* after controlling for market capitalization is easier when we analyse extreme strategies.

Firstly, we observe a positive relation between the *book-to-market* ratio and stock returns among small stocks. The small-high portfolio generates on average +2.24% per month vs. +2.05% for the small-low strategy. The effect disappears for big stock (+0.93% for the big-high strategy and +0.95% for the big-low). The relation between *operating profitability* ratio and stock returns is also positive but stronger than the *book-to-market*. The small-robust strategy earns on average +2.26% per month vs. +1.57% for the small-weak strategy. The effect is less visible for with big stocks (+0.94% for the big-robust vs. +0.74% for the big-weak). Secondarily, we do not report like Fama and French (2015) [25] a negative relation between the growth effect (*investment*) and stock returns but a positive one. The small-aggressive strategy earns on average +2.07% per month vs. +1.66% for the small-conservative strategy. In line with the previous effects, this *investment* effect is clearly less notable for big stocks (+0.81% for the big-aggressive portfolio and +0.84% for the big-conservative). Analysing those extreme strategies in terms of annualized risks leads to opposite conclusions. Long strategies on high *book-to-market* firms are riskier among big stocks (26.72% vs. 21.71%) and safer for small stocks (15.75% vs. 19.67%). The same observation can be done for extreme *investment* portfolios: 23.12% vs. 18.87% among big stocks and 14.33% vs. 20.94% for small. Exceptions are made with *operating profitable* strategies: buying robust firms appears safer among big stocks (17.17% vs. 25.23%) while it is riskier for small (19.57% vs. 19.46%).

2.4.2. ***Descriptive statistics of the zero-cost strategies.*** The table 2 brings some insights on the explanatory variables based on zero-cost strategies. From January 1990 to July 2016, *market premium*, *size*, *value*, *operating profitability* and *investment* factors are respectively proxied by the portfolios: $R_M - R_f$, *SMB, HML, RMW* and *AMC*. They earn on average 0.83%, 1.09%, 0.09%, 0.44% and 0.19% per month for annualized risks of 17.74%, 13.67%, 15.43%, 13.10% and 13.25%. The orthogonal version of the *size* factor earns 1.59% with a risk of 13.67%. Among all of our explanatory variables, the two *size* factors (SMB and $SMB^{\perp}$) have the highest Sharpe ratios (0.25 and 0.40 respectively). As a preliminary observation, long strategies on small caps outperform than every other strategy. There is a weak but positive relation between average returns and the *high-minus-low* portfolio on the French market for the studied period. This *value* strategy earns on average 0.09% per month with an annualized risk of 15.43% driving to a very low Sharpe ratio (0.02). The *operating profitability* effect is stronger. The *robust-minus-weak* factor earns on average 0.45% and has the lowest risk of the group (13.10%). Conversely to the U.S. market, we do not observe a negative relation between average returns and growth stocks. Empirically, aggressive stocks outperform conservative ones. The average monthly return of the *aggressive-minus-conservative* portfolio is 0.189% with a very low 0.05 Sharpe ratio due to a significant annual risk (13.25 percent).

2.4.3. ***Descriptive statistics of the three panels D, E and F.*** After assigning our 1163 firms to one of four quartiles based on annual 1. *book-to-market*, 2. *operating profitability* and 3. *growth rates*, we calculate monthly returns for value-scaled portfolios on the next 12 months. To control for firm capitalization, stocks are independently ranked into one of four market value quartiles leading to generate every time 16 portfolios (4x4). We subsequently compute time series of returns for each one from January 1990 to July 2016. The tables 5, 6 and 7 summarize descriptive statistics of the panel D, E and F. The average excess returns range for the panel D goes from 0.73% per month (for the lower) to 2.82%, 0.71% to 2.95% for the panel E and 0.70% to 3.23% for the panel F. Among the smallest 25% firms of our sample in terms of market values, the highest quartile of stocks investing a lot year-over-year outperform conservative by + 1.02% that constitutes a real French specificity. Analysing aggressive stocks must be jointly done by taking into account the strong French *size* effect. Most of aggressive stocks are also small which may justify why conservative (usually big stocks) underperform aggressive ones (mostly small). Furthermore, microcaps are less volatile. Traded volume might potentially be useful to explain this phenomenon. The French investment culture could reveal that investors deal mostly on big capitalisations while microcaps are mainly owned by stable shareholders (family for instance). A such observation could be thus interpreted as a new evidence of a lack of liquidity. In that case, removing microcaps in the sample like Harvey *et al.* [29] and Hou *et al.*(2014) [31] makes sense and could be a valid explanation of why aggressive microcap returns are much harder to explain and why they do not behave like expected. We shed light on a French specificity by observing a higher level of risk for high *book-to-market* firms for the 20% biggest firms. The surprise stays complete for the other 80%.

Secondarily, microcaps do not covary like bigger with the market premium. Their covariances are empirically lower explaining why their betas are smaller than megacaps.

It is not surprising to observe successful long-short strategies based on being both long on low-betas and short on bigger. This strategy is quite similar than investing on a *small-minus-big* portfolio where the *size* is measured by market value. If the *size* effect appears strong on a market (which is our case), "betting against beta" (Frazzini and Pedersen, 2014 [26]) has stronger chances to generate positive returns. Comparing those two long-short equity strategies is another robustness test.

Summary statistics do not document on *size*, *value, operating profitability* or *investment* premia but regression results do so in the following section.

3. Regression results

In this section, we examine regression details and especially intercepts and slopes. Contrary to Fama and French (2015) [25], we do not reject their five-factor model for the same reason. While they drop *HML* considered as a redundant factor (regarding *RMW* and *AMC*) for describing average returns, we are tempted (for the French market) to drop *SMB* instead.

3.1. The orthogonalisation process.

We regress each of the five factors on the other four in the table 3. Firstly, the *market premium* is explained by *size*, *value*, *operating profitability* and *investment.* The intercept is estimated to 0.017% ($t = 8.5$) per month vs. 0.80% ($t = -0.47$) for Fama and French in the case of the U.S. market from July 1963 to December 2014. We report a strong adjusted R^2 for this time series regression (42.46% vs. 23.03%). The large average return is mostly captured by *HML* (-0.958***, $t = -17.74$) and *SMB* (-0.776***, $t = -14.37$). This result seems to be a consequence of a strong negative correlation with the *size* factor (-0.62) as reported in the table 8. Thereafter, we explain *HML* with the same process. In this regression, the intercept is 0.004% ($t = 1.33$) vs. -0.04% ($t = -0.47$) with an adjusted R^2 of 16% vs. 51%. The main average return of that proxy is mainly captured by *RMW* (-0.350***, $t = -5.64$) and *AMC* (-0.293***, $t = 4.57$) factors. As stated by Novy-Marx (2013) [42], *profitability* strategy is a *different dimension of value.* It is based on financing the acquisition not on under-valued assets but on productive assets by selling unproductive assets. Those two effects are closely related which explains why *HML* remains well-captured by *RMW.* Secondarily, the two negative *RMW* and *AMC* slopes indicate that high *book-to-market* firms mostly promote conservative investment policies and are finally poorly profitable. The *market premium* captures a small part of *HML* average return which is surprising regarding the significant role played by *HML* when $R_M - R_f$ is regressed.

We regress *SMB* subsequently. Its constant is estimated to 0.014% ($t = 7$) per month vs. 0.39% ($t = 3.23$). As expected, *SMB* is mainly captured by the *market premium* (-0.518***) and by the *investment* factor

(0.305***). We explain last observation by the fact that most of aggressive firms are small caps. While Fama and French (2015) [25] reject *HML* for describing average returns on the U.S. market, we drop *SMB* instead. It makes sense that developing an orthogonal version of the *size* factor appears to be more relevant and is a consistent answer addressed to the French context. The strong (negative) correlation between the *market premium* and the *small-minus-big* factor can be explained by the way they are built. Both of them are value-scaled portfolios and promote for the first one a long strategy on big capitalizations while the second is (partly) short on them. Lastly, the *size* effect is poorly explained by the *operating profitability* factor (0.029, t = 0.56) contrary to Fama and French (-0.48***, t = 8.43) leading us to conclude that *operating profitability* effect is a strong market anomaly unrelated to market capitalization in a first place. *SMB* is slightly negatively correlated with *HML* (-0.045); $SMB^{\perp}$ increases this correlation to -0.191 leading to similar levels of correlation than Fama and French (2015) [25] (-0.11)[11] and Novy-Marx (-0.26)[12].

We designate *SMB* factor by γ and put $SMB^{\perp}$ (*Orthogonal SMB*) as the sum of the intercept (α_γ) and residual (ϵ_γ) from the following time series regression: $R_{\gamma_t} = \alpha_\gamma + \beta_\gamma(R_{M_t} - R_{f_t}) + h_\gamma(R_{HML_t}) + r_\gamma(R_{RMW_t}) + c_\gamma(R_{AMC_t}) + \epsilon_{\gamma_t}$. The orthogonal version of *SMB* is thus equal to $SMB_t^{\perp} = SMB_t - \beta_\gamma(R_{M_t} - R_{f_t}) - h_\gamma(R_{HML_t}) - r_\gamma(R_{RMW_t}) - c_\gamma(R_{AMC_t}) = \alpha_\gamma + \epsilon_{\gamma_t}$. Substituting $SMB^{\perp}$ for the original *SMB* brings us the following alternative five-factor model:

$$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + s_i(R_{SMB_t^{\perp}}) + h_i(R_{HML_t}) + r_i(R_{RMW_t}) + c_i(R_{AMC_t}) + \epsilon_{i_t} \tag{3.1}$$

The correlation between *size* and *market premium* collapses to 0.00 when *SMB* is orthogonalised. Finally, *SMB* and $SMB^{\perp}$ remain highly correlated (0.754).

The average *market premium* slopes (β) among panels (D, E and F) tend to get close to 1 when new factors are added in the time series regressions. For instance, the average slopes for the three panels D, E and F are respectively 0.647 for the single factor, 0.940 and 0.929 for the three and five factor models. This average *market beta*, when the alternative five-factor model is applied, strongly decreases to 0.649 (see table 18). Taking into account both the *Pearson* and *Spearman* correlations between *size* and *market* factors (-0.61 and -0.69), the sign of β_γ is naturally negative (-0.518^{***}) (table 3) that explains why the *market* slopes decrease ($\beta_i^{Mkt} = [\beta_i + s_i\beta_\gamma]$) when we swap *SMB* by its orthogonal version (Details related to the orthogonalisation process are shown in Appendices). This observation is at least true for portfolios comprising small stocks where the *size* slopes (s_i) are higher and by the way positive. The *market beta* can however increase *if and only if* the *SMB* slope becomes negative leading to a positive sign in the following

[11] Fama and French (2015) [25], p.7, table 4
[12] Novy-Marx (2012) [41], p.61, table A.1

term: $\beta_i^{Mkt} = [\beta_i + (-s_i) \times (-\beta_\gamma)]$. The correlation between *size* and *investment* is positive and quite high (0.265). It significantly increases with $SMB^{\perp}$ (0.598).

Finally, we reject the criticism of Kothari *et al.* (1995) [33] on the *survivor bias*. Using DATASTREAM to construct an *out-of-sample test* with 1,163 French firms from January 1990 to July 2016 appears as a consistent test. Confirming the persistence of the effect shows that is not driven by any *survivor bias*. Fama and French [23] add that the bias is not able to describe the month-by-month *size* and *book-to-market* risk factors in returns and add that wether the bias exists, it does not explain the good specification of the time series regressions related to the intercepts. We can associate our results with Barber and Lyon (1997) [7] that document both *value* and *size* effects on the U.S. market from July 1973 to December 1994. Their sample comprise financial and non-financial firms and shows that *size* and *book-to-market* effects are neither explained by *selection biases* nor *data-snooping*.

The five-factor HML slopes for the 16 *size* and *book-to-market* portfolios (Panel D of table 15) show a notable pattern. Slopes are related to market capitalizations for the third and the highest *book-to-market* quartiles, they are higher for portfolios comprising big stocks (respectively 0.157 and 0.388 for microcaps; 0.227 and 0.882 for megacaps). This observation holds for the weakest quartile of *operating profitable* firms (0.267 for microcaps and 0.420 for megacaps) or for the most *aggressive* 25% firms (0.104 for microcaps and 0.191 for megacaps). Empirically, we corroborate what is stated by the financial literature, high *book-to-market* firms are usually small. In line with Novy-Marx (2012) [41], we observe a partial association between *value* and *profitable* stocks. Regression slopes of the *robust-minus-weak* factor have mostly the same signs than the *high-minus-low* explanatory variable and they change similarly relatively to *size*. We conjecture that *operating profitable* firms are also small explaining also why *small-minus-big* and orthogonal *small-minus-big* are positively correlated with *robust-minus-weak* factors (respectively 0.17 and 0.12). Conversely to Fama and French (2015) [25], the AMC slopes are not close to zero. Portfolios formed on *book-to-market* and *operating profitability* show strong exposure to the *investment* effect which reinforce the usefulness of that fifth factor.

3.2. **Time-series regressions of portfolio returns using GRS test.** An asset pricing model fully capturing expected returns has an intercept (α) indistinguishable from zero (this is our H_0 hypothesis). We challenge the Sharpe-Lintner-Black, the Fama and French three-factor and five-factor models on this basis. The orthogonal version of the last one produces the same results than the Fama and French five-factor model (see equation 5.4 in Appendices). Results presented in the table 20 are thus indifferent if we use the equation 2.3 rather than 2.4. We subsequently use three sets of *left-hand-side* portfolios (panels D, E and F) replicating the market anomalies revealed by the recent literature. The table 20 shows that the average intercepts in absolute values noted $|\alpha_i|$ are smaller for the five-factor model (0.39%) than for the three-factor model (0.43%) or the Sharpe-Lintner-Black CAPM (1.14%). Considering the three panels, the five factors bring higher improvements in the average absolute intercepts than the three-factor model (D: 0.41% vs. 0.43%; E: 0.33% vs. 0.40%; F: 0.44% vs. 0.47%). Those improvements remain however higher for the panels E and F which is not surprising: "*The results suggest that the FF three-factor model is likely to fare poorly when applied to portfolios with strong profitability and investment tilts*" (Fama and French, 2015 [25], p.10). The average *Student t statistic* in absolute value of the intercepts ($t[\alpha_i]$) for the single factor model is 4.35 and collapses to 1.78 when the *size* and *value* factors are added and decreases to 1.61 for the five-factor model. Those improvements between the two last models do not come from higher standard errors of their respective intercepts, they actually decrease (0.22% vs. 0.23%). They are due to significant reductions of the five-factor intercepts (0.39% vs. 0.43%) which constitutes a remarkable advantage. In order to go deeper in our analysis, we run a GRS statistic test (Gibbons, Ross, and Shanken, 1989 [27]) to challenge our H_0[13] hypothesis where we assume that our intercepts α_i are indistinguishable from zero for combinations of left hand side portfolios.

The joint test results for the three studied asset pricing models are higher than their respective critical values (located in the rejection area) meaning that intercepts are not jointly equal to zero. Models we run are currently not able to capture all the variation in expected returns. It is important for us to recall than our main goal is and remains to identify an asset pricing model that best describes average returns of stocks (*assuming a margin of error managed as good as possible*) on *LHS* portfolios formed to reveal market market anomalies. Our interest resides in improving the existing asset pricing model by proposing innovative alternatives. Despite its rejection, the five-factor model produces lower GRS statistics meaning that we actually get closer to our purpose.

in line with Fama and French, our result lead to a "*strong presumption that the common factors in fundamentals drive the risk factors in returns*" (Fama and French, 1995, [23], p.150). Tables 15, 16, 17 and 18 suggest there are *market, size, book-to-market, operating profitability* and *investment* effects on the French market over the studied period.

The biggest difficulties encountered by all the tested asset pricing models remain microcaps (the smallest *size* quartile).

The orthogonal five-factor model brings strong improvements regarding the intercepts. Even if they remain significant, they considerably collapse. On average, intercept of the Panel D is 0.021 with the single factor and 0.007 for the three and five factor models. We make a similar observation for the panel E and F. Respectively, the average intercepts of the panel E for the single factor are 0.022, 0.009 for the three and

[13] $H_0 : \alpha^\top = [\alpha_1 \cdots \alpha_n] = 0$ and $H_1 : \alpha^\top = [\alpha_1 \cdots \alpha_n] \neq 0$

0.008 for the five-factor models. Finally, intercepts on average are 0.022, 0.010 for the three and five factor models.

In the tests on the three panels D, E and F, intercepts are almost all significant, except the second *book-to-market* quartile which is slightly negative (-0.005).

To summarize our results, we observe evidence on *book-to-market, operating profitability* and *investment* on the French market between January 1990 and July 2016. Those effects remain by far, more visible when they are studied on small stocks. Actually, they mostly disappear with large capitalizations suggesting they are directly related to *size*. This surprising observation can be partially explained by a kind of "*learning effect*". Operators might integrate anomalies (since they are revealed by academics). That being said, common investors mainly deal with large capitalizations (very liquid) while small caps' investors are more stable. Williams (1938) [51] brings an interesting definition of the investor: "*...we shall define an investor as a buyer interested in dividends, or coupons and principal and a speculator as a buyer interested in the resale price.*[...]*, the pure investor must hold his security for long periods, while the pure speculator must sell promptly...*" (p.4). Based on its definition, the "*pure speculator*" could integrate market anomalies impactinf valuation on the short run. The "*pure investor*" holds securities for years sometimes without rebalancing their portfolios explaining why anomalies might be seen among small and microcaps. This explanation can also justifies why small stocks are less volatile on the period. Dichev (1998) [19] reports that the *size* effect "*...has virtually disappeared since 1980*" (p.1132). Assuming a form of "*learning effect*" could then be a valid justification for its disappearance.

4. Conclusion

In line with Harvey, Liu, and Zhu (2013) [29] and Hou, Xue and Zhang (2014) [31], the *high-minus-low* portfolio, flag bearer of the *value* effect, does not outperform significantly glamour stocks. Evidence of a *value* effect is however visible for firms with market values lower than the median French market capitalization. Both *operating profitability* and *investment* effects are stronger among small caps. Market values play thus a crucial role legitimating methodologies that recommend to control for it. Our orthogonal five-factor model better describes common stock returns. Conversely to the U.S. market, firms with high asset growth rates outperform more conservative ones which constitutes a French specificity. Several explanations can be mobilized. Firstly, it is harder to observe a strong variation in total assets of a big firm than a small one. Most of aggressive stocks are also small in terms of market value. The *size* effect (Banz, 1981 [6]) is remarkable over the studied period which explains why conservative (usually big) underperform aggressive ones (mostly microcaps). Small stocks are surprisingly less volatile than big caps. The investment culture might be mostly turned into big capitalisations while microcaps are mainly owned by stable shareholders (family for instance).

Hou *et al.* (2015) [32] exclude microcaps from their sample attesting that *"...anomalies in microcaps are unlikely to be exploitable in practice*" (p.4). Their main argument is that transaction costs coupled to lack of liquidity are sufficient to delete them from ther sample. Those differences in methodology might partially explain why our results are significantly different than the U.S. market. Like Fama and French (2015) [25], the GRS test rejects our five-factor model directed at capturing the four studied market anomalies. Notwithstanding this, every other model is also rejected and the orthogonal one is finally the least rejected. All the other statistical tests (AIC, BIC and log-likelihood) underline its higher capacity to describe stock returns. Almost all intercepts considered as abnormal returns for portfolios are significantly lower (very close to zero) than presented by Fama and French (2015) [25]. The discussion in the section detailing regression results is well-documented and show that despite rejection on the GRS test, our orthogonal five-factor model outperforms the others. Digging in the financial literature for more explanations will probably lead us to find other criteria allowing other robustness tests potentially driving us to retain factors sufficiently robust to succeed the GRS test. Our study on the French market suggests that *SMB* portfolio is a redundant factor in the original five-factor model. It is mostly fully captured by the *market premium* which is especially true when *operating profitability* and investment are added in the time series regression. An alternative four-factor model deleting *SMB* actually leaves higher abnormal returns for each panel. Furthermore, considering evidence of the *size* effect, the central problematic remains concentrated in microcaps. Removing *SMB* is thus not an adequate answer. Lastly, this orthogonal version constitutes an interesting signal for the asset pricing field. This study participate to the financial puzzle on the French market that have been already documented with a few studies (e.g. Lajili-Jarjir, 2006 [34]; 2007 [35]). Studying new market anomalies on the European level would help us to clarify what is precisely a local specificity.

References

[1] G. Aharoni, B. Grundy, and Q. Zeng. Stock returns and the miller-modigliani valuation formula: Revisiting the fama-french analysis. *Journal of Financial Economics*, 10(2):347–357, November 2013.

[2] E. I. Altman. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance*, 23(4):589–609, September 1968.

[3] E. I. Altman. *Corporate Financial Distress: A Complete Guide to Predicting, Avoiding and Dealing with Bankruptcy.* John Wiley & Sons, 2 edition, March 1993.

[4] P. Asquith, R. Gertner, and D. Scharfstein. Anatomy of financial distress: An examination of junk-bond issuers. *The Quarterly Journal of Economics*, 109(3):625–658, August 1994.

[5] M. Baker and J. Wurgler. Market timing and capital structure. *The Journal of Finance*, 57(1):1–32, 2002.

[6] R.W. Banz. The relationship between return and market value of common stocks. *Journal of Financial Economics*, (9):3–18, 1981.

[7] B.M. Barber and J.D. Lyon. Firm size, book-to-market ratio, and security returns : a holdout sample of financial firms. *The Journal of Finance*, LII(2):875–83, 1997.

[8] S. Basu. Investment performance of common stocks in relation to their price-earnings ratios: A test of the efficient market hypothesis. *Journal of Finance*, 32(3):663–82, June 1977.

[9] J.B. Berk. A critique of size-related anomalies. *The Review of Financial Studies*, 8(2):275–86, 1995.

[10] F. Black. Beta and return. *Journal of Portfolio Management*, 20(1):9–18, 1993.

[11] M.J. Brennan, T. Chordia, and A. Subrahmanyam. A re-examination of some popular security return anomalies. *Working Papers*, pages 1–39, 1997.

[12] R. F. Bruner, K. M. Eades, R. S. Harris, and R. C. Higgins. Best practices in estimating the cost of capital: Survey and synthesis. *Financial Practice and Education*, 8:13–28, 1998.

[13] J. Y. Campbell, J. Hilscher, and J. Szilagyi. In search of distress risk. *The Journal of Finance*, 63(6):2899–2939, November 2008.

[14] M.M. Carhart. On persistence in mutual fund performance. *The Journal of Finance*, 52(1):57–82, March 1997.

[15] K.C. Chan, Nai fu Chen, and David A. Hsieh. An exploratory investigation of the firm size effect. *The Journal of Finance*, 14(3):451–471, September 1985.

[16] L. Chen and L. Zhang. A better three-factor model that explains more anomalies. *The Journal of Finance*, 65(2):563–595, April 2010.

[17] M. J. Cooper, H. Gulen, and M. J. Schill. Asset growth and the cross-section of stock returns. *The Journal of Finance*, 63(4):1609–1651, 2008.

[18] M. A. Crain. A literature review of the size effect. *Working Paper*, 2011. Florida Atlantic University.

[19] I. D. Dichev. Is the risk of bankruptcy a systematic risk? *The Journal of Finance*, 53(3):1131–1147, June 1998.

[20] E. F. Fama. A review of theory and empirical work. *The Journal of Finance*, 25(2):383–417, May 1970.

[21] E. F. Fama and K. R. French. The cross section of expected stock returns. *The Journal of Finance*, 47(2):427–65, 1992.

[22] E. F. Fama and K. R. French. Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, 33:3–56, 1993.

[23] E. F. Fama and K. R. French. Size and book to market factors in earnings and returns. *The Journal of Finance*, L(1):131–55, 1995.

[24] E. F. Fama and K. R. French. Size, value, and momentum in international stock returns. *Journal of Finanacial Economics*, (105):457–472, 2012.

[25] E. F. Fama and K. R. French. A five-factor asset pricing model. *Journal of Financial Economics*, 116:1–22, 2015.

[26] A. Frazzini and L. H. Pedersen. Betting against beta. *Journal of Financial Economics*, 111:1–25, 2014.

[27] M. Gibbons, S. Ross, and J. Shanken. A test of the efficiency of a given portfolio. *Econometrica*, 57:1121–1152, 1989.

[28] B. Graham and D. L. Dodd. *Security Analysis: Principles and Technique*. The Mcgraw Hill Companies, 6 edition, 1934.

[29] C. Harvey, Y. Liu, and H. Zhu. ... and the cross-section of expected returns. *The Review of Financial Studies*, pages 1–64, 2015.

[30] J. L Horowitz, T. Loughran, and N.E Savin. Three analyses of the firm size premium. *Journal of Empirical Finance*, 7(2):143–153, August 2000.

[31] K. Hou, C. Xue, and L. Zhang. Digesting anomalies: An investment approach. *Review of Financial Studies*, 28:605–705, 2014.

[32] K. Hou, C. Xue, and L. Zhang. A comparison of new factor models. *Working papers*, 2015.

[33] S.P. Kothari, J. Shanken, and R.G. Sloan. Another look at the cross-section of expected stock returns. *The Journal of Finance*, L(1):185–224, 1995.

[34] S. Lajili-Jarjir. Les modelles d'evaluation des actifs financiers et les co-moments d'ordre trois et quatre. *Banque et Marches*, (81):39–50, December 2006.

[35] S. Lajili-Jarjir. Explaining the cross-section returns in france: Characteristics or risk factors? *The European Journal of Finance*, 13(2):145–158, February 2007.

[36] J. Lakonishok, A. Shleifer, and R.W. Vishny. Contrarian investment, extrapolation, and risk. *Journal of Finance*, XLIX(5):1541–78, December 1994.

[37] M. Levy and R. Roll. The market portfolio may be mean/variance efficient after all. *The Review of Financial Studies*, 23(6):2464–2491, June 2010.

[38] A.C. MacKinlay. Multifactor models do not explain deviations from the CAPM. *Journal of Financial Economics*, 38:3–28, 1995.

[39] H. Markowitz. Portfolio selection. *Journal of Finance*, (7):77–91, March 1952.

[40] R. C. Merton. A simple model of capital market equilibrium with incomplete information. *The Jounal of Finance*, 42(3):483–510, july 1987.

[41] R. Novy-Marx. Is momentum really momentum? *Journal of Financial Economics*, 103(3):429–453, March 2012.

[42] R. Novy-Marx. The other side of value: The gross profitability premium. *Journal of Financial Economics*, 108(1):1–28, April 2013.

[43] T. C. Opler and S. Titman. Financial distress and corporate performance. *The Journal of Finance*, 49(3):1015–1040, July 1994.

[44] M.R. Reinganum. Misspecification of capital asset pricing: Empirical anomalies based on earnings' yields and market values. *Journal of Financial Economics*, (9):19–46, 1981.

[45] R. Roll. A critique of the asset pricing theory's tests. *Journal of Financial Economics*, (4):129–76, 1977.

[46] G.W. Schwert. Size and stock returns, and other empirical regularities. *Journal of Financial Economics*, 12:3–12, 1983.

[47] W.F. Sharpe. Capital asset prices: A theory of market equilibrium under conditions of risk. *The Journal of Finance*, 19(3):425–42, 1964.

[48] S.Titman, K. C. J. Wei, and F. Xie. Capital investments and stock returns. *The Journal of Financial and Quantitative Analysis*, 39(4):677–700, December 2004.

[49] S. H. Teoh, I. Welch, and T. J. Wong. Earnings management and the long-run market performance of initial public offerings. *The Journal of Finance*, 53(6):1935–1974, 1998.

[50] A. Watanabe, Y. Xu, T. Yao, and T. Yu. The asset growth effect: Insights from international equity markets. *Journal of Financial Economics*, 108:529–563, 2013.

[51] John Burr Williams. *The Theory of Investment Value*. Fraser Publishing, 1938.

5. Appendices

5.1. **Orthogonalisation of the SMB factor.** We put $SMB^{\perp}$ (*Orthogonal SMB*) as the sum of the intercept (α_γ) and residual (ϵ_γ) from the following time series regression: $R_{\gamma_t} = \alpha_\gamma + \beta_\gamma(R_{M_t} - R_{f_t}) + h_\gamma(R_{HML_t}) + r_\gamma(R_{RMW_t}) + c_\gamma(R_{AMC_t}) + \epsilon_{\gamma_t}$, the orthogonal version of *SMB* noted $SMB^{\perp}$ is equal to $SMB^{\perp}_t = SMB_t - \beta_\gamma(R_{M_t} - R_{f_t}) - h_\gamma(R_{HML_t}) - r_\gamma(R_{RMW_t}) - c_\gamma(R_{AMC_t}) = \alpha_\gamma + \epsilon_{\gamma_t}$. Substituting $SMB^{\perp}$ for the original *SMB* brings us the following alternative five-factor model:

$$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + s_i(R_{SMB^{\perp}_t}) + h_i(R_{HML_t}) + r_i(R_{RMW_t}) + c_i(R_{AMC_t}) + \epsilon_{i_t} \tag{5.1}$$

From the equation 5.1, we can easily rewrite the original model in terms of $SMB^{\perp}$ in the equation 5.2:

$$\begin{aligned} R_{i_t} - R_{f_t} = \alpha_i &+ [\beta_i + s_i\beta_\gamma](R_{M_t} - R_{f_t}) + [h_i + s_i h_\gamma](R_{HML_t}) + [r_i + s_i r_\gamma](R_{RMW_t}) \\ &+ [c_i + s_i c_\gamma](R_{AMC_t}) + s_i[R_{\gamma_t} - \beta_\gamma(R_{M_t} - R_{f_t}) - h_\gamma(R_{HML_t}) - r_\gamma(R_{RMW_t}) - c_\gamma(R_{AMC_t})] + \epsilon_{i_t} \end{aligned} \tag{5.2}$$

$$\begin{aligned} R_{i_t} - R_{f_t} = \alpha_i &+ [\beta_i + s_i\beta_\gamma](R_{M_t} - R_{f_t}) + [h_i + s_i h_\gamma](R_{HML_t}) + [r_i + s_i r_\gamma](R_{RMW_t}) \\ &+ [c_i + s_i c_\gamma](R_{AMC_t}) + s_i[\alpha_\gamma + \epsilon_{\gamma_t}] + \epsilon_{i_t} \end{aligned} \tag{5.3}$$

$$\begin{aligned} R_{i_t} - R_{f_t} = \alpha_i &+ [\beta_i + s_i\beta_\gamma](R_{M_t} - R_{f_t}) + [h_i + s_i h_\gamma](R_{HML_t}) + [r_i + s_i r_\gamma](R_{RMW_t}) \\ &+ [c_i + s_i c_\gamma](R_{AMC_t}) + s_i[R_{SMB^{\perp}_t}] + \epsilon_{i_t} \end{aligned} \tag{5.4}$$

The demonstration here above show that neither intercepts nor residuals are impacted by the process. It thus means that tests oriented towards heteroskedasticity or towards intercepts evaluations are unchanged.

5.2. **The Gibbons Ross and Shanken test in details.** The GRS statistic can be written as follows for models comprising several explanatory variables:

$$GRS = \frac{T - N - K}{N} \times \left(1 + \widehat{\mu}^{\top}\widehat{\Omega}^{-1}\widehat{\mu}\right)^{-1} \times \left(\widehat{\alpha}^{\top}\widehat{\Sigma}^{-1}\widehat{\alpha}\right) \sim \mathcal{F}_{N,T-N-K} \tag{5.5}$$

We put $\widehat{\mu}$ as the mean of the excess returns of the explanatory variables computed as follows: $\widehat{\mu}_i = \frac{1}{T}\sum_{t=1}^{t=T}(R_{i_t} - R_{f_t})$ where $\widehat{\mu}^{\top} = [\widehat{\mu}_1 \cdots \widehat{\mu}_N]$. Ω^{-1} is the inverse of their covariance matrix, $\Omega = \frac{1}{T}\sum_{t=1}^{t=T}(R_i - \mu_i)(R_i - \mu_i)^{\top}$ and N is the number of assets (here, we test three sets of sixteen *LHS* portfolios). The parameter noted Σ^{-1}

is the inverse of the covariance matrix of the regression residuals ϵ_i, $\Sigma = \frac{1}{T}\sum_{t=1}^{t=T} \epsilon_i \epsilon_i^{\top}$. Finally, $\widehat{\alpha_i}$ denotes the vector of the intercept of the regression i, $\widehat{\alpha}^{\top} = [\widehat{\alpha}_1 \cdots \widehat{\alpha}_N]$. We use the properties of minimum-variance frontiers of Markowitz (1952) [39] to apply the test in the case of a single factor model:

$$GRS = \left(\frac{T-N-1}{N}\right) \times \left(\frac{[\widehat{\mu}_{\xi}/\widehat{\sigma}_{\xi}]^2 - [\widehat{\mu}_M/\widehat{\sigma}_M]^2}{1 + [\widehat{\mu}_M/\widehat{\sigma}_M]^2}\right) \tag{5.6}$$

$\widehat{\mu}_{R_M}/\widehat{\sigma}_{R_M}$ is the Sharpe ratio of the value-scaled market portfolio and $\widehat{\mu}_{\xi}/\widehat{\sigma}_{\xi}$ is the Sharpe ratio of the tangency portfolio formed from our 16 assets plus the *market premium* factor (μ_M).

TABLE 1. **Descriptive statistics of the panel A, B and C from January 1990 to July 2016**

The table hereunder presents descriptive statistics of monthly percent excess returns for portfolios formed on a double and independent classification: *size* and *book-to-market* (panel A), *size* and *operating profitability* (panel B), *size* and *investment* (panel C) from January 1990 to July 2016 (318 months) based on a sample comprising 1163 French stocks. Portfolios are named with two letters describing the strategy used: the first letter corresponds to the *size* [small (50%) and big (50%)], the second corresponds to A. *book-to-market* [low (30%), neutral (40%) and high (30%)], B. *operating profitability* [weak (30%), neutral (40%) and robust (30%)] and C. *investment* [conservative (30%), neutral (40%) and aggressive (30%)].

	Strategies	*Mean (%)*	*Median (%)*	*Std dev. (%)*	*Min (%)*	*Max (%)*	25^{th}*perc. (%)*	75^{th}*perc. (%)*	*Kurto.*	*Skewn.*	*Sharpe R.*
book-to-market *Panel A*	Small Low - SL	2.05	1.87	19.67	-13.39	40.18	2.05	36.14	7.50	1.17	0.361
	Small Neutral - SN	1.54	1.40	17.46	-41.58	21.27	1.40	17.46	17.67	-1.38	0.305
	Small High - SH	2.24	1.90	15.75	-8.08	21.54	2.24	21.54	2.22	0.90	0.493
	Big Low - BL	0.95	1.01	21.71	-16.64	53.15	0.95	21.71	16.20	2.00	0.151
	Big Neutral - BN	0.69	0.63	17.91	-19.32	15.21	0.63	13.38	0.69	-0.19	0.134
	Big High - BH	0.93	0.19	26.72	-22.95	58.98	0.93	26.72	9.95	1.44	0.121
profitability *Panel B*	Small Weak - SW	1.57	1.00	19.46	-21.33	36.81	1.57	27.96	7.93	1.25	0.28
	Small Neutral - SN	1.88	1.72	14.63	-11.67	18.19	1.88	18.19	1.27	0.19	0.446
	Small Robust - SR	2.26	2.28	19.57	-38.26	34.34	2.26	19.57	11.35	-0.47	0.40
	Big Robust - BW	0.74	0.12	25.23	-25.93	43.97	0.74	25.23	3.99	0.59	0.102
	Big Neutral - BN	0.86	0.61	20.06	-14.45	45.24	0.86	20.06	11.00	1.55	0.149
	Big Robust - BR	0.94	1.09	17.17	-15.41	20.74	0.94	17.17	0.88	-0.13	0.19
investment *Panel C*	Small Aggressive - SA	2.07	1.76	20.94	-16.73	44.38	2.07	34.29	8.77	1.36	0.343
	Small Neutral - SN	1.93	1.96	14.11	-12.70	15.52	1.93	14.11	1.13	-0.11	0.474
	Small Conservative - SC	1.66	1.43	14.33	-9.82	16.11	1.66	16.11	0.79	0.43	0.402
	Big Aggressive - BA	0.81	1.38	18.87	-18.25	14.69	0.81	14.69	0.87	-0.53	0.148
	Big Neutral - BN	0.84	0.98	17.61	-13.95	17.69	0.84	16.47	0.44	-0.04	0.165
	Big Conservative - BC	0.84	0.30	23.12	-24.43	49.81	0.84	23.12	12.36	1.92	0.126

Table 2. **Summary statistics for monthly factor percent returns: January 1990 to July 2016, 318 months**

$R_M - R_f$ is the French *market premium* and corresponds to value-scaled monthly returns of our full sample. Assuming $R_{M_t} = \sum_{t=1}^{t=n} w_{pi_t} R_{i_t}$ where R_{i_t} is the monthly return of the stock i and w_{pi_t} is the ratio of market value of the stock i on the total market value of portfolio named M. Finally, n is the number of the existing stocks comprised in the portfolio M at time t. The market premium is the excess return of the portfolio R_{M_t} (net of the 3 months EURIBOR). At the end of each July, stocks are re-classified into two *size* groups using the median French market capitalization as the *size* breakpoint. This breakpoint distinguishes in t *big* and *small* stocks in $t+1$. Stocks are independently classified to three *book-to-market*, *operating profitability*, and *investment* groups, by using their 30th and 70th percentiles as respective breakpoints. *HML*, utilizes value-weighted portfolios formed from the intersection of the *size* and *book-to-market* sorts ($2 \times 3 = 6$ portfolios). This mechanic is similar for *operating profitability* and *investment* giving respectively *RMW* and *AMC*. *SMB* portfolio corresponds to the difference between the average monthly stock returns of the three portfolios of small capitalizations (SL, SM and SH) and the average monthly stock returns of the three portfolios of high capitalizations (BL, BM and BH): $SMB = \{(SL+SM+SH)-(BL+BM+BH)\}/3$. We designate the *SMB* factor by γ. $SMB^{\perp}$ (*Orthogonal SMB*) corresponds to the sum of the intercept (α_γ) and residual (ϵ_γ) from the regression on which we explain *SMB* by the four other explanatory variables: $R_{\gamma_t} = \alpha_\gamma + \beta_\gamma(R_{M_t} - R_{f_t}) + h_{\gamma_t}(R_{HML_t}) + r_{\gamma_t}(R_{RMW_t}) + c_{\gamma_t}(R_{AMC_t}) + \epsilon_{\gamma_t}$.

		$R_M - R_f$	$SMB^{2\times3}$	$SMB^{\perp}$	$HML^{2\times3}$	$RMW^{2\times3}$	$AMC^{2\times3}$
Descriptive Statistics	*Mean (%)*	0.83	1.09	1.59	0.09	0.45	0.19
	Median (%)	0.93	1.37	1.30	0.05	0.48	0.46
	Variance (%)	0.26	0.18	0.16	0.20	0.14	0.15
	Standard deviation (%)	5.12	4.29	3.95	4.46	3.78	3.83
	Annualized St. Dev. (%)	17.74	14.85	13.67	15.43	13.10	13.25
	Kurtosis	1.97	4.82	8.11	5.83	3.42	6.41
	Skewness	0.40	-0.91	0.39	0.04	-0.62	-0.99
	25th percentile (%)	-2.61	-1.15	-0.30	-2.14	-1.50	-1.41
	Minimum (%)	-14.14	-23.27	-18.82	-19.21	-17.37	-22.84
	Maximum (%)	26.82	14.09	26.26	22.25	13.88	15.81
	75th percentile (%)	3.83	3.53	3.34	2.30	2.52	1.99
	Sharpe ratio	0.16	0.25	0.40	0.02	0.12	0.05

Table 3. **Using four factors in regressions to explain average returns on the fifth: January 1990 to July 2016**

$R_M - R_f$ is the *market premium*. *SMB*, *HML*, *RMW* and *AMC* respectively correspond to the *size*, *value*, *operating profitability* and *investment* factors. They are constructed by using separate sorts of stocks into two *size* groups, three *book-to-market* groups (*high minus low*: $HML^{2\times3}$), three *operating profitability* groups (*robust minus weak*: $RMW^{2\times3}$), and three investment groups (*aggressive minus conservative*: $AMC^{2\times3}$).

		Explanatory variables							
		Int.	**Mkt**	**SMB**	**HML**	**RMW**	**AMC**	**Adj. R^2**	**F-Stat.**
Dependant variables	*Mkt*	**0.017** ***		**-0.776** ***	**-0.958** ***	**-0.158** **	**0.238** ***	**42.46**	**59.48**
		(0.002)		(0.054)	(0.054)	(0.061)	(0.062)		
	SMB	**0.014** ***	**-0.518** ***		**-0.002**	**0.029**	**0.305** ***	**45.22**	**66.42**
		(0.002)	(0.036)		(0.044)	(0.051)	(0.049)		
	HML	**0.004**	**-0.106** *	**-0.004**		**-0.350** ***	**-0.293** ***	**16.00**	**16.13**
		(0.003)	(0.059)	(0.073)		(0.062)	(0.064)		
	RMW	**0.005** **	**-0.131** **	**0.036**	**-0.263** ***		**0.014**	**12.33**	**12.14**
		(0.002)	(0.051)	(0.063)	(0.047)		(0.058)		
	AMC	**-0.004**	**0.190** ***	**0.365** ***	**-0.212** ***	**0.013**		**17.45**	**17.76**
		(0.002)	(0.049)	(0.058)	(0.047)	(0.055)			

TABLE 4. **Pearson and Spearman correlation matrix of monthly excess returns of panel A, B and C: January 1990 to July 2016**

Panel A, B and C respectively correspond to portfolios formed from independent sorts of our 1163 stocks on A. *size* and *book-to-market*, B. on *size* and *operating profitability* and C. on *size* and *investment*. In Panel A, Stocks are dispatched into three groups relatively to their *book-to-market* ratio. The breakpoints are the 30th and the 70th percentiles corresponding to the groups indicated by *low* (L), *medium* (M) and *high* (H) *book-to-market* groups. In Panel B, stocks are dispatched into three groups relatively to their *operating profitability* ratio. The breakpoints are the 30th and the 70th percentiles corresponding to the groups indicated by *weak* (W), *neutral* (N) and *robust* (R) *operating profitability* groups. In Panel C, stocks are dispatched into three groups relatively to their *investment*. The breakpoints are the 30th and the 70th percentiles corresponding to the groups indicated by *conservative* (C), *neutral* (N) and *Aggressive* (A) *investment* groups. Finally, stocks are subsequently balanced between two size groups (*Big* and *Small* based on the median breakpoint).

Spearman correlation (above the diagonal); *Pearson correlation* (below the diagonal)

	SL	SM	SH	BL	BM	BH	SW	SN	SR	BW	BN	BR	SA	SN	SC	BA	BN	BC	Mkt	SMB	HML	RMW	AMC
SL		0.67	0.65	0.55	0.65	0.59	0.77	0.74	0.84	0.61	0.63	0.57	0.85	0.78	0.76	0.61	0.63	0.53	0.65	0.01	-0.11	-0.17	0.22
SM	0.57		0.71	0.43	0.58	0.58	0.76	0.82	0.78	0.58	0.54	0.50	0.79	0.80	0.77	0.54	0.53	0.47	0.56	0.09	0.17	-0.16	0.14
SH	0.53	0.59		0.45	0.56	0.62	0.80	0.83	0.74	0.61	0.53	0.50	0.74	0.83	0.82	0.51	0.52	0.56	0.55	0.08	0.38	-0.25	-0.02
BL	0.48	0.33	0.36		0.74	0.60	0.46	0.49	0.48	0.62	0.90	0.83	0.51	0.51	0.45	0.77	0.80	0.77	0.89	-0.59	-0.22	-0.01	0.12
BM	0.59	0.49	0.49	0.65		0.74	0.61	0.62	0.58	0.78	0.88	0.85	0.62	0.60	0.58	0.87	0.88	0.75	0.90	-0.53	0.05	-0.17	0.14
BH	0.49	0.46	0.53	0.55	0.68		0.60	0.61	0.59	0.85	0.71	0.71	0.60	0.62	0.59	0.70	0.78	0.73	0.80	-0.49	0.44	-0.32	0.01
SW	0.81	0.60	0.65	0.34	0.51	0.45		0.71	0.68	0.63	0.56	0.52	0.78	0.77	0.85	0.56	0.59	0.50	0.59	0.07	0.19	-0.44	0.08
SN	0.73	0.75	0.75	0.45	0.61	0.58	0.63		0.72	0.61	0.58	0.55	0.79	0.82	0.82	0.58	0.56	0.54	0.60	0.03	0.19	-0.18	0.07
SR	0.74	0.84	0.64	0.41	0.51	0.48	0.58	0.7		0.60	0.56	0.51	0.83	0.83	0.73	0.57	0.55	0.52	0.60	0.07	0.06	-0.01	0.19
BW	0.51	0.45	0.53	0.57	0.76	0.86	0.46	0.57	0.49		0.70	0.66	0.60	0.63	0.60	0.72	0.76	0.72	0.81	-0.46	0.28	-0.51	0.02
BN	0.56	0.43	0.43	0.92	0.79	0.65	0.44	0.55	0.48	0.65		0.80	0.60	0.59	0.53	0.84	0.87	0.78	0.92	-0.56	-0.09	-0.12	0.14
BR	0.53	0.43	0.47	0.75	0.82	0.65	0.45	0.56	0.46	0.63	0.72		0.56	0.54	0.52	0.80	0.84	0.78	0.90	-0.56	0.01	0.04	0.11
SA	0.91	0.66	0.59	0.43	0.55	0.49	0.81	0.76	0.75	0.49	0.52	0.5		0.75	0.73	0.59	0.60	0.53	0.63	0.04	0.06	-0.17	0.31
SN	0.70	0.70	0.81	0.48	0.60	0.59	0.64	0.82	0.75	0.59	0.56	0.56	0.66		0.76	0.57	0.58	0.57	0.61	0.05	0.15	-0.18	0.10
SC	0.72	0.66	0.76	0.40	0.58	0.55	0.75	0.82	0.65	0.57	0.49	0.52	0.68	0.76		0.52	0.55	0.51	0.56	0.09	0.21	-0.29	-0.10
BA	0.57	0.45	0.45	0.68	0.85	0.65	0.47	0.57	0.49	0.67	0.75	0.78	0.53	0.57	0.51		0.77	0.64	0.86	-0.51	-0.01	-0.10	0.37
BN	0.60	0.49	0.49	0.68	0.83	0.74	0.52	0.60	0.52	0.76	0.78	0.79	0.57	0.60	0.57	0.74		0.70	0.91	-0.54	0.05	-0.17	0.12
BC	0.43	0.35	0.43	0.76	0.68	0.75	0.35	0.47	0.41	0.75	0.76	0.71	0.39	0.51	0.46	0.56	0.61		0.83	-0.52	0.14	-0.13	-0.22
Mkt	0.61	0.48	0.48	0.87	0.86	0.79	0.49	0.60	0.55	0.82	0.91	0.86	0.58	0.61	0.56	0.82	0.88	0.83		-0.61	0.02	-0.16	0.11
SMB	0.09	0.22	0.13	-0.60	-0.50	-0.56	0.18	0.07	0.19	-0.52	-0.59	-0.51	0.15	0.04	0.09	-0.47	-0.48	-0.62	-0.62		-0.01	0.07	0.04
HML	-0.28	0.11	0.37	-0.35	0.01	0.44	-0.04	0.10	-0.02	0.29	-0.22	-0.06	-0.16	0.13	0.12	-0.05	0.02	0.07	-0.07	-0.04		-0.35	-0.25
RMW	-0.20	0.02	-0.21	-0.01	-0.20	-0.38	-0.46	-0.13	0.15	-0.53	-0.12	0.06	-0.18	-0.12	-0.28	-0.11	-0.20	-0.21	-0.18	0.17	-0.30		0.19
AMC	0.35	0.18	0.00	-0.05	0.13	-0.11	0.26	0.15	0.24	-0.1	0.02	0.05	0.46	0.08	-0.04	0.36	0.14	-0.41	0.02	0.26	-0.29	0.11	

Table 5. **Panel D: Summary statistics of returns of 16 portfolios constructed from independent sorts on size and book-to-market from January 1990 to July 2016**

The panel D corresponds to the average monthly excess returns for 16 value-weighted portfolios from independent sorts of stocks into four *size* groups and four *book-to-market* groups. It is composed of 1163 French stocks. The table hereunder describes statistically the monthly excess return of each portfolio. The the unweighted arithmetic average μ_i is computed as follows: $\mu_i = \frac{1}{n}\sum_{t=1}^{t=n} R_{i_t}$ where R_{i_t} is the monthly return of stock i for the month t. Its empirical variance noted σ_i^2 is equal to $\sigma_i^2 = 1/(n-1)\sum_{t=1}^{t=n}(R_{i_t}-\mu_i)^2$ implying a standard deviation noted σ_i equal to the square root of the empirical variance. The Sharpe Ratio (SR) is a risk-adjusted return measure calculated as follows: $SR = \{\mu_i - R_f\}/\sigma_i$. The standard error of the mean is $SD_\mu = \sigma_i/\sqrt{n}$ and n is the number of observations.

Mean (%), μ

	Book-to-market ratio			
	Low	2	3	*High*
Small	2.82	2.06	2.49	2.72
2	1.89	1.37	1.42	2.16
3	1.50	1.48	1.46	1.51
Big	1.05	0.73	0.59	1.01

Variance (%), σ^2

	Book-to-market ratio			
	Low	2	3	*High*
Small	0.36	0.57	0.26	0.34
2	0.39	0.23	0.22	0.26
3	0.34	0.21	0.18	0.22
Big	0.41	0.28	0.31	0.78

Standard deviation (%), σ

	Book-to-market ratio			
	Low	2	3	*High*
Small	6.01	7.53	5.12	5.84
2	6.26	4.79	4.68	5.13
3	5.82	4.56	4.19	4.71
Big	6.42	5.29	5.58	8.82

Kurtosis

	Book-to-market ratio			
	Low	2	3	*High*
Small	0.85	37.62	1.83	21.93
2	9.35	3.11	2.11	4.28
3	5.57	0.81	1.15	1.85
Big	16.73	1.25	0.40	12.73

Skewness

	Book-to-market ratio			
	Low	2	3	*High*
Small	0.34	-2.99	0.71	2.47
2	1.21	0.83	0.33	1.18
3	0.60	-0.13	-0.27	0.26
Big	2.12	-0.36	-0.08	1.86

Median (%)

	Book-to-market ratio			
	Low	2	3	*High*
Small	2.09	1.72	2.09	2.23
2	1.66	0.95	1.14	1.93
3	1.58	1.37	1.61	1.59
Big	1.12	0.83	0.58	0.09

Minimum (%)

	Book-to-market ratio			
	Low	2	3	*High*
Small	-17.29	-76.52	-9.09	-18.93
2	-20.75	-11.87	-12.78	-12.27
3	-21.69	-14.22	-13.50	-15.11
Big	-15.75	-22.83	-14.75	-23.18

Maximum (%)

	Book-to-market ratio			
	Low	2	3	*High*
Small	23.35	30.07	25.09	56.34
2	45.34	24.38	23.78	28.36
3	37.02	15.25	16.09	21.07
Big	54.62	15.77	20.29	71.48

Sharpe ratio

	Book-to-market ratio			
	Low	2	3	*High*
Small	0.470	0.274	0.486	0.465
2	0.302	0.285	0.304	0.420
3	0.258	0.325	0.349	0.321
Big	0.163	0.139	0.106	0.114

25th percentile (%)

	Book-to-market ratio			
	Low	2	3	*High*
Small	-1.04	-1.36	-0.60	-1.04
2	-1.16	-1.41	-1.02	-1.02
3	-1.40	-1.30	-1.05	-1.07
Big	-2.30	-2.28	-2.62	-3.75

75th percentile (%)

	Book-to-market ratio			
	Low	2	3	*High*
Small	6.31	4.80	5.12	5.66
2	4.80	3.72	3.99	4.67
3	4.67	4.26	4.14	3.99
Big	4.15	4.31	4.22	5.10

Standard error (%)

	Book-to-market ratio			
	Low	2	3	*High*
Small	0.337	0.423	0.288	0.328
2	0.351	0.269	0.263	0.288
3	0.327	0.256	0.235	0.265
Big	0.360	0.297	0.313	0.496

Table 6. **Panel E: Summary statistics of returns of 16 portfolios constructed from independent sorts on size and operating profitability from January 1990 to July 2016**

The panel E corresponds to the average monthly excess returns for 16 value-weighted portfolios from independent sorts of stocks into four *size* groups and four *operating profitability* groups. It is composed of 1163 French stocks. The table hereunder describes statistically the monthly excess return of each portfolio. The the unweighted arithmetic average μ_i is computed as follows: $\mu_i = \frac{1}{n}\sum_{t=1}^{t=n} R_{i_t}$ where R_{i_t} is the monthly return of stock i for the month t. Its empirical variance noted σ_i^2 is equal to $\sigma_i^2 = 1/(n-1)\sum_{t=1}^{t=n}(R_{i_t}-\mu_i)^2$ implying a standard deviation noted σ_i equal to the square root of the empirical variance. The Sharpe Ratio (SR) is a risk-adjusted return measure calculated as follows: $SR = \{\mu_i - R_f\}/\sigma_i$. The standard error of the mean is $SD_\mu = \sigma_i/\sqrt{n}$ and n is the number of observations.

	Mean (%), μ					***Variance (%), σ^2***					***Standard deviation (%), σ***			
	Operating profitability ratio					*Operating profitability* ratio					*Operating profitability* ratio			
	Weak	2	3	*Robust*		*Weak*	2	3	*Robust*		*Weak*	2	3	*Robust*
Small	2.19	2.24	2.85	2.95	*Small*	0.50	0.23	0.29	0.53	*Small*	7.08	4.84	5.35	7.29
2	1.31	1.60	1.82	2.17	2	0.38	0.22	0.23	0.31	2	6.17	4.68	4.75	5.57
3	1.41	1.56	1.49	1.47	3	0.34	0.20	0.20	0.28	3	5.80	4.45	4.43	5.31
Big	0.73	0.86	0.71	0.99	*Big*	0.67	0.30	0.40	0.26	*Big*	8.17	5.44	6.35	5.09

	Kurtosis					***Skewness***					***Median (%)***			
	Operating profitability ratio					*Operating profitability* ratio					*Operating profitability* ratio			
	Weak	2	3	*Robust*		*Weak*	2	3	*Robust*		*Weak*	2	3	*Robust*
Small	14.19	1.03	0.87	33.72	*Small*	2.21	0.45	0.68	-3.06	*Small*	1.26	1.56	1.89	2.71
2	7.55	2.10	1.41	6.38	2	1.04	0.56	0.32	0.95	2	1.02	1.28	1.62	1.99
3	0.83	1.07	1.51	3.63	3	0.20	-0.01	-0.14	-0.18	3	1.48	1.66	1.73	1.73
Big	5.43	0.77	10.56	1.56	*Big*	0.70	-0.19	1.60	-0.12	*Big*	0.45	1.36	0.61	1.08

	Minimum (%)					***Maximum (%)***					***Sharpe ratio***			
	Operating profitability ratio					*Operating profitability* ratio					*Operating profitability* ratio			
	Weak	2	3	*Robust*		*Weak*	2	3	*Robust*		*Weak*	2	3	*Robust*
Small	-17.01	-16.11	-11.88	-71.42	*Small*	58.62	17.69	22.78	28.04	*Small*	0.309	0.463	0.531	0.405
2	-23.45	-13.58	-13.73	-14.21	2	39.42	19.87	21.51	38.48	2	0.212	0.342	0.384	0.390
3	-16.10	-13.92	-15.02	-21.93	3	21.67	17.94	19.58	25.10	3	0.244	0.352	0.336	0.276
Big	-28.07	-19.39	-21.31	-15.49	*Big*	53.53	20.82	47.77	24.40	*Big*	0.089	0.157	0.112	0.195

	25th percentile (%)					***75th percentile (%)***					***Standard error (%)***			
	Operating profitability ratio					*Operating profitability* ratio					*Operating profitability* ratio			
	Weak	2	3	*Robust*		*Weak*	2	3	*Robust*		*Weak*	2	3	*Robust*
Small	2.19	2.24	2.85	2.95	*Small*	2.19	2.24	2.85	2.95	*Small*	0.398	0.272	0.301	0.409
2	1.31	1.60	1.82	2.17	2	1.31	1.60	1.82	2.17	2	0.347	0.263	0.267	0.313
3	1.41	1.56	1.49	1.47	3	1.41	1.56	1.49	1.47	3	0.326	0.250	0.249	0.298
Big	0.73	0.86	0.71	0.99	*Big*	0.73	0.86	0.71	0.99	*Big*	0.459	0.305	0.357	0.286

Table 7. **Panel F: Summary statistics of returns of 16 portfolios constructed from independent sorts on size and investment from January 1990 to July 2016**

The panel F corresponds to the average monthly excess returns for 16 value-weighted portfolios from independent sorts of stocks into four *size* groups and four *investment* groups. It is composed of 1163 French stocks. The table hereunder describes statistically the monthly excess return of each portfolio. The the unweighted arithmetic average μ_i is computed as follows: $\mu_i = \frac{1}{n}\sum_{t=1}^{t=n} R_{i_t}$ where R_{i_t} is the monthly return of stock i for the month t. Its empirical variance noted σ_i^2 is equal to $\sigma_i^2 = 1/(n-1)\sum_{t=1}^{t=n}(R_{i_t}-\mu_i)^2$ implying a standard deviation noted σ_i equal to the square root of the empirical variance. The Sharpe Ratio (SR) is a risk-adjusted return measure calculated as follows: $SR = \{\mu_i - R_f\}/\sigma_i$. The standard error of the mean is $SD_\mu = \sigma_i/\sqrt{n}$ and n is the number of observations.

	Mean (%), μ					***Variance (%), σ^2***					***Standard deviation (%), σ***			
	Investment					*Investment*					*Investment*			
	Cons.	2	3	*Aggress.*		*Cons.*	2	3	*Aggress.*		*Cons.*	2	3	*Aggress.*
Small	2.21	2.30	2.55	3.23	*Small*	0.26	0.24	0.35	0.50	*Small*	5.1	4.90	5.95	7.05
2	1.47	1.68	1.76	1.79	2	0.22	0.21	0.20	0.43	2	4.66	4.60	4.42	6.55
3	1.54	1.26	1.47	1.48	3	0.25	0.15	0.23	0.42	3	5.00	3.88	4.84	6.45
Big	0.84	0.70	0.83	0.81	*Big*	0.60	0.30	0.31	0.32	*Big*	7.73	5.44	5.53	5.65

	Kurtosis					***Skewness***					***Median (%)***			
	Investment					*Investment*					*Investment*			
	Cons.	2	3	*Aggress.*		*Cons.*	2	3	*Aggress.*		*Cons.*	2	3	*Aggress.*
Small	1.11	1.79	8.12	1.97	*Small*	0.65	0.76	1.12	0.63	*Small*	1.21	1.86	2.09	2.20
2	0.52	3.15	2.10	8.40	2	0.27	0.50	-0.11	1.24	2	1.14	1.29	1.85	1.18
3	1.52	1.33	2.33	5.37	3	0.08	-0.26	0.15	0.33	3	1.41	1.36	1.72	2.03
Big	22.33	0.85	0.70	1.93	*Big*	2.84	0.16	-0.23	-0.23	*Big*	0.06	0.86	1.10	1.32

	Minimum (%)					***Maximum (%)***					***Sharpe ratio***			
	Investment					*Investment*					*Investment*			
	Cons.	2	3	*Aggress.*		*Cons.*	2	3	*Aggress.*		*Cons.*	2	3	*Aggress.*
Small	-13.17	-8.47	-20.81	-19.83	*Small*	21.55	26.02	42.24	35.13	*Small*	0.434	0.47	0.429	0.458
2	-12.06	-15.03	-14.65	-22.16	2	15.87	24.80	19.57	45.51	2	0.316	0.366	0.397	0.274
3	-13.60	-14.02	-13.82	-26.06	3	24.49	14.69	22.90	41.68	3	0.308	0.326	0.304	0.230
Big	-25.63	-16.33	-18.18	-20.96	*Big*	70.10	21.8	17.50	26.19	*Big*	0.108	0.128	0.150	0.144

	25th percentile (%)					***75th percentile (%)***					***Standard error (%)***			
	Investment					*Investment*					*Investment*			
	Cons.	2	3	*Aggress.*		*Cons.*	2	3	*Aggress.*		*Cons.*	2	3	*Aggress.*
Small	-1.22	-0.89	-0.53	-1.18	*Small*	5.25	4.86	5.22	6.68	*Small*	0.286	0.275	0.334	0.396
2	-1.07	-0.89	-0.86	-1.51	2	4.19	4.14	4.36	4.73	2	0.262	0.258	0.248	0.368
3	-1.11	-0.63	-1.22	-2.16	3	4.50	3.49	4.12	4.56	3	0.281	0.218	0.272	0.362
Big	-2.96	-2.98	-2.28	-2.37	*Big*	4.17	3.79	4.33	4.36	*Big*	0.434	0.305	0.310	0.317

Table 8. **Pearson and Spearman correlation matrix of monthly excess returns of the panel D: January 1990 to July 2016**

At the end of each July, stocks are classified into four size groups (*small to big*) using market capitalization breakpoints. Stocks are subsequently allocated independently to four *book-to-market* groups (*low to high*) constituting the Panel D. The intersections of the two sorts produce 16 value-weighted portfolios corresponding the *left hand side* variables. The *right hand side* variables are explanatory variables: the excess market returns, net of the 3 months EURIBOR interest rate, $(R_M - Rf)$, the *size* factor (SMB), the *value* factor (HML), the *operating profitability* factor (RMW), and the *investment* factor (AMC). The last explanatory variable is the size effect in its orthogonal version noted $SMB^{\perp}$. We use both the *Pearson* (black figures) and the *Spearman* (blue figures) correlations to study the relations between variables. The first two characters correspond to the size quartile (1 is the smallest and 4 is the biggest). The three next correspond to the *book-to-market* ratio quartile (1 is the smallest and 4 is the biggest). For instance, S1BM4 is a value-scaled portfolio comprising simultaneously the smallest 25% firms and the highest 25% book-to-market stocks.

Spearman correlation (above diagonal); *Pearson correlation matrix* (below diagonal)

	S1BM1	S1BM2	S1BM3	S1BM4	S2BM1	S2BM2	S2BM3	S2BM4	S3BM1	S3BM2	S3BM3	S3BM4	S4BM1	S4BM2	S4BM3	S4BM4	Mkt	SMB	HML	RMW	AMC	$SMB^{\perp}$
S1BM1		0.40	0.53	0.44	0.61	0.59	0.58	0.58	0.56	0.58	0.61	0.56	0.39	0.50	0.47	0.48	0.51	0.03	0.04	-0.10	0.21	0.49
S1BM2	0.33		0.48	0.41	0.45	0.51	0.53	0.49	0.52	0.48	0.46	0.51	0.27	0.41	0.41	0.44	0.41	0.09	0.14	-0.13	0.02	0.41
S1BM3	0.53	0.38		0.44	0.50	0.50	0.53	0.58	0.48	0.51	0.53	0.50	0.32	0.46	0.41	0.43	0.44	0.05	0.16	-0.13	0.08	0.40
S1BM4	0.45	0.35	0.39		0.39	0.43	0.45	0.55	0.37	0.42	0.49	0.45	0.26	0.36	0.37	0.41	0.37	0.07	0.31	-0.20	0.07	0.37
S2BM1	0.57	0.32	0.44	0.28		0.59	0.56	0.58	0.69	0.66	0.66	0.58	0.48	0.66	0.58	0.54	0.64	-0.04	-0.12	-0.15	0.20	0.49
S2BM2	0.59	0.41	0.45	0.37	0.61		0.64	0.59	0.63	0.53	0.58	0.56	0.36	0.50	0.47	0.49	0.48	0.09	0.06	-0.12	0.17	0.52
S2BM3	0.57	0.47	0.54	0.38	0.55	0.64		0.64	0.60	0.66	0.66	0.59	0.40	0.56	0.55	0.55	0.56	0.03	0.20	-0.24	0.10	0.47
S2BM4	0.54	0.41	0.55	0.42	0.44	0.48	0.60		0.58	0.62	0.65	0.71	0.40	0.54	0.51	0.56	0.54	0.07	0.35	-0.24	-0.04	0.45
S3BM1	0.57	0.38	0.42	0.33	0.73	0.67	0.58	0.47		0.69	0.64	0.60	0.48	0.67	0.60	0.58	0.65	-0.16	0.03	-0.18	0.20	0.35
S3BM2	0.61	0.37	0.54	0.34	0.56	0.53	0.67	0.60	0.62		0.71	0.66	0.47	0.64	0.64	0.57	0.64	-0.16	0.12	-0.19	0.05	0.29
S3BM3	0.63	0.39	0.54	0.43	0.57	0.56	0.69	0.61	0.59	0.73		0.70	0.48	0.60	0.57	0.60	0.62	-0.10	0.16	-0.11	0.07	0.37
S3BM4	0.56	0.38	0.52	0.41	0.46	0.49	0.60	0.68	0.53	0.68	0.73		0.44	0.56	0.54	0.58	0.58	-0.12	0.25	-0.20	-0.07	0.28
S4BM1	0.34	0.18	0.30	0.17	0.41	0.34	0.36	0.31	0.45	0.47	0.46	0.42		0.72	0.65	0.51	0.85	-0.60	-0.24	0.03	0.09	-0.07
S4BM2	0.48	0.29	0.44	0.28	0.63	0.50	0.55	0.45	0.66	0.63	0.61	0.53	0.63		0.78	0.63	0.89	-0.50	-0.01	-0.15	0.21	0.10
S4BM3	0.47	0.35	0.42	0.28	0.50	0.48	0.56	0.46	0.58	0.66	0.61	0.57	0.61	0.78		0.68	0.85	-0.52	0.14	-0.18	0.07	0.00
S4BM4	0.40	0.29	0.35	0.31	0.44	0.42	0.50	0.43	0.47	0.53	0.56	0.52	0.48	0.58	0.64		0.73	-0.45	0.46	-0.33	-0.02	0.00
Mkt	0.49	0.32	0.42	0.28	0.60	0.49	0.54	0.45	0.65	0.64	0.63	0.57	0.84	0.86	0.83	0.74		-0.61	0.02	-0.16	0.11	0.02
SMB	0.08	0.22	0.07	0.12	0.04	0.13	0.06	0.13	-0.08	-0.16	-0.1	-0.12	-0.62	-0.47	-0.5	-0.53	-0.62		-0.01	0.07	0.04	0.69
HML	-0.02	0.13	0.08	0.25	-0.30	-0.05	0.14	0.35	-0.13	0.08	0.10	0.22	-0.35	-0.08	0.1	0.44	-0.07	-0.04		-0.35	-0.25	-0.09
RMW	-0.08	0.02	-0.11	-0.18	-0.21	-0.06	-0.20	-0.18	-0.16	-0.15	-0.09	-0.17	0.02	-0.2	-0.19	-0.39	-0.18	0.17	-0.3		0.19	0.06
AMC	0.19	0.05	0.06	0.04	0.37	0.23	0.14	0.00	0.31	0.04	0.04	-0.04	-0.1	0.22	0.03	-0.15	0.02	0.26	-0.29	0.11		-0.41
$SMB^{\perp}$	0.47	0.47	0.37	0.33	0.55	0.54	0.47	0.43	0.44	0.26	0.32	0.24	-0.13	0.13	0.02	-0.14	0.00	0.75	-0.19	0.12	-0.59	

TABLE 9. **Pearson and Spearman correlation matrix of monthly excess returns of the panel E: January 1990 to July 2016**

At the end of each July, stocks are classified into four size groups (*small to big*) using market capitalization breakpoints. Stocks are subsequently allocated independently to four *operating profitability* groups (*weak to robust*) constituting the Panel E. The intersections of the two sorts produce 16 value-weighted portfolios corresponding the *left hand side* variables. The *right hand side* variables are explanatory variables: the excess market returns, net of the 3 months EURIBOR interest rate, $(R_M - Rf)$, the *size* factor (SMB), the *value* factor (HML), the *operating profitability* factor (RMW), and the *investment* factor (AMC). The last explanatory variable is the size effect in its orthogonal version noted $SMB^{\perp}$. We use both the *Pearson* (black figures) and the *Spearman* (blue figures) correlations to study the relations between variables. The first two characters correspond to the size quartile (1 is the smallest and 4 is the biggest). The three next correspond to the *operating profitability* ratio quartile (1 is the weakest and 4 is the most robust). For instance, S1OP4 is a value-scaled portfolio comprising simultaneously the smallest 25% firms and the highest 25% *operating profitable* stocks.

Spearman correlation (above the diagonal); *Pearson correlation matrix* (below the diagonal)

	S1OP1	S1OP2	S1OP3	S1OP4	S2OP1	S2OP2	S2OP3	S2OP4	S3OP1	S3OP2	S3OP3	S3OP4	S4OP1	S4OP2	S4OP3	S4OP4	Mkt	SMB	HML	RMW	AMC	$SMB^{\perp}$
S1OP1		0.36	0.33	0.44	0.46	0.47	0.49	0.44	0.48	0.42	0.44	0.49	0.46	0.39	0.31	0.36	0.41	0.05	0.20	-0.30	0.04	0.36
S1OP2	0.34		0.46	0.46	0.51	0.47	0.53	0.44	0.44	0.47	0.51	0.45	0.34	0.35	0.28	0.36	0.34	0.12	0.19	-0.13	0.07	0.42
S1OP3	0.37	0.41		0.45	0.43	0.52	0.56	0.53	0.46	0.52	0.52	0.52	0.40	0.38	0.36	0.40	0.42	0.00	0.13	-0.03	0.11	0.39
S1OP4	0.33	0.40	0.36		0.52	0.55	0.57	0.54	0.52	0.60	0.54	0.53	0.45	0.47	0.44	0.43	0.50	0.03	0.10	-0.05	0.15	0.44
S2OP1	0.40	0.48	0.33	0.43		0.58	0.63	0.61	0.67	0.59	0.64	0.62	0.56	0.54	0.50	0.47	0.57	0.06	0.14	-0.41	0.08	0.49
S2OP2	0.40	0.48	0.49	0.51	0.54		0.66	0.61	0.58	0.70	0.65	0.63	0.55	0.57	0.50	0.49	0.56	-0.01	0.18	-0.18	0.04	0.42
S2OP3	0.42	0.55	0.53	0.52	0.62	0.7		0.63	0.61	0.65	0.69	0.68	0.54	0.55	0.46	0.52	0.57	0.04	0.12	-0.17	0.10	0.49
S2OP4	0.33	0.48	0.48	0.45	0.63	0.6	0.67		0.60	0.61	0.66	0.64	0.53	0.53	0.47	0.47	0.55	0.03	0.02	-0.03	0.20	0.54
S3OP1	0.45	0.46	0.45	0.39	0.54	0.52	0.57	0.52		0.64	0.62	0.61	0.58	0.59	0.49	0.49	0.57	-0.11	0.18	-0.30	0.01	0.30
S3OP2	0.34	0.47	0.52	0.50	0.54	0.69	0.64	0.59	0.63		0.70	0.70	0.55	0.61	0.57	0.57	0.63	-0.13	0.11	-0.11	0.02	0.31
S3OP3	0.39	0.53	0.53	0.51	0.61	0.66	0.72	0.68	0.61	0.71		0.74	0.56	0.63	0.59	0.58	0.64	-0.11	0.13	-0.13	0.10	0.36
S3OP4	0.39	0.49	0.44	0.49	0.64	0.63	0.72	0.67	0.54	0.64	0.73		0.60	0.61	0.59	0.60	0.67	-0.14	0.08	-0.13	0.15	0.36
S4OP1	0.32	0.33	0.34	0.35	0.43	0.50	0.50	0.47	0.54	0.52	0.53	0.55		0.69	0.61	0.61	0.78	-0.44	0.26	-0.48	0.04	0.05
S4OP2	0.31	0.35	0.37	0.42	0.46	0.54	0.53	0.49	0.57	0.62	0.64	0.60	0.67		0.72	0.77	0.86	-0.50	0.10	-0.15	0.12	0.06
S4OP3	0.20	0.25	0.30	0.34	0.40	0.44	0.45	0.44	0.41	0.51	0.55	0.54	0.56	0.64		0.74	0.87	-0.58	-0.09	-0.10	0.13	-0.03
S4OP4	0.27	0.36	0.38	0.35	0.43	0.48	0.53	0.46	0.46	0.58	0.60	0.60	0.56	0.74	0.62		0.88	-0.54	-0.02	0.05	0.11	0.02
Mkt	0.29	0.35	0.39	0.42	0.50	0.53	0.58	0.54	0.53	0.63	0.67	0.67	0.79	0.83	0.86	0.82		-0.61	0.02	-0.16	0.11	0.02
SMB	0.13	0.14	0.04	0.17	0.16	0.06	0.06	0.11	-0.10	-0.11	-0.10	-0.09	-0.51	-0.48	-0.60	-0.48	-0.62		-0.01	0.07	0.04	0.69
HML	0.19	0.11	0.10	0.05	-0.11	0.18	0.04	-0.09	0.17	0.06	0.03	-0.06	0.27	0.05	-0.22	-0.08	-0.07	-0.04		-0.35	-0.25	-0.09
RMW	-0.33	-0.11	0.01	0.13	-0.40	-0.17	-0.14	0.01	-0.28	-0.09	-0.09	-0.13	-0.52	-0.16	-0.09	0.07	-0.18	0.17	-0.30		0.19	0.06
AMC	0.03	0.14	0.08	0.14	0.29	0.11	0.18	0.29	0.00	0.03	0.16	0.25	-0.09	0.07	0.03	0.08	0.02	0.26	-0.29	0.11		-0.41
$SMB^{\perp}$	0.33	0.42	0.33	0.52	0.58	0.45	0.51	0.57	0.24	0.30	0.39	0.43	-0.07	0.05	-0.07	0.06	0.00	0.75	-0.19	0.12	-0.60	

TABLE 10. **Pearson and Spearman correlation matrix of monthly excess returns of the panel F: January 1990 to July 2016**

At the end of each July, stocks are classified into four size groups (*small to big*) using market capitalization breakpoints. Stocks are subsequently allocated independently to four *investment* groups (*conservative to aggressive*) constituting the Panel F. The intersections of the two sorts produce 16 value-weighted portfolios corresponding the *left hand side* variables. The *right hand side* variables are explanatory variables: the excess market returns, net of the 3 months EURIBOR interest rate, $(R_M - Rf)$, the *size* factor (SMB), the *value* factor (HML), the *operating profitability* factor (RMW), and the *investment* factor (AMC). The last explanatory variable is the size effect in its orthogonal version noted $SMB^{\perp}$. We use both the *Pearson* (black figures) and the *Spearman* (blue figures) correlations to study the relations between variables. The first two characters correspond to the size quartile (1 is the smallest and 4 is the biggest). The four next correspond to the *investment* quartile (1 is the most conservative and 4 is the most aggressive). For instance, S1INV4 is a value-scaled portfolio comprising simultaneously the smallest 25% firms and the highest 25% *aggressive* stocks.

Spearman correlation

Pearson correlation matrix

	S1INV1	S1INV2	S1INV3	S1INV4	S2INV1	S2INV2	S2INV3	S2INV4	S3INV1	S3INV2	S3INV3	S3INV4	S4INV1	S4INV2	S4INV3	S4INV4	Mkt	SMB	HML	RMW	AMC	$SMB^{\perp}$
S1INV1		0.43	0.46	0.40	0.51	0.52	0.55	0.56	0.53	0.46	0.52	0.54	0.40	0.39	0.37	0.38	0.44	0.06	0.19	-0.26	0.01	0.39
S1INV2	0.44		0.39	0.40	0.53	0.50	0.53	0.54	0.45	0.49	0.42	0.46	0.36	0.38	0.35	0.38	0.39	0.05	0.21	-0.11	0.07	0.35
S1INV3	0.40	0.31		0.45	0.49	0.52	0.57	0.55	0.48	0.48	0.54	0.56	0.41	0.40	0.40	0.44	0.47	0.01	0.09	-0.12	0.16	0.41
S1INV4	0.42	0.38	0.42		0.52	0.54	0.51	0.51	0.49	0.50	0.50	0.49	0.40	0.44	0.41	0.44	0.47	0.01	0.07	-0.10	0.16	0.42
S2INV1	0.54	0.51	0.49	0.51		0.65	0.61	0.63	0.59	0.62	0.62	0.60	0.42	0.49	0.49	0.44	0.51	0.10	0.17	-0.24	-0.11	0.46
S2INV2	0.49	0.44	0.49	0.47	0.65		0.65	0.66	0.60	0.61	0.60	0.62	0.52	0.51	0.52	0.51	0.57	0.01	0.14	-0.19	0.08	0.45
S2INV3	0.52	0.52	0.54	0.48	0.65	0.62		0.68	0.63	0.60	0.65	0.67	0.52	0.53	0.51	0.51	0.58	0.04	0.09	-0.17	0.14	0.53
S2INV4	0.49	0.42	0.46	0.47	0.62	0.54	0.67		0.62	0.62	0.63	0.71	0.52	0.56	0.52	0.53	0.59	0.03	0.08	-0.18	0.28	0.56
S3INV1	0.54	0.46	0.47	0.46	0.62	0.60	0.61	0.48		0.66	0.67	0.64	0.60	0.53	0.53	0.54	0.60	-0.15	0.19	-0.25	-0.03	0.26
S3INV2	0.46	0.48	0.44	0.47	0.64	0.64	0.62	0.47	0.68		0.63	0.63	0.57	0.56	0.53	0.52	0.59	-0.14	0.18	-0.15	-0.00	0.30
S3INV3	0.49	0.40	0.51	0.52	0.65	0.58	0.72	0.65	0.61	0.60		0.71	0.49	0.60	0.58	0.56	0.63	-0.11	0.03	-0.15	0.11	0.35
S3INV4	0.51	0.40	0.51	0.47	0.64	0.58	0.69	0.74	0.55	0.56	0.75		0.56	0.60	0.61	0.60	0.67	-0.15	0.10	-0.12	0.18	0.38
S4INV1	0.29	0.26	0.30	0.28	0.37	0.46	0.42	0.35	0.52	0.50	0.43	0.42		0.64	0.64	0.59	0.80	-0.51	0.13	-0.18	-0.18	-0.08
S4INV2	0.40	0.36	0.38	0.45	0.52	0.48	0.54	0.56	0.55	0.54	0.62	0.61	0.53		0.80	0.67	0.86	-0.51	0.09	-0.16	0.07	0.04
S4INV3	0.36	0.32	0.39	0.41	0.53	0.51	0.55	0.47	0.53	0.57	0.61	0.60	0.55	0.78		0.74	0.89	-0.57	0.00	-0.13	0.15	0.01
S4INV4	0.35	0.31	0.40	0.36	0.44	0.49	0.53	0.45	0.53	0.52	0.56	0.60	0.50	0.63	0.71		0.82	-0.50	0.00	-0.10	0.37	0.11
Mkt	0.41	0.34	0.43	0.44	0.52	0.55	0.59	0.54	0.60	0.59	0.65	0.65	0.77	0.83	0.87	0.78		-0.61	0.02	-0.16	0.11	0.02
SMB	0.09	0.07	0.04	0.06	0.10	0.00	0.07	0.15	-0.17	-0.15	-0.07	-0.06	-0.6	-0.43	-0.51	-0.47	-0.62		-0.01	0.07	0.04	0.69
HML	0.15	0.17	0.07	-0.02	0.09	0.12	0.01	-0.16	0.19	0.15	-0.07	-0.08	0.11	0.02	-0.03	-0.03	-0.07	-0.04		-0.35	-0.25	-0.09
RMW	-0.28	-0.07	-0.08	-0.09	-0.23	-0.12	-0.14	-0.2	-0.25	-0.12	-0.12	-0.10	-0.26	-0.19	-0.17	-0.10	-0.18	0.17	-0.30		0.19	0.06
AMC	0.04	0.02	0.14	0.18	-0.01	0.02	0.22	0.45	-0.04	-0.04	0.20	0.32	-0.40	0.10	0.14	0.36	0.02	0.26	-0.29	0.11		-0.41
$SMB^{\perp}$	0.39	0.31	0.37	0.41	0.45	0.37	0.53	0.65	0.20	0.22	0.42	0.47	-0.26	0.11	0.07	0.12	0.00	0.75	-0.19	0.12	-0.59	

Table 11. **Time series regressions of monthly excess returns of the 18 portfolios of the three panels A, B and C with the Sharpe-Lintner-Black model (1964): January 1990 to July 2016**

The sample is composed of 1163 stocks. The 16 portfolios are constructed based on a double and independent size and book-to-market classification. The table hereunder describes statistically the monthly excess return of each portfolio.

$$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + \epsilon_{i_t}$$

		Panel A			**Panel B**			**Panel C**		
		Intercept, α								
		Book-to-market Ratio			*Operating profitability Ratio*			*Investment*		
	α_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Cons.
Size	Small	**0.015** ***	**0.011** ***	**0.019** ***	**0.011** ***	**0.015** ***	**0.018** ***	**0.015** ***	**0.015** ***	**0.013** ***
		(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)
	Big	**0.001**	**0.000**	**-0.001**	**-0.002**	**0.000**	**0.003** *	**0.001**	**0.001**	**-0.001**
		(0.002)	(0.001)	(0.003)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
		Market Premium, $R_M - R_f$								
		Book-to-market Ratio			*Operating profitability Ratio*			*Investment*		
	β_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Cons.
Size	Small	**0.680** ***	**0.473** ***	**0.427** ***	**0.538** ***	**0.493** ***	**0.604** ***	**0.680** ***	**0.483** ***	**0.450** ***
		(0.049)	(0.049)	(0.044)	(0.054)	(0.037)	(0.052)	(0.054)	(0.036)	(0.038)
	Big	**1.065** ***	**0.873** ***	**1.196** ***	**1.162** ***	**1.034** ***	**0.829** ***	**0.871** ***	**0.877** ***	**1.076** ***
		(0.034)	(0.028)	(0.052)	(0.046)	(0.026)	(0.028)	(0.034)	(0.026)	(0.041)

Table 12. **Time series regressions of monthly excess returns of the 18 portfolios of the three panels A, B and C with the Fama and French three-factor model (1993): January 1990 to July 2016**

The sample is composed of 1163 stocks. The 16 portfolios are constructed based on a double and independent size and book-to-market classification. The table hereunder describes statistically the monthly excess return of each portfolio.

$$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + s_i(R_{SMB_t}) + h_i(R_{HML_t}) + \epsilon_{i_t}$$

		Panel A			Panel B			Panel C		
					Intercept, α					
		Book-to-market Ratio			*Operating profitability Ratio*			*Investment*		
	α_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**0.000**	**-0.004** **	**0.006** ***	**-0.005** **	**0.003** **	**0.000**	**-0.002**	**0.005** ***	**0.002**
		(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
	Big	**0.005** ***	**-0.002**	**-0.001**	**-0.004** *	**0.002**	**0.002**	**0.000**	**-0.001**	**0.003**
		(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)
					Market Premium, $R_M - R_f$					
		Book-to-market Ratio			*Operating profitability Ratio*			*Investment*		
	β_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**1.169** ***	**1.016** ***	**0.876** ***	**1.086** ***	**0.884** ***	**1.209** ***	**1.266** ***	**0.840** ***	**0.834** ***
		(0.039)	(0.038)	(0.032)	(0.048)	(0.032)	(0.039)	(0.043)	(0.032)	(0.033)
	Big	**0.924** ***	**0.921** ***	**1.217** ***	**1.226** ***	**0.978** ***	**0.847** ***	**0.906** ***	**0.957** ***	**0.961** ***
		(0.033)	(0.036)	(0.038)	(0.047)	(0.030)	(0.036)	(0.044)	(0.032)	(0.051)
					Small Minus Big, SMB					
		Book-to-market Ratio			*Operating profitability Ratio*			*Investment*		
	s_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**0.971** ***	**1.020** ***	**0.810** ***	**1.048** ***	**0.731** ***	**1.153** ***	**1.139** ***	**0.665** ***	**0.715** ***
		(0.047)	(0.046)	(0.038)	(0.057)	(0.038)	(0.046)	(0.052)	(0.038)	(0.040)
	Big	**-0.221** ***	**0.082** *	**-0.060**	**0.058**	**-0.083** **	**0.033**	**0.066**	**0.141** ***	**-0.241** ***
		(0.040)	(0.043)	(0.046)	(0.057)	(0.036)	(0.043)	(0.053)	(0.039)	(0.060)
					High Minus Low, HML					
		Book-to-market Ratio			*Operating profitability Ratio*			*Investment*		
	h_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**-0.221** ***	**0.246** ***	**0.487** ***	**0.082** *	**0.198** ***	**0.123** ***	**-0.064**	**0.218** ***	**0.213** ***
		(0.036)	(0.035)	(0.029)	(0.044)	(0.029)	(0.035)	(0.039)	(0.029)	(0.030)
	Big	**-0.434** ***	**0.089** ***	**0.857** ***	**0.571** ***	**-0.213** ***	**-0.003**	**0.010**	**0.111** ***	**0.165** ***
		(0.030)	(0.033)	(0.034)	(0.043)	(0.027)	(0.033)	(0.040)	(0.029)	(0.046)

Table 13. **Time series regressions of monthly excess returns of the 18 portfolios of the three panels A, B and C with the Fama and French five-factor model (2015): January 1990 to July 2016**

Eighteen portfolios are constructed based on a double and independent size and book-to-market classification from our sample comprising 1163 stocks. We have five explanatory variables: the market premium, HML, SMB, RMW and AMC. The risk free interest rate used is the 3 months EURIBOR interest rate. The table hereunder describes statistically the monthly excess return of each portfolio.

$$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + s_i(R_{SMB_t}) + h_i(R_{HML_t}) + c_i(R_{AMC_t}) + r_i(R_{RMW_t}) + \epsilon_{i_t}$$

Panel A | **Panel B** | **Panel C**

Intercept, α

			Book-to-market Ratio			*Operating profitability Ratio*			*Investment*	
	α_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**0.003** *	**-0.005** ***	**0.006** ***	**-0.001**	**0.003** **	**-0.002**	**0.001**	**0.005** ***	**0.002**
		(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
	Big	**0.003** **	**-0.001**	**0.000**	**-0.001**	**0.001**	**0.000**	**0.002**	**0.000**	**0.000**
		(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)

Market Premium, $R_M - R_f$

			Book-to-market Ratio			*Operating profitability Ratio*			*Investment*	
	β_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**1.096** ***	**1.044** ***	**0.897** ***	**0.979** ***	**0.884** ***	**1.255** ***	**1.154** ***	**0.858** ***	**0.856** ***
		(0.036)	(0.038)	(0.033)	(0.035)	(0.033)	(0.034)	(0.037)	(0.033)	(0.031)
	Big	**0.979** ***	**0.879** ***	**1.179** ***	**1.156** ***	**0.989** ***	**0.880** ***	**0.801** ***	**0.915** ***	**1.099** ***
		(0.032)	(0.036)	(0.038)	(0.038)	(0.031)	(0.033)	(0.035)	(0.032)	(0.037)

Small Minus Big, SMB

			Book-to-market Ratio			*Operating profitability Ratio*			*Investment*	
	s_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**0.921** ***	**1.015** ***	**0.854** ***	**1.036** ***	**0.732** ***	**1.130** ***	**0.995** ***	**0.691** ***	**0.812** ***
		(0.045)	(0.047)	(0.040)	(0.043)	(0.041)	(0.042)	(0.046)	(0.040)	(0.038)
	Big	**-0.145** ***	**0.013**	**-0.077** *	**0.097** **	**-0.063** *	**0.003**	**-0.151** ***	**0.071** *	**0.031**
		(0.040)	(0.044)	(0.047)	(0.047)	(0.038)	(0.041)	(0.042)	(0.039)	(0.045)

High Minus Low, HML

			Book-to-market Ratio			*Operating profitability Ratio*			*Investment*	
	h_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**-0.269** ***	**0.298** ***	**0.458** ***	**-0.075** **	**0.197** ***	**0.232** ***	**-0.040**	**0.210** ***	**0.110** ***
		(0.035)	(0.037)	(0.031)	(0.034)	(0.032)	(0.033)	(0.036)	(0.031)	(0.029)
	Big	**-0.453** ***	**0.120** ***	**0.820** ***	**0.402** ***	**-0.226** ***	**0.094** ***	**0.150** ***	**0.144** ***	**0.000**
		(0.031)	(0.034)	(0.036)	(0.036)	(0.030)	(0.032)	(0.033)	(0.031)	(0.035)

Robust Minus Weak, RMW

			Book-to-market Ratio			*Operating profitability Ratio*			*Investment*	
	r_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**-0.315** ***	**0.203** ***	**-0.014**	**-0.679** ***	**0.001**	**0.392** ***	**-0.252** ***	**0.030**	**-0.186** ***
		(0.040)	(0.042)	(0.036)	(0.039)	(0.036)	(0.038)	(0.041)	(0.036)	(0.034)
	Big	**0.107** ***	**-0.040**	**-0.194** ***	**-0.602** ***	**-0.001**	**0.326** ***	**0.050**	**-0.036**	**-0.016**
		(0.035)	(0.040)	(0.042)	(0.042)	(0.034)	(0.037)	(0.038)	(0.035)	(0.040)

Aggressive Minus Conservative, AMC

			Book-to-market Ratio			*Operating profitability Ratio*			*Investment*	
	c_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**0.170** ***	**-0.010**	**-0.118** ***	**0.108** ***	**-0.003**	**0.021**	**0.421** ***	**-0.074** **	**-0.245** ***
		(0.041)	(0.043)	(0.036)	(0.039)	(0.037)	(0.039)	(0.042)	(0.036)	(0.035)
	Big	**-0.220** ***	**0.193** ***	**0.068**	**-0.040**	**-0.055**	**0.047**	**0.590** ***	**0.196** ***	**-0.744** ***
		(0.036)	(0.040)	(0.043)	(0.043)	(0.035)	(0.037)	(0.039)	(0.036)	(0.041)

Table 14. **Time series regressions of monthly excess returns of the Panels A, B and C with our alternative orthogonal Fama and French five-factor model: January 1990 to July 2016**

Sixteen portfolios are constructed based on a double and independent size and book-to-market classification from our sample comprising 1163 stocks. We have five explanatory variables: the market premium, HML, SMB, RMW and AMC. The risk free interest rate used is the 3 months EURIBOR interest rate. The table hereunder describes statistically the monthly excess return of each portfolio.

$$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + s_i(R_{SMB_t^{\perp}}) + h_i(R_{HML_t}) + c_i(R_{AMC_t}) + r_i(R_{RMW_t}) + \epsilon_{i_t}$$

Panel A **Panel B** **Panel C**

Intercept, α

		Book-to-market Ratio			*Operating profitability Ratio*			*Investment*		
	α_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**0.003** *	**-0.005** ***	**0.006** ***	**-0.001**	**0.003** **	**-0.002**	**0.001**	**0.005** ***	**0.002**
		(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
	Big	**0.003** **	**-0.001**	**0.000**	**-0.001**	**0.001**	**0.000**	**0.002**	**0.000**	**0.000**
		(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)

Market Premium, $R_M - R_f$

		Book-to-market Ratio			*Operating profitability Ratio*			*Investment*		
	β_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**0.619** ***	**0.518** ***	**0.455** ***	**0.442** ***	**0.505** ***	**0.670** ***	**0.639** ***	**0.500** ***	**0.435** ***
		(0.028)	(0.030)	(0.025)	(0.027)	(0.026)	(0.027)	(0.029)	(0.025)	(0.024)
	Big	**1.054** ***	**0.873** ***	**1.219** ***	**1.106** ***	**1.021** ***	**0.878** ***	**0.879** ***	**0.878** ***	**1.083** ***
		(0.025)	(0.028)	(0.030)	(0.029)	(0.024)	(0.026)	(0.027)	(0.025)	(0.028)

Orthogonal Small Minus Big, $SMB^{\perp}$

		Book-to-market Ratio			*Operating profitability Ratio*			*Investment*		
	s_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**0.921** ***	**1.015** ***	**0.854** ***	**1.036** ***	**0.732** ***	**1.130** ***	**0.995** ***	**0.691** ***	**0.812** ***
		(0.045)	(0.047)	(0.040)	(0.043)	(0.041)	(0.042)	(0.046)	(0.040)	(0.038)
	Big	**-0.145** ***	**0.013**	**-0.077** *	**0.097** **	**-0.063** *	**0.003**	**-0.151** ***	**0.071** *	**0.031**
		(0.040)	(0.044)	(0.047)	(0.047)	(0.038)	(0.041)	(0.042)	(0.039)	(0.045)

High Minus Low, HML

		Book-to-market Ratio			*Operating profitability Ratio*			*Investment*		
	h_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**-0.267** ***	**0.301** ***	**0.460** ***	**-0.073** **	**0.199** ***	**0.235** ***	**-0.038**	**0.212** ***	**0.112** ***
		(0.035)	(0.037)	(0.031)	(0.034)	(0.032)	(0.033)	(0.036)	(0.031)	(0.029)
	Big	**-0.453** ***	**0.120** ***	**0.820** ***	**0.402** ***	**-0.226** ***	**0.094** ***	**0.150** ***	**0.144** ***	**0.000**
		(0.031)	(0.034)	(0.036)	(0.036)	(0.030)	(0.032)	(0.033)	(0.031)	(0.035)

Robust Minus Weak, RMW

		Book-to-market Ratio			*Operating profitability Ratio*			*Investment*		
	r_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**-0.341** ***	**0.174** ***	**-0.038**	**-0.709** ***	**-0.020**	**0.360** ***	**-0.280** ***	**0.011**	**-0.209** ***
		(0.040)	(0.042)	(0.036)	(0.039)	(0.036)	(0.038)	(0.041)	(0.036)	(0.034)
	Big	**0.112** ***	**-0.040**	**-0.191** ***	**-0.605** ***	**0.001**	**0.326** ***	**0.054**	**-0.038**	**-0.017**
		(0.036)	(0.040)	(0.042)	(0.042)	(0.034)	(0.037)	(0.038)	(0.035)	(0.040)

Aggressive Minus Conservative, AMC

		Book-to-market Ratio			*Operating profitability Ratio*			*Investment*		
	c_i	Low	Neutral	High	Weak	Neutral	Robust	Aggress.	Neutral	Conserv.
Size	Small	**--0.111** **	**--0.320** ***	**--0.378** ***	**--0.208** ***	**--0.226** ***	**--0.323** ***	**-0.118** **	**--0.285** ***	**--0.493** ***
		(0.047)	(0.050)	(0.042)	(0.046)	(0.043)	(0.045)	(0.048)	(0.042)	(0.040)
	Big	**--0.176** ***	**-0.189** ***	**-0.091** *	**--0.070**	**--0.036**	**-0.046**	**-0.636** ***	**-0.175** ***	**--0.753** ***
		(0.042)	(0.047)	(0.049)	(0.049)	(0.040)	(0.043)	(0.045)	(0.041)	(0.047)

Table 15. Time series regressions of monthly excess returns of the 16 portfolios of the Panel D formed from independent sorts on size and book-to-market: January 1990 to July 2016

At the end of each July, stocks are classified into four size groups (*small to big*) using market capitalization breakpoints. Stocks are subsequently allocated independently to four *book-to-market* groups (*low to high*). The intersections of the two sorts produce 16 value-weighted *size-book-to-market* portfolios corresponding the LHS (left hand side) variables of the panel D. The RHS (right hand side) variables are the excess market return, net of the 3 months EURIBOR interest rate, $(R_M - Rf)$, the *size* factor (SMB), the *value* factor (HML), the *operating profitability* factor (RMW), and the *investment* factor (AMC), constructed using independent 2x3 sorts on *size* and each of *book-to-market, operating profitability,* and *investment.* Three asset pricing models are thus used in order to produce the following regressions. The table hereunder presents, for each portfolio, its slopes (bold figures), its standard errors (between brackets) and its *Student t test* illustrated with stars ($^{*}p < 0.1$;** $p < 0.05$;*** $p < 0.01$).

Intercept, (α)

	Sharpe-Lintner-Black CAPM (1964)				Fama-French three-factor model (1993)				Fama-French five-factor model (2015)			
	Book-to-market Ratio				*Book-to-market* Ratio				*Book-to-market* Ratio			
α_i (Size)	*Low*	2	3	*High*	*Low*	2	3	*High*	*Low*	2	3	*High*
Small	**0.023** ***	**0.017** ***	**0.021** ***	**0.024** ***	**0.010** ***	**-0.003**	**0.011** ***	**0.013** ***	**0.010** ***	**-0.005**	**0.011** ***	**0.013** ***
	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)
2	**0.013** ***	**0.010** ***	**0.010** ***	**0.018** ***	**-0.001**	**-0.002**	**-0.001**	**0.004** **	**0.002**	**-0.002**	**-0.001**	**0.004** *
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
3	**0.009** ***	**0.010** ***	**0.010** ***	**0.011** ***	**-0.002**	**0.003** *	**0.003** *	**0.003**	**0.000**	**0.003**	**0.002**	**0.003**
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Big	**0.002**	**0.000**	**-0.002**	**0.000**	**0.007** ***	**-0.002**	**-0.003**	**0.000**	**0.005** ***	**0.000**	**-0.003**	**0.001**
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)

Market Premium, $(R_M - R_f)$

	Sharpe-Lintner-Black CAPM (1964)				Fama-French three-factor model (1993)				Fama-French five-factor model (2015)			
	Book-to-market Ratio				*Book-to-market* Ratio				*Book-to-market* Ratio			
β_i (Size)	*Low*	2	3	*High*	*Low*	2	3	*High*	*Low*	2	3	*High*
Small	**0.577** ***	**0.465** ***	**0.416** ***	**0.324** ***	**1.039** ***	**1.135** ***	**0.771** ***	**0.725** ***	**1.028** ***	**1.205** ***	**0.785** ***	**0.718** ***
	(0.057)	(0.078)	(0.051)	(0.061)	(0.061)	(0.080)	(0.057)	(0.070)	(0.063)	(0.081)	(0.059)	(0.070)
2	**0.732** ***	**0.454** ***	**0.495** ***	**0.450** ***	**1.201** ***	**0.866** ***	**0.894** ***	**0.926** ***	**1.105** ***	**0.853** ***	**0.878** ***	**0.952** ***
	(0.055)	(0.046)	(0.043)	(0.050)	(0.050)	(0.046)	(0.041)	(0.043)	(0.046)	(0.047)	(0.043)	(0.043)
3	**0.736** ***	**0.569** ***	**0.514** ***	**0.526** ***	**1.098** ***	**0.800** ***	**0.772** ***	**0.788** ***	**1.026** ***	**0.809** ***	**0.794** ***	**0.814** ***
	(0.049)	(0.039)	(0.036)	(0.042)	(0.053)	(0.045)	(0.039)	(0.048)	(0.052)	(0.046)	(0.040)	(0.048)
Big	**1.056** ***	**0.885** ***	**0.905** ***	**1.267** ***	**0.874** ***	**0.948** ***	**0.949** ***	**1.269** ***	**0.956** ***	**0.882** ***	**0.935** ***	**1.236** ***
	(0.038)	(0.030)	(0.034)	(0.066)	(0.039)	(0.038)	(0.042)	(0.059)	(0.036)	(0.036)	(0.043)	(0.059)

Small Minus Big, (SMB)

	Fama-French three-factor model (1993)				Fama-French five-factor model (2015)			
	Book-to-market Ratio				*Book-to-market* Ratio			
s_i (Size)	*Low*	2	3	*High*	*Low*	2	3	*High*
Small	**0.881** ***	**1.251** ***	**0.665** ***	**0.724** ***	**0.859** ***	**1.317** ***	**0.699** ***	**0.738** ***
	(0.073)	(0.095)	(0.068)	(0.081)	(0.077)	(0.100)	(0.072)	(0.086)
2	**0.939** ***	**0.791** ***	**0.739** ***	**0.860** ***	**0.864** ***	**0.766** ***	**0.734** ***	**0.906** ***
	(0.060)	(0.055)	(0.049)	(0.050)	(0.057)	(0.058)	(0.052)	(0.053)
3	**0.705** ***	**0.427** ***	**0.478** ***	**0.469** ***	**0.611** ***	**0.448** ***	**0.501** ***	**0.515** ***
	(0.063)	(0.053)	(0.047)	(0.056)	(0.064)	(0.056)	(0.049)	(0.059)
Big	**-0.299** ***	**0.122** ***	**0.060**	**-0.111**	**-0.191** ***	**0.018**	**0.027**	**-0.093**
	(0.046)	(0.045)	(0.050)	(0.070)	(0.044)	(0.044)	(0.053)	(0.072)

High Minus Low (HML)

	Fama-French three-factor model (1993)				Fama-French five-factor model (2015)			
	Book-to-market Ratio				*Book-to-market* Ratio			
h_i (Size)	*Low*	2	3	*High*	*Low*	2	3	*High*
Small	**0.098** *	**0.372** ***	**0.182** ***	**0.420** ***	**0.109** *	**0.392** ***	**0.156** ***	**0.388** ***
	(0.055)	(0.072)	(0.052)	(0.061)	(0.060)	(0.078)	(0.056)	(0.067)
2	**-0.288** ***	**0.046**	**0.254** ***	**0.514** ***	**-0.336** ***	**0.060**	**0.236** ***	**0.489** ***
	(0.045)	(0.041)	(0.037)	(0.038)	(0.044)	(0.045)	(0.041)	(0.041)
3	**-0.055**	**0.165** ***	**0.175** ***	**0.313** ***	**-0.039**	**0.149** ***	**0.179** ***	**0.289** ***
	(0.048)	(0.040)	(0.035)	(0.042)	(0.050)	(0.044)	(0.038)	(0.046)
Big	**-0.442** ***	**-0.009**	**0.202** ***	**0.960** ***	**-0.461** ***	**0.032**	**0.226** ***	**0.882** ***
	(0.035)	(0.034)	(0.038)	(0.053)	(0.034)	(0.035)	(0.041)	(0.056)

Robust Minus Weak, (RMW)

	Fama-French five-factor model (2015)			
	Book-to-market Ratio			
r_i (Size)	*Low*	2	3	*High*
Small	**-0.005**	**0.243** ***	**-0.026**	**-0.098**
	(0.069)	(0.089)	(0.065)	(0.077)
2	**-0.382** ***	**-0.002**	**-0.087** *	**0.010**
	(0.051)	(0.052)	(0.047)	(0.047)
3	**-0.158** ***	**-0.011**	**0.071**	**0.013**
	(0.057)	(0.051)	(0.044)	(0.053)
Big	**0.181** ***	**-0.085** **	**0.021**	**-0.279** ***
	(0.039)	(0.040)	(0.048)	(0.064)

Aggressive Minus Conservative, (AMC)

	Fama-French five-factor model (2015)			
	Book-to-market Ratio			
c_i (Size)	*Low*	2	3	*High*
Small	**0.059**	**-0.208** **	**-0.093**	**-0.029**
	(0.071)	(0.091)	(0.066)	(0.078)
2	**0.248** ***	**0.068**	**0.023**	**-0.128** ***
	(0.052)	(0.053)	(0.048)	(0.048)
3	**0.272** ***	**-0.057**	**-0.071**	**-0.129** ***
	(0.058)	(0.052)	(0.045)	(0.054)
Big	**-0.314** ***	**0.295** ***	**0.089** *	**-0.017**
	(0.040)	(0.041)	(0.048)	(0.066)

Table 16. **Time series regressions of monthly excess returns of the 16 portfolios of the Panel E formed from independent sorts on size and operating profitability: January 1990 to July 2016**

At the end of each July, stocks are classified into four size groups (*small to big*) using market capitalization breakpoints. Stocks are subsequently allocated independently to four *operating profitability* groups (*low to high*). The intersections of the two sorts produce 16 value-weighted *size-operating profitability* portfolios corresponding the LHS (left hand side) variables of the panel E. The RHS (right hand side) variables are the excess market return, net of the 3 months EURIBOR interest rate, $(R_M - Rf)$, the *size* factor (SMB), the *value* factor (HML), the *operating profitability* factor (RMW), and the *investment* factor (AMC), constructed using independent 2x3 sorts on *size* and each of *book-to-market, operating profitability,* and *investment*. Three asset pricing models are used in order to produce the following regressions. The table hereunder presents, for each portfolio, its slopes (bold figures), its standard errors (between brackets) and its *Student t test* illustrated with stars ($^{*}p < 0.1$;** $p < 0.05$;*** $p < 0.01$).

Intercept (α)

Size	Sharpe-Lintner-Black CAPM (1964)				Fama-French three-factor model (1993)				Fama-French five-factor model (2015)			
	Operating profitability Ratio				*Operating profitability* Ratio				*Operating profitability* Ratio			
α_i	*Weak*	2	3	*Robust*	*Weak*	2	3	*Robust*	*Weak*	2	3	*Robust*
Small	**0.019** ***	**0.020** ***	**0.025** ***	**0.025** ***	**0.005**	**0.009** ***	**0.016** ***	**0.006** *	**0.007** *	**0.009** ***	**0.015** ***	**0.003**
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.002)	(0.003)	(0.003)	(0.004)	(0.002)	(0.003)	(0.003)
2	**0.008** ***	**0.012** ***	**0.014** ***	**0.017** ***	**-0.008** ***	**0.000**	**0.002**	**0.003**	**-0.004** **	**0.001**	**0.002**	**0.003**
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
3	**0.009** ***	**0.011** ***	**0.010** ***	**0.009** ***	**0.001**	**0.004** *	**0.002**	**-0.001**	**0.001**	**0.003**	**0.002**	**0.000**
	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Big	**-0.003**	**0.001**	**-0.002**	**0.003** *	**-0.004**	**0.000**	**0.002**	**0.002**	**-0.001**	**0.000**	**0.002**	**0.001**
	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

Market Premium $(R_M - R_f)$

Size	Sharpe-Lintner-Black CAPM (1964)				Fama-French three-factor model (1993)				Fama-French five-factor model (2015)			
	Operating profitability Ratio				*Operating profitability* Ratio				*Operating profitability* Ratio			
β_i	*Weak*	2	3	*Robust*	*Weak*	2	3	*Robust*	*Weak*	2	3	*Robust*
Small	**0.397** ***	**0.331** ***	**0.405** ***	**0.603** ***	**0.880** ***	**0.695** ***	**0.729** ***	**1.252** ***	**0.839** ***	**0.682** ***	**0.754** ***	**1.326** ***
	(0.074)	(0.050)	(0.054)	(0.072)	(0.084)	(0.055)	(0.063)	(0.071)	(0.083)	(0.057)	(0.065)	(0.071)
2	**0.604** ***	**0.485** ***	**0.536** ***	**0.592** ***	**1.169** ***	**0.882** ***	**0.947** ***	**1.077** ***	**1.054** ***	**0.878** ***	**0.935** ***	**1.063** ***
	(0.059)	(0.044)	(0.043)	(0.051)	(0.055)	(0.042)	(0.040)	(0.050)	(0.044)	(0.043)	(0.042)	(0.050)
3	**0.601** ***	**0.545** ***	**0.578** ***	**0.690** ***	**0.900** ***	**0.804** ***	**0.868** ***	**1.035** ***	**0.888** ***	**0.831** ***	**0.864** ***	**0.995** ***
	(0.054)	(0.038)	(0.036)	(0.044)	(0.062)	(0.043)	(0.038)	(0.047)	(0.063)	(0.044)	(0.040)	(0.047)
Big	**1.255** ***	**0.878** ***	**1.063** ***	**0.819** ***	**1.306** ***	**0.929** ***	**0.936** ***	**0.851** ***	**1.224** ***	**0.911** ***	**0.938** ***	**0.880** ***
	(0.055)	(0.034)	(0.036)	(0.032)	(0.060)	(0.042)	(0.043)	(0.038)	(0.051)	(0.043)	(0.044)	(0.038)

Small Minus Big (SMB)

Size	Fama-French three-factor model (1993)				Fama-French five-factor model (2015)			
	Operating profitability Ratio				*Operating profitability* Ratio			
s_i	*Weak*	2	3	*Robust*	*Weak*	2	3	*Robust*
Small	**0.885** ***	**0.677** ***	**0.601** ***	**1.226** ***	**0.944** ***	**0.664** ***	**0.601** ***	**1.231** ***
	(0.100)	(0.065)	(0.075)	(0.087)	(0.101)	(0.069)	(0.079)	(0.087)
2	**1.093** ***	**0.734** ***	**0.776** ***	**0.935** ***	**1.067** ***	**0.737** ***	**0.768** ***	**0.876** ***
	(0.065)	(0.050)	(0.048)	(0.058)	(0.054)	(0.053)	(0.051)	(0.061)
3	**0.540** ***	**0.483** ***	**0.545** ***	**0.661** ***	**0.586** ***	**0.516** ***	**0.523** ***	**0.596** ***
	(0.074)	(0.051)	(0.046)	(0.055)	(0.078)	(0.054)	(0.049)	(0.058)
Big	**0.026**	**0.083**	**-0.215** ***	**0.064**	**0.065**	**0.039**	**-0.222** ***	**0.027**
	(0.072)	(0.050)	(0.051)	(0.048)	(0.063)	(0.053)	(0.054)	(0.047)

High Minus Low (HML)

Size	Fama-French three-factor model (1993)				Fama-French five-factor model (2015)			
	Operating profitability Ratio				*Operating profitability* Ratio			
h_i	*Weak*	2	3	*Robust*	*Weak*	2	3	*Robust*
Small	**0.417** ***	**0.200** ***	**0.203** ***	**0.236** ***	**0.265** ***	**0.199** ***	**0.245** ***	**0.349** ***
	(0.076)	(0.049)	(0.057)	(0.066)	(0.079)	(0.054)	(0.062)	(0.068)
2	**-0.010**	**0.292** ***	**0.147** ***	**0.010**	**-0.160** ***	**0.281** ***	**0.140** ***	**0.073**
	(0.049)	(0.038)	(0.037)	(0.044)	(0.042)	(0.041)	(0.040)	(0.047)
3	**0.311** ***	**0.146** ***	**0.125** ***	**0.043**	**0.228** ***	**0.141** ***	**0.150** ***	**0.071**
	(0.056)	(0.039)	(0.035)	(0.042)	(0.060)	(0.042)	(0.038)	(0.045)
Big	**0.609** ***	**0.135** ***	**-0.253** ***	**-0.022**	**0.420** ***	**0.168** ***	**-0.239** ***	**0.078** **
	(0.054)	(0.038)	(0.039)	(0.037)	(0.049)	(0.041)	(0.042)	(0.037)

Robust Minus Weak (RMW)

Size	Fama-French five-factor model (2015)			
	Operating profitability Ratio			
r_i	*Weak*	2	3	*Robust*
Small	**-0.482** ***	**-0.035**	**0.170** ***	**0.480** ***
	(0.091)	(0.062)	(0.071)	(0.078)
2	**-0.679** ***	**-0.038**	**-0.051**	**0.112** **
	(0.048)	(0.047)	(0.046)	(0.055)
3	**-0.236** ***	**0.063**	**0.049**	**-0.043**
	(0.069)	(0.048)	(0.044)	(0.052)
Big	**-0.685** ***	**0.031**	**0.041**	**0.324** ***
	(0.056)	(0.048)	(0.048)	(0.042)

Aggressive Minus Conservative (AMC)

Size	Fama-French five-factor model (2015)			
	Operating profitability Ratio			
c_i	*Weak*	2	3	*Robust*
Small	**-0.109**	**0.040**	**-0.016**	**-0.066**
	(0.093)	(0.063)	(0.072)	(0.079)
2	**0.146** ***	**-0.005**	**0.028**	**0.150** ***
	(0.049)	(0.048)	(0.047)	(0.056)
3	**-0.097**	**-0.098** **	**0.055**	**0.183** ***
	(0.071)	(0.049)	(0.044)	(0.053)
Big	**-0.031**	**0.117** ***	**0.016**	**0.065**
	(0.057)	(0.049)	(0.049)	(0.043)

TABLE 17. **Time series regressions of monthly excess returns of the 16 portfolios of the Panel F formed from independent sorts on size and investment: January 1990 to July 2016**

At the end of each July, stocks are classified into four size groups (*small to big*) using market capitalization breakpoints. Stocks are subsequently allocated independently to four *investment* groups (*conservative to aggressive*). The intersections of the two sorts produce 16 value-weighted *size-investment* portfolios corresponding the LHS (left hand side) variables of the panel F. The RHS (right hand side) variables are the excess market return, net of the 3 months EURIBOR interest rate, $(R_M - Rf)$, the *size* factor (*SMB*), the *value* factor (*HML*), the *operating profitability* factor (*RMW*), and the *investment* factor (*AMC*), constructed using independent 2x3 sorts on *size* and each of *book-to-market, operating profitability,* and *investment.* Three asset pricing models are thus used in order to produce the following regressions. The table hereunder presents, for each portfolio, its slopes (bold figures), its standard errors (between brackets) and its *Student t test* illustrated with stars ($^{*}p < 0.1;^{**} p < 0.05;^{***} p < 0.01$).

Intercept (α)

	Sharpe-Lintner-Black CAPM (1964)				Fama-French three-factor model (1993)				Fama-French five-factor model (2015)			
	Investment				*Investment*				*Investment*			
α_i (*Size*)	*Cons.*	2	3	*Aggress.*	*Cons.*	2	3	*Aggress.*	*Cons.*	2	3	*Aggress.*
Small	**0.019** ***	**0.020** ***	**0.021** ***	**0.027** ***	**0.008** ***	**0.011** ***	**0.010** ***	**0.013** ***	**0.008** ***	**0.011** ***	**0.011** ***	**0.014** ***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.004)
2	**0.011** ***	**0.013** ***	**0.013** ***	**0.012** ***	**-0.001**	**0.003**	**0.002**	**-0.006** ***	**-0.001**	**0.002**	**0.003**	**-0.002**
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
3	**0.011** ***	**0.009** ***	**0.010** ***	**0.008** ***	**0.004** *	**0.004** **	**0.000**	**-0.005** *	**0.004** *	**0.003**	**0.001**	**-0.004**
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Big	**-0.001**	**0.000**	**0.001**	**0.001**	**0.003**	**-0.003** *	**0.000**	**0.000**	**0.001**	**-0.003**	**0.000**	**0.002**
	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

Market Premium ($R_M - R_f$)

	Sharpe-Lintner-Black CAPM (1964)				Fama-French three-factor model (1993)				Fama-French five-factor model (2015)			
	Investment				*Investment*				*Investment*			
β_i (*Size*)	*Cons.*	2	3	*Aggress.*	*Cons.*	2	3	*Aggress.*	*Cons.*	2	3	*Aggress.*
Small	**0.411** ***	**0.327** ***	**0.497** ***	**0.606** ***	**0.798** ***	**0.633** ***	**0.875** ***	**1.078** ***	**0.785** ***	**0.656** ***	**0.865** ***	**1.054** ***
	(0.051)	(0.051)	(0.059)	(0.069)	(0.055)	(0.058)	(0.068)	(0.081)	(0.055)	(0.060)	(0.070)	(0.081)
2	**0.476** ***	**0.490** ***	**0.507** ***	**0.688** ***	**0.891** ***	**0.825** ***	**0.894** ***	**1.293** ***	**0.916** ***	**0.854** ***	**0.874** ***	**1.167** ***
	(0.044)	(0.042)	(0.039)	(0.061)	(0.042)	(0.045)	(0.037)	(0.048)	(0.041)	(0.046)	(0.038)	(0.048)
3	**0.587** ***	**0.445** ***	**0.613** ***	**0.819** ***	**0.823** ***	**0.634** ***	**0.935** ***	**1.261** ***	**0.832** ***	**0.660** ***	**0.918** ***	**1.196** ***
	(0.044)	(0.034)	(0.040)	(0.054)	(0.050)	(0.040)	(0.043)	(0.056)	(0.051)	(0.041)	(0.045)	(0.056)
Big	**1.167** ***	**0.881** ***	**0.935** ***	**0.855** ***	**1.016** ***	**0.981** ***	**0.970** ***	**0.876** ***	**1.146** ***	**0.952** ***	**0.926** ***	**0.768** ***
	(0.054)	(0.033)	(0.030)	(0.039)	(0.065)	(0.042)	(0.039)	(0.041)	(0.054)	(0.043)	(0.039)	(0.041)

Small Minus Big (*SMB*)

	Fama-French three-factor model (1993)				Fama-French five-factor model (2015)			
	Investment				*Investment*			
s_i (*Size*)	*Cons.*	2	3	*Aggress.*	*Cons.*	2	3	*Aggress.*
Small	**0.715** ***	**0.561** ***	**0.707** ***	**0.900** ***	**0.762** ***	**0.589** ***	**0.680** ***	**0.866** ***
	(0.065)	(0.069)	(0.081)	(0.094)	(0.067)	(0.073)	(0.086)	(0.100)
2	**0.777** ***	**0.620** ***	**0.734** ***	**1.178** ***	**0.872** ***	**0.670** ***	**0.709** ***	**1.028** ***
	(0.050)	(0.053)	(0.044)	(0.064)	(0.050)	(0.056)	(0.046)	(0.058)
3	**0.421** ***	**0.341** ***	**0.619** ***	**0.850** ***	**0.471** ***	**0.381** ***	**0.596** ***	**0.730** ***
	(0.060)	(0.048)	(0.051)	(0.067)	(0.063)	(0.050)	(0.055)	(0.069)
Big	**-0.322** ***	**0.180** ***	**0.063**	**0.036**	**-0.029**	**0.131** ***	**-0.016**	**-0.196** ***
	(0.078)	(0.050)	(0.046)	(0.060)	(0.066)	(0.052)	(0.047)	(0.050)

High Minus Low (*HML*)

	Fama-French three-factor model (1993)				Fama-French five-factor model (2015)			
	Investment				*Investment*			
h_i (*Size*)	*Cons.*	2	3	*Aggress.*	*Cons.*	2	3	*Aggress.*
Small	**0.270** ***	**0.257** ***	**0.192** ***	**0.094**	**0.182** ***	**0.252** ***	**0.214** ***	**0.102**
	(0.049)	(0.052)	(0.061)	(0.071)	(0.052)	(0.057)	(0.067)	(0.077)
2	**0.201** ***	**0.217** ***	**0.116** ***	**-0.086** *	**0.106** ***	**0.194** ***	**0.118** ***	**-0.077** *
	(0.038)	(0.040)	(0.033)	(0.048)	(0.039)	(0.044)	(0.036)	(0.045)
3	**0.293** ***	**0.195** ***	**0.021**	**0.028**	**0.237** ***	**0.181** ***	**0.026**	**0.092** *
	(0.045)	(0.036)	(0.039)	(0.051)	(0.049)	(0.039)	(0.042)	(0.053)
Big	**0.254** ***	**0.115** ***	**0.043**	**0.036**	**0.046**	**0.137** ***	**0.086** **	**0.191** ***
	(0.059)	(0.038)	(0.035)	(0.045)	(0.051)	(0.041)	(0.037)	(0.039)

Robust Minus Weak (*RMW*)

	Fama-French five-factor model (2015)			
	Investment			
r_i (*Size*)	*Cons.*	2	3	*Aggress.*
Small	**-0.251** ***	**0.051**	**0.027**	**-0.048**
	(0.060)	(0.066)	(0.077)	(0.089)
2	**-0.160** ***	**0.025**	**-0.049**	**-0.326** ***
	(0.045)	(0.050)	(0.041)	(0.052)
3	**-0.112** **	**0.038**	**-0.035**	**-0.027**
	(0.056)	(0.045)	(0.049)	(0.061)
Big	**-0.142** ***	**-0.025**	**-0.018**	**0.076** *
	(0.059)	(0.047)	(0.042)	(0.045)

Aggressive Minus Conservative (*AMC*)

	Fama-French five-factor model (2015)			
	Investment			
c_i (*Size*)	*Cons.*	2	3	*Aggress.*
Small	**-0.101** *	**-0.084**	**0.069**	**0.098**
	(0.061)	(0.067)	(0.078)	(0.091)
2	**-0.242** ***	**-0.137** ***	**0.073** *	**0.446** ***
	(0.045)	(0.051)	(0.042)	(0.053)
3	**-0.123** **	**-0.114** ***	**0.065**	**0.329** ***
	(0.057)	(0.046)	(0.050)	(0.063)
Big	**-0.786** ***	**0.137** ***	**0.219** ***	**0.626** ***
	(0.060)	(0.048)	(0.043)	(0.046)

Table 18. **Time series regressions of monthly excess returns of the Panels D, E and F with an alternative orthogonal five-factor model: January 1990 to July 2016**

An alternative five-factor model is used on our three panel D, E and F. The *RHS* variables are the excess market return net of the 3 months EURIBOR interest rate ($R_M - Rf$), the *size* factor in its orthogonal version ($SMB^{\perp}$), the *value* (HML), the *operating profitability* (RMW) and the *investment* (AMC) factors. The table hereunder presents, for each portfolio, their slopes (bold figures), their standard errors (between brackets) and their *Student t test* illustrated with stars ($^{*}p < 0.1$;$^{**} p < 0.05$;$^{***} p < 0.01$).

Panel D | **Panel E** | **Panel F**

Intercept, α

	Book-to-market Ratio					*Operating profitability* Ratio					*Investment*			
α_i	*Low*	2	3	*High*	α_i	*Weak*	2	3	*Robust*	α_i	*Cons.*	2	3	*Aggress.*
Small	**0.010** ***	**-0.005**	**0.011** ***	**0.013** ***	*Small*	**0.007** *	**0.009** ***	**0.015** ***	**0.003**	*Small*	**0.008** ***	**0.011** ***	**0.011** ***	**0.014** ***
	(0.003)	(0.004)	(0.003)	(0.003)		(0.004)	(0.002)	(0.003)	(0.003)		(0.002)	(0.003)	(0.003)	(0.004)
2	**0.002**	**-0.002**	**-0.001**	**0.004** *	2	**-0.004** **	**0.001**	**0.002**	**0.003**	2	**-0.001**	**0.002**	**0.003**	**-0.002**
	(0.002)	(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)	(0.002)
3	**0.000**	**0.003**	**0.002**	**0.003**	3	**0.001**	**0.003**	**0.002**	**0.000**	3	**0.004** *	**0.003**	**0.001**	**-0.004**
	(0.002)	(0.002)	(0.002)	(0.002)		(0.003)	(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)	(0.002)
Big	**0.005** ***	**0.000**	**-0.003**	**0.001**	*Big*	**-0.001**	**0.000**	**0.002**	**0.001**	*Big*	**0.001**	**-0.003**	**0.000**	**0.002**
	(0.002)	(0.002)	(0.002)	(0.003)		(0.002)	(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)	(0.002)

Market premium, β

	Book-to-market Ratio					*Operating profitability* Ratio					*Investment*			
β_i	*Low*	2	3	*High*	β_i	*Weak*	2	3	*Robust*	β_i	*Cons.*	2	3	*Aggress.*
Small	**0.583** ***	**0.523** ***	**0.423** ***	**0.335** ***	*Small*	**0.350** ***	**0.338** ***	**0.443** ***	**0.689** ***	*Small*	**0.390** ***	**0.350** ***	**0.513** ***	**0.605** ***
	(0.049)	(0.063)	(0.046)	(0.054)		(0.064)	(0.044)	(0.050)	(0.055)		(0.043)	(0.046)	(0.054)	(0.063)
2	**0.658** ***	**0.456** ***	**0.498** ***	**0.482** ***	2	**0.502** ***	**0.497** ***	**0.537** ***	**0.609** ***	2	**0.464** ***	**0.507** ***	**0.506** ***	**0.634** ***
	(0.036)	(0.037)	(0.033)	(0.033)		(0.034)	(0.033)	(0.032)	(0.038)		(0.031)	(0.035)	(0.029)	(0.037)
3	**0.709** ***	**0.577** ***	**0.535** ***	**0.547** ***	3	**0.584** ***	**0.563** ***	**0.593** ***	**0.686** ***	3	**0.588** ***	**0.463** ***	**0.609** ***	**0.817** ***
	(0.040)	(0.036)	(0.031)	(0.037)		(0.049)	(0.034)	(0.031)	(0.037)		(0.040)	(0.032)	(0.034)	(0.043)
Big	**1.055** ***	**0.872** ***	**0.921** ***	**1.284** ***	*Big*	**1.190** ***	**0.891** ***	**1.053** ***	**0.866** ***	*Big*	**1.161** ***	**0.884** ***	**0.935** ***	**0.869** ***
	(0.028)	(0.028)	(0.033)	(0.045)		(0.040)	(0.034)	(0.034)	(0.030)		(0.042)	(0.033)	(0.030)	(0.032)

Orthogonal Small Minus Big, $SMB^{\perp}$

	Book-to-market Ratio					*Operating profitability* Ratio					*Investment*			
s_i	*Low*	2	3	*High*	s_i	*Weak*	2	3	*Robust*	s_i	*Cons.*	2	3	*Aggress.*
Small	**0.859** ***	**1.317** ***	**0.699** ***	**0.738** ***	*Small*	**0.944** ***	**0.664** ***	**0.601** ***	**1.231** ***	*Small*	**0.762** ***	**0.589** ***	**0.680** ***	**0.866** ***
	(0.077)	(0.100)	(0.072)	(0.086)		(0.101)	(0.069)	(0.079)	(0.087)		(0.067)	(0.073)	(0.086)	(0.100)
2	**0.864** ***	**0.766** ***	**0.734** ***	**0.906** ***	2	**1.067** ***	**0.737** ***	**0.768** ***	**0.876** ***	2	**0.872** ***	**0.670** ***	**0.709** ***	**1.028** ***
	(0.057)	(0.058)	(0.052)	(0.053)		(0.054)	(0.053)	(0.051)	(0.061)		(0.050)	(0.056)	(0.046)	(0.058)
3	**0.611** ***	**0.448** ***	**0.501** ***	**0.515** ***	3	**0.586** ***	**0.516** ***	**0.523** ***	**0.596** ***	3	**0.471** ***	**0.381** ***	**0.596** ***	**0.730** ***
	(0.064)	(0.056)	(0.049)	(0.059)		(0.078)	(0.054)	(0.049)	(0.058)		(0.063)	(0.050)	(0.055)	(0.069)
Big	**-0.191** ***	**0.018**	**0.027**	**-0.093**	*Big*	**0.065**	**0.039**	**-0.222** ***	**0.027**	*Big*	**-0.029**	**0.131** ***	**-0.016**	**-0.196** ***
	(0.044)	(0.044)	(0.053)	(0.072)		(0.063)	(0.053)	(0.054)	(0.047)		(0.066)	(0.052)	(0.047)	(0.050)

High Minus Low, HML

	Book-to-market Ratio					*Operating profitability* Ratio					*Investment*			
h_i	*Low*	2	3	*High*	h_i	*Weak*	2	3	*Robust*	h_i	*Cons.*	2	3	*Aggress.*
Small	**0.111** *	**0.395** ***	**0.157** ***	**0.390** ***	*Small*	**0.267** ***	**0.201** ***	**0.246** ***	**0.352** ***	*Small*	**0.183** ***	**0.254** ***	**0.215** ***	**0.104**
	(0.060)	(0.078)	(0.056)	(0.067)		(0.079)	(0.054)	(0.062)	(0.068)		(0.052)	(0.057)	(0.067)	(0.077)
2	**-0.334** ***	**0.062**	**0.237** ***	**0.491** ***	2	**-0.157** ***	**0.282** ***	**0.141** ***	**0.075**	2	**0.108** ***	**0.195** ***	**0.120** ***	**-0.075**
	(0.044)	(0.045)	(0.041)	(0.041)		(0.042)	(0.041)	(0.040)	(0.047)		(0.039)	(0.044)	(0.036)	(0.045)
3	**-0.038**	**0.150** ***	**0.180** ***	**0.290** ***	3	**0.229** ***	**0.142** ***	**0.151** ***	**0.073**	3	**0.238** ***	**0.182** ***	**0.027**	**0.094** *
	(0.050)	(0.044)	(0.038)	(0.046)		(0.060)	(0.042)	(0.038)	(0.045)		(0.049)	(0.039)	(0.042)	(0.053)
Big	**-0.462** ***	**0.032**	**0.227** ***	**0.882** ***	*Big*	**0.420** ***	**0.168** ***	**-0.239** ***	**0.078** **	*Big*	**0.046**	**0.138** ***	**0.086** **	**0.191** ***
	(0.034)	(0.035)	(0.041)	(0.056)		(0.049)	(0.041)	(0.042)	(0.037)		(0.051)	(0.041)	(0.037)	(0.039)

Robust Minus Weak, RMW

	Book-to-market Ratio					*Operating profitability* Ratio					*Investment*			
r_i	*Low*	2	3	*High*	r_i	*Weak*	2	3	*Robust*	r_i	*Cons.*	2	3	*Aggress.*
Small	**-0.030**	**0.206** **	**-0.046**	**-0.119**	*Small*	**-0.509** ***	**-0.054**	**0.152** **	**0.445** ***	*Small*	**-0.273** ***	**0.034**	**0.007**	**-0.073**
	(0.069)	(0.089)	(0.065)	(0.077)		(0.091)	(0.062)	(0.071)	(0.078)		(0.060)	(0.066)	(0.077)	(0.089)
2	**-0.406** ***	**-0.024**	**-0.108** **	**-0.015**	2	**-0.710** ***	**-0.059**	**-0.073**	**0.087**	2	**-0.185** ***	**0.006**	**-0.069** *	**-0.355** ***
	(0.051)	(0.052)	(0.047)	(0.048)		(0.048)	(0.047)	(0.046)	(0.055)		(0.045)	(0.050)	(0.042)	(0.052)
3	**-0.175** ***	**-0.024**	**0.056**	**-0.002**	3	**-0.253** ***	**0.048**	**0.034**	**-0.060**	3	**-0.126** **	**0.027**	**-0.052**	**-0.047**
	(0.057)	(0.051)	(0.044)	(0.053)		(0.070)	(0.048)	(0.044)	(0.052)		(0.057)	(0.045)	(0.049)	(0.062)
Big	**0.187** ***	**-0.085** **	**0.020**	**-0.277** ***	*Big*	**-0.687** ***	**0.029**	**0.047**	**0.324** ***	*Big*	**-0.142** ***	**-0.029**	**-0.018**	**0.082** *
	(0.039)	(0.040)	(0.048)	(0.065)		(0.056)	(0.048)	(0.048)	(0.042)		(0.059)	(0.047)	(0.043)	(0.045)

Aggressive Minus Conservative, AMC

	Book-to-market Ratio					*Operating profitability* Ratio					*Investment*			
c_i	*Low*	2	3	*High*	c_i	*Weak*	2	3	*Robust*	c_i	*Cons.*	2	3	*Aggress.*
Small	**-0.203** ***	**-0.609** ***	**-0.306** ***	**-0.253** ***	*Small*	**-0.396** ***	**-0.163** **	**-0.199** ***	**-0.441** ***	*Small*	**-0.333** ***	**-0.263** ***	**-0.138**	**-0.166**
	(0.082)	(0.105)	(0.076)	(0.090)		(0.107)	(0.073)	(0.084)	(0.092)		(0.071)	(0.077)	(0.091)	(0.105)
2	**-0.015**	**-0.165** ***	**-0.200** ***	**-0.404** ***	2	**-0.179** ***	**-0.229** ***	**-0.206** ***	**-0.116** *	2	**-0.508** ***	**-0.341** ***	**-0.143** ***	**0.133** **
	(0.060)	(0.061)	(0.055)	(0.056)		(0.057)	(0.056)	(0.054)	(0.064)		(0.052)	(0.059)	(0.049)	(0.062)
3	**0.086**	**-0.194** ***	**-0.224** ***	**-0.286** ***	3	**-0.276** ***	**-0.255** ***	**-0.104** **	**0.001**	3	**-0.267** ***	**-0.230** ***	**-0.117** **	**0.107**
	(0.067)	(0.060)	(0.052)	(0.062)		(0.082)	(0.057)	(0.051)	(0.061)		(0.066)	(0.053)	(0.057)	(0.072)
Big	**-0.256** ***	**0.289** ***	**0.081**	**0.011**	*Big*	**-0.050**	**0.105** *	**0.083**	**0.057**	*Big*	**-0.777** ***	**0.097** *	**0.224** ***	**0.685** ***
	(0.046)	(0.047)	(0.056)	(0.076)		(0.066)	(0.056)	(0.057)	(0.050)		(0.070)	(0.055)	(0.050)	(0.053)

Table 19. **Adjusted coefficient of determination related to the time series regressions of the Panel D, E and F with the three asset pricing models: January 1990 to July 2016**

We use an adjusted R^2 to indicate how well terms fit a line and creates an adjustment depending on the number of factors in a model. Adding useless variables makes it decrease contrary to the classic R^2.

$$\bar{R}^2 = 1 - \frac{(1-R^2)(N-1)}{(N-p-1)} \tag{5.7}$$

N corresponds to the number of observations and p, the number of parameters, constant excluded.

Adjusted R^2, (%)

$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + \epsilon_{i_t}$

	Book-to-market					*Operating profitability*					*Investment*			
	Low	2	3	*High*		*Weak*	2	3	*Robust*		*Conserv.*	2	3	*Aggress.*
Small	24.01	9.71	17.05	7.81	*Small*	7.94	12.03	14.73	17.70	*Small*	16.80	11.44	18.08	19.16
2	35.70	23.31	29.22	19.91	2	24.86	27.87	33.12	29.37	2	27.08	29.62	34.20	28.74
3	41.76	40.63	39.34	32.52	3	27.98	39.20	44.52	44.13	3	36.00	34.35	41.88	42.13
Big	70.92	73.36	68.98	53.98	*Big*	61.90	68.34	73.40	67.91	*Big*	59.76	68.72	75.00	60.10

$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + s_i(R_{SMB_t}) + h_i(R_{HML_t}) + \epsilon_{i_t}$

	Book-to-market					*Operating profitability*					*Investment*			
	Low	2	3	*High*		*Weak*	2	3	*Robust*		*Conserv.*	2	3	*Aggress.*
Small	47.88	42.84	36.80	32.18	*Small*	29.67	35.37	30.07	49.88	*Small*	41.90	29.33	34.51	37.13
2	67.65	53.68	60.38	65.87	2	60.45	59.95	63.43	61.11	2	59.68	52.34	65.21	66.51
3	58.73	51.74	55.76	49.99	3	41.54	53.23	61.93	61.29	3	48.92	46.33	60.05	61.49
Big	81.59	73.83	71.39	77.94	*Big*	72.67	69.50	77.25	67.94	*Big*	64.11	70.42	75.08	59.96

$R_{i_t} - R_{f_t} = \alpha_i + \beta_i(R_{M_t} - R_{f_t}) + s_i(R_{SMB_t}) + h_i(R_{HML_t}) + r_i(R_{RMW_t}) + c_i(R_{AMC_t}) + \epsilon_{i_t}$

	Book-to-market					*Operating profitability*					*Investment*			
	Low	2	3	*High*		*Weak*	2	3	*Robust*		*Conserv.*	2	3	*Aggress.*
Small	47.67	44.69	36.83	32.13	*Small*	35.36	35.10	30.89	55.09	*Small*	45.09	29.36	34.28	37.02
2	73.96	53.63	60.58	66.41	2	76.03	59.78	63.38	62.27	2	64.22	53.15	65.46	74.94
3	62.00	51.63	56.17	50.58	3	43.62	53.75	62.03	62.55	3	49.98	47.14	60.07	64.41
Big	85.33	77.72	71.53	79.07	*Big*	81.39	69.91	77.17	73.07	*Big*	76.92	71.02	76.84	74.87

Table 20. **Summary statistics for tests of one-, three-, and five-factor models: January 1990 to July 2016**

The regressions use the Sharpe-Lintner-Black (1964), the Fama-French three-factor (1993), the Fama-French five-factor (2015) models on our three panels (D, E and F). The GRS statistic tests whether all intercepts in a set of 16 (4x4) regressions are zero ; $\frac{1}{N}\sum_{i=1}^{N}|\alpha_i|$ is the average absolute intercept for a set of regressions ; $\frac{1}{N}\sum_{i=1}^{N}\bar{R}_i^2$ is the average adjusted R^2. We put $\frac{1}{N}\sum_{i=1}^{N}s_{\alpha_i}$ as the average standard error of the intercepts. Finally, with 16 portfolios and 318 monthly returns, the critical values of the GRS statistic for the tested models are: $\mathcal{F}_{90\%}(v1,v2)=1.41; \mathcal{F}_{95\%}(v1,v2)=1.56; \mathcal{F}_{97.5\%}(v1,v2)=1.69; \mathcal{F}_{99\%}(v1,v2)=1.86; \mathcal{F}_{99.9\%}(v1,v2)=2.25$. The GRS statistic is computed as follows:

$$GRS=\frac{T-N-K}{N}\times\left(1+\widehat{\mu}^{\top}\widehat{\Omega}^{-1}\widehat{\mu}\right)^{-1}\times\left(\widehat{\alpha}^{\top}\widehat{\Sigma}^{-1}\widehat{\alpha}\right)\sim\mathcal{F}_{N,T-N-K}$$

Where $\widehat{\mu}$ is the mean of excess returns of the explanatory variables computed as follows: $\widehat{\mu}_i=\frac{1}{T}\sum_{t=1}^{t=T}(R_{i_t}-R_{f_t})$ and $\widehat{\mu}^{\top}=[\widehat{\mu}_1\cdots\widehat{\mu}_N]$. Ω^{-1} is the inverse of their covariance matrix, $\Omega=\frac{1}{T}\sum_{t=1}^{t=T}(R_i-\mu_i)(R_i-\mu_i)^{\top}$ and N is the number of assets. The parameter Σ^{-1} is the inverse of the covariance matrix of the regression residuals ϵ_i, $\Sigma=\frac{1}{T}\sum_{t=1}^{t=T}\epsilon_i\epsilon_i^{\top}$. Finally, $\widehat{\alpha_i}$ denotes the vector of the intercept of the regression i, $\widehat{\alpha}^{\top}=[\widehat{\alpha}_1\cdots\widehat{\alpha}_N]$
The orthogonal version of the five-factor model gives the same results than the original Fama-French five-factor model. Rewriting the model with the orthogonal version of the *size* factor ($SMB_t^{\perp}$) shows there is no incidence the the intercept: $R_{i_t}-R_{f_t}=\alpha_i+[\beta_i+s_i\beta_\gamma](R_{M_t}-R_{f_t})+[h_i+s_ih_\gamma](R_{HML_t})+[r_i+s_ir_\gamma](R_{RMW_t})+[c_i+s_ic_\gamma](R_{AMC_t})+s_i[R_{SMB_t^{\perp}}]+\epsilon_{i_t}$.
The properties of minimum-variance frontier of Markowitz are used to apply the test in the case of a single factor model:

$$GRS=\left(\frac{T-N-1}{N}\right)\times\left(\frac{\left[\widehat{\mu}_\xi/\widehat{\sigma}_\xi\right]^2-\left[\widehat{\mu}_M/\widehat{\sigma}_M\right]^2}{1+\left[\widehat{\mu}_M/\widehat{\sigma}_M\right]^2}\right)$$

$$R_{i_t}-R_{f_t}=\alpha_i+\beta_i(R_{M_t}-R_{f_t})+\epsilon_{i_t}$$

	$\left(\frac{T-N-K}{N}\right)$	$(\widehat{\mu}_\xi/\widehat{\sigma}_\xi)$	$\widehat{\alpha}^{\top}\widehat{\Sigma}^{-1}\widehat{\alpha}$	*GRS test*	$\frac{1}{N}\sum_{i=1}^{N}\bar{R}_i^2$ (%)	$\frac{1}{N}\sum_{i=1}^{N}\lvert\alpha_i\rvert$ (%)	$\frac{1}{N}\sum_{i=1}^{N}s_{\alpha_i}$ (%)
Panel D	18.81	0.5127	0.4181	4.8060	36.76	1.1288	0.2517
Panel E	18.81	0.5178	0.4349	4.9023	37.18	1.1689	0.2514
Panel F	18.81	0.4741	0.4351	4.1077	37.69	1.1076	0.2416

$$R_{i_t}-R_{f_t}=\alpha_i+\beta_i(R_{M_t}-R_{f_t})+s_i(R_{SMB_t})+h_i(R_{HML_t})+\epsilon_{i_t}$$

	$\left(\frac{T-N-K}{N}\right)$	$\left(1+\widehat{\mu}^{\top}\widehat{\Omega}^{-1}\widehat{\mu}\right)^{-1}$	$\widehat{\alpha}^{\top}\widehat{\Sigma}^{-1}\widehat{\alpha}$	*GRS test*	$\frac{1}{N}\sum_{i=1}^{N}\bar{R}_i^2$ (%)	$\frac{1}{N}\sum_{i=1}^{N}\lvert\alpha_i\rvert$ (%)	$\frac{1}{N}\sum_{i=1}^{N}s_{\alpha_i}$ (%)
Panel D	18.69	0.8093	0.2178	3.293	58.02	0.4260	0.2235
Panel E	18.69	0.8093	0.2292	3.465	55.95	0.3990	0.2316
Panel F	18.69	0.8093	0.2507	3.792	54.56	0.4659	0.2276

$$R_{i_t}-R_{f_t}=\alpha_i+\beta_i(R_{M_t}-R_{f_t})+s_i(R_{SMB_t})+h_i(R_{HML_t})+r_i(R_{RMW_t})+c_i(R_{AMC_t})+\epsilon_{i_t}$$

	$\left(\frac{T-N-K}{N}\right)$	$\left(1+\widehat{\mu}^{\top}\widehat{\Omega}^{-1}\widehat{\mu}\right)^{-1}$	$\widehat{\alpha}^{\top}\widehat{\Sigma}^{-1}\widehat{\alpha}$	*GRS test*	$\frac{1}{N}\sum_{i=1}^{N}\bar{R}_i^2$	$\frac{1}{N}\sum_{i=1}^{N}\lvert\alpha_i\rvert$	$\frac{1}{N}\sum_{i=1}^{N}s_{\alpha_i}$
Panel D	18.56	0.7879	0.2097	3.067	59.37	0.4058	0.2215
Panel E	18.56	0.7879	0.2248	3.287	58.84	0.3309	0.2244
Panel F	18.56	0.7879	0.2380	3.481	57.80	0.4380	0.2195