A Work Project, presented as part of the requirements for the Award of a Master's degree in Finance from the Nova School of Business and Economics.

EXPLOITING VALUE WITH A CYCLICALLY ADJUSTED ENTERPRISE VALUE TO EBIT RATIO

Bogdana Blidari

Work project carried out under the supervision of:

Nicholas Hirschey

16/12/2022

Abstract

This paper aims to exploit value investing with a cyclically adjusted enterprise value-to-EBIT (CAEE) ratio. The results show that a long-only strategy based on this ratio can generate positive and significant abnormal returns, outperforming the CAPE ratio, the starting point for the development of CAEE, and the market. However, the strategy entails relatively high volatility, showing that value stocks may be riskier. A standardized CAEE ratio was also explored by removing the sector effect, which proved to be relatively unsuccessful. Overall, the strategy performance proves that value is not "dead" yet, although the value premium may be lower.

Keywords: Finance, Financial Markets, Value Investing, US Stock Market, Performance Analysis, Investment Strategy

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

1 Introduction

Among the several investment strategies that have been developed over time, value investing, first developed by Graham and Dodd (1934), is still highly abode by modern investors, such as Warren Buffet, one of the world's most successful investors. However, value investing has been controversial recently due to a sharp decline in returns in the second half of the 1963-2019 period, affirmed by Fama and French (2020). According to Moore (2021) in one Forbes article, it appears that as value investing has been highly popularized, "it may have become a crowded trade, reducing its effectiveness". Nonetheless, as value returns are historically volatile, the impact of value investing is hard to predict with precision, so there is still not enough evidence that value is "dead". Moreover, as Ben Graham developed and Warren Buffet later reinforced, value investing focuses on choosing stocks based on the quality of the company and its ability to generate earnings in the long term. Value investing, thus, "is not just the output of a statistical number crunching, it has a logical backbone to it as well" (Moore 2021), which will hardly be discredited soon.

Several systematic implementations of value portfolios have been developed, i.e., portfolios of stocks sorted on measures like price/earnings (P/E), price/book value (P/BV), or dividend yield (DIV/P). Among these, P/E is the simplest and most widely used ratio among value investors. In spite of its popularity, Graham and Dodd (1934) noted one-year earnings were too volatile to effectively predict the intrinsic value of a company, and so Shiller (1996) later introduced the cyclically adjusted price-to-earnings ratio (CAPE), a variant of the P/E that divided the current price of a stock by its average inflation-adjusted earnings over the last ten years. The CAPE, also known as Shiller's ratio, helps to smooth out the earnings' noise providing a better picture of the company earnings' strength. Although it was created to be used at the firm level, as the P/E, CAPE has been mostly used as a macro indicator, since its peaks (1929, 1999, and 2007) applied to S&P have been followed by major market drops, as the Great Depression

(1930), the dot-com bubble burst (2000), and the housing market crash (2008), being then associated to an indicator of impending market crashes. CAPE has proved to be a more consistent future stock returns estimator than P/E, but still shows conceptual limitations similar to the P/E ratio. Among these is the fact that neither CAPE or P/E consider the company's debt, which can affect both the share price and the company's earnings. On one side, as debt levels increase, the firm's earnings become increasingly volatile due to the payment of large amounts of interest before dividends (Jahfer 2006), leading to a lower P/E. On the other side, if the business is good, a company with higher leverage can stand to see higher earnings, and consequently a lower P/E, *ceteris paribus*.

Seen this, the main rationale of the investment strategy further developed was to expand the CAPE ratio concept by attenuating one of its main limitations: the disregard of each firm's debt. To do this, it was added the net debt of each firm to its market value, that is the product of the share price and the respective common shares outstanding, representing, thus, the enterprise value of the company. The enterprise value is important to get a clear idea of a company's real value on the market, as it considers both the price paid for an equity stake as well as the debt financing used by the company to help generate earnings. Moreover, when considering the enterprise instead of the market value solely, it is more coherent using the operating earnings, or EBIT, which are the earnings with interest and taxes added back to them, for the computation of the new ratio's denominator. Using EBIT places companies on equal footing despite their different levels of debt and different tax rates. Moreover, while the net earnings assess the company's ability to generate value for shareholders, EBIT allows to evaluate the capability of the firm to generate value for both the shareholders and debtholders. Therefore, as we aim to assess the company's value in a more holistic way, EBIT is more adequate. Finally, the factor of the quantitative investment strategy has been built as the ratio between the enterprise value of the company and the average of its operating earnings over the past ten years, to smooth out the noise, and has been called CAEE (cyclically adjusted EV-to-EBIT) ratio along the paper. Shortly, the objective of CAEE is, thus, to measure the value of the company versus its earnings strength over the last ten years, and the goal of the quantitative investment strategy developed based on this ratio was, therefore, to create a new approach to value investing.

2 Literature Review

Value investing is, historically, a global approach to capital allocation based on the company's fundamentals, which are reflected on its income statement, balance sheet, and cash flows, and analyses the relationship between the current share price and its intrinsic value (Battisti, et al. 2019). When Graham and Dodd (1934) developed the intrinsic value concept, they underlined that "intrinsic value does not always coincide with the market value, but it is a volatile measure of the company's valuation". There were several strategic approaches underlying value investing developed over time. Amongst them, Battisti, et al. (2019) highlighted the followings in a systematic literature review:

(1) Graham and Dodd (1934) argued that "investing in shares means having a direct interest in a company, and to be successful one must manage the investment based on the principles of the business economy". The theory is based on the "margin of safety", which is the difference between the share price and the company's intrinsic value. According to Graham (2003), to ensure a sufficient safety margin, the earnings yield (E/P) must be equal to or higher than the investment grade bonds' rate at that time.

(2) Fama and French (1992) stated that companies with a lower price-to-book value ratio (P/BV) and small market capitalization have greater returns than companies with high P/BV and higher market capitalization. They further developed a three-factor model, expanding the CAPM model, on which considered a value factor based on the value premium (high-minus-low book-to-market), and a size factor that accounts for the small-cap premium (Fama and French, Common risk factor in the returns of stocks and bonds 1993). Their

conviction on value investing is that it is indeed successful and gives higher returns than growth investing.

(3) Lakonishok et al. (1994) argued that value strategies generate higher returns because they exploit the behavioural biases of investors. He found that value stocks tend to outperform "glamour"[1] stocks by wide margins, mainly because "investors tend to extrapolate the past good results too far into the future", leading well-performing stocks to become overpriced, and vice-versa.

Davis et al. (2012) confirmed that valuation metrics such as price/earnings ratios have an "inverse or mean-reverting relationship with future stock markets returns" but are only meaningful in long horizons. The same applies to cyclically adjusted or smoothed earnings, which are used for the CAPE ratio calculation. Campbell and Shiller (1988) earlier explained that long-term returns are significantly forecastable, while one-year returns are apparently random because these display a lot of noise, but over longer time intervals this noise effectively smooths out.

Shiller (1996) considered the use of the one-year's earnings in the P/E ratio as an "unfortunate convention, driven by convenience rather than logic". Graham and Dodd (1934) previously stated that one should use an average of earnings "not less than five years, preferably seven or ten years" when exanimating such ratios, as one-year earnings tend to be highly volatile. Later, Shiller and Campbell (1998) proposed the smoothed price-to-earnings ratio, or CAPE, and argued that this should have better forecasting power than the simple price-to-earnings ratio due to its short-term cyclical noise.

Regarding the effect of debt on earnings, stock market analysts stated that changes in capital structure have an impact on earnings per share (EPS), share price, price/earnings ratio, and cost of capital of a company (Jahfer 2006). On one hand, if the leverage is too low, shareholder

[1] Stocks with higher P/BV, P/E or P/C ratios or a lower DIV/P ratio (Basu 1977).

value opportunities are possibly missed by not replacing "cheap" debt for equity. If it is too high, there is additional risk, so a higher discount rate can be applied to the future earnings attributable to shareholders. Glen Arnold (1998) stated that at a very high level of leverage, taking higher risk increases the probability of default, and so does the discount rate as a penalty for the possibility of business failure.

In 1958, Modigliani and Miller (1958) proved, under very restrictive conditions, that the firm value is not affected by its capital structure, i.e., altering the debt/equity ratio cannot enhance the shareholders' wealth. This conclusion was based on major assumptions and required the firm to operate in a perfect world free of taxation and cost of financial distress. However, McConnell and Servaes (1995) found that leverage is positively related to firm value for low-growth firms, but negatively related to firm value for high-growth firms.

In the light of literature more closely to the CAEE ratio, Joel Greenblatt (2005) stated that EBIT/EV helps to measure the earnings potential of a stock versus its market value. If the ratio is greater than the risk-free rate, then Greenblatt considers that there may be a good investment opportunity, and the higher the ratio the better. Later, Patrick Larkin (2009) tested several value investment strategies and concluded that the best-performing ones were EBIT/EV and return on capital.

3 Data and Methodology

The creation and further analysis of the strategy based on the cyclically adjusted EV-to-EBIT ratio, or the CAEE ratio, has been carried out on the US stock market. To build the ratio, annual company fundamentals data has been downloaded from January 1991 until December 2020 from the Compustat database. More concretely, it was retrieved the common shares outstanding ($CSHO_{i,t}$) and the price close ($PRCC_{i,t}$) at year-end to compute the market value for each company ($MV_{i,t}$), and the total long-term debt ($DLTT_{i,t}$), the total debt in current liabilities ($DLC_{i,t}$), and the cash and short-term investments ($CHE_{i,t}$) to calculate the net debt ($ND_{i,t}$), which were both necessary to calculate the enterprise value ($EV_{i,t}$) for each stock within the sample, detailed in Equation 1. To guarantee the reliability of the data, duplicates were removed, as well as stocks with common shares outstanding or price close equal to zero, as indicates that these were not publicly traded at some point.

$$MV_{i,t} = CSHO_{i,t} * PRCC_{i,t} \tag{1.1}$$

$$ND_{i,t} = DLTT_{i,t} + DLC_{i,t} - CHE_{i,t} \tag{1.2}$$

$$EV_{i,t} = MV_{i,t} + ND_{i,t} \tag{1.3}$$

*Equation 1: The first two formulas represent the market value and the net debt for each stock **i** at time **t**, respectively. The last one describes the enterprise value of each stock **i** at time **t**, which will be used to build the ratio.*

Furthermore, the denominator of the ratio ($EBIT10_{i,t}$) was computed doing the simple moving average of the operating earnings for each firm stock ***i*** ($EBIT_{i,t}$) using a period of ten years (from ***t-9*** to ***t,*** included), as depicted in Equation 2.

$$EBIT10_{i,t} = \frac{EBIT_{i,t-9} + EBIT_{i,t-8} + \cdots + EBIT_{i,t-1} + EBIT_{i,t}}{10}$$

*Equation 2: $\boldsymbol{EBIT10_{i,t}}$ represents the cyclically adjusted operating earnings for each stock **i** at time **t**.*

EBIT data has been filtered to values equal or higher than **ε** (*epilson*), being **ε** a real positive number that can be as small as necessary, to restrain the CAEE ratio (detailed in Equation 3) from negative values on one hand, as enterprise value will always be positive, and on the other hand to avoid major outliers, since these would have a significant impact on further calculations.

$$CAEE_{i,t} = \frac{EV_{i,t}}{EBIT10_{i,t}}$$

*Equation 3: The $\boldsymbol{CAEE_{i,t}}$ **ratio** represents the $EV_{i,t}$ –to– $EBIT10_{i,t}$ relation for each stock **i** at time **t.** The higher the EV, ceteris paribus, the higher will be the ratio, and vice-versa.*

Empirically, a company with high enterprise value versus a low ten-year average of operating earnings, which reflects the potential of the firm to generate earnings over the last ten years, will be considered overvalued compared to one with low enterprise value and high EBIT10. Thus, it is expected that stocks with a low CAEE ratio translate into higher returns than stocks with a high CAEE ratio. Additionally, it was taken the sector for each stock in the sample from the Compustat (GSECTOR), which represents the first level in the hierarchy of the Global Industry Classification Standard (GICS) to create a standardized CAEE ratio. As we are considering EBIT instead of the EBITDA for the ratio's denominator, the depreciation and amortization expenses of the firm, which are non-cash expenses related to the company's assets, are not considered. Companies within capital intensive sectors (e.g., Energy), require large amounts of investment and have a high percentage of fixed assets as property, plant, and equipment (PP&E), leading to higher depreciation and amortization levels, and, consequently, to relatively low EBIT values. Therefore, the CAEE ratio can be sector biased, as stocks within capital intensive sectors, with typically lower EBIT values, will systematically have a higher EV/EBIT, leading to higher CAEE values. To bypass this limitation, and to evaluate its impact on the overall strategy, a standardized CAEE ratio ($STD\ CAEE_{i,t}$) was created by subtracting the sector value-weighted CAEE average to each stock's CAEE value every year (Equation 4).

$$SEC_{AVG_t} = \sum_{i=1}^{n} CAEE_{i,t} * \frac{MV_{i,t}}{Total\ MV_t} \tag{4.1}$$

$$STD\ CAEE_{i,t} = CAEE_{i,t} - SEC_{AVG_t} \tag{4.2}$$

*Equation 4: The first formula represents the sector value-weighted CAEE average ($\boldsymbol{SEC_{AVG_t}}$) at each point of time **t**, while the second describes the $\boldsymbol{STD\ CAEE_{i,t}}$ ratio for each stock **i** at time **t**.*

To perform the investment strategies onwards detailed, US stock monthly returns were downloaded from Compustat from January 2000 to December 2020, and the dataset with both ratios ($CAEE_{i,t}$ and $STD\ CAEE_{i,t}$) was resampled from annual to monthly to match with the returns data. To further get the excess returns, the risk-free rate data has been retrieved from Kenneth French Data Library.

Long-only and long-short strategies were developed for the CAEE ratio and the STD CAEE ratio separately in order to compare both ratios' performance. To assess this, the stocks within our sample were ordered by the CAEE and the STD CAEE values, separately, in an ascending way, and further divided into terciles. Based on the logical interpretation of the cyclically adjusted EV-to-EBIT ratio, which is also applicable for the standardized one, it was expected that the first tercile, composed by stocks with a lower factor, performed relatively better than the third tercile on every portfolio. Therefore, the long-only strategies were created by holding long the first tercile, and to create the long-short strategies it was added a short-leg to these that held short the third tercile of each portfolio described above. Furthermore, monthly value-weighted returns, with weights calculated at month ***t*** based on each firm's market capitalization at month ***t-1***, and equal-weighted returns were computed for each strategy. The rationale of the equal-weighting method was solely to test if there is a significant disparity between these strategies when using different weighting schemes. Then, monthly excess returns were calculated subtracting the risk-free rate at month ***t*** from both monthly value-weighted and equal-weighted returns. Although using monthly returns, all the strategies are rebalanced annually due to the use of annual fundamentals.

To assess the performance of each portfolio constructed, the average annual excess return, the standard deviation, and the Sharpe Ratio were calculated in a naïve performance analysis approach. The risk factors' exposure was evaluated using the Fama French 3-Factor model (FF3). The FF3 model (Fama and French 1992) is an extension of the Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965), that only considers the market risk factor (Mkt-Rf), by adding size (SMB) and value (HML) as risk factors (Equation 5). SMB factor accounts for the difference in returns between small-cap stocks (long-leg) and big-cap stocks (short-leg), whereas HML factor represents the difference in stock returns between value companies (long-leg), and growth companies (short-leg).

$$r_{i,t}^{e} = \alpha_i + \beta_{i,M} r_{M,t}^{e} + \beta_{i,SMB} r_{SMB,t}^{e} + \beta_{i,HML} r_{HML,t}^{e} + \varepsilon_{i,t}$$

*Equation 5: Fama and French three-factor regression at time **t**, under the supposition of explanatory power for $\boldsymbol{r_{i,t}^{e}}$, the monthly excess returns of portfolio **i**.*

Since the CAEE ratio has been developed from the CAPE ratio, it was reasonable to compare both performances beyond the comparison with the market portfolio, formed by the market value-weighted excess returns. Then, it has been retrieved the CAPE ratio data from Compustat, and further constructed a value-weighted[2] long-only strategy following the same methodology as previously. This was held as benchmark for the CAEE-based strategies, and further analysed through the naïve approach and the factor analysis.

4 Results and Analysis

4.1 Naïve performance analysis

All the portfolios were computed for the full sample, from January 2000 to December 2020, and are, firstly, compared through a naïve performance analysis considering the average annual excess returns, the standard deviations, and the respective Sharpe ratio statistics, as it is shown on Table 1. In the first instance, it is noticeable that the weighting scheme used to form the portfolios has a substantial impact on their performance. For each of the factors, CAEE and the standardized CAEE, both the long-only and the long-short strategies perform better when using an equal-weighting scheme.

[2] It was not created an equal-weighted portfolio for the CAPE ratio as this weighting-method was used solely for testing reasons.

Table 1: Analysis of the average annual excess return, volatility and Sharpe ratio of each portfolio considering the full sample.

Weighting Scheme	Factor	Strategy	Annual Return	Volatility	Sharpe Ratio
Equal-Weights	CAEE	Long-only	15.96%	21.36%	0.75
		Long-short	4.51%	8.21%	0.55
	STD CAEE	Long-only	15.00%	21.19%	0.71
		Long-short	3.34%	6.52%	0.51
Value-Weights	CAEE	Long-only	10.30%	18.49%	0.56
		Long-short	3.70%	10.47%	0.35
	STD CAEE	Long-only	7.05%	17.32%	0.41
		Long-short	0.48%	7.09%	0.07
	CAPE	Long-only	4.72%	29.62%	0.16
	Market	Long-only	7.04%	16.33%	0.43

In the light of literature, this difference was predictable, as Loughran and Ritter (2000) argued that "because various methodologies use different weighting schemes, the magnitude of abnormal returns should differ, and in a predictable manner". Later, Kevin Chiang (2002) proved that "equal-weight portfolio return metric systematically yields higher estimates of portfolio returns than value-weight portfolio return metric, as a result of the negative empirical correlation between within-sample value weights and raw returns distorting the true weights within the sample", which echoed Fama (1998) previous findings on the negative correlation between raw returns and size. Therefore, as value-weighted portfolios overweight stocks with higher market capitalization, on one hand it reduces their overall volatility, emphasized on Table 1, but on the other hand it neglects the effect of higher excess returns from small capitalization firms, which Fama and French (1992) denominated by size premium, on the total returns of each portfolio. Despite the lower volatility of the value-weighted portfolios comparing to the equal-weighted ones, their Sharpe ratios are still lower, meaning that the risk-adjusted performance of the equal-weighted portfolios is better. Other than the weighting scheme impact on returns, Table 1 highlights the relatively poor performance of the long-short strategies compared to the long-only ones, which suggests that the short-leg of the long-short strategies underperformed. On other words, firms with high CAEE did not present substantially lower returns than firms with low CAEE, so short-selling the third tercile led to lower excess returns on the long-short strategy compared to the short-constrained one. However, the long-short strategies' volatility is much lower due to lower systematic risk, according to literature (Levy and Jacobs 1993). The long-short strategies are indeed created to help investors build portfolios that minimize the systematic risk. On the other hand, it is important to notice that real-life long-short investments carry much higher costs from leveraging, shorting, and more frequent trading, which directly affects their profits (Price 2022). Apart from this, it is worth mentioning that the long-short strategy based on the standardized CAEE ratio is the worst performer, suggesting that the first tercile (long-leg) and the third tercile (short-leg) returns moved closely and in the same direction, meaning that there is no significant difference in stock returns between firms with high STD CAEE and low STD CAEE. This result, on the other hand, highlights that there is indeed a sector bias, which the standardized ratio effectively minimizes. Oppositely to the long-short STD CAEE strategy, the long-only CAEE strategy presented the best performance after adjusting to risk with Sharpe ratios of 0.76 and 0.56, using equal-weights and value-weights, respectively.

Following the performance analysis, only the value-weighted portfolios were used for comparison with both the market and the benchmark (the CAPE based strategy), exhibited on Figure 1. Although the equal-weighted portfolios performed relatively better, as depicted previously, these are not so realistic because they attribute the same weight to every stock independently of its liquidity, which is positively correlated with market capitalization and important to consider in real-life trading.

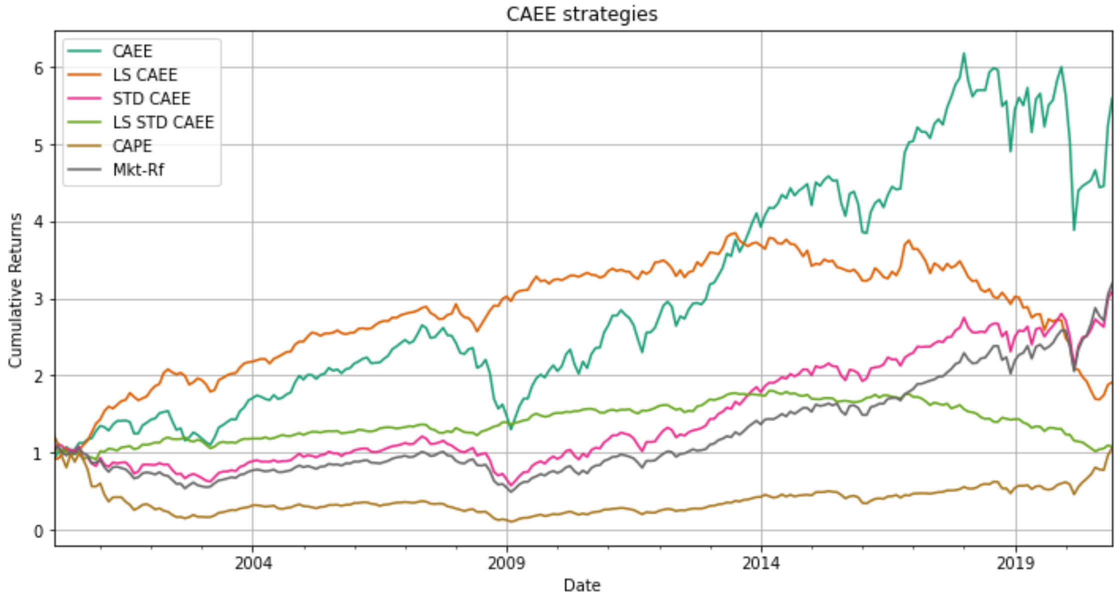


Figure 1: Cumulative returns of the CAEE strategies against the market portfolio (Mkt-Rf), and the benchmark (CAPE).

From the figure above, it is noticeable the outperformance of the long-only CAEE strategy over the other strategies developed, the market, and the benchmark. For both the long-only and the long-short strategies, the difference between the standardized and the original ratio performance was a surprise. Smoothing out the sector effect on the CAEE ratio was expected to generate higher cumulative returns, as uniformizes the sample and diminishes the bias, as previously mentioned. However, from further analysis, it was seen that within the S&P 500, industries that are typically more capital-intensive, as Oil & Gas, part of the Energy sector, in fact underperformed the Index average from 1/1/2000 to 31/12/2020 on a total price return metric[3] (-79.71% vs. 155.65%). Therefore, enhancing these stocks by removing the sector bias may have led to lower returns, contrarily to expected. On the other hand, Table 1 shows that the standardized strategies are less volatile, and as volatility has a positive correlation with expected returns, it can also justify the underperformance of the STD CAEE in terms of returns compared to the original ratio. Regarding the standardized strategies, Figure 1 also emphasizes the fact that the long-only STD CAEE returns moved very closely with the market, propounding a high

[3]The total price return has been retrieved from Bloomberg on 18/11/2022.

correlation between these.

Other than this, Figure 1 strengthens the previously stated conclusion on the difference between the long-only and the long-short strategies, as it not only exhibits the long-short strategies' low-correlation with the market, but also their relatively low volatility and returns compared to the long-only portfolios. It is also noteworthy that the long-short strategies actually outperformed the long strategies until mid-2014, but significantly drown after, leading to lower cumulative returns by the end of 2020. The long-leg cumulative returns on each long-short strategy, that correspond to the respective long-only portfolio, keep growing, implying that the long-short cumulative returns decrease from 2014 is due to an increase in the third terciles returns, consequently driving the long-short performance down, as we held a short position on these.

4.2 Factor analysis

The naïve performance analysis omits the underlying risk factors that ultimately drive the returns of the investigated portfolios. Therefore, excess returns were tested considering the Fama French 3-Factor model (FF3), described by Equation 5, and the results are summarized on Table 2.

Table 2: Results of the FF3 regression on each portfolio returns.

Factor	Strategy	α	β_{MKT}	β_{HML}	β_{SMB}	t-stat	R^2	IR
CAEE	Long-only	2.67%	0.972	0.595	-0.019	2.154	0.900	0.48
CAEE	Long-short	0.23%	-0.025	0.685	0.143	1.770	0.546	0.39
STD CAEE	Long-only	-0.14%	0.997	0.127	0.012	-0.113	0.895	-0.03
STD CAEE	Long-short	-0.01%	0.001	0.217	0.174	-0.056	0.157	-0.01
CAPE	Long-only	-0.61%	1.505	-0.336	0.715	-3.887	0.915	-0.86

The results overall reinforce some of the conclusions stated on the naïve analysis. More concretely, the fact that the long-only CAEE strategy is the best performer with the higher abnormal rate of return, measured by alpha (2.67%), being statistically significant at a 95% confidence level, as the t-statistic is higher than 1.96. Moreover, the long CAEE strategy has a positive loading on the MKT and the HML factor, while negative on SMB, as expected, indicating that the portfolio returns are weighted towards value stocks, complying with the main objective of the strategy, and big-cap stocks. The R-squared is close to 1, meaning that the FF3 explains well the portfolio's returns, or in trader terms, it is a good hedge on the portfolio. Other than that, both long-short strategies have a factor loading on MKT close to zero, reinforcing their low systematic risk, measured by the exposure to the market (β_{MKT}). The long-short CAEE strategy is the only long-short strategy with a positive alpha (0.23% vs. -0.01%), but it is not significant. Regarding the CAPE strategy, the negative factor loading on HML (-0.336) was a surprise, as it shows that the returns of the CAPE strategy are mainly explained by growth rather than value stocks, which does not follow the value investing rationale. Other than that, the information ratios, which represent the average excess return per unit of risk, overall reflect the t-statistics results, being greater than 0.40 in absolute terms for significant alphas, and lower for insignificant alphas.

5 Conclusion

The literature on value investing is extensive, and more recently it has also become controversial. On one hand, previous documentation proves that, historically, value stocks have earned higher returns than growth stocks. On the other hand, recent papers exploit the fact that value may be "dead", as its returns have fallen sharply over the last years. Nevertheless, several quantitative investment strategies have been developed to exploit value, mostly generating positive and significant abnormal returns.

Considering the ratio between the enterprise value, instead of the share price only, and the cyclically adjusted operating earnings of the firm, rather than the earnings to shareholders, denominated by CAEE, proved to be an effective measure to exploit value investing and generated a statistically significant alpha (2.67%), when used on a value-weighted long-only portfolio. In the light of the "lively debate that exists over the question of whether this value premium exists because value stocks are riskier or because the market is inefficient" (Larkin 2009), the results indicate that the first assumption is more likely, since the strategies developed on this paper that outperformed the market, also presented higher volatilities. Although not so realistic, an equal-weighted portfolio was created to understand the impact of the weighting-scheme on returns, and the results reinforce the assumption that value premium may exist due to the higher risk of value stocks, as the equal-weighted long CAEE strategy presented a higher average annual return (15% vs. 10.3%) but increased its volatility (21.4% vs. 18.5%) as well. Other than that, standardising the ratio has demonstrated to be not so effective, as the long STD CAEE strategy generated a negative alpha (-0.14%), and showed to be highly correlated with the market, but with a slightly higher volatility (17.3% vs. 16.3%), leading to a lower Sharpe ratio than the market (0.41 vs. 0.43). Furthermore, both ratios outperformed the CAPE based investment strategy, which generated a negative and significant alpha (-0.61%).

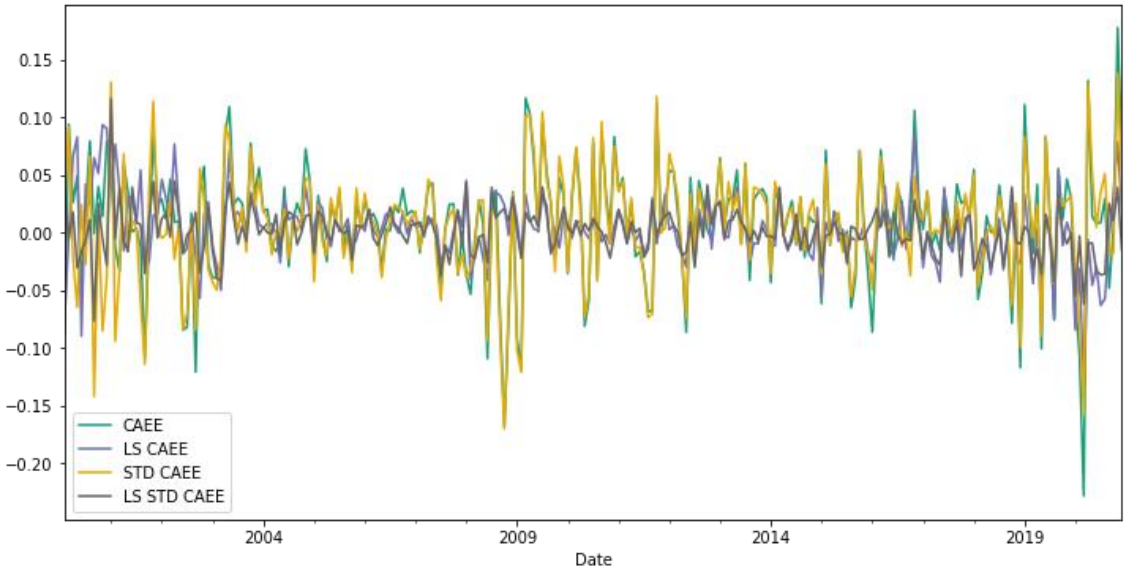
In conclusion, the results prove that using the CAEE ratio is a good measure to exploit value investing on short-constrained portfolios, generating higher returns than the market and the CAPE ratio, the starting point for the development of the new ratio. Value investing, thus, appears to not be "dead", although the value premium may be lower over the last twenty years.

Appendix

Appendix 1.1: First level of the GICS Sectors and the respective identifier codes

Global Industry Classification Standard	
Code	Sector
10	Energy
15	Materials
20	Industrials
25	Consumer Discretionary
30	Consumer Staples
35	Health Care
40	Financials
45	Information Technology
50	Communication Services
55	Utilities
60	Real Estate

Appendix 1.2: Value-weighted CAEE strategies' returns.



References

Shiller, Robert. 1996. “Price-earnings ratios as forecasters of returns: the stock market outlook in 1996.” Yale University.

Sharpe, William F. 1964. “Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk.” *The Journal of Finance* 19 (3): 425-442.

Price, Mike. 2022. *What is Long-Short Equity Strategy?* January. Accessed November 2022. https://www.thebalancemoney.com/what-is-long-short-equity-strategy-5207788.

Moore, Simon. 2021. “Is value investing dead? Not so fast, a recent study says.” *Forbes.*

Modigliani, Franco, and Merton Miller. 1958. “The cost of capital, corporate finance, and the theory of investment.” *American Economic Review* 48 (3): 261-297.

McConnell, John, and Henri Servaes. 1995. “Equity Ownership and the two faces of debt.” *Journal of Financial Economics* 39 (1): 131-157.

Loughran, Tim, and Jay Ritter. 2000. “Uniformly least powerful tests of market efficiency.” *Journal of Financial Economics* 55 (3): 361-389.

Lintner, John. 1965. “Security Prices, Risk, and Maximal Gains from Diversification.” *The Journal of Finance* 20 (4): 587-615.

Levy, Kenneth N., and Bruce I. Jacobs. 1993. “Long/short equity investing.” *Journal of Portfolio Management* 20 (1): 52-63.

Lakonishok, Josef, Andrei Shleifer, and Robert Vishny. 1994. “Contrarian investment, extrapolation and risk.” *Journal of Finance* 49 (5): 1541-1578.

Jahfer, Athambawa. 2006. “The Impact of Financial Leverage on the Wealth of Shareholds relevant to the Firms in Sri Lanka.” *Journal of Management* 4 (1): 10-18.

Graham, Benjamin. 2003. *The Intelligent Investor.*

Graham, Benjamin, and David Dodd. 1934. *Security Analysis.*

Fama, Eugene, and Kenneth French. 2020. "The Value Premium." *Fama-Miller Working Paper* 20 (1).

Fama, Eugene, and Kenneth French. 1992. “The cross-section of expected returns.” *Journal of Finance* 53 (6): 1975-1999.

Fama, Eugene. 1998. “Market Efficiency, Long-Term Returns, and Behavioral Finance.” *Journal of Financial Economics* 33 (3): 3-56.

Davis, Joseph, Roger Aliage-Diaz, and Charles Thomas. 2012. “Forecasting stock returns:

What signals matter, and what do they say now?” *Vanguard Research.*

Chiang, Kevin C.H. 2002. “Portfolio Return Metric: Equal Weights Versus Value Weights.” University of Alaska Fairbanks.

Battisti, Enrico, Nicola Miglietta, Antonio Salvi, and Fabio Creta. 2019. “Strategic approaches to value investing: a systematic literature review on international studies.” *Review of International Business and Strategy* 29 (3): 253-266.

Arnold, Glen. 1998. *Corporate Financial Management.* Financial Times Pitman.

Greenblatt, Joel. 2005. *The little book that still beats the market.*

Campbell, John, and Robert Shiller. 1998. “Valuation ratios and the long-run stock market outlook.” *Journal of Portfolio Management* 24 (2): 11-26.

Campbell, John, and Robert Shiller. 1988. “Stock prices, earnings, and expected dividends.” *Journal of Finance* 43 (3): 661-676.

Campbell, John Y., and Robert J. Shiller. 2001. “Valuation ratios and the long-run stock market outlook: An update.” *Advances in Behavorial Finance* 2: 173-201.

Basu, Sanjoy. 1977. “Investment performance of common stock in relation to their price-earnings ratio: a test of efficient market hypothesis.” *Journal of Finance* 32 (3): 663-682.

Campbell, John Y., and Samuel B. Thompson. 2008. “Predicting excess stock returns out of sample: Can anything beat the historical average?” *The Review of Financial Studies* 21 (4): 1509-1531.

Abarbanell, Jeffery S., and Brian J. Bushee. 1998. “Abnormal Returns to a Fundamental Analysis Strategy.” *Accounting Review* 73 (1): 19-45.

Fama, Eugene, and Kenneth French. 1993. “Common risk factor in the returns of stocks and bonds.” *Journal of Financial Economics* 33 (1): 3-56.

Kenourgios, Dimitrios, Spyros Papathanasiou, and Christina A. Bampili. 2022. “On the predictive power of CAPE or Shiller's PE ratio: the case of the Greek stock market.” *Operational Research* 22 (4): 3748-3768.

Larkin, Patrick J. 2009. “Can Individual Investors Capture the Value Premium?” *Journal of Business & Economics Research* 7 (5): 25-34.

A Work Project, presented as part of the requirements for the Award of a Master's degree in Finance from the Nova School of Business and Economics.

FIELD LAB: ANALYSIS OF QUANTITATIVE INVESTMENT STRATEGIES

Analyzing the Analysts: How does consensus moves with profitability?

Exploiting value with a cyclically adjusted enterprise value-to-EBIT ratio

Intangible to Asset Growth and the Cross-Section of Returns

Beatriz Côdea

Bogdana Blidari

Julius Hildebrandt

Work project carried out under the supervision of:

Nicholas Hirschey

16/12/2022

Abstract

The group report aims to combine three strategies covering US equities: the IBES and Profitability, the cyclically adjusted EV-to-EBIT, and the Intangible-to-Asset Growth strategies. These were treated as individual securities to further create the equal-weighted, the tangency, and the global minimum variance portfolios. The first showed the best performance yielding on average 7.01% yearly, outperforming the market with a Sharpe ratio of 0.53 (vs. 0.43). The global minimum variance portfolio minimized indeed the volatility, which was significantly lower than the market's (7.36% vs. 16.3%). The three combined strategies performed worse than the best individual strategy – the long cyclically adjusted EV-to-EBIT.

Keywords: Finance, Financial Markets, US Stock Market, Performance Analysis, Modern Portfolio Theory, Portfolio Construction.

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

1 Introduction

Quantitative investing dates back to 1950 but it was not until the late 1970s that it became popular. Today, sophisticated algorithm-based programs process billions of financial data in search of signals that a stock is likely to outperform the market. As the race between traditional and quantitative investment continues, hedge funds and investors are seeking to find new ways of delivering abnormal returns. This project aims to combine three previously created quantitative investment strategies: the value-weighted long-only IBES and Profitability, the value-weighted long-only cyclically adjusted EV-to-EBIT, and, lastly, the value-weighted long-short Intangible-to-Asset Growth. All three strategies are explained in more detail in the next section. The individual strategies were combined into three different portfolios: the equal-weighted portfolio, the tangency portfolio, and the global minimum variance portfolio. The purpose of this analysis is to see to which extent these diversified portfolios perform better than the individual strategies alone. This means, analyzing if each portfolio provides investors with superior risk-adjusted returns. The goal of building such portfolios is to combine various stocks by allocating them while minimizing risk and optimizing returns. Therefore, the tangency and global minimum variance portfolios are constructed in a way such that it automatically allows investors to readjust the individual strategies' weights throughout time in order to comply with the underlying strategy. The analysis is reported as follows. Section 3.1 presents a brief comparison between the individual strategies through some performance metrics. Section 3.2 describes the methodology behind the construction of the three portfolios. Further sections examine the naïve performance of all these portfolios and present the regression analysis using Fama French 3-Factor Model and Fama French 5-Factor Model. The final sections evaluate the portfolio weights and drawdowns over time, and lastly, compare our performance against a 60/40 portfolio.

2 Individual Strategies

2.1 Analyzing the Analysts: How does consensus moves with profitability?

2.1.1 Economic Motivation

These days, most of the investment community has adopted several quantitative strategies – machine learning, advanced mathematical models, factor investing, and many others– to outperform stocks and increase their returns when compared to an index. The purpose of this work project is to build and analyze a quantitative investment strategy based on both the Institutional Brokers' Estimate System (IBES) estimates and one of the measures of a company's profitability, the Return on Equity (ROE).

Prior studies by Womack (1996) found that an upgrade (downgrade) in a recommendation is associated with positive (negative) abnormal returns around their announcements. In addition, a paper published by the University of Illinois ("A Comparative Analysis of ROE and Value-to-Price based Trading Rules: Do Conventional Risk Factors Matter?") (2001), found that a ROE based trading rule could generate significant returns over 12 month period after portfolio formation.

2.1.2 Data and Methodology

Firstly, data was retrieved from IBES, covering quarterly US data from 01/12/1992 up to 31/09/2022, and containing the I/B/E/S Recommendation Code (IRECCD). IBES standardizes recommendations as 1 (strong buy), 2 (buy), 3(hold), 4 (sell), and 5 (strong sell). The order was reversed so that small numbers represent negative recommendations and higher numbers represent positive recommendations. Data from the Compustat covering 31/01/1991 until 31/12/2021 was also extracted, containing the return on equity for US securities. The two datasets were merged on CUSIP (an 8- or 9-digit unique stock identifier operated and maintained by the S&P Global Market Intelligence) and also by date, to obtain the final database containing the analyst's recommendation and the Return on Equity, by date, and CUSIP. To this dataset was added the key "GVKEY" for further analysis, leaving 341,353 observations on the portfolio after cleaning and filtering (to ensure that non-numerical or invalid values are filtered out).

The strategy was thus constructed as the sum of both factors and on a value-weighted basis. The long-only strategy's main idea is to take a long position on those stocks that present a higher factor. This is, buying stocks in the top quintile (the "winners") and selling stocks in the bottom quintile (the "losers").

2.1.3 Performance Analysis

The purpose of this section is to analyze the strategy's performance (long-only and long-short) and compare how different it would perform if any investor decided to go against what analysts recommend. To execute the analysis several performance measures were calculated, mainly the average excess returns, the annualized Sharpe ratio, and also the information ratio.

Table 1: Performance statistics summary on IBES and Profitability strategies

Strategy	Period	Annual Return	Volatility	Sharpe Ratio
Long-only	Full sample	7.11%	32.24%	0.21
	First half	-5.60%	35.06%	-0.16
	Second half	21.48%	28.80%	0.68
Long-short	Full sample	1.46%	28.88%	0.05
	First half	2.66%	28.77%	0.09
	Second half	0.27%	29.10%	0.01

Table 1 shows the results for the full sample period (in-sample) and for the first and second half (out-of-sample) to test the consistency of the strategy in different portfolios. Overall, the long-only strategy presents a better performance after adjusting to risk, with a Sharpe ratio of 0.21, an annualized return of 7.11%, and volatility of more than 30%. Figure 1 shows how the long-only strategy hits its bottom early in the sample (beginning of 2000) but starts to slowly increase throughout the first decade, with a slight step back in 2008. During the second half of the sample, it is clear that the returns ascent rapidly amid the Covid-19 pandemic.

The long-short strategy is able to generate lower risks but also lower returns. The full sample is only able to get an average annualized return of 1.46%, a volatility of 29%, and a Sharpe ratio of only 0.05.

Despite starting higher than the long-only strategy and the market portfolio, this strategy is not very stable throughout the sample, with lots of ups and downs. Contrary to what happens in the long-only strategy, in the second half, the strategy performs worse, reaching its lowest point in 2020.

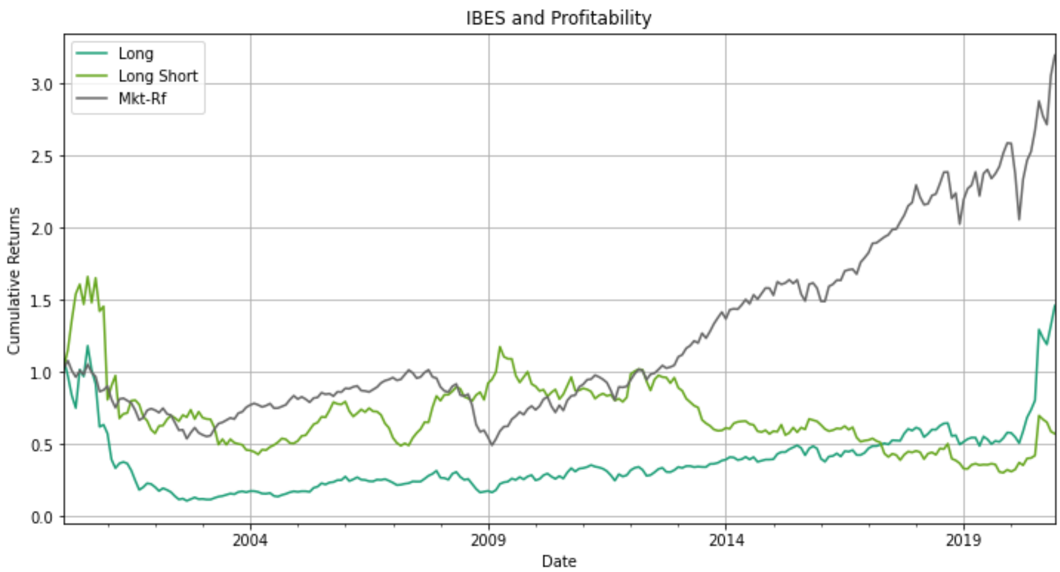


Figure 1: Cumulative returns of the IBES and Profitability strategies

However, after analyzing a strategy that goes against analyst recommendations but keeps the rule on return on equity, this is, that buys stocks with a "strong sell" recommendation and sells stocks with a "strong buy" recommendation, the results were curious.

This analysis came from the skepticism around the consensus on analyst's recommendations that were brought up by previous research, that have shown that different researchers have somewhat different beliefs. Per se, Abarbanell and Bushee (1997) have stated that analysts' earnings forecasts do not fully efficiently incorporate financial statement information. Also, a study conducted by Bradshaw (2004) did not find any correlation between the consensus from analysts' recommendations and adjusted returns. And prior studies even suggest an inverse relation between analysts' recommendations and a future abnormal return during certain periods.

Table 2: Performance statistics' summary on reverse IBES and Profitability strategies

Strategy	Period	Annual Return	Volatility	Sharpe Ratio
Long-only	Full sample	10.49%	29.00%	0.34
	First half	2.80%	36.00%	0.08
	Second half	18.77%	21.00%	0.79
Long-short	Full sample	4.26%	27.00%	0.15
	First half	7.69%	26.80%	0.28
	Second half	0.90%	27.90%	0.03

The same performance measures as before were used to analyze this strategy. When looking at Table 2, one can find that the excess returns of the long-only are still higher than the long-short strategy, and also, both are above the strategy seen before. Despite the higher annualized returns, the strategy maintains extremely volatile (29%). By looking at the performance of the strategy in Figure 2, it is clear that the long-only strategy almost mimicked the market portfolio, even though from 2019 onwards it consistently outperforms the market, ending up with more than 300% of cumulative returns.

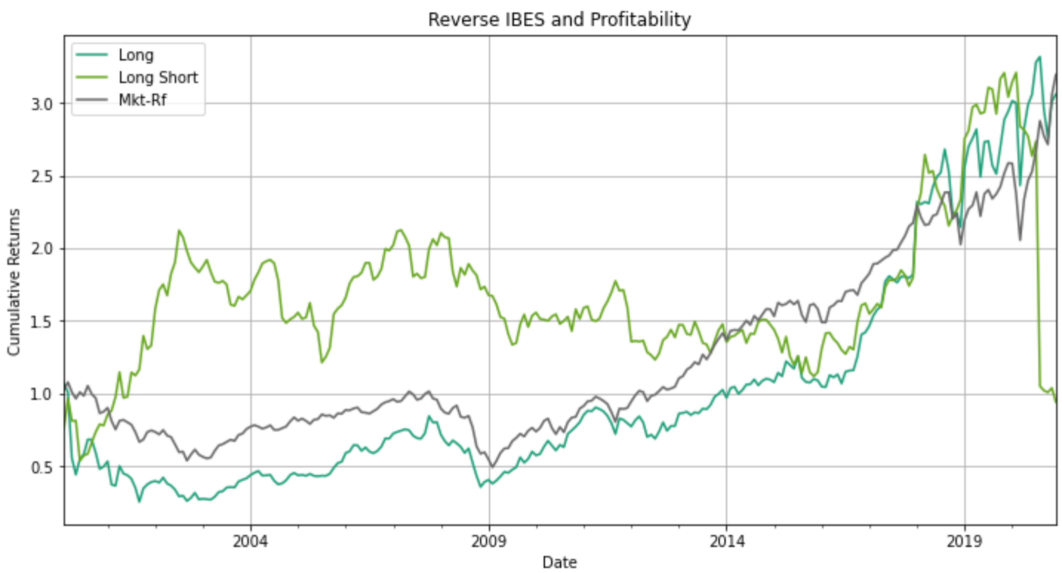


Figure 2 - Cumulative returns of the reverse IBES and Profitability strategies

While analyzing the long-only performance of this strategy under the CAPM and the Fama-French Three Factor Model, it is seen that the alpha is positive in both models almost throughout the whole sample, this is, the strategy is able to beat the market given that it manages to post stronger returns than comparable investments in the market. This is one of the major differences between the two strategies. As seen before, when following the analysts' consensus, the performance shows that is not able to outperform. As for the long-short strategy, the same can be stated. It presents positive and insignificant alphas. Table 3 presents the performance measures summarized for both strategies.

Table 3: Results of the FF3 regression on each portfolio's excess returns

Long-only	**Full sample**	**First half**	**Second half**
CAPM			
Alpha	0.75%	4.38%	0.33%
t-statistic	0.16	0.55	0.07
IR	0.04	0.17	0.02
FF3			
Alpha	0.76%	7.63%	-0.71%
t-statistic	0.18	1.09	-0.15
IR	0.04	0.352	-0.05
Long short	**Full sample**	**First half**	**Second half**
CAPM			
Alpha	5.61%	7.18%	3.43%
t-statistic	0.94	0.87	0.38
IR	0.21	0.27	0.12
FF3			
Alpha	6.12%	9.89%	6.59%
t-statistic	1.07	1.26	0.73
IR	0.24	0.41	0.24

Further analysis will be done on the reverse IBES and profitability strategy given its superior performance, presenting not only higher annualized returns (10.49% vs 7.11%), lower volatility (29% vs 32%), and also positive alphas throughout the sample. For simplification effects, this strategy onwards will be mentioned as "IBES and Profitability".

2.2 Exploiting value with a cyclically adjusted enterprise value-to-EBIT ratio

2.2.1 Economic Motivation

Among the several investment strategies that have been developed over time, value investing, first developed by Graham and Dodd (1934) is still highly above by modern investors, such as

Warren Buffet, one of the world's most successful investors. However, value investing has been controversial recently due to a sharp decline in returns in the second half of the 1963-2019 period, affirmed by Fama and French (2020).

Within the concept of value investing, there have been developed several systematic implementations of value portfolios, i.e., portfolios of stocks sorted on measures like price/earnings (P/E) or dividend yield (DIV/P). Shiller (1996) introduced the cyclically adjusted price-to-earnings ratio (CAPE), a variant of the P/E that divided the current price of a stock by its average inflation-adjusted earnings over the last ten years. The CAPE, also known as Shiller's ratio, still shows conceptual limitations similar to P/E. Among these is the fact that neither CAPE or P/E consider the company's debt, which can affect both the share price and the company's earnings.

Seen this, the main rationale of the investment strategy developed based on a cyclically adjusted enterprise value-to-EBIT ratio (CAEE) was to expand the CAPE ratio concept by attenuating one of its limitations: the disregard of each firm's debt. Moreover, it was intended to exploit value investing with CAEE to understand if value is in fact "dead".

2.2.2 Data and Methodology

The creation and further analysis of the strategy based on the cyclically adjusted EV-to-EBIT ratio has been carried out on the US stock market. To build the ratio, annual company fundamentals data has been downloaded from January 1991 until December 2020 from the Compustat database. More concretely, it was retrieved the common shares outstanding ($CSHO_{i,t}$) and the price close ($PRCC_{i,t}$) at year-end to compute the market value for each company ($MV_{i,t}$), and the total long-term debt ($DLTT_{i,t}$), the total debt in current liabilities ($DLC_{i,t}$), and cash and short-term investments ($CHE_{i,t}$) to calculate the net debt ($ND_{i,t}$), which were both necessary to calculate the enterprise value ($EV_{i,t}$) for each stock within the sample. To guarantee the reliability of the data, duplicates were removed, as well as stocks with common shares outstanding or price close equal to zero, as indicates that were not publicly traded at some point. Furthermore, the denominator of the ratio ($EBIT10_{i,t}$) was computed doing the simple moving average of the operating earnings for each firm stock ***i*** ($EBIT_{i,t}$) using a period of ten years (from ***t-9*** to ***t,*** included).

EBIT data has been filtered to values equal or higher than **ε** (*epilson*), being **ε** a real positive number that can be as small as necessary, to restrain the CAEE ratio (detailed in Equation 1) from outliers or non-sense values.

$$CAEE_{i,t} = \frac{EV_{i,t}}{EBIT10_{i,t}}$$

*Equation 1: The $CAEE_{i,t}$ ratio represents the $EV_{i,t}$ –to– $EBIT10_{i,t}$ relation for each stock **i** at time **t.***

Since the CAEE ratio can be sector biased, as stocks within capital intensive sectors, with typically lower EBIT values, that will systematically have a higher EV/EBIT, leading to higher CAEE values, it was taken the sector for each stock in the sample from Compustat (GSECTOR), which represents the first level in the hierarchy of the Global Industry Classification Standard (GICS), and created a standardized CAEE ratio (Equation 2).

$$SEC_{AVG_t} = \sum_{i=1}^{n} CAEE_{i,t} * \frac{MV_{i,t}}{Total\ MV_t} \quad (2.1)$$

$$STD\ CAEE_{i,t} = CAEE_{i,t} - SEC_{AVG_t} \quad (2.2)$$

Equation 2: The first formula represents the sector value-weighted CAEE average (SEC_{AVG_t}) at each point of time t, while the second describes the $STD\ CAEE_{i,t}$ ratio for each stock i at time t.

Long-only and long-short strategies were developed for the CAEE and the STD CAEE separately to compare both ratios' performance. To assess this, monthly value-weighted returns, with weights calculated at month ***t*** based on each firm's market capitalization at month ***t-1***, and equal-weighted returns were computed. The rationale of the equal-weights method was solely to test the impact of the weighting scheme on the strategies' performance. Then, monthly excess returns were calculated subtracting the risk-free rate at month ***t*** from both monthly value-weighted and equal-weighted returns. As the ratio was developed from the CAPE ratio, this was retrieved from Compustat and used as a benchmark after following the same procedure.

Based on the logical interpretation of the ratio, which is also applicable for the standardized one, it was expected that the lower the ratio, the higher the returns generated. Therefore, the long-only strategies were created by holding long the first tercile, and to create the long-short strategies it was added a short-leg to these that held short the third tercile. Although using monthly returns, all the strategies are rebalanced annually due to the use of annual fundamentals.

2.2.3 Performance Analysis

All the portfolios are firstly, compared through a naïve performance analysis considering the average annual excess returns, the standard deviations, and the respective Sharpe ratio statistics, which are summarized on Table 4.

Table 4: Performance statistics' summary on CAEE strategies

Weighting Scheme	Factor	Strategy	Annual Return	Volatility	Sharpe Ratio
Equal-Weights	CAEE	Long-only	15.96%	21.36%	0.75
		Long-short	4.51%	8.21%	0.55
	STD CAEE	Long-only	15.00%	21.19%	0.71
		Long-short	3.34%	6.52%	0.51
Value-Weights	CAEE	Long-only	10.30%	18.49%	0.56
		Long-short	3.70%	10.47%	0.35
	STD CAEE	Long-only	7.05%	17.32%	0.41
		Long-short	0.48%	7.09%	0.07
	CAPE	Long-only	4.72%	29.62%	0.16
	Market	Long-only	7.04%	16.33%	0.43

From Table 4, it is noticeable that the weighting scheme used to form the portfolios has a substantial impact on their performance. In the light of literature, Kevin Chiang (2002) proved that "equal-weight portfolio return metric systematically yields higher estimates of portfolio returns than value-weight portfolio return metric, as a result of the empirical negative correlation between within-sample value weights and raw returns distorting the true weights within the sample". Despite the lower volatility of the value-weight portfolios compared to the equal-weight ones, their Sharpe ratios are still lower, meaning that when using an equal-weighting scheme, the risk-adjusted performance is better. Overall, the long-only CAEE strategy is the one that shows better performance after adjusting to risk with Sharpe ratios of 0.76 and 0.56, using equal-weights and value-weights, respectively.

Following with the performance analysis, only the value-weighted portfolios were used for comparison with both the market and the benchmark (the CAPE based strategy), exhibited on Figure 3, as these are more realistic.

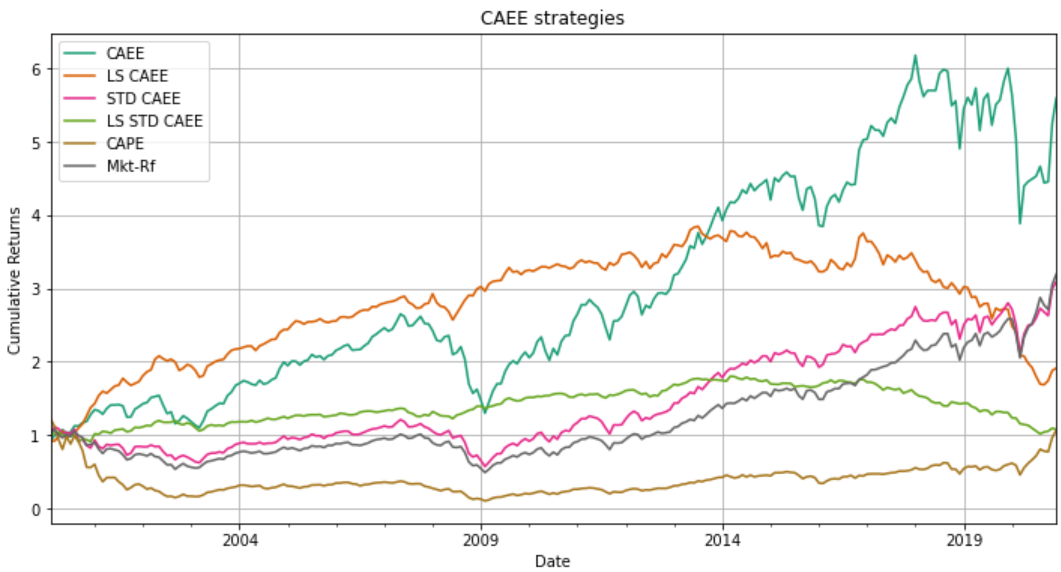


Figure 3: Cumulative returns of the value-weighted CAEE strategies against the market portfolio (Mkt-Rf), and the benchmark (CAPE)

The figure highlights the outperformance of the long-only CAEE strategy over all the other portfolios. On the one hand, the long-only outperformance over the long-short strategies suggests that firms with high CAEE did not present substantially lower returns than firms with low CAEE, so short-selling the first tercile led to lower cumulative returns on the long-short strategy compared to the short-constrained one. On the other hand, it is noteworthy that the long-short strategies are less volatile, uncorrelated with the market, and outperformed the respective long-only strategies until mid-2014, but significantly drown after, leading to lower cumulative returns by the end of 2020. The STD CAEE underperformance compared to the CAEE, both on the long-only and the long-short strategies, was a surprise, showing that removing the sector bias does not generate higher returns, but decreases the portfolio's volatility. All strategies significantly outperformed the benchmark, suggesting that using the CAPE ratio at the stock level may not be very effective on generating excess returns.

The naïve performance analysis omits the underlying risk factors that ultimately drive the returns of the investigated portfolios. Therefore, excess returns were tested considering the Fama French 3-factor model (FF3), and the results are summarized on Table 5.

Table 5: Results of the FF3 regression on each portfolio excess returns

Factor	Strategy	α	β_{MKT}	β_{HML}	β_{SMB}	t-stat	R^2	IR
CAEE	Long-only	2.67%	0.972	0.595	-0.019	2.154	0.900	0.48
CAEE	Long-short	0.23%	-0.025	0.685	0.143	1.770	0.546	0.39
STD CAEE	Long-only	-0.14%	0.997	0.127	0.012	-0.113	0.895	-0.03
STD CAEE	Long-short	-0.01%	0.001	0.217	0.174	-0.056	0.157	-0.01
CAPE	Long-only	-0.61%	1.505	-0.336	0.715	-3.887	0.915	-0.86

The results overall reinforce some of the conclusions stated on the naïve analysis. More concretely, the long-only CAEE strategy reinforced itself as the best performer with the higher abnormal rate of return, measured by alpha (2.67%), being statistically significant at a 95% confidence level, as the t-statistic is higher than 1.96. Moreover, it has a positive loading on the MKT and the HML factor, while negative on SMB, as expected, indicating that the portfolio returns are weighted towards value stocks, complying with the main objective of the strategy, and big-cap stocks. The R-squared is close to 1, meaning that the FF3 explains well the portfolio's returns, or in trader terms, it is a good hedge on the portfolio. Other than that, long-short strategies have a MKT factor loading close to zero, reinforcing their low systematic risk. Apart from the CAEE based strategies, the other portfolios have negative alphas. Regarding the

CAPE strategy, the negative factor loading on HML (-0.336) was a surprise, as it shows that the returns of CAPE strategy are mainly explained by growth rather than value stocks. Other than that, the information ratios overall reflect the t-statistics results, being greater than 0.40 in absolute terms for significant alphas, and lower for insignificant alphas.

2.3 Intangible-to-Asset Growth

2.3.1 Economic Motivation

The intangible-to-asset growth strategy aims to utilize recent development in the estimation of intangible assets, the increased importance of intangible assets, and the well-established asset growth effect (Cooper, Gulen, and Schill 2008). The intangible-to-asset growth ratio measures the relative growth in investments in intangible assets compared to the growth in total assets. The approach is mainly motivated by the work of (Eisfeldt, Kim, and Papanikolaou 2020), which shows how integrating intangibles into the book value of assets improves a classic value approach to investing. Since intangible assets such as intellectual property, customer relationships, brand recognition, and human capital are increasingly important in the modern economy they should not be overlooked as an explanatory factor for stock returns. However, it lies in the nature of intangible assets and in the accounting principles that govern their recognition that they are not easily quantifiable. Since internally developed intangible assets are most of the time expensed rather than capitalized, methods that accumulate certain expenses are often used to estimate the value of a firm’s intangible capital stock. Other methods, like questionnaires, are not practical for the construction of a trading strategy since the data is often limited. This study is following the perpetual inventory method relying on Selling, General & Administrative expenses (Eisfeldt and Papanikolaou 2014) to estimate the stock of intangible assets on a quarterly basis. The intangible-to-asset growth factor is then calculated by dividing the growth of intangibles by the growth of total assets. This ratio should be able to capture how efficiently a company is spending its money. Since the asset growth effect shows that higher growth rates in total assets are linked to lower stock returns and lower growth rates are linked to higher stock returns, we assume it to be the other way around for intangible growth rates due to the enhancing effect on the value factor and the described increased importance of intangible assets. Hence, the hypothesis is that the higher the intangibles-to-asset growth ratio the more efficiently resources are spent. A low ratio suggests that the company is spending relatively too much on tangible assets in comparison to intangibles. A high ratio suggests that a company is developing intangible assets faster than tangible assets and should therefore be a predictor of more efficient utilization of capital. This strategy is insofar an extension of the approach by Cooper, Gulen, and Schill (2008) because it does not punish expanding companies with high growth in tangible assets if intangible assets grow by an equal or even higher proportion.

2.3.2 Data and Methodology

To construct the signals, we use quarterly company fundamental data obtained from Compustat via the Wharton Research Data base (WRDS). The return data is the same as for the two other strategies to have a common investment universe and obtained from the Center for Research in Security Prices (CRSP) as well as Compustat. The asset growth factor is constructed in the following way:

$$AssetGrowth_{it} = \frac{Assets_{it} - Assets_{it-1}}{Assets_{it-1}}$$

Equation 3: Asset Growth factor for stock i at time t.

This is the same approach as taken by Cooper, Gulen, and Schill (2008) with the slight difference that *t* is measured in quarterly intervals instead of annual intervals. To construct the intangible growth factor, first intangibles need to be estimated by following Eisfeldt, Kim, and Papanikolaou (2020) and applying the perpetual inventory method to flows of Selling, General, and Administrative (SG&A) expenses to compute INT_{it}.

$$INT_{it} = (1-\delta)INT_{it-1} + SG\&A_t$$

Equation 4: Perpetual Inventory Method to flows of SG&A for stock i at time t.

INT_{i0} is initialized by setting $INT_{i0} = SG\&A_t \,/\, (g + \delta)$ using SG&A when it first appears in Compustat. I set g to the growth rate of SG&A in my sample which is 0.189 and assume a depreciation rate of $\delta = 0.2$ following Eisfeldt and Papanikolaou (2014). I apply this method to all firms in Compustat and begin my main sample in 2000. Subsequently, I compute intangible growth on a quarterly basis for each firm:

$$INTGrowth_{it} = \frac{INT_{it} - INT_{it-1}}{INT_{it-1}}$$

Equation 5: Intangible Growth Factor for stock i at time t.

From this follows the newly introduced factor Intangible-to-Asset Growth (*IntAssetGrowth*), which is obtained by normalizing (min-max scaling) $INTGrowth_{it}$ and $AssetGrowth_{it}$ across companies for each point in time so that values fit into the [0,1] range. This is necessary to avoid negative growth values. Finally, the $IntAssetGrowth_{it}$ is constructed in the following way:

$$IntAssetGrowth_{it} = \frac{INTGrowth_{it}}{AssetGrowth_{it}}$$

Equation 6: Intangible-to-Asset Growth Factor for stock i at time t.

Portfolios are formed by sorting the stocks in the investment universe according to the signal in month *t* and dividing them into terciles. To avoid look-ahead bias the long (upper tercile) and long-short (long upper tercile, short lower tercile) portfolios are then applied to the returns in $t+1$. Portfolios are formed using market value weighting to ensure the feasibility of the strategy since large investments in small markets cap stocks potentially face liquidity constraints.

2.3.3 Performance Evaluation

Figure 4 shows the cumulative excess returns of the long and long-short Intangible-to-Asset growth strategy in comparison to the excess returns of a value-weighted portfolio of all the stocks in the investment universe (market portfolio). One can clearly see that the long and especially long-short strategies fail to outperform the market portfolio. The long-short strategy barely holds onto its starting value during the 20-year period. Furthermore, it is interesting that the long-short strategy showed a profit during the 2008 financial crisis and achieves rather low volatility. However, this should be taken with a grain of salt since it is not entirely clear if those positive aspects of the strategy are not simply caused by the short exposure to the market.

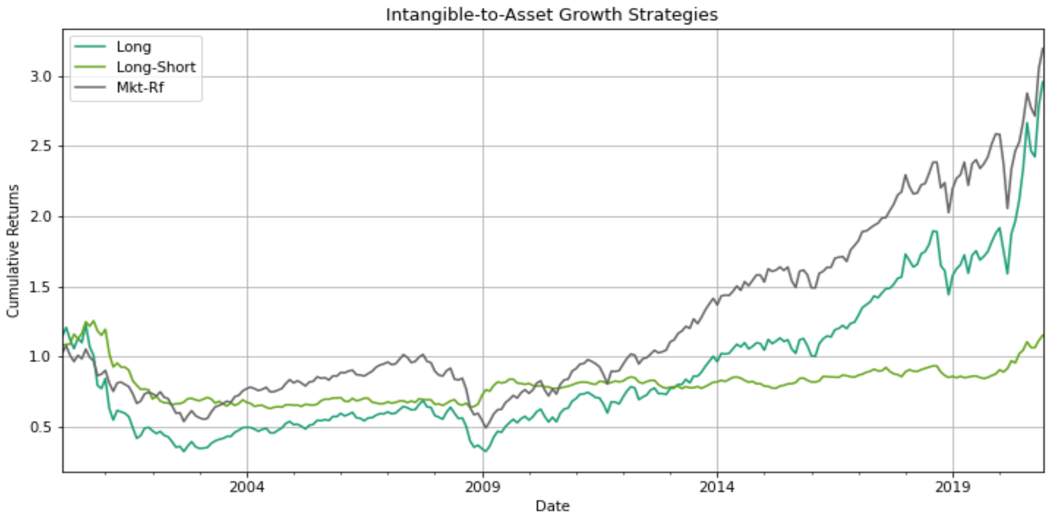


Figure 4: Cumulative returns of the Intangible-to-Asset Growth strategies

Table 6 shows the summary statistics for the strategy. Regarding the long-only strategy, we can note that although the arithmetic mean is around 0.8 percentage points higher than the arithmetic mean of the market strategy, it clearly falls short regarding its standard deviation and Sharpe ratio.

Table 6: Performance statistics' summary on Intangible-to-Asset Growth strategies

	Long-only	Long-short	Market
Average Excess Return	0.0760	0.0110	0.0683
Standard Deviation	0.2171	0.0921	0.1582
Sharpe Ratio	0.3500	0.1197	0.4315

Table 7 shows the Fama French 3-Factor analysis of the full strategy, the first half of the sample, and the second half of the sample. The long-only strategy is highly exposed to the market factor and negatively exposed to the HML factor, which means that the strategy tends to be exposed to stocks with low book-to-market ratios. The exposure to the SMB factor is for all subperiods close to zero and not significant. The long-short strategy behaves in a similar fashion regarding the exposure to the HML factor but exhibits a small but significant exposure to the SMB factor that is driven by the first half of the sample. The coefficient of the market factor is positive but small which suggests that the performance of the long-short strategy cannot be explained by the market risk factor.

Table 7: Results of the FF3 regression on each portfolio excess returns

	Full Sample Feb 2000 - Dec 2020		**First Half** Feb 2000 - July 2010		**Second Half** Aug 2010 - Dec 2020	
	Long	Long-short	Long	Long-short	Long	Long-short
Alpha	-0.0089	0.0040	0.0195	0.0220	-0.0191	-0.0037
	(-0.6168)	(0.2200)	(0.8389)	(0.6905)	(-1.0876)	(-0.1947)
Mkt - Rf	1.2761	0.1966	1.3280	0.1670	1.2264	0.2232
	(46.7689)	(5.7066)	(32.9222)	(3.0291)	(33.8264)	(5.6126)
HML	-0.3493	-0.2924	-0.3993	-0.3799	-0.2358	-0.2027
	(-9.4302)	(-6.2528)	(-7.3459)	(-5.1152)	(-4.4675)	(-3.5014)
SMB	0.0427	-0.1251	0.0498	-0.1891	-0.0642	-0.0471
	(1.0888)	(-2.5289)	(0.9314)	(-2.5880)	(-1.0201)	(-0.6822)
R^2	0.9113	0.2148	0.9136	0.2221	0.9169	0.2501
IR	-0.1369	0.0488	0.2704	0.2225	-0.3668	-0.0657

The table presents the results of a Fama-French 3 Factor Regression. T-statistics are in parentheses.

The explanatory power of the model, judged by the coefficient of determination, is very good for the long-only strategy but fails to explain the long-short strategy. However, the performance is rather poor for all strategies and all subperiods. The long-short strategy is proposed for the group portfolio since it offers a positive information ratio and might help to diversify the portfolio due to its low volatility.

3 Combined Strategy

The three strategies described above, and their corresponding returns were considered to create a combined strategy. Each strategy was treated as an individual security and further as part of a diversified portfolio, noting that each one only included equity. In the next subsections, the individual strategies first will be compared and then combined through three different procedures. Thus, three portfolios were created and further analyzed: the equal-weighted portfolio (EW), the tangency portfolio (TP), and the global minimum variance portfolio (GMV).

3.1 Comparison between individual strategies

The naïve performance metrics of each individual strategy, more concretely, the value-weighted long-only IBES and Profitability (S1), the value-weighted long-only cyclically adjusted EV-to-EBIT (S2), and the value-weighted long-short Intangible-to-Asset Growth (S3), are summarized on Table 8.

Table 8: Analysis of the average annual excess return, the volatility, and the Sharpe ratio for each individual strategy

	(S1) IBES and Profitability	(S2) Cyclically adjusted EV-to-EBIT	(S3) Intangible-to-Asset Growth
Annualized Return	10.49%	10.30%	1.10%
Volatility	29%	18.49%	9.21%
Sharpe Ratio	0.362	0.557	0.119

From Table 8, we can notice that S1, the IBES and Profitability strategy, shows the highest average annual return, followed by S2, the cyclically adjusted EV-to-EBIT strategy. However, S1 is highly volatile relative to the other strategies, and S2 is, thus, the best-performing strategy with the highest Sharpe ratio, showing the best risk-adjusted returns amongst the three individual strategies. S3, the Intangible-to-Asset growth strategy, showed the lowest annualized returns but carried less risk as well. Although the strategies do not proportionate incredibly high risk-adjusted returns individually, some interesting characteristics from each can make the combined portfolios more attractive.

Figure 5: Cumulative returns of the three individual strategies over the full sample

Figure 5, on the one hand, highlights the outperformance of the cyclically adjusted EV-to-EBIT strategy (S2) compared to IBES and Profitability (S1) and the Intangible-to-Asset Growth (S3) strategies. On the other hand, it shows that there is not much correlation between these, which is positive when merging the strategies into a combined portfolio, as it may reduce the overall portfolio's volatility. While S2 suffered a big drawdown in the first months of 2020, corresponding to the beginning of the Covid-19 pandemic, S3 maintained a very consistent position and did not suffer any significant decrease in cumulative returns. S1 returns, on the other hand, decreased similarly to S2, but at a smaller scale. However, during the dot-com bubble burst period (2000-2002), S1 was the strategy that consistently presented bigger drawdowns, but also higher peaks in returns, as Figure 6 reflects. Overall, Figure 6 reinforces the relatively high volatility of the IBES and Profitability strategy (S1), and, contrasting, the low volatility of the Intangible-to-Asset Growth strategy (S3).

Figure 6: Excess returns of the three individual strategies over the full sample

Although the previous charts do not show much correlation between the individual strategies at the first sight, a correlation matrix between their returns was computed to depict these analytically.

Table 9: Correlation matrix performed over the returns of the individual strategies

	S1	S2	S3
S1	1.00	0.52	0.25
S2	0.52	1.00	0.12
S3	0.25	0.12	1.00

From Table 9, it is noticeable that both S1 and S2 returns show a low correlation with S3 returns, 0.25 and 0.12, respectively. S1 and S2 returns present a higher correlation between them (0.52), but still significantly lower than 1. Therefore, it is possible to take advantage of the diversification effect (Markowitz 1959) within the combined portfolios.

3.2 Methodology

After comparing the individual strategies, the three combined portfolios mentioned above were constructed. The naïve combined strategy, which is the equal-weighted portfolio (EW), was constructed by assigning a weight of one-third to each individual strategy. The excess returns of this portfolio are, thus, described by the following equation:

$$r_t^e = {}^1/_3\, r_{S1,t}^e + {}^1/_3\, r_{S2,t}^e + {}^1/_3\, r_{S3,t}^e$$

Equation 7: Excess returns of the equal-weighted portfolio at time t.

Furthermore, an efficient frontier was built to find both the tangency portfolio and the global minimum variance portfolio (GMV). To find the tangency portfolio (TP), we computed the capital market line (CML), depicted in equation 8. This represents the allocation between the risk-free rate and the risky portfolio for all investors combined. An investor is only willing to accept a higher risk if the rate of return increases proportionally.

$$E(r_p) = r_f + \sigma_p \left[\frac{E(r_M) - r_f}{\sigma_M}\right]$$

Equation 8: Capital market line formula, where the slope corresponds to the market Sharpe ratio. When multiplied by the portfolio's volatility, it represents the risk premium.

The efficient frontier, which was developed by Markowitz in 1952, graphically represents all portfolios that maximize returns for each level of risk and is the upper part of the minimum-variance frontier. The last, in turn, maps all the feasible portfolios with different securities combinations.

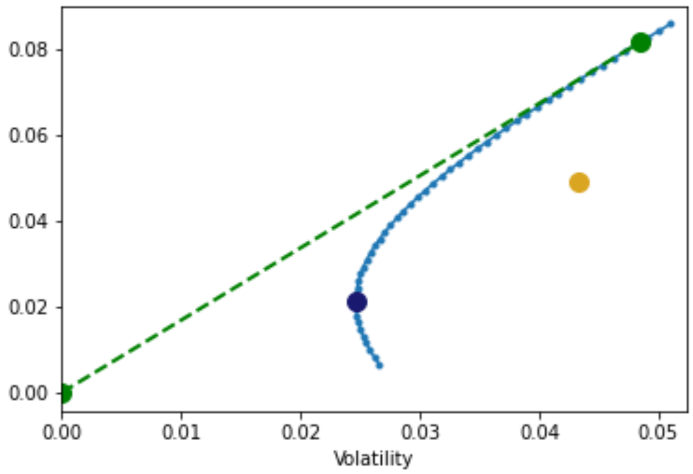


Figure 7: Graphical representation of the minimum variance frontier and the CML

From Figure 7, it is possible to find the global minimum variance portfolio (GMV), which is the blue point at the leftmost position on the minimum variance frontier, representing the portfolio with the lowest possible volatility. The efficient frontier, more concretely, is represented by the portfolios above the global minimum variance portfolio. All combinations below this point are not efficient, as there is always a portfolio that offers a higher expected return for the same amount of risk. Finally, the tangency portfolio (TP) is represented by the tangency point between the CML and the efficient frontier.

Since building a tangency portfolio and a global minimum variance portfolio based on the whole sample would result in a look-ahead bias, it is crucial to use an estimation window to compute expected returns, variances, and covariances. We settled for an estimation window of two years. This means that our sample now starts in February 2002 and uses the return data for the past two years to calculate the portfolio weights on a rolling basis.

3.3 Naïve Performance Analysis

We are then looking at three different types of portfolios: the equal-weighted portfolio (EW), also known as the 1/N rule, the tangency portfolio (TP), and the global minimum variance portfolio (GMV). The TP is the one with the highest return-to-risk combination measured by the Sharpe ratio, while the global minimum variance portfolio (GMV) minimizes the overall variance of the portfolio. Before the regression analysis, all portfolios were compared through a naïve performance analysis. To do so, we considered the average annual excess returns, the standard deviations, and the respective Sharpe ratio statistics for each portfolio, presented in Table 10.

Table 10: Performance statistics summary of the combined strategies

Portfolio	Annual Return	Volatility	Sharpe Ratio
Equal-weighted (EW)	7.01%	13.11%	0.53
Tangency portfolio (TP)	6.28%	15.39%	0.41
Global minimum variance (GMV)	3.29%	7.36%	0.45

From Table 10, one can see that different portfolios have somehow different performances. Whilst the global minimum variance portfolio (GMV) presents a lower annualized excess return (3.29%) and also a lower volatility (7.36%), the equal-weighted portfolio (EW) shows the highest annualized return of 7.01% and a volatility of 13.11%. Finally, the tangency portfolio (TP) shows the highest volatility but a lower annualized return of 6.28% compared to the EW portfolio. This analysis shows that the global minimum variance portfolio carries a lower risk than all the other portfolios, but also lower returns as they are correlated with volatility. By choosing the global minimum variance portfolio (GMV), investors are concerned with minimizing risks while also maximizing returns, so they diversify their holdings to reduce volatility such that no other portfolio produces a lower risk than the one at this point. The GMV portfolio however is unable to perform better than the TP. In fact, the latter is optimal because the slope of CML is the highest, meaning that we achieve the highest returns per additional unit of risk. However, this applies only to the estimation window. When applied to the next period, the GMV and the TP portfolios are both unable to outperform the EW portfolio throughout the whole sample. Also, despite the lower returns of the GMV portfolio, its Sharpe ratio (0.45) is higher than the tangency portfolio (0.41), while the equal-weighted portfolio reaches the highest risk-adjusted performance, with a Sharpe ratio of 0.53. Figure 8 highlights the outperformance of the equal-weighted portfolio over all the other portfolios. Taking into consideration an estimation window of 24 months – in order to eliminate the look-ahead bias – the equal-weighted portfolio has the highest cumulative returns, followed by the tangency portfolio and lastly, the global minimum variance portfolio. As for the fact that the equal-weighted portfolio outperforms the global minimum variance and the tangency portfolio from 2010 onwards should not come as a surprise given that many prior studies have shown the ability of the 1/N rule to outperform other portfolios. Nonetheless, the TP towered above all other portfolios from the beginning of 2002 until 2010. The three portfolios almost mimic one another, slowly increasing until late 2008 when the global financial crisis hit the economy and markets tumbled to their lowest values in years.

After that, all portfolios started to increase, with some pitfalls along the way but with the tangency portfolio getting around 350% cumulative returns, the equal-weighted portfolio more than 400%, and 200% for the global minimum variance portfolio.

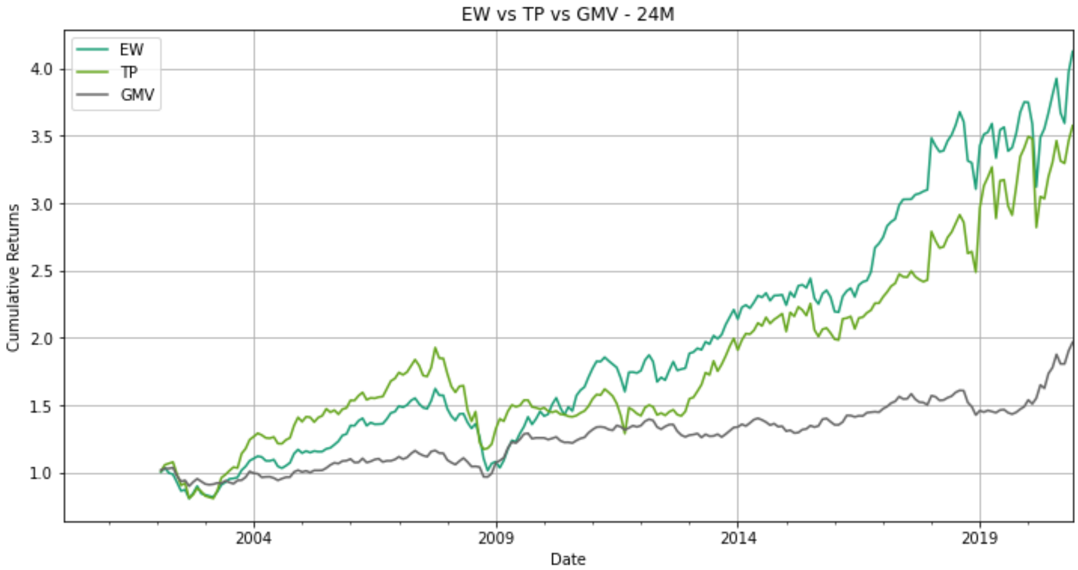


Figure 8: Cumulative returns of the three combined strategies

3.4 Fama French 3-Factor Analysis

Table 11 shows the results of a regression on the Fama French 3-factor model (FF3) (Fama and French 1992). The factors are obtained from Kenneth R. French's website[1]. We can observe that all three portfolios exhibit positive alphas between 2% and 3%, although only the alpha of the equal-weighted (EW) portfolio is statistically different from zero. Hence, only the EW portfolio shows an abnormal rate of return compared to the FF3 benchmark. Judging by the coefficient of determination we can see that the model differs in its ability to explain the performance of our three portfolios. The portfolio with the highest coefficient of determination is the EW portfolio. The exposure to the market is the highest in absolute terms and is highly significant. Additionally, the portfolio exhibits a significant value tilt.

[1] https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Table 11: Results of the FF3 regression on each combined portfolio excess returns

	EW	TP	GMV
Alpha	0.0286	0.0300	0.0208
	(0.05)	(0.22)	(0.12)
Mkt-Rf	0.6498	0.6055	0.2421
	(0.00)	(0.00)	(0.00)
HML	0.1651	0.0305	-0.0633
	(0.00)	(0.63)	(0.06)
SMB	0.0401	0.0078	-0.0678
	(0.32)	(0.91)	(0.06)
R^2	0.7190	0.4310	0.2820
IR	0.4760	0.2723	0.3453

The table presents the results of a Fama French 3-Factor Regression. p-values are in parentheses. Alphas and Information Ratios are annualized.

The tangency portfolio is only significantly exposed to the market factor, although the exposure is smaller in magnitude compared to the equal-weighted portfolio's exposure. This is also true for the GMV portfolio at the five percent significance level. The GMV portfolio is the only one that has a negative value and size tilt, although small in magnitude and only statistically significant at the ten percent level. The information ratio (IR) reveals the superior performance of the EW portfolio compared to the two complex portfolios. It lies in an attractive range for investors with an IR against the FF3 benchmark of almost 0.5. This shows that rebalancing the portfolio with the goal of maximizing the Sharpe ratio or minimizing the variance can result in a worse performance than a simple 1/N portfolio weighting.

3.5 Fama French 5-Factor Analysis

To extend the analysis conducted in the previous section, we regress the excess portfolio returns on the Fama French 5-factor model in this section. The model was developed by Eugene Fama and Kenneth French in 2016 and is an extension of the famous 3-factor model. It proposes that the expected return of a stock can be predicted by five factors: market risk, size, value, profitability, and investment.

Table 12: Results of the FF5 regression on each combined portfolio excess returns

	EW	TP	GMV
Alpha	0.0159	0.0111	0.0092
	(0.30)	(0.67)	(0.50)
Mkt - Rf	0.6841	0.6602	0.2768
	(0.00)	(0.00)	(0.00)
HML	0.0658	-0.1179	-0.1389
	(0.20)	(0.17)	(0.00)
SMB	0.0916	0.0678	-0.0302
	(0.05)	(0.38)	(0.46)
RMW	0.1170	0.1563	0.1052
	(0.04)	(0.11)	(0.04)
CMA	0.1378	0.2563	0.1472
	(0.08)	(0.06)	(0.04)
R^2	0.7270	0.4450	0.3030
IR	0.2619	0.1009	0.1537

The table presents the results of a Fama-French 5 Factor Regression. p-values are in parentheses. Alphas and Information Ratios are annualized.

The additional factors profitability (RMW – robust minus weak) and investment (CMA – conservative minus aggressive) suggest that stocks with high operating profitability perform better and stocks of companies with high total asset growth have below-average returns, respectively. Both new criteria are examples of what is frequently referred to as quality factors. Table 12 presents the results of the regression on the 5-factor model. In comparison to the 3-factor model, we do not observe any statistically significant alphas. The abnormal risk-adjusted returns observed with respect to the 3-factor model for the EW portfolio are therefore explained by the added factors. All the portfolios show to some extent a profitability and investment tilt. The IRs drop below 0.3 for the EW portfolio and even below 0.2 for the more complex portfolios, which shows that by choosing the correct benchmark most abnormal returns can be explained by the exposure to risk factors.

3.6 Portfolio weights analysis

In order to better understand which individual strategies drive the portfolio performance, it is crucial to understand how the portfolio weights change over time. Figure 9 shows the evolution of those weights for the GMV and TP portfolios.

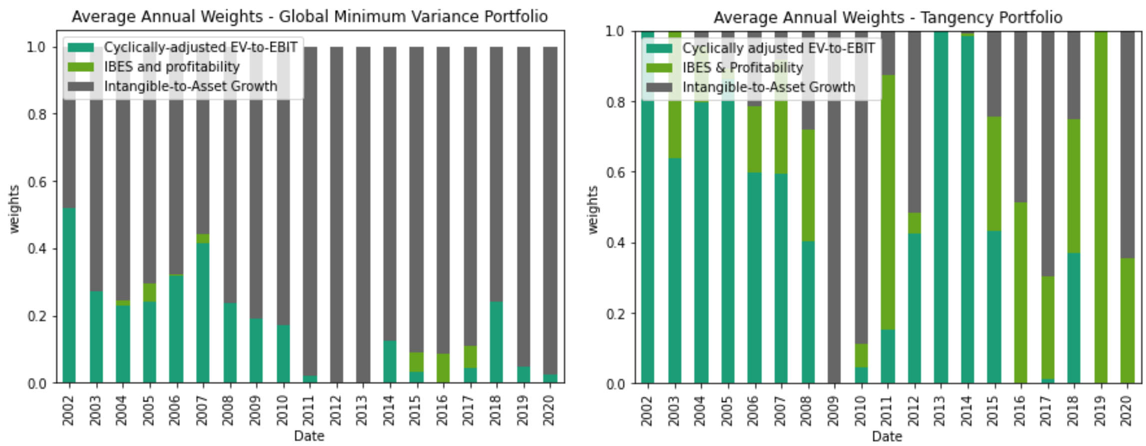


Figure 9: Average annual weights of the TP and GMV portfolio

We can see that the GMV portfolio is heavily dependent on the Intangible-to-Asset Growth strategy, which does not come as a surprise since it offers the lowest volatility of the three strategies. On the other hand, the IBES and profitability strategy only plays a minor role due to its high volatility. The tangency portfolio is heavily dominated by the cyclically adjusted EV-to-EBIT strategy, which is especially evident in the years leading up to the financial crisis of 2008. Interestingly, in 2009, the portfolio shifts completely to the Intangible-to-Asset Growth strategy, which mimics a minimum volatility approach. By looking again at Figure 8, we can see that this is in fact not good for the performance of the tangency portfolio in 2009 since it recovers slower than the EW and GMV approaches. During 2010, this reliance on the Intangible-to-Asset Growth strategy results in a loss in an overall favorable market environment. Hence, after the financial crisis, the TP adjusts too slowly back to the other two strategies. The weakness of the cyclically adjusted EV-to-EBIT strategy towards the end of the sample is also reflected in the TP, which relies from 2019 onwards entirely on the other two strategies. This shows that although the tangency portfolio has the problem to adjust quickly to rapidly changing market conditions it generally has the ability to switch to better-performing individual strategies.

3.7 Drawdown analysis

Figure 10 depicts the drawdown, which is the peak-to-trough decline of the portfolios. Hence, it is a measure of downside risk and gives the investor an idea of how long it takes to recover from a peak and what maximum loss historically occurred.

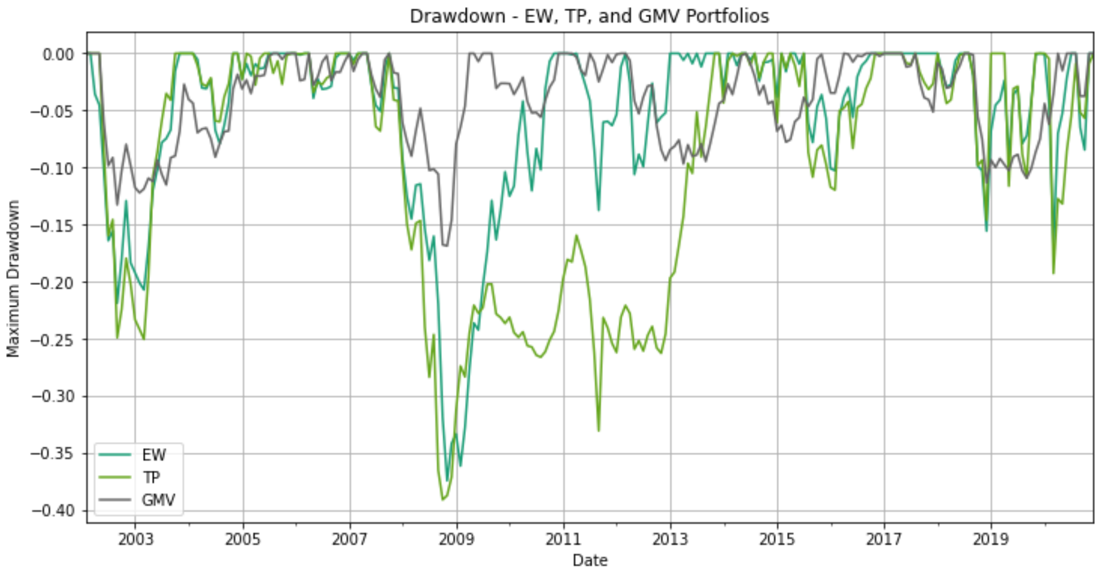


Figure 10: Drawdowns of the combined portfolios over the full sample

The GMV portfolio offers the lowest downside risk in terms of maximum drawdown, which shows that the strategy to minimize the portfolio variance effectively reduces downside risk. However, the portfolio that needs the least time to recover from its losses is the equal-weighted portfolio (Table 13). The tangency portfolio clearly performs the worst regarding the downside potential. Not only the portfolio loses almost 40% from its relatively highest peak to its relatively lowest trough but it also needs up to six years to recover. All things considered, the GMV portfolio offers the best protection against downside risk. It recovers almost as fast as the EW portfolio and exhibits a moderate maximum drawdown of about 17%.

Table 13: Drawdown analysis of each combined strategy

	EW	TP	GMV
Max. Drawdown	-37.46%	-39.12%	-16.87%
Max. Months in Drawdown	36	72	38

3.9 Investment strategies as part of a diversified portfolio

To further analyze the performance of our portfolios and investment strategies, we have added the iShares Core U.S. Aggregate Bond ETF (AGG) and the Vanguard Total Stock Market Index Fund ETF (VTI) to the portfolio formation process. They represent easily investible ETFs in the broad U.S. bond and stock market, respectively.

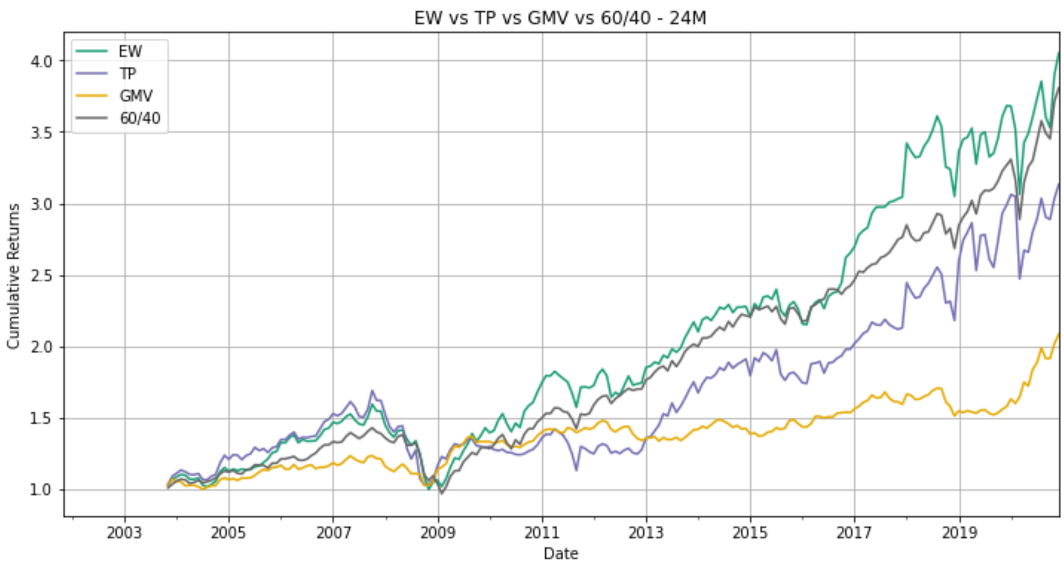


Figure 11 – EW, TP, and GMV against 60/40 portfolio

Figure 11 shows the cumulative returns of our three portfolios against a simple 60/40 portfolio, which invests 60 percent in stocks (VTI) and 40% in bonds (AGG). The beginning of the sample is set to the beginning of the AGG ETF sample period. Following the simple 60/40 rule leads to higher cumulative returns than our two complex strategies (TP and GMV) and only falls slightly short of the EW portfolio. However, the 60/40 portfolio exhibits lower volatility (0.09) than the EW portfolio (0.13). This shows that the complex method of building our three strategies, which possibly incurs high transaction costs, is not noticeably better than a simple 60/40 portfolio with monthly rebalancing.

Table 14: Average portfolio weights for Tangency Portfolio (TP) and Global Minimum Variance Portfolio (GMV) including AGG and VTI

	TP	GMV
Cyclically adjusted EV-to-EBIT (S1)	8.6%	5.7%
IBES and profitability (S2)	4.9%	0.8%
Intangible-to-Asset Growth (S3)	9.2%	19.4%
AGG	70.0%	73.9%
VTI	7.3%	0.2%

Table 14 shows the portfolio weights when we add the VTI and AGG ETFs to the portfolio optimization processes. Both portfolios are heavily dominated by bonds, which is caused by the sample period overlapping a period with extraordinary bond returns. Interestingly, S3 plays the biggest role of the three individual strategies. This is caused by low correlations to other investments and is likely a result of the short exposure of this strategy, since S1 and S2 are long-only strategies.

4 Conclusion

In conclusion, our research has shown that the combination of the individual strategies to a portfolio improves the performance in terms of risk-return considerations. We observe that the different return characteristics and risk exposures provide diversification benefits due to low correlations between the strategies, which is especially true for the Intangible-to-Asset growth strategy. Of the three implemented portfolios, the equal-weighted portfolio performs particularly well. This shows that investing according to more complicated strategies does not generally result in a better performance. The hope, that the tangency portfolio is able to timely switch its investments to the best-performing strategy, has not come true. Due to the estimation window of two years, the portfolio adapts too slowly to changing market environments. The Sharpe ratios of the individual strategies are not persistent enough that a tangency portfolio could provide better performance results than a simple 1/N portfolio. The global minimum variance portfolio achieves its goal – minimizing portfolio variance – relatively decent. For a defensive investor, the GMV portfolio could be attractive due to its relatively stable returns and ability to maintain its value during crises. However, it is heavily reliant on the Intangible-to-Asset growth strategy, which has very limited upward potential, slowly recovers from losses, and relies on a rather complicated security selection mechanism. Additionally, the annualized return of about 3.3% is only attractive in a low-interest rate and low-inflation environment. Finally, we can say that the cyclically adjusted EV-to-EBIT and Intangible-to-Asset Growth strategies offer some diversification benefits and could potentially improve a broad portfolio. The IBES and Profitability strategy however offers little diversification benefits due to its high volatility. Hence, we have not found a "get rich quick" scheme, it is hard to consistently outperform the market, and high returns are most of the time only earned by taking high risks.

References

Abarbanell, Jeffrey, and Brian Bushee. 1997. "*F*undamental Analysis, Future Earnings, and Stock Prices." *Journal of Accounting Research* 1-24.

Bradshaw, Mark. 2004. "How Do Analysts Use Their Earnings Forecasts in Generating Stock Recommendations?" *The Accounting Review* 25-50.

Cooper, Michael J, Huseyin Gulen, and Michael J Schill. 2008. "Asset Growth and the Cross-Section of Stock Returns." *The Journal of Finance* 63 (4): 1609–51.

Eisfeldt, Andrea L, Edward Kim, and Dimitris Papanikolaou. 2020. "*Intangible Value*."

Eisfeldt, Andrea L, and Dimitris Papanikolaou. 2014. "The Value and Ownership of Intangible Capital." *American Economic Review* 104 (5): 189–94.

Fama, Eugene F, and Kenneth R French. 1992. "The Cross-Section of Expected Stock Returns." *The Journal of Finance* 47 (2): 427–65.

Fama, Eugene F, and Kenneth R French. 2016. "Dissecting Anomalies with a Five-Factor Model." *The Review of Financial Studies* 29 (1): 69–103.

Markowitz, Harry. 1959. *Portfolio Selection: Efficient Diversification*

Sam, Han, and Kang Tony. 2001. "*A Comparative Analysis of ROE and Value-to-Price based Trading Rules: Do Conventional Risk Factors Matter?*" University of Illinois.

Womack, Kent L. 1996. "Do Brokerage Analysts' Recommendations Have Investment Value?" *The Journal of Finance* 137-167