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Intangible Capital and the Value Factor: Has Your Value Definition Just Expired?

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Abstract

Many index providers claim that the book-to-price ratio is no longer a sufficient descriptor of the value factor. They argue that it has become outdated because reported book value ignores investments into intangible assets. As a solution, they propose including other valuation ratios, such as earnings-to-price, sales-to-price, cash flow-to-price or dividend yield. However, this solution overlooks a superior alternative: intangible capital can be estimated and added to the book value.

In this paper, we compare these alternative solutions. Beyond a naïve analysis of performance, we ask:
i) whether improvements persist when considering implicit exposure to other factors, and
ii) whether they align with a risk-based explanation for the value factor.

We show that including unrecorded intangibles in the book value increases the value premium and aligns with risk-based explanations. By contrast, other valuation ratios do not add investment value beyond picking up implicit exposure to factors other than value. Such valuation ratios also fail to improve the alignment of value strategies with risk-based explanations.

It is useful to question the traditional definition of the value factor which, as a composite, is problematic. Combining different valuation ratios creates implicit exposure to factors such as profitability. For multi-factor investors, this creates factor overlap and reduces risk-adjusted performance. Composite value definitions no longer add value because of changes in investment practices that have led to a rise of multi-factor investing. On the other hand, the traditional academic definition, book-to-price, has not lost its meaning in the age of intangibles. We can adjust reported book values to account for intangibles. Such an adjustment delivers significant value-added for multi-factor investors.

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1. Introduction

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Many index providers traditionally use a combination of accounting ratios, such as earnings-to-price, sales-to-price, cash-flow-to-price or dividend-to-price, to identify value stocks. This practice is in stark contrast with the empirical evidence of the value factor that relies on book-to-price (see Barillas and Shanken, 2018, and references therein). Of late, providers seem to have found new support for this practice of deviating from the standard definition.

Echoing recent press articles[1], providers argue that "*investors are sensing that something has changed and weighing the growing importance of things like intangible assets, R&D, brand value* […]"[2]. They emphasise that "book-to-price may no longer capture the true value of a stock"[3] and conclude[4] that book-to-price as a definition of value "*is approaching its expiration date*".

Some providers argue that this problem justifies combining several accounting ratios, instead of relying on book-to-price alone. For example, index provider MSCI states: "*Book value may be a good measure of value for companies that rely predominantly on fixed tangible assets. But for other types of companies, […], that have intangible assets, other valuation measures such as those based on sales, earnings, cash flow, and enterprise value may be more appropriate*" (Melas, 2018). Other providers, such as Research Affiliates and Northern Trust, similarly criticise the omission of intangible capital in book-to-price ratios and propose value strategies that include other accounting ratios as a solution (see Svaluto Moreolo, 2019b, and Hunstad and Mehta, 2019).

This solution is problematic for two reasons.

- First, the objective of the value factor is not to replace securities valuation. Factor investing is justified by insights from asset pricing that have identified patterns in the cross section of expected returns. Exposure to the value factor captures differences in expected returns across stocks; it does not capture the true value of a stock. Index providers – instead of implementing the insights of asset pricing – content themselves with reflecting the traditional investment practice of active managers, who search for securities that are under-priced relative to their true value.
- Second, if the problem is that intangible assets are excluded from reported book values, the obvious answer seems to adjust book value to include unrecorded intangibles.[5] The academic literature has developed well-established measures of intangible capital, and has shown how intangible capital influences stocks' risk and return. Rather than dismissing book-to-price as outdated, we can update how it is measured by including intangible capital in the book value.

This paper compares two approaches to addressing issues with book-to-price. The first, proposed by some index providers, is to use other valuation ratios, following intuitive perception. The second approach is to add unrecorded intangibles, following the academic literature.

We find that many alternatives fare better than the standard book-to-price when simply assessing their standalone performance. The standard book-to-price ratio delivers a return of 2.21% per year. Earnings-to-price, sales-to-price and cash flow-to-price lead to significantly positive returns

1 - The Economist and the Wall Street Journal titled 'Why Book Value has lost its meaning' and 'Why the traditional way of measuring value stocks may be history' (see <https://www.economist.com/finance-and-economics/2019/03/23/why-book-value-has-lost-its-meaning> and <https://www.wsj.com/articles/why-the-traditional-way-of-measuring-value-stocks-may-be-history-1536545400>).
2 - See Svaluto Moreolo (2019a)
3 - See 'Definitions: Contrasting approaches pose a predicament', Investments and Pensions Europe, April 2019. Available at <https://www.ipe.com/reports/special-reports/factor-investing/definitions-contrasting-approaches-pose-a-predicament/10030359.article>
4 - See Hunstad and Mehta (2019)
5 - Other valuation ratios do not make the value factor more up to date on recognising the importance of intangibles. Lev and Zarowin (1999) argue that book value, reported earnings and cash flows have lost relevance due to changes that are not appropriately captured by accounting rules. Lev (2000) notes: "Since R&D and most other intangible investments are immediately expensed in financial reports, changes in these expenditures affect the bottom line - earnings - dollar for dollar."

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ranging from 2.77% to 4.20%. Including intangible capital in the book-to-price ratio leads to a return of 4.82%. Only the dividend yield factor fails to deliver a positive standalone return.

From an investor's perspective, though, standalone performance is not the relevant criterion. A straightforward way to improve the standalone performance of a factor is to change its definition so that it captures exposure to additional factors. For example, we can define a new value definition, which overweighs stocks with high profitability. Since combining different factors like value and profitability leads to better performance, we will be able to show that such a new value factor outperforms. But multi-factor investors hold portfolios that already include the profitability factor. Adding profitability exposure in the value factor will create factor overlap which reduces diversification and does not offer any new investment opportunities. We need to correct the performance of the value factor for implicit exposure to other factors to determine the value-added for an investor.

When accounting for implicit factor exposures, we find that only the intangible-adjusted book-to-price factor leads to a significant value premium of 2.09% per year. By contrast, alternative valuation ratios only pick up implicit exposure to other factors and do not add investment value for investors who already have exposure to multiple factors. A composite value definition leads to high exposures to the profitability and low risk factors. Adjusted for these exposures, the premium of a composite value factor is indistinguishable from zero, at -0.41% per year. For multi-factor investors, changing from book-to-price to other valuation ratios or composite metrics reduces the Sharpe ratio, due to factor overlap. For example, switching from book-to-price to earnings-to-price reduces the Sharpe ratio by 11% for an investor who holds exposure to value and profitability. When using a composite value definition instead of book-to-price, the Sharpe ratio reduces by a similar amount.

In addition to empirical evidence, investors require that a factor has an economic rationale. The book-to-price factor fulfils this requirement. Using book-to-price as a factor definition, value stocks have been shown to be more risky than growth stocks in terms of countercyclical variation in market betas and in terms of earnings cyclicality. Such findings provide a basis for the persistence of the value premium. We test whether alternative value proxies also align with a risk based explanation. We find that alternative accounting ratios often fail to align with the systematic risk exposures that were established for the book-to-price factor. For example, earnings-to-price only keeps about 30% of the market beta cyclicality and 40% of the earnings cyclicality of the book-to-price factor. The intangible-adjusted book-to-price factor maintains riskiness in line with the results for the standard book-to-price factor.

The remainder of this paper proceeds as follows. First, we review the relevance of intangible assets for a value factor definition. Second, we describe the data we use to construct alternative value factors. Third, we explain our methodology for testing the benefits of alternative value factor definitions and discuss our results.

2. Why is Intangible Capital Relevant for the Value Factor?

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2.1 The Value Factor Does not Aim to Replace Security Valuation

Many index providers define value by combining various valuation ratios, because this approach resembles traditional investment practice. For example, one leading provider states:
"*Evaluating multiple descriptors reflects investment practice. For example, value investors do not exclusively measure value through price to book; they recognise that this is only one of several complementary measures* ***to assess the intrinsic value*** *of a stock and use different financial ratios to capture the multiple dimensions of value.*" (From Melas, 2018, emphasis added.)

Such an approach builds on the insights in Graham and Dodd (1934). This prominent book on "security analysis" provides guidance to stock-pickers on how to identify securities that are under-priced relative to their intrinsic value. A common misunderstanding of the value factor is that its definition provides a measure of intrinsic value that can be used to identify under-priced stocks.

Of course, a combination of accounting metrics does not infallibly reveal the true value of a stock. We can derive from first principles that – if they are valued fairly – different firms may have discrepant accounting ratios, depending on their growth prospects and risk[6]. Valuation needs to account for investors' growth expectations and risk perceptions. Financial accounts and even analyst forecasts do not provide sufficient information. More generally, if true value could be extracted from financial and market data, there would not be an armada of active managers working hard to identify under-priced stocks.

Identifying true value is more an art than a science and best left to active managers. Factor investing does not require true values as an input. It operates with observable quantities and identifies firm characteristics that are related to differences in expected returns across stocks. Including intangible capital may be relevant if it improves information about such differences.

2.2 Foundations of the Value Factor

Investors who rely on a rational explanation of the value factor do not try to identify under-priced stocks but want to harvest the premium from taking on exposure to losses in bad times. Research has shown that well-diversified portfolios of value stocks (with high book-to-price ratio) have higher long-term returns than well-diversified portfolios of growth stocks (with low book-to-price ratio). Rational asset pricing explains the value premium by the additional risk of value stocks. While they may not have higher volatility or higher market beta, value stocks tend to produce losses in bad economic times, when marginal utility of consumption is high. Investors need to be compensated for holding such risk (Cochrane, 2005). There is a detailed economic mechanism that leads value firms to suffer in bad economic times (Zhang, 2005; Cooper, 2006). Such firms' value is mainly made up of assets in place – rather than growth options. If assets in place are costly to reverse, such firms cannot adapt easily to reduced output in bad economic times. The value of growth firms, on the other hand, mainly consists of growth options. Such firms can delay their growth options flexibly without incurring high costs. Therefore, value firms are riskier than growth firms. Investment patterns observed for listed

6 - Likewise, undervalued and overvalued firms may have identical accounting ratios. See the illustration in Exhibit A11 in the appendix.

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firms confirm that downward adjustments of a firm's capital stock are indeed more difficult than upward adjustments, and such differences help explain the value premium (Bai et al., 2019). Related explanations why value stocks are more risky than growth stocks include higher operating leverage (Carlson, Fisher and Giammarino, 2004), lower cash flow duration (Lettau and Wachter, 2007), and higher cash flow risk (Bansal, Dittmar and Lundblad, 2005).

Including intangibles in the value factor definition may be useful if it helps to capture such risks of value firms. In particular, if intangible capital is costly to reverse, holding a large stock of intangible capital may increase a firm's risk and lead to compensation for stockholders.

An alternative explanation of the value premium is that value stocks are not fundamentally riskier than growth stocks, but investors extrapolate news about a firm too far into the future (Lakonishok, Shleifer and Vishny, 1994). Even if such an explanation holds, identifying value stocks does not require knowledge of the true value of a stock. Instead, a value definition will allow distinguishing value stocks with recent bad news, from glamour stocks with recent good news[7].

2.3 Intangible Capital

Economists recognised early on that intangible capital is a crucial part of firms' capital stock and have tried to measure its impact on firm productivity (see Grabowski and Mueller, 1978, and Griliches, 1979). In addition to physical capital (property, plant and equipment), firms invest in knowledge capital and organisation capital. Knowledge capital is created through research and development (R&D) that leads to know-how in the form of patents, improved processes, and better product quality. Organisation capital is created through investment in training, advertising and organisational design and leads to a skilled workforce, brand recognition, and customer relationships.

Intangible capital is mostly unrecorded on company balance sheets. Nevertheless, accounting data allows measuring intangible capital. A standard approach is to use data on reported expenses that contribute to the formation of intangible capital. In particular, R&D expenses can be reinterpreted as investment into knowledge capital, advertising expense as investment into brand capital, and part of overheads (selling, general and administrative expenses) as investment into organisation capital. This approach is recommended in the accounting literature (see Canibano, Garcia-Ayuso and Sanchez, 2000) and widely followed in the economics literature (see Corrado and Hulten, 2010).

Equipped with measures of intangible capital, financial economists have established a relationship between intangible capital and stock returns. For example, firms with high organisation capital relative to their market value tend to have higher stock returns (Eisfeldt and Papanikolaou, 2013). Likewise, there is evidence of higher returns for firms with high brand capital (Belo, Vitorino and Lin, 2014) or high knowledge capital (Chan, Lakonishok and Sougiannis, 2001; Fang, Tian and Tice, 2014). Rational explanations of the value premium require that value firms are more risky than growth firms. It is thus relevant to ask whether intangible capital increases firms' risk.

7 - Although the book-to-price effect has been related to over extrapolation, more direct ways to capture this effect are through past long-term returns, which is low for value or contrarian stocks, or through sales growth, which tends to be high for glamour stocks. It is obvious that past returns or past sales growth do not provide an indicator of company value, but they may be informative about expected returns.

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Empirical research has shown that investment into intangible capital increases systematic risk (see Lev and Sougiannis, 1999). In particular, such investments are costly to reverse, just like investments into physical capital (Peters and Taylor, 2017; Belo, Vitorino and Lin, 2014)[8]. Firms with high capital stock will have difficulty to downsize to adapt to an economic shock. Firms with high capital, whether it is physical or intangible capital, are thus more risky.

Intangible capital also exposes firms to shocks in financing conditions in the economy. Eisfeldt and Papanikolaou (2013) show that firms that invest heavily into organisation capital are exposed to a risk of key talent leaving the firm and thus damaging the organisation capital. Dou et al. (2019) show that talent dependency increases the risk exposure of firms to financing constraints, as key talent will tend to leave financially constraint firms when financing conditions deteriorate. Similarly, knowledge capital is risky since firms may have to abandon R&D projects under financial stress leading to additional losses in bad times (Li, 2011; Gu, 2016). More generally, firms cannot use intangible assets as collateral[9] (Giglio and Severo, 2012; Ai et al., 2019), exposing them to a risk of tighter financing constraints in bad economic times.

Behavioural explanations of the value premium rely on investors making systematic errors, in particular by extrapolating bad news. Such mechanisms may also apply to firms with high levels of intangible assets. For example, Chan, Lakonishok and Sougiannis (2001) suggest that the market underreacts to the information about future opportunities of firms that, despite poor stock returns, continue to invest in intangible capital. More generally, there is a substantial literature arguing that investors have difficulty valuing intangible assets (e.g. Cohen, Diether and Malloy, 2013).

Considering intangible assets when defining the value factor can thus be motivated both from a rational and from a behavioural perspective.

2.4 The Intangible-Adjusted Book-to-Price Factor

Drawing on these insights, recent research adds estimates of intangible capital to physical capital, to get a more comprehensive picture of firms' capital (Park, 2019; Peters and Taylor, 2017). In addition to adding unrecorded intangibles, these papers suggest omitting recorded goodwill, which is polluted by market value due to accounting rules. This approach is a straightforward answer to the criticism of using accounting book value that omits most intangible assets. Peters and Taylor (2017) find that including intangibles in firms' capital strengthens the relationship between Tobin's q (the ratio of market value to replacement value of a firm's capital) and firm investment. Park (2019) finds that adjusting book-to-price for intangibles leads to a stronger value premium.

Despite the empirical success and the economic rationale of using a comprehensive measure of capital, omitting intangibles may be justified. Goncalves, Xue and Zhang (2019) defend omitting intangibles by referring to measurement problems. Others have argued that relying on an imperfect proxy for intangible capital is still better than omitting intangible capital entirely (see Peters and Taylor, 2017).

8 - This contrasts with an assumption that intangible capital corresponds to growth options (see Ai, Croce and Li, 2012).
9 - Intangible capital is often difficult to identify as a separate assets. Firms are unlikely to be able to use their brand, customer loyalty, product quality or know-how as collateral when borrowing. Patents are an exception.

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Next, we will compare the intangible-adjusted book-to-price factor to value factors based on other valuation ratios.

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3.1 Value Metrics

We will empirically compare three categories of alternatives for the standard book-to-price ratio. First, we consider including intangibles in the standard book-to-price definition of the value factor. Second, we consider various accounting metrics used in value indices offered by index providers. Third, we assess composite value definitions.

First, we follow Park (2019), who proposes adjusting the book value of equity to include omitted intangibles. More specifically, we add knowledge and organisation capital to the book value and deduct goodwill from it. Such an adjustment does not question the rationale behind the standard value factor based on book-to-price, but tries to account for biases in reported book values. Using the intangible-adjusted book value may provide a better measurement of book-to-price than using reported book values, which suffer from accounting conservatism with respect to intangible assets. Our estimates of knowledge and organisation capital are calculated following Peters and Taylor (2017). Knowledge capital is estimated by capitalising past R&D expenses via the perpetual inventory method. Every year, the past year's knowledge capital stock is depreciated and the current year's R&D expenses are added to calculate the current amount of knowledge capital. The initial amount of knowledge capital is estimated under the assumption that R&D expenses between the firm's founding year and the year of entering the Compustat database grew by 40% annually, following Park (2019). This allows us to calculate the knowledge capital for every year since the firm's inception. Organisation capital is obtained similarly. We capitalise 30% of SG&A expenses, assuming that the remaining 70% are expenses to generate income in the current period. The rest of the process is the same as for the estimation of knowledge capital, using the perpetual inventory method[10]. Every year, these estimated values for knowledge and organisation capital are added to the standard book value of equity. The amount of goodwill to be deducted is directly taken from Compustat. We will refer to this alternative as the intangible-adjusted book-to-price ratio (iB/P).

Second, we test several of the popular alternative accounting ratios used by providers of value indices. Unlike book-to-price, such ratios are not motivated by a theory of the value premium. Instead, index providers include accounting ratios that are popular among active managers in practice[11]. We test four different ratios in this category; sales-to-price (S/P), earnings-to-price (E/P), dividend yield (D/P) and cash flow-to-price (CF/P). The values for sales and earnings are net sales and income before extraordinary items, directly taken from Compustat. We calculate the dividends following Fama and French (1988). These are obtained by comparing them with and without dividend returns from CRSP. For cash flows, we use the definition described on the K. French database. It is defined as the total earnings before extraordinary items, with the addition of equity's share of depreciation and deferred taxes.

In practice, the alternative ratios are often combined into a composite value score. Consequently, we assess two composite scores as a third category of alternatives. The first one is based on the four alternative valuation ratios, based on sales, earnings, dividends and cash flows. The second one also adds the standard book-to-price ratio to the other four. The composite scores are obtained by

10 - We provide further details on the estimation methodology for knowledge and organisation capital in section A2 of the appendix.
11 - For example, see the MSCI world value weighted index and the FTSE global factor index series (https://www.msci.com/documents/10199/9133ebac-9308-4bb7-aeec-60c1dcd2c98a and https://research.ftserussell.com/products/downloads/ftse_global_factor_index_series_methodology_overview.pdf).

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averaging the cross-sectional z-scores of the constituents. A firm is not required to have a valid score for all four or five metrics to have a composite score. If one or more ratios are not available, we just take the average of the available z-scores.

Exhibit 1 summarises these alternatives.

Exhibit 1: Overview of the alternative value proxies tested

Alternative value proxy	Adjustment
Book-to-price (B/P)	The book-to-price ratio as proposed by Fama and French (2018)
Adjusting the book value for intangibles	
Intangible-adjusted book-to-price (iB/P)	Add knowledge and organisation capital to the book value, while deducting goodwill
Using other valuation ratios	
Sales-to-price (S/P)	Replace book value by sales
Earnings-to-price (E/P)	Replace book value by earnings
Dividend yield (D/P)	Replace book value by dividends
Cash flow-to-price (CF/P)	Replace book value by cash flows
Composites	
Composite of S/P, E/P, D/P and CF/P	Average of the z-scores of the individual metrics
Composite of B/P, S/P, E/P, D/P and CF/P	Average of the z-scores of the individual metrics

3.2 Data and Factor Construction

Our sample consists of all NYSE, Amex and NASDAQ[12] firms for which data is available in both Compustat and CRSP under share codes 10 or 11. The accounting data we use to construct the alternative value proxies are taken from Compustat. Our analysis is based on annual accounting data for fiscal years ending between January 1975 and December 2017. However, older data is used for the calculation of initial knowledge and organisation capital, as in Peters and Taylor (2017)[13]. The reason to start our sample in 1975 is to avoid inconsistencies due to changing accounting regulations. More specifically, SFAS 2 became effective in 1975 to standardise accounting rules on R&D.

We compute all alternative value proxies for a given firm in year t based on the accounting values of the most recent fiscal year end in that year, and market value at the end of December of year t, based on CRSP data[14]. We compute all value proxies for which the necessary data is available, so we do not require a firm to have the necessary data to calculate all the proxies before we include it in the sample. We follow Fama and French (2018) to construct factors based on each alternative value proxy. At the end of June of year t+1, all firms are independently sorted according to their current market capitalisation and the respective value scores for year t. We define breakpoints as the 50th percentile of the market capitalisation and the 30th and 70th percentiles for the value scores. These breakpoints are based on NYSE firms only. The intersection of both sorts results in six cap-weighted portfolios. We use return data from CRSP to calculate monthly returns for these portfolios. The value factor returns are then defined as the difference between the average return of the large cap-high value and the

12 - We also conduct the analysis looking at the large value factor and small value factor separately. Moreover, we assess results for a reduced universe of the 500 largest stocks. The results are reported in Exhibit A22, Exhibit A23, Exhibit A24 and Exhibit A25 in the appendix.
13 - We use data on R&D and SG&A expenses starting in 1950. We slightly deviate from Peters and Taylor (2017) in the treatment of missing values before 1977 for which interpolation is not possible and the calculation of the initial capital stock. They use assumed growth rates in these expenses based on IPO dates, but since there is a large amount of missing IPO dates we follow Park (2019) in assuming a growth rate of 40%.
14 - Note that dividend yield is an exception. Following Fama and French (1988), the dividends from July of year t until June of year t+1 per dollar of market capitalisation in June of year t+1 are used. For the book-to-price and ibook-to-price, we account for the potential time difference between the fiscal year end and the end of December by applying the net stock issuance adjustment as described in Fama and French (2018). The market value is defined as the price times the number of shares outstanding.

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small cap-high value portfolios on the one hand and the average return of the large cap-low value and the small cap-low value portfolios on the other. The reason to have a lag of at least six months between the accounting data and the yearly rebalancing is to ensure that the accounting statements are publicly available. Following this methodology, we obtain a time-series of monthly returns from July 1976 until December 2018 for each of the alternative value factors.

Asness and Frazzini (2013) point out that, while it is necessary to lag the accounting data to ensure availability, it is not required to do the same for the market value in the denominator of the value scores. These values are available immediately. They argue that in the presence of the momentum factor, using more up to date market values in the value scores is preferable. We have conducted all our analysis also with this adjustment, without a change in our conclusions. The key results for the versions of the factors using up to date market values are reported in Exhibit A19 in the appendix.

3.3 How Different are Alternative Value Metrics?

Before going to the performance analysis of the alternative value factors, it is worth asking whether the alternative value scores look very different when compared with the standard book-to-price ratio. This will give us an idea whether the alternatives end up capturing something similar to the standard value factor or not. First, we look at the average magnitude of the intangible adjustment. Exhibit 2 shows the average proportion in total capital that the omitted intangibles and goodwill represent. Total capital is defined here as total assets plus knowledge and organisation capital minus goodwill, corresponding to the adjustments in the intangible-adjusted book-to-price ratio.

The first observation from this graph is that there is a clear trend. The intuition that the importance of intangibles has increased over time is supported by a clear increase in the average proportion of knowledge capital. In 1975, it represented only 2.6% of total capital, but this number had increased to 12.1% by 2017. The importance of goodwill has also strongly increased over time. Organisation capital, on the other hand, seems relatively stable. Its proportion fluctuates between 14.1% and 16.5% without an obvious trend. In terms of size, the omitted intangibles represent around 20% of total capital on average. Consequently, these adjustments might impact the value scores substantially.

Exhibit 2 gives a good snapshot of the aggregate size of the adjustments over time. However, the value scores are used to distinguish between firms in the cross-section. To see how they would impact the factor construction process, we can look directly at the cross-sectional rank correlation of the alternative value scores with the standard version. This exercise also allows us to compare the intangible adjustment with the alternative valuation ratios or the composite scores.

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Exhibit 2: Proportion of omitted intangible capital
The graph shows the evolution over time of knowledge capital, organisation capital and goodwill as a percentage of total capital. The yearly values are the average percentages across companies. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Total capital is defined as total assets plus knowledge capital plus organisation capital minus goodwill. Knowledge and organisation capital are calculated following Peters and Taylor (2017) and Park (2019). The analysis is based on accounting data for fiscal years ending between 1975 and 2017. However, older data is used for the calculation of knowledge and organisation capital. Data source: Compustat.

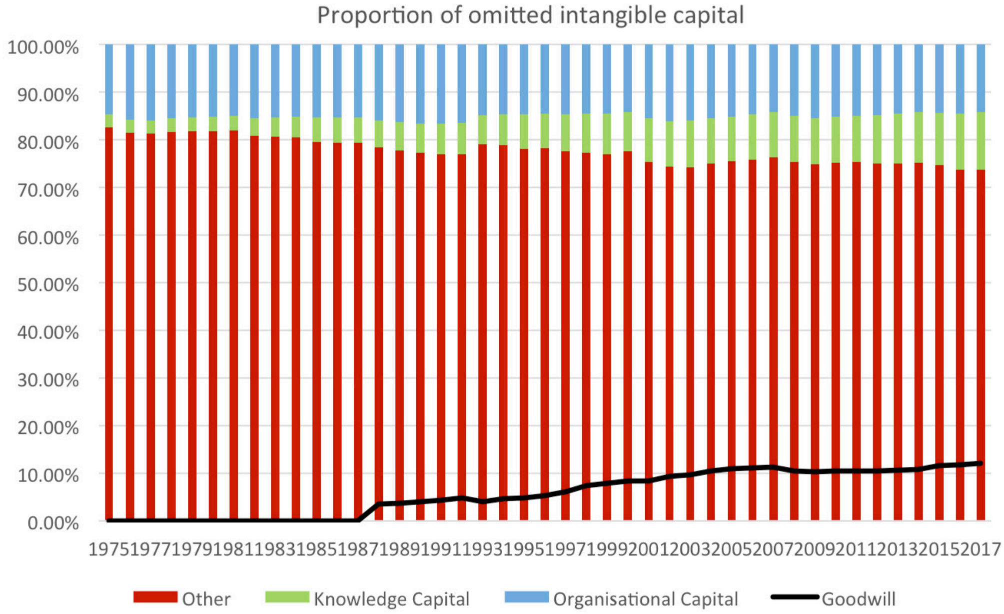

Exhibit 3 plots Spearman's rank correlation coefficient with the book-to-price ratio for every alternative in every year in the sample. This gives an idea of how similarly the different value scores rank the stocks. The graph shows that the intangible adjustment is expected to have less impact on the stock selection than using other valuation ratios. The rank correlation of the ibook-to-price scores with the standard book-to-price scores varies between 0.9 and 0.6 over time. Using metrics such as earnings, cash flows and dividends on the other hand, reduces rank correlations. The values go as low as -0.1 for earnings-to-price. These results indicate that the intangible adjustment to the book value results in a value proxy that is more closely related to the standard one than alternatives that use other valuation ratios.

The graph also shows that the rank correlations seem to be declining over time for all alternatives. This points to a potentially greater impact of the adjustments on the stock selection within the factors in recent years. To give a more concrete idea of how stocks can differ in terms of their rankings according to the various value scores, Exhibit A14 in the appendix contains an overview of these ranks for the 20 largest stocks in the sample as of the most recent rebalancing.

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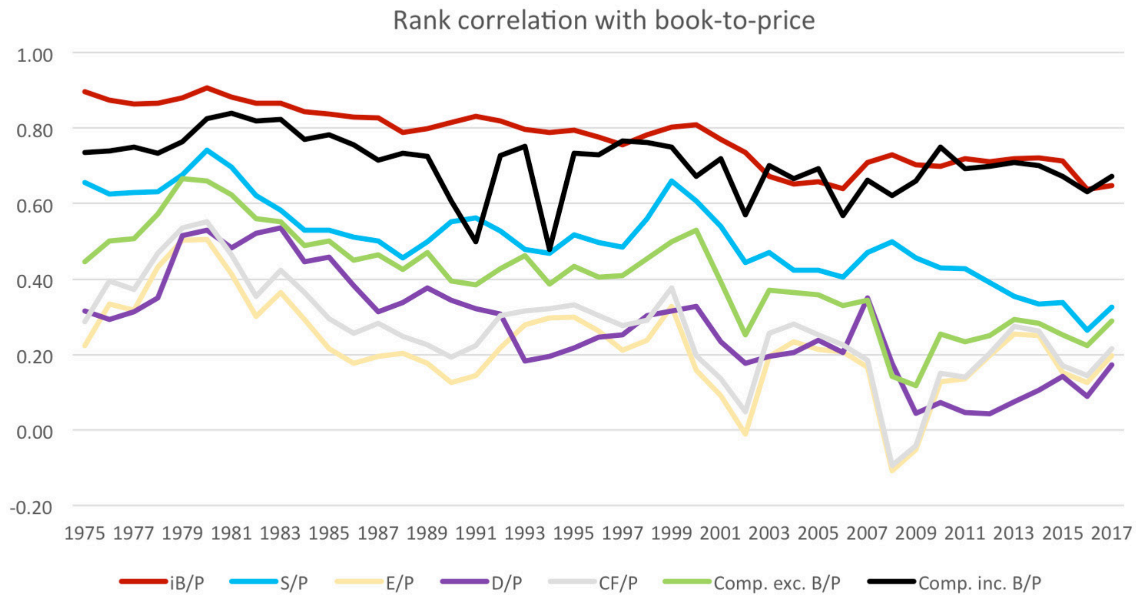
Exhibit 3: Rank correlation with standard book-to-price
The graph shows the evolution over time of the cross-sectional Spearman rank correlation of the alternative value scores with the standard B/P. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Intangible book equity in iB/P is book equity plus knowledge and organisation capital minus goodwill. We define book equity as in Davis, Fama and French (2000). Knowledge and organisation capital are calculated following Peters and Taylor (2017) and Park (2019). E/P, D/P and CF/P are calculated following the methodology used for the data in the French database. S/P is defined similarly. The composite excluding B/P is the average of the cross-sectional z-scores of S/P, E/P, D/P and CF/P. The composite including B/P is the average of the cross-sectional z-scores of S/P, E/P, D/P, CF/P and B/P. The analysis is based on accounting data for fiscal years ending between January 1975 and December 2017 and monthly return data between July 1975 and June 2018 for D/P. However, older data is used for the calculation of knowledge and organisation capital. Data source: CRSP, Compustat, K. French database.



4. Assessing the Value-Added of Alternative Value Definitions: Performance and Risk

4. Assessing the Value-Added of Alternative Value Definitions: Performance and Risk

4.1 How to assess alternative value factor definitions?

Researchers commonly asses alternative factor definitions by looking at standalone performance (e.g. Harvey and Liu, 2019). We can follow such an approach, sort stocks by alternative value metrics, go long value stocks and short growth stocks, and analyse whether the returns of such a zero-investment portfolio are significantly different from zero. This approach, however, is not a proper test for the existence of a separate factor premium. In fact, if value stocks have a higher market beta than growth stocks, such differences in loadings on the market factor may explain the factor return. There would not even be an anomaly relative to the CAPM. But even if a factor constitutes an anomaly relative to the CAPM, it may be subsumed by other factors. In order to test whether a factor carries a separate premium, we need to adjust returns for exposures to a set of benchmark factors. These benchmark factors correspond to the set of factors used in empirical asset pricing models, which have been shown to capture differences in expected returns.

There are two reasons for adjusting returns of alternative value factors for exposures to other factors. First, it has been shown that ignoring how new factors overlap with previously documented factors leads to an almost unbounded proliferation of factors. Given the large number of accounting ratios, it would not be a surprise if providers came up continuously with new definitions of the value factor. Feng, Giglio and Xiu (2019) underline the importance of looking at the marginal impact that a factor has relative to factors that are already known. Accounting for overlap with the standard factors is important to avoid ending up with a zoo of value definitions.

Second, ignoring overlap with other factors means that we are not properly assessing the value-added for an investor. Standalone performance is only meaningful if investors are planning to hold 100% of their portfolio in value. For investors who also have exposure to momentum, profitability, investment, low risk, and similar factors, the relevant question is how adding the value factor to other available factors improves their investment opportunities. For example, if a provider proposes a new value factor that is just a combination of value and profitability, this value definition does not add any value to investors, because it creates overlap with their existing exposure to the profitability factor. Documenting outperformance of alternative value definitions over the traditional book-to-price definition without adjusting performance for overlap with other factors has the potential to mislead investors about the actual investment benefits of such alternatives. To see whether a new value factor improves investment outcomes, we need to account for implicit exposures to the other factors.

We use spanning regressions to analyse whether a factor carries information over and above what the set of benchmark factors does. Furthermore, we perform tests of model fit of asset pricing models, for which we report results in Exhibit A27 in the appendix. In both cases, we include the market, size, momentum, low volatility, high profitability and low investment factors in the set of benchmark factors. These represent well-documented rewarded factors that investors can access easily[15].

Spanning regressions relate the time series of factor returns to returns of other factors. If information about average returns of a factor is captured by its exposure to other factors, the intercept of such

15 - Data on these additional factors are obtained from the K. French database, except for low volatility for which we use data on the betting against beta factor from the website from AQR.

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a regression will be indistinguishable from zero. This approach has been used by researchers to establish that factors such as investment and profitability are not captured by the three-factor model including the market, size and value factor (see Hou, Xue and Zhang, 2015). Similarly, we will ask whether different value factors add information about expected returns to a model including six well-documented factors (the market, size, momentum, low risk, investment and profitability factors). There is a straightforward interpretation in terms of investment implications of such spanning regressions: value factors that have a positive intercept expand investment opportunities; the Sharpe ratio an investor can realise from allocating to such a value factor and the other factors is higher than what he could achieve without the value factor. Value factors that have an intercept of zero do not extend investment opportunities. Spanning regressions are the preferred tool in recent tests of asset pricing models because they do not require us to define a menu of test assets, which may influence results (see Barillas and Shanken, 2017, 2018, Fama and French, 2018, and Hou et al., 2019).

To complement the results from spanning regressions, we assess the model fit of an asset pricing model in section A5 of the Appendix. Here, we ask whether a set of factors is able to explain return differences across a set of portfolios, called the test assets[16]. Using this approach, we can test whether including a particular value definition along with other factors helps explain the return levels of portfolios that are sorted on the characteristics that were used to construct the factors. If the set of factors in a model fully captured differences in return levels across the test assets, the intercepts in time series regressions of returns of the test assets on the factors would be zero. Large intercepts on the other hand would indicate that the model is unable to explain differences in return levels across the test assets. To test the validity of a model, we can use test statistics that draw on intercepts to assess model fit. This testing approach has generated results that have led Fama and French (2015) to adopt a five-factor model as a better alternative to their earlier three-factor model.

We will start by analysing standalone performance for different alternatives to book-to-price, because providers often use such results to suggest benefits of deviating from the standard definition. The main part of the analysis is guided by the importance of accounting for exposures to other factors when testing alternative value definitions.

There is another important aspect that standalone performance does not capture. Beyond past returns, investors are interested in what they can expect going forward. For past performance to persist, there needs to be a clear economic rationale for the value factor. The book-to-price effect has been explained by the higher risk of value stocks compared to growth stocks. If an alternative value definition does not align with this pattern, we will be short of a reason for why its performance should persist.

Similar to Belo, Vitorino and Lin (2014), we assess riskiness of alternative value factors from two different angles, beta cyclicality and earnings cyclicality.

To assess beta cyclicality, we follow Petkova and Zhang (2005) who show that the market beta of the standard value factor is higher in bad economic times. This means that the factor has more

16 - Another approach to test factor premia based on a set of test assets is the two-step approach of Fama and MacBeth (1973).

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systematic risk precisely when investors are more risk-averse. Good and bad economic times are defined according to the expected market risk premium, estimated from a predictive regression of the excess market returns on macroeconomic state variables (the short rate, term spread, default spread and dividend yield)[17]. In peak periods[18], good economic times, the expected market premium is low because investors require less compensation to take on risk. In trough periods on the other hand, investors are risk-averse and require a high expected market premium. We then compare the market beta of the value factor across these regimes. Higher market betas in bad times imply that the value factor is risky.

The downside of this approach is that it assesses risk based on returns. Stock returns do not necessarily reflect the fundamental performance of the company. Costly reversibility of assets-in-place implies that value stocks have weaker fundamental performance in bad economic conditions. This risk should be reflected in the fundamental performance of a company. Showing that value companies are more exposed to economic downturns in their profit and loss statement provides more direct support for the costly reversibility explanation.

To assess whether alternative value factors pick up fundamentally riskier stocks, we follow Ball, Sadka and Tseng (2019). They show that high book-to-price firms are more risky than low book-to-price firms because their earnings growth is more sensitive to aggregate economic supply and demand[19]. This higher sensitivity means that value firms are more cyclical and tend to have lower earnings growth in bad economic times. We first confirm their results by assessing whether stocks in the long leg of the standard value factor are more risky than stocks in the short leg. We repeat the analysis for the alternative value factors.

Standalone performance is not a sufficient criterion for judging alternative value definitions. To see whether multi-factor investors benefit from alternatives to book-to-price, we analyse value-added relative to the existing factor menu. To provide an outlook on persistence of performance, we assess the riskiness of alternative value definitions. These additional steps are necessary to judge the merits of the alternative value definitions from an investor's perspective.

4.2 Performance of Alternative Value Factors

Standalone performance

Alternative value scores are often proposed based on their superior standalone performance. Therefore, we start the performance analysis with these measures. Exhibit 4 presents standard metrics regarding the risk and return of the alternative factors.

Indeed, the standard value factor seems to be one of the worst performers based on these results. Value definitions based on sales, earnings and cash flow all have higher returns and higher Sharpe ratios than the book-to-price factor. Returns range from 2.77% per year to 4.20%, compared to 2.21% for book-to-price. Only dividend yield leads to lower annualised returns than book-to-price

17 - We use the market factor returns from the K. French database as the market premium. The three-month T-bill secondary market rate is used as the short rate, the term spread is the difference between the 10-year and one-year treasury constant maturity rates and the default spread is the difference between the Moody's seasoned Baa and Aaa corporate bond yields. This yield data is obtained from the FED of St. Louis. The dividend yield is based on the difference between the total and price returns on the CRSP value weighted market index.
18 - We assign monthly observations to one of four regimes (peak, expansion, recession, or trough).
19 - The proxy for aggregate supply is total factor productivity growth, as made available by John Fernald via the FED of San Francisco. The acceleration in aggregate household wealth growth based on data from the Board of Governors of the Federal Reserve System is used as a proxy for aggregate demand.

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with -0.28%. Adjusting reported book values to account for intangible capital leads to the most pronounced improvement. The intangible-adjusted book-to-price factor has a return of 4.82%, which is more than double the return of the standard value factor. In general, these results make clear why alternative valuation ratios are used by index providers. Selecting accounting ratios that differ from book-to-price allows improving the standalone performance of the value factor.

Exhibit 4: Standalone performance measures
The table shows the standalone performance measures for alternative value factors. The analysis is based on monthly returns from July 1976 to December 2018. The factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. Data source: CRSP, Compustat, K. French database.

Standalone performance	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Ann. Absolute Return	2.21%	4.82%	4.20%	2.95%	-0.28%	2.77%	2.66%	2.50%
P-value	0.08	0.00	0.00	0.03	0.90	0.04	0.05	0.07
Ann. Volatility	9.77%	7.93%	9.04%	10.74%	9.75%	10.27%	10.93%	11.19%
Sharpe Ratio	0.23	0.61	0.46	0.27	-0.03	0.27	0.24	0.22
Max Drawdown	44.44%	28.66%	48.83%	54.94%	50.08%	50.93%	55.39%	56.43%

Added value to a multi-factor portfolio

Multi-factor investors will not hold 100% of their equity portfolio in the value factor. Limiting the analysis to standalone performance does not take this into account. In this subsection, we account for the exposures to other rewarded factors.

We first present the results when only considering the market and size factors, in addition to the value factor. The use of the alternative valuation ratios in investment products dates back to the 1990s when common investment styles were based on size groups or value versus growth, but indices on other factors were not available. It is thus interesting to analyse the performance of the alternatives in a world that only considers the market, size and value factors.

Exhibit 5 shows that all the alternative value factors have significantly positive unexplained returns. No matter how it is defined, the value factor adds value to investors who also have access to the market and size factors, but not to any other factors. As was the case for the standalone performance, only dividend yield performs worse than book-to-price. Intangible-adjusted book-to-price and the composite factors have an unexplained return that is more than one percentage point higher than book-to-price. Using earnings or cash flows even increases performance by around two percentage points, because of a strong negative exposure to the size factor. This could provide an explanation for the popularity of a measure such as earnings-to-price as an alternative valuation ratio.

Exhibit 5: Factor exposure analysis – two factor model

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The table shows the results of a factor regression of the alternative value factors on the market and the size factors. The analysis is based on monthly returns from July 1976 to December 2018. The value factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The explanatory factors are obtained from the K. French database. Data source: CRSP, Compustat, K. French database.

Factor exposures - two factor model	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Ann. unexplained	4.12%	5.40%	4.82%	6.41%	3.27%	6.10%	5.83%	5.51%
P-value	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Market	-0.16	-0.09	-0.04	-0.27	-0.34	-0.27	-0.27	-0.26
P-value	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00
Size	-0.08	0.16	0.04	-0.30	-0.20	-0.25	-0.18	-0.15
P-value	0.07	0.00	0.36	0.00	0.00	0.00	0.00	0.00

The financial literature and the investment industry have evolved since the 1990s, with research efforts continuously improving the available knowledge and investment products. Investors now also have access to products that give exposure to factors such as momentum, low volatility or quality. Therefore, we need to include these additional factors in our factor exposure analysis to assess the added value of alternative value definitions for investors.

Exhibit 6 presents the corresponding results. The unexplained returns from this regression represent the additional performance that the value factor can provide when combining it with all these other factors that are available today. Compared to the above results, a different picture emerges. Using sales, earnings or cash flows to define value delivers value-added which is undistinguishable from zero. Using dividends leads to the highest value-added among the alternative valuation ratios but fails to achieve statistical significance at the 5% level. The composite value definition including four accounting ratios has an average return of virtually zero, with -0.08% per year.

Index providers argue that using a combination of alternative valuation ratios better captures the true value of a stock. Given that true value is not observable, we cannot test this claim. However, we can test whether such value definitions improve investment outcomes. Our results show that none of these alternative valuation ratios delivers unexplained returns that are significantly different from zero. Their performance could thus be replicated by a combination of the other factors in the menu. Accounting for intangibles when measuring the book value leads to a different result. The intangible-adjusted book-to-price factor shows a significant unexplained return of 2.09%, with a p-value of 0.02. This finding is in line with results reported by Park (2019), who shows that the intangible-adjusted book-to-price ratio performs well in a series of asset pricing tests.

The conclusion on the value-added of alternative value definitions changes drastically when we account for factors other than the market and size factors. The factor exposures provide an explanation for why this difference arises. All value factors are highly exposed to the low investment factor, as shown by Fama and French (2015) and Hou, Xue and Zhang (2015) for book-to-price. However, most of the alternatives, apart from ibook-to-price and dividend yield, are also highly exposed to

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the high profitability factor. The composite value factor that combines five accounting ratios leads to a profitability exposure of 0.32, compared to a profitability exposure of 0.09 for the standard value factor. There is a threefold increase in factor overlap with the profitability factor. For multi-factor investors, such an overlap implies a reduction in factor diversification which may deteriorate investment outcomes.

The intangible-adjusted book-to-price factor on the other hand, improves the performance beyond what could be replicated by the set of other factors. Exposure to the profitability factor is virtually zero. For multi-factor investors, adapting the book value with the intangible adjustment thus seems to be a more promising route than replacing book-to-price by other valuation ratios or a combination of such ratios. In Exhibit A19 in the appendix, we show that these results also hold when using up to date market values in the value scores. The alphas increase slightly for most alternatives, but conclusions regarding the significance remain intact.

Exhibit 6: Factor exposure analysis - six factor model
The table shows the results of a factor regression of the alternative value factors on the market, size, momentum, low volatility, high profitability and low investment factors. The analysis is based on monthly returns from July 1976 to December 2018. The value factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The explanatory factors are obtained from the K. French database and AQR (for low volatility). Data source: CRSP, Compustat, K. French database, AQR.

Factor exposures – six factor model	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Ann. unexplained	-0.72%	2.09%	-1.24%	-0.27%	1.77%	-0.11%	-0.08%	-0.41%
P-value	0.50	0.02	0.22	0.80	0.09	0.92	0.94	0.72
Market	0.00	0.04	0.12	-0.12	-0.27	-0.13	-0.11	-0.09
P-value	0.94	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Size	-0.05	0.15	0.17	-0.14	-0.22	-0.11	-0.06	-0.05
P-value	0.12	0.00	0.00	0.00	0.00	0.00	0.08	0.11
Momentum	-0.17	-0.12	-0.17	-0.13	-0.15	-0.14	-0.25	-0.25
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Low volatility	0.16	0.07	0.19	0.21	0.09	0.20	0.24	0.23
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
High profitability	0.09	-0.01	0.44	0.57	-0.11	0.49	0.39	0.32
P-value	0.05	0.75	0.00	0.00	0.02	0.00	0.00	0.00
Low investment	0.85	0.77	0.61	0.43	0.52	0.47	0.63	0.75
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tests of model fit of asset pricing models when using different value definitions confirm this conclusion. We report the results for model fit in Exhibit A27 in the appendix. When looking at the Gibbons-Ross-Shanken (GRS) test statistic, the model including the intangible-adjusted book-to-price factor has the best performance. A high GRS statistic indicates that the model fits poorly as unexplained returns across test assets are large. The model including the intangible-adjusted book-to-price factor has the lowest GRS statistic, with a value of 1.48. This compares to a value of 1.65 for the model with the

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standard value factor or 1.71 and 1.68 for the two composite factors. Other test statistics indicating the fraction of unexplained returns are also lower for ibook-to-price compared with the other alternatives. Including an ibook-to-price factor thus leads to better model fit than combining multiple valuation ratios. This implies that the ibook-to-price factor is more informative about differences in asset return levels than composite value indicators.

Our analysis shows that there is a stark contrast in conclusions about different value factor definitions, depending on whether we assume investors have access to other factors or not. In particular, overlap with the profitability factor questions the value-added of alternative valuation ratios for multi-factor investors. To illustrate this point, we report performance of portfolios that combine different sets of factors. Exhibit 7 shows Sharpe ratios of portfolios that hold alternative versions of the value factor along with other factors. To provide insights into how factor overlap impacts portfolios, the exhibit also displays the correlation of the value factor with the other factors held in the portfolios, and portfolio volatility.

The Sharpe ratios when investing 100% in value recall that most alternatives improve the risk-adjusted performance compared to book-to-price. Investing 100% in earnings-to-price increases the Sharpe ratio from 0.23 to 0.27, i.e. by more than 15%. However, when combining value with high profitability and low volatility, using book-to-price leads to a Sharpe ratio of 0.79 and replacing it with earnings-to-price reduces the Sharpe ratio to 0.73, i.e. by 8%. Earnings-to-price creates overlap with the profitability factor and its correlation with the other two factors (0.64) is much higher than the correlation of the book-to-price factor with high profitability and low volatility (0.37). Volatility of the multi-factor portfolio thus increases from 7.5% when using the book value to 8.4% when using earnings. Similarly, composite value definitions increase correlation with the high profitability and low volatility factor portfolio, increase volatility of the three-factor portfolio and reduce its Sharpe ratio. By contrast, using the intangible-adjusted book values leads to lower correlation (0.19), lower volatility (6.7%) and a higher Sharpe ratio (1.02) than using reported book values. Similarly, when considering portfolios that hold six factors, ibook-to-price leads to a noticeable improvement in Sharpe ratio.

Overall, our results suggest that for investors who only hold exposure to value and size, moving from book-to-price to alternative valuation ratios or composite value definitions may lead to modest improvements in performance. However, for investors who have access to additional factors, such a change does not improve performance. Instead, changing the value definition to alternative valuation ratios creates substantial overlap with other factors, in particular profitability. Such factor overlap tends to increase portfolio risk and reduce risk-adjusted performance for multi-factor investors. Intangible-adjusted book-to-price emerges as the only alternative that continues to provide significant benefits when accounting for other factors.

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Exhibit 7: Performance impact in a factor portfolio

The table shows results for five different factor portfolios. The first row is the standalone value factor, the following rows are equal weighted allocations to value and high profitability in the second row, value and low volatility in the third, value, high profitability and low volatility in the fourth and size, value, momentum, low volatility, high profitability and low investment in the fifth. The top panel shows the Sharpe ratio of these allocations. The second panel shows the difference in Sharpe ratio compared to when standard book-to-price is used. The third panel shows the annualised volatility. The bottom panel shows the correlation of the value factors with an equal weighted allocation to the other factors in the portfolios. The analysis is based on monthly returns from July 1976 to December 2018. The value factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The non-value factors are obtained from the K. French database and AQR (for low volatility). Data source: CRSP, Compustat, K. French database, AQR.

Performance of factor portfolios	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Sharpe ratio								
Value	0.23	0.61	0.46	0.27	-0.03	0.27	0.24	0.22
Value + High profitability EW	0.46	0.80	0.58	0.41	0.28	0.41	0.41	0.41
Value + Low volatility EW	0.75	1.01	0.86	0.73	0.65	0.74	0.71	0.70
Value + High prof. + Low vol EW	0.79	1.02	0.86	0.73	0.71	0.74	0.74	0.74
6 Factor EW	1.00	1.12	1.05	0.98	0.96	0.98	0.99	0.99
Sharpe ratio improvement (difference with B/P)								
Value	-	0.38	0.24	0.05	-0.25	0.04	0.02	0.00
Value + High profitability EW	-	0.35	0.13	-0.05	-0.18	-0.04	-0.04	-0.05
Value + Low volatility EW	-	0.26	0.11	-0.02	-0.10	-0.01	-0.03	-0.04
Value + High prof. + Low vol EW	-	0.23	0.07	-0.06	-0.08	-0.05	-0.05	-0.05
6 Factor EW	-	0.11	0.05	-0.02	-0.04	-0.02	-0.01	-0.02
Volatility								
Value	9.8%	7.9%	9.0%	10.7%	9.8%	10.3%	10.9%	11.2%
Value + High profitability EW	6.9%	5.6%	7.0%	8.4%	6.8%	8.1%	8.1%	8.0%
Value + Low volatility EW	9.2%	8.1%	9.1%	9.9%	8.6%	9.7%	9.9%	9.9%
Value + High prof. + Low vol EW	7.5%	6.7%	7.6%	8.4%	7.2%	8.2%	8.2%	8.2%
6 Factor EW	5.2%	5.1%	5.3%	5.5%	5.0%	5.4%	5.4%	5.4%
Correlation with other factors								
High profitability	0.21	-0.02	0.36	0.62	0.18	0.58	0.46	0.39
Low volatility	0.38	0.27	0.46	0.47	0.22	0.47	0.46	0.44
High prof. + Low vol EW	0.37	0.19	0.50	0.64	0.25	0.61	0.55	0.50
5 Factor (ex. value) EW	0.22	0.22	0.33	0.32	0.06	0.32	0.25	0.24

Have these adjustments become more important in recent years?

A popular argument to dismiss book-to-price is that it might have been a valid proxy for value when it was first discovered, but that the economy has changed and intangible assets have become much more important in recent years. It is argued that book value has lost a lot of its meaning because of this, making book-to-price as a value score irrelevant. This argument is often used to provide an intuitive explanation for the poor performance of the book-to-price factor over the past decade. According to this argument, we might expect that the outperformance of the alternatives over the standard value factor has become stronger in recent years. The above results, based on averages

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across the entire sample period from 1976 to 2018, may hide the fact that the alternatives add value, but only in the recent period.

We present the outperformance of the alternatives over the standard value factor in the past four decades in Exhibit 8 to assess this argument. Although we do not conduct a formal test of time variation, this analysis provides an overview of how outperformance behaves over time. The table shows both the standalone return and the unexplained return when adjusting for multiple factor exposures. We report differences with respect to the standard book-to-price factor. None of the alternatives exhibits a clear evolution in the outperformance over time. For example, the outperformance of ibook-to-price was higher between 1999 and 2008 than in the 2009 to 2018 period, both for the absolute and unexplained returns.

Based on these results, there is not much support for the idea that the economy has undergone a dramatic change to intangible assets in the past decade nor would this imply that the relevance of intangibles has diminished. Indeed, as indicated in Exhibit 2, intangible capital already made up more than 20% of firms' capital in the 1980s. The effects of including intangibles in the book-to-price factor are fairly stable over the past 40 years, which is consistent with the idea that the rise of intangible assets is not a recent phenomenon. Short-term variations in value return can often be explained not by structural changes in the economy, but by the fact that the value factor is sensitive to macro-economic conditions, as shown by Amenc et al. (2019).

Exhibit 8: Outperformance over book-to-price over time
The table shows the difference in standalone returns and unexplained returns, after taking into account exposures to other factors, between the alternative value factors and the standard value factor. These measures are calculated in the same way as in Exhibit 4 and Exhibit 6, respectively, apart from the time period considered. This analysis is based on monthly returns which are divided in the four 10-year periods between January 1979 and December 2018. The value factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. Data source: CRSP, Compustat, K. French database, AQR.

Excess performance over book-to-price		iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Ann. Absolute return	1979 to 1988	2.76%	3.57%	1.91%	-4.91%	1.40%	1.30%	0.68%
	1989 to 1998	1.54%	-0.23%	-0.56%	-3.01%	-1.58%	-2.48%	-1.76%
	1999 to 2008	4.33%	1.71%	1.62%	-2.58%	2.02%	1.30%	1.15%
	2009 to 2018	2.23%	3.14%	-0.16%	0.90%	-0.35%	2.31%	1.51%
Ann. Unexplained return	1979 to 1988	-0.07%	-0.77%	0.66%	-1.75%	1.74%	0.13%	0.26%
	1989 to 1998	3.84%	2.50%	-2.35%	1.34%	-0.77%	0.25%	-0.36%
	1999 to 2008	3.09%	0.34%	1.50%	1.02%	1.46%	-0.04%	-0.06%
	2009 to 2018	1.38%	0.47%	-0.49%	2.58%	-0.94%	1.89%	1.63%

4.3 Is value still riskier than growth?

After considering the impact that different value definitions have on the investment opportunities of multi-factor investors, we turn to the results on riskiness. Alignment with risk patterns that have been documented for the value factor will lend support to the persistence of the value premium.

4. Assessing the Value-Added of Alternative Value Definitions: Performance and Risk

The riskiness of value factor returns

We analyse cyclicality of market betas following the methodology of Petkova and Zhang (2005). Exhibit 9 shows the market betas of the alternative value factors in different economic regimes. To align with the pattern that has been documented for book-to-price, alternative value definitions would need to display countercyclical variation in market betas. The value factor is risky if betas increase in a trough, when investors are more risk averse and require a higher compensation for risk. All value definitions lead to increases in market beta in bad times. The differences between trough and peak are large and highly significant. Beta cyclicality is highest for book-to-price, with a market beta that is 0.49 higher in trough periods compared to peak periods. Beta cyclicality is weakest when using dividends or earnings, with a difference of only 0.12 and 0.16, respectively.

Exhibit 9: Cyclicality of the value factors' market betas
The table shows the average market betas in different economic regimes, together with the difference between the two extremes and the associated p-value. The results are based on the methodology proposed by Petkova and Zhang (2005). We use rolling market betas based on a five-year rolling window. We define four states by sorting on the expected market risk premium, which is estimated as a linear function of the dividend yield, term premium, default premium, three-month Treasury bill rate and a constant term. Peak are the months with the 10% lowest observations for the premium, expansion are the remaining months with a below average premium, trough corresponds to the 10% months with the highest premium and recession are the remaining months. The analysis is based on monthly returns from July 1976 to December 2018. The factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The market factor is obtained from the K. French database. Data source: CRSP, Compustat, K. French database, FED of St. Louis.

Market beta in different regimes	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Peak	-0.36	-0.26	-0.20	-0.33	-0.41	-0.40	-0.49	-0.47
Expansion	-0.30	-0.15	-0.12	-0.44	-0.42	-0.43	-0.44	-0.44
Recession	-0.08	0.02	0.06	-0.22	-0.33	-0.22	-0.16	-0.14
Trough	0.14	0.14	0.11	-0.17	-0.29	-0.12	-0.08	0.00
Trough-Peak	0.49	0.40	0.31	0.16	0.12	0.28	0.40	0.48
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The riskiness of the fundamentals of value stocks versus growth stocks

We complement the analysis of market beta cyclicality with an analysis of earnings cyclicality, following Ball, Sadka and Tseng (2019). To assess the fundamental risk exposure of alternative value factors, we compute the difference in aggregate earnings growth between stocks in the long leg and stocks in the short leg of each factor. If the growth differential has a positive sensitivity to aggregate demand or supply, this means that the value stocks have earnings that are more cyclical than the earnings of the growth stocks.

Our results in Exhibit 10 confirm the results from Ball, Sadka and Tseng (2019). The earnings growth differential for book-to-price is significantly exposed to total factor productivity growth, which proxies for aggregate supply. The exposure to acceleration in household wealth growth, which proxies for aggregate demand is not significant. Part of the alternative factors show a similar pattern, with a significantly positive exposure to total factor productivity and an insignificant exposure to household wealth. The exposures based on earnings, dividends or cash flows, however, are not distinguishable

4. Assessing the Value-Added of Alternative Value Definitions: Performance and Risk

from zero for both aggregate demand and supply. Hence, these factors do not capture exposure to earnings cyclicality.

The adjusted R^2 confirms this difference across value definitions. Aggregate demand and supply do not explain much of the variability in the earnings growth differential when using earnings, dividends or cash flows to define value, with adjusted R^2 values of 0.01, 0.05 and -0.01, respectively. This compares to a much higher value of 0.33 for the standard value definition or 0.34 when adjusting book values for intangibles.

Exhibit 10: Cyclicality of the value factors' accounting earnings
The table shows the results of a regression in which total factor productivity growth (TFP) and the acceleration in household wealth growth (HHW) are the explanatory variables. The difference between the aggregate earnings growth for the stocks in the long leg of a factor and the aggregate earnings growth for the stocks in the short leg of a factor is the dependent variable. TFP, HHW and aggregate earnings growth are defined as in Ball, Sadka and Tseng (2019). TFP data are made available by John Fernald on the website of the federal reserve bank of San Francisco, HHW is based on data from the website of the Board of Governors of the Federal Reserve. The p-values for the coefficients are based on standard errors that are adjusted for heteroscedasticity. The analysis is based on accounting data from fiscal years ending between January 1975 and December 2017. The factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. Data source: CRSP, Compustat, K. French database, Federal reserve bank of San Francisco, Board of Governors of the Federal Reserve.

Cyclicality of accounting earnings		B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Total factor productivity	Coefficient	1.11	1.51	1.50	0.46	0.46	0.29	0.67	0.92
	P-value	0.01	0.01	0.01	0.19	0.23	0.32	0.02	0.00
Household wealth	Coefficient	0.29	0.25	0.08	-0.33	0.04	-0.23	-0.02	0.07
	P-value	0.14	0.18	0.71	0.22	0.82	0.29	0.91	0.64
	Adjusted R^2	0.33	0.34	0.23	0.01	0.05	-0.01	0.11	0.28

Our results on the riskiness of the value factors come to the same conclusion as other studies; value stocks are more risky than growth stocks. Both the factor returns and the fundamentals of the stocks comprising the factors confirm this. This finding holds for the standard book-to-price definition of value, intangible-adjusted book-to-price and for some of the alternative valuation ratios and composites thereof. Using earnings, dividends or cash flows, however, appears to be less aligned with this risk-based explanation. Their market betas show the weakest counter-cyclical behaviour and the earnings growth differential between value and growth stocks based on these definitions is not related to aggregate supply and demand.

5. Conclusion

5. Conclusion

We have considered two different ways to tackle the problem that the book-to-price ratio ignores the majority of intangible capital when using reported book values. First, we have adjusted the book value to include unrecorded intangibles. Second, we have analysed the use of other valuation ratios to define the value factor.

We find that the intangible-adjusted book-to-price factor produces a stronger value premium, which remains significant when accounting for exposures to other factors. The intangible adjustment thus improves investment outcomes for multi-factor investors. It also aligns closely with the macroeconomic risks of the standard book-to-price factor. It leads to similar countercyclical variation in market betas and earnings cyclicality.

Many alternative valuation ratios improve standalone performance, compared to book-to-price. Most alternatives have higher returns and Sharpe ratios compared to the standard value factor. However, this improvement in performance is explained by implicit exposures to other factors, especially to the profitability factor. When adjusting for these exposures, the premium of a composite value factor is not distinguishable from zero. Investors who already have exposure to profitability and other factors do not gain anything from getting the same exposures, repackaged under the value label.

Combining various valuation metrics is an old recipe from the 1990s when style indices became popular. Back then, investors used such indices to tilt to different size segments or to value versus growth. Investors did not have access to factor indices on other factors, such as quality or low risk[20]. In this old setting, picking up implicit exposure to other factors may have improved investment outcomes, albeit not in a transparent manner. More than 20 years later, investment practices have changed. Many investors hold portfolios that combine multiple factors. Beyond the value factor, exposures to momentum, low risk, and quality factors are common. In the age of multi-factor investing, picking up implicit exposure to other factors in a composite value definition does not improve investment outcomes. Such composite value definitions may be approaching their expiration date.

20 - For example, the MSCI World Value Index was launched in 1997 and combines earnings-to-price, dividend yield and book-to-price. The MSCI World Quality Index was launched only in 2012. Russell introduced value indices in 1987 but only introduced defensive indices in 2010. Research Affiliates introduced indices tilting to sales-, cash flow-, book value-, and dividend-to-price in 2005 and only introduced low volatility and quality factor indices in 2017.

Appendix

Appendix

A1. Value Versus True Value

Exhibit A11 shows fair values derived from a dividend discount model. Fair value depends not only on earnings and dividends but also on investors' view on the growth rate and their perception of risk, which influences the required rate of return. The example below considers the effect of different growth rates. It shows that accounting ratios such as book-to-price, earnings-to-price and dividend-to-price do not help in identifying whether a company is priced at its true value.

Exhibit A11: True value in a dividend discount model
This table provides a stylised illustration to show that simple accounting ratios should not be expected to capture the true value of a stock. Three firms, which only differ in their expected future growth rate, are placed in two scenarios. The first scenario assumes that the market prices firms correctly, the second scenario allows for under- or overvaluation. The resulting accounting ratios are presented accordingly.

True value in a dividend discount model			
Book equity	100	Required rate of return	10%
ROE	10%	Earnings	10
Payout ratio	50%	Dividends	5
Scenario 1	Firm 1	Firm 2	Firm 3
Growth rate	6%	5%	4%
Market price	125.00	100.00	83.33
True value	125.00	100.00	83.33
B/P	0.80	1.00	1.20
E/P	0.08	0.10	0.12
D/P	0.04	0.05	0.06
Scenario 2	Firm 1	Firm 2	Firm 3
Growth rate	6%	5%	4%
Market price	100.00	100.00	100.00
True value	125.00	100.00	83.33
B/P	1.00	1.00	1.00
E/P	0.10	0.10	0.10
D/P	0.05	0.05	0.05

A2. Knowledge and Organisation Capital Estimation

The intangible-adjusted book-to-price ratio adjusts the book value in the numerator for intangible assets. More specifically, knowledge and organisation capital are added to the standard book value, while goodwill is deducted. Goodwill can be found directly on the balance sheet, as obtained from the Compustat database. Knowledge and organisation capital, on the other hand, need to be estimated. We will describe here in more detail the methodology used to estimate these values, following Peters and Taylor (2017) and Park (2019).

Knowledge and organisation capital are estimated by capitalising research and development (R&D) expenses and a part of selling, general and administrative (SG&A) expenses, respectively, according to the perpetual inventory method. Every year, the past year's knowledge and organisation capital stock are depreciated and the current year's R&D and SG&A expenses are added to calculate the

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current amount of omitted intangible capital. This methodology requires three steps. First, we need to define the exact values of R&D and SG&A expenses that are to be capitalised. Second, we need to estimate initial knowledge and organisation capital stock for the first year the firm appears in the Compustat database. Third, we need to decide which depreciation rates to use.

Yearly R&D expenses are the research and development expense (XRD) field from the Compustat database. Since the reporting requirements under US GAAP regarding R&D expenses changed in 1975, we treat missing values differently before and after 1977. This gives firms two years to comply with the new accounting requirements and report R&D expenses separately. After 1977, we fill missing values by linearly interpolating the expenses of the nearest non-missing values where possible. This is only done if the firm's total assets are also missing, indicating that the values are indeed missing and not zero. Any remaining missing values after 1977 are then assumed to be zero. Before 1977, missing values are set to zero if the value in 1977 was also zero. We assume that these firms also didn't invest in R&D in previous years. To fill values that are still missing after this step, we linearly interpolate the expenses of the nearest non-missing values where possible. Any remaining missing values before 1977 are then filled by assuming that R&D expenses grow by 40% per year, going back in time from the first year for which R&D expenses are available.

The yearly SG&A expenses are based on the selling, general and administrative expense (XSGA) field in Compustat. However, this value usually includes R&D expenses according to the Compustat definition. Since we treat R&D separately, we deduct it from the obtained SG&A expenses. In process R&D expenses (RDIP in Compustat) are also deducted because Compustat only adds the part of R&D not representing acquired in process R&D in the XSGA field, and in process R&D is a negative value in the database. We thus define non-R&D SG&A expenses as XSGA minus XRD minus RDIP. We do not make this adjustment to XSGA if XRD exceeds XSGA, indicating that the former value is not included in the latter. We treat missing values similarly as for R&D expenses, apart from the fact that no distinction needs to be made between the before 1977 and after 1977 periods. When the value for a firm's total assets is missing, we assume it is an omission and not a zero value and linearly interpolate the SG&A expenses of the nearest non-missing values where possible. Any remaining missing values are assumed to be zero. Finally, we assume that 30% of the SG&A expenses represent investments in organisation capital and 70% represents expenses that contribute to the current year's net income. Therefore, we only capitalise 30% of the SG&A expenses.

Since the current year's intangible capital stock is based on the previous year's value, we need to estimate the initial knowledge or organisation capital in the firm when it enters the Compustat database. These estimates are based on the assumptions that a firm has zero knowledge and organisation capital when it is founded and that R&D and SG&A expenses grow at a rate of 40% per year between the firm's founding year and the year it first appears in Compustat. Founding years are obtained from Jay Ritter's website[21]. If a founding year is missing, we define it as the minimum of the IPO year minus eight and the first year the firm appears in Compustat. Data on the IPO year is taken from Compustat. If the IPO year is missing, we use the first year the firm appears in Compustat as

21 - We thank Jay Ritter for making this data available at <https://site.warrington.ufl.edu/ritter/ipo-data/>.

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the founding year. R&D and SG&A expenses are then estimated for every year between the founding year and the year the firm first appears in Compustat based on the value of these expenses in the year the firm first appears in Compustat and the assumed growth rate. These estimates allow us to calculate the knowledge and organisation capital for every year between the founding year and the year the firm first appears in Compustat.

We have explained how we obtain the yearly R&D and SG&A expenses to be capitalised. These expenses are added to the depreciated values of the previous year's knowledge and organisation capital to obtain the current year's values. The depreciation rates used for knowledge capital depend on the industry in which the firm operates. This approach is based on the industry-specific R&D depreciation rates as estimated by the bureau of economic analysis. Exhibit A12 gives an overview of the rates used for the corresponding SIC codes. A depreciation rate of 15% is used as the default rate for industries not mentioned in the table. Organisation capital is depreciated at a rate of 20% for all firms.

Exhibit A12: Knowledge capital depreciation rates
The table is taken from Park (2019), where it is compiled based on data coming from Li and Hall (2016) for SIC codes and Li (2012) for depreciation rates.

Industry	SIC codes	Depreciation rate
Computers and peripheral equipment	3570-3579, 3680-3689 and 3695	40%
Software	7372	22%
Pharmaceuticals	2830, 2831 and 2833 - 2836	10%
Semiconductor	3661-3666 and 3669-3679	25%
Aerospace product and parts	3720, 3721, 3724, 3728 and 3760	22%
Communication equipment	3576, 3661, 3663, 3669 and 3679	27%
Computer system design	7370, 7371 and 7373	36%
Motor vehicles, bodies, trailers, and parts	3585, 3711, 3713 and 3716	31%
Navigational, measuring, electromedical, and control instruments	3812, 3822, 3823, 3825, 3826, 3829, 3842, 3844 and 3845	29%
Scientific research and development	8731	16%
Other	Other	15%

A3. Descriptive Statistics for Different Value Factor Definitions

The exhibits in this section provide information on how similar the alternative value proxies are compared to the standard book-to-price ratio.

Exhibit A13 gives an idea of the average impact of the intangible adjustment to the book value of equity. It shows the cross-sectional average values of the book value, the book value with the addition of knowledge and organisation capital and the book value with the additional of these omitted intangibles and the removal of goodwill. The values are normalised by the average standard book value in each year. In the beginning of the sample period, the intangible adjustment increased the book value by around 35%. The effect of the goodwill adjustment became stronger over time, and almost offsets the addition of the omitted intangibles in the most recent years. Of course, these are average effects; the graph does not tell us anything regarding cross-sectional differences.

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Exhibit A13: Average impact of the adjustments for intangible capital
The graph shows the evolution over time of how the cross-sectional average values for the numerators of the value ratios with an adjusted book value compare to the average value for book equity. The yearly values are the cross-sectional average of the adjusted book values divided by the cross-sectional average of the standard book value. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. We define book equity as in Davis, Fama and French (2000). Omitted intangibles are knowledge and organisation capital, calculated following Peters and Taylor (2017) and Park (2019). The analysis is based on accounting data for fiscal years ending between January 1975 and December 2017. However, older data is used for the calculation of knowledge and organisation capital. Data source: Compustat, K. French database.

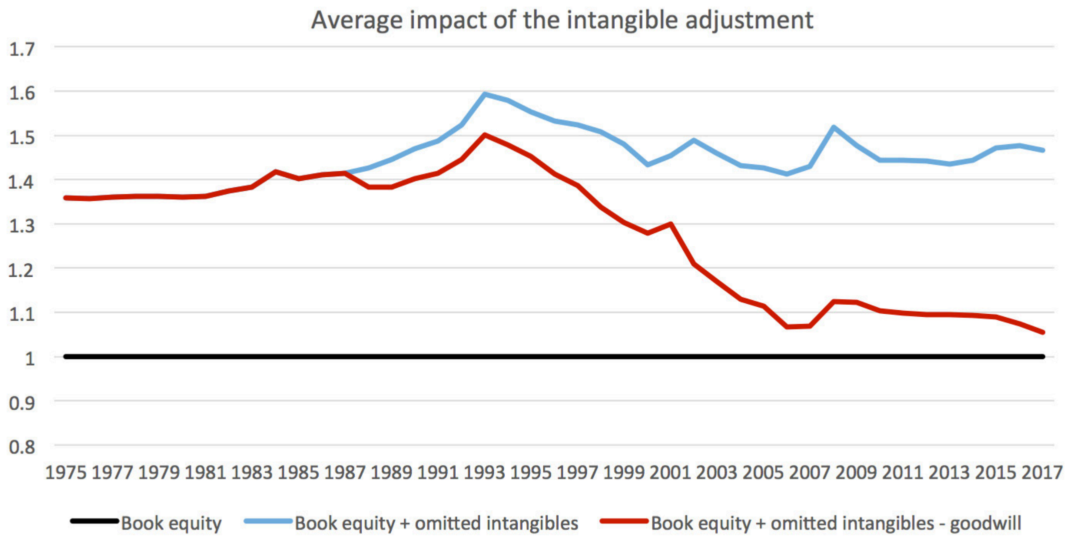

Exhibit A14 shows how the largest stocks rank on the various value scores. A rank from 0.5 to 1 indicates that the company is ranked as a value stock. A rank from 0 to 0.5 indicates it is ranked as a growth stock. The results suggest that the intangible adjustment of book-to-price has a noticeable impact but does not fundamentally change the categorisation of stocks. For example, Amazon and Alphabet rank slightly more towards value when adjusting for intangibles. Earnings-to-price leads to more drastic changes. For example, Apple and Facebook become value stocks according to earnings-to-price.

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Exhibit A14: Ranks of the 20 largest stocks for every alternative value score
The table shows the cross-sectional rank of companies in terms of the alternative value scores. The companies are the 20 largest companies based on market capitalisation on 30 June 2018. The values presented are the rank of a company for the corresponding value score, scaled between 0 and 1. A value close to 1 indicates a relatively high score, a value close to 0 indicates a relatively low score compared to the other firms in the sample. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. The value scores are defined in Exhibit 1. The scores are based on accounting data for fiscal years ending in 2017. However, older data is used for the calculation of knowledge and organisation capital in iB/P. Data source: Compustat, CRSP, K. French database.

Ranking of largest stocks - 30/06/2018	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
APPLE INC	0.20	0.18	0.32	0.79	0.36	0.77	0.38	0.30
AMAZON.COM INC	0.09	0.15	0.38	0.39	-	0.38	0.48	0.25
MICROSOFT CORP	0.15	0.14	0.16	0.55	0.44	0.46	0.31	0.24
FACEBOOK INC	0.24	0.18	0.13	0.61	-	0.52	0.50	0.34
JPMORGAN CHASE & CO	0.70	0.56	0.37	0.85	0.58	0.79	0.53	0.62
EXXON MOBIL CORP	0.62	0.54	0.62	0.79	0.86	0.76	0.78	0.76
ALPHABET INC	0.58	0.60	0.42	0.63	-	0.69	0.63	0.61
JOHNSON & JOHNSON	0.21	0.32	0.23	0.38	0.74	0.38	0.46	0.34
BANK OF AMERICA CORP	0.83	0.65	0.39	0.81	0.45	0.85	0.48	0.68
WELLS FARGO & CO	0.69	0.60	0.39	0.88	0.74	0.82	0.66	0.69
WALMART INC	0.34	0.58	0.84	0.70	0.66	0.77	0.80	0.67
BERKSHIRE HATHAWAY	0.95	0.78	0.70	0.97	-	0.98	0.89	0.94
CHEVRON CORP	0.70	0.58	0.55	0.62	0.83	0.83	0.74	0.75
VISA INC	0.17	0.08	0.12	0.55	0.09	0.51	0.20	0.18
UNITEDHEALTH GROUP INC	0.30	0.12	0.71	0.73	0.32	0.61	0.54	0.42
AT&T INC	0.67	0.35	0.62	0.95	0.94	0.90	0.90	0.88
INTEL CORP	0.41	0.42	0.35	0.67	0.64	0.83	0.54	0.47
HOME DEPOT INC	0.08	0.12	0.47	0.59	0.54	0.51	0.46	0.27
PFIZER INC	0.42	0.46	0.28	0.93	0.85	0.91	0.76	0.66
VERIZON COMMUNICATIONS INC	0.26	0.26	0.58	0.96	0.91	0.92	0.86	0.75

Apart from the stock selection, another potential source of difference in the composition of the alternative factors is the weight of the selected stocks. We use capitalisation weighted portfolios to construct the factor returns, so the weight for a stock will differ depending on which other stocks are included. Exhibit A15 looks at the difference between the alternative factors and the standard book-to-price factor in terms of the weights of the constituents. For every rebalancing date in the sample, the graph represents the sum across all stocks of the absolute difference in the weight in the standard value factor and the alternative factors. A value of 100% would mean that there was not a single common constituent in either the long or the short leg, whereas a value of 0% indicates the composition is exactly the same. Intangible-adjusted book-to-price and the composite score that includes book-to-price look the most similar to the standard book-to-price factor based on the constituent weights. Dividend yield is clearly the most different from the standard value factor.

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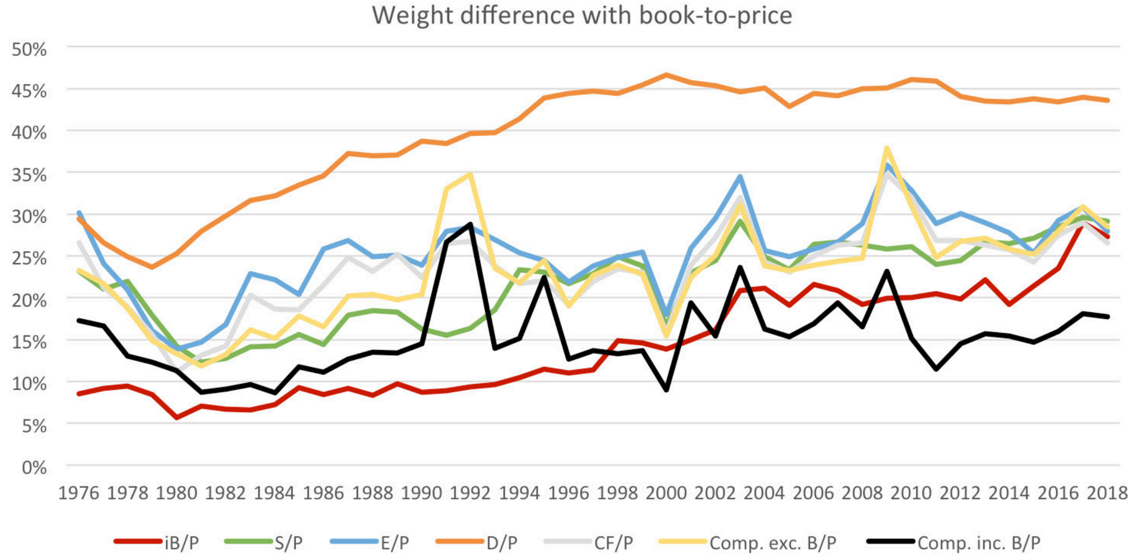
Exhibit A15: Difference in factor composition across alternatives
The graph shows the sum of the absolute differences in weights for all the stocks in the sample between the standard value factor and the alternative factors. At every rebalancing at the end of June, between 1976 and 2018, the difference is taken between the weights of the stocks in the standard factor and the weights in the stocks in the alternative factors. The sum of these absolute differences for every alternative is then normalised by dividing it by 4, so that the values range from 0 to 100%. The factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. Data source: CRSP, Compustat, K. French database.



We can also look at return correlations to more directly assess the similarity in factor performance between the alternative factors. Exhibit A16 shows the correlation matrix of the monthly factor returns. Overall, this table confirms the result from the previous exhibits. The intangible adjustment or the composites result in a factor that is more similar to book-to-price than using dividend or earnings.

Exhibit A16: Correlations of the alternative value factor returns
The table shows the correlations between the returns of the alternative value factors. The analysis is based on monthly returns from July 1976 to December 2018. The factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. Data source: CRSP, Compustat, K. French database.

Return correlations	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
B/P	0.82	0.69	0.76	0.64	0.76	0.81	0.91
iB/P		0.71	0.49	0.42	0.49	0.62	0.71
S/P			0.61	0.28	0.64	0.74	0.75
E/P				0.65	0.93	0.85	0.85
D/P					0.64	0.74	0.72
CF/P						0.89	0.86
Comp. exc. B/P							0.96

Exhibit A17 shows the results of a performance analysis conditional on the returns of the standard value factor. This answers a similar question as the correlation matrix presented above, but focuses

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specifically on the similarity with the standard book-to-price factor. Value factor definitions that are similar to the standard value factor will tend to perform very strong in bull periods for the standard value factor and very weak in bear periods.

Exhibit A17: Conditionality on book-to-price returns
The table shows the return and the correlation with the standard value factor for alternative value factors, conditional on whether the standard value factor is in a bull or bear regime. A bull regime is defined as a quarter in which it has positive returns, a bear regime is a quarter in which it has negative returns. The analysis is based on monthly returns from July 1976 to December 2018. The factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. Data source: CRSP, Compustat, K. French database.

Performance conditional on book-to-price returns		B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Ann. Absolute Return	Bull	18.12%	16.96%	14.28%	14.33%	8.88%	13.89%	15.65%	18.02%
	Bear	-14.90%	-8.76%	-7.29%	-9.86%	-10.79%	-9.77%	-11.72%	-14.27%
Correlation with B/P	Bull	-	0.82	0.68	0.76	0.60	0.76	0.79	0.89
	Bear	-	0.71	0.61	0.69	0.58	0.69	0.77	0.88

A4. Robustness Tests

Our main results are the unexplained returns of the alternative value factors when taking the exposures to other rewarded factors into account. We show that only the intangible-adjusted book-to-price factor has significantly positive unexplained returns. In practice, there are many choices that need to be made in the construction of the value factor apart from the accounting variable to use in the numerator. For many of these choices, there is no clear consensus on the most appropriate option. To test the robustness of our results, the following tables show the unexplained returns when some of the construction details of the factors are varied.

Exhibit A18 below considers an adjusted book-to-price factor, where unrecorded intangibles are added, but goodwill is left untouched. The results suggest that both the addition of unrecorded intangibles and the goodwill adjustment drive the positive value premium when adjusting for exposure to the six other factors. This is in line with results reported by Park (2019).

Exhibit A18: Factor exposure analysis – ibook-to-price$_G$
The table shows the results of a factor regression of ibook-to-price$_G$ on the market, size, momentum, low volatility, high profitability and low investment factors. The analysis is based on monthly returns from July 1976 to December 2018. The ibook-to-price$_G$ factor is created following Fama and French (2018) based on ibook-to-price$_G$, which adds knowledge and organisation capital to book equity, but does not deduct goodwill. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The explanatory factors are obtained from the K. French database and AQR (for low volatility). Data source: CRSP, Compustat, K. French database, AQR.

Factor exposures – ibook-to-price$_G$	Coefficient	P-value
Ann. unexplained	1.26%	0.21
Market	0.06	0.00
Size	0.17	0.00
Momentum	-0.16	0.00
Low volatility	0.08	0.00
High profitability	0.02	0.55
Low investment	0.79	0.00

Appendix

It is necessary to lag the accounting data in the value scores to ensure availability. However, this is not needed for the market value in the denominator of the value scores as these are available immediately. Asness and Frazzini (2013) argue that it is preferable to use more up-to-date market values in the presence of the momentum factor. Exhibit A19 below shows the results of the spanning regressions when using the most recent market capitalisations, as of the end of June, instead of the end of December values as the denominator for the value scores. Note that the dividend yield was already using the end of June market capitalisation in our main results, since the dividend yield is only based on return data and not on accounting data. The table confirms the result of Asness and Frazzini (2013) that the unexplained value factor return increases following a decrease in the momentum exposure. Our conclusions regarding the intangible-adjusted book-to-price factor as compared to other alternatives remain intact.

Exhibit A19: Factor exposure analysis – Six factor model when using current market values
The table shows the results of a factor regression of the alternative value factors on the market, size, momentum, low volatility, high profitability and low investment factors. The analysis is based on monthly returns from July 1976 to December 2018. The value factors are created based on Fama and French (2018) according to an adapted version of the different value score adjustments presented in Exhibit 1. The subscript C indicates that the most recent (June) market capitalisation is used as the value score denominator, as opposed to the end of December value in the standard scores. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The explanatory factors are obtained from the K. French database and AQR (for low volatility). Data source: CRSP, Compustat, K. French database, AQR.

Factor exposures – using current market values	B/P_C	iB/P_C	S/P_C	E/P_C	D/P	CF/P_C	Comp. exc. B/P_C	Comp. inc. B/P_C
Ann. unexplained	-0.08%	2.57%	-1.28%	0.18%	1.77%	0.37%	-0.01%	0.26%
P-value	0.94	0.01	0.20	0.87	0.09	0.72	0.99	0.81
Market	-0.02	0.03	0.12	-0.14	-0.27	-0.15	-0.13	-0.08
P-value	0.39	0.13	0.00	0.00	0.00	0.00	0.00	0.00
Size	-0.09	0.13	0.17	-0.15	-0.22	-0.12	-0.06	-0.07
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.04
Momentum	-0.34	-0.26	-0.29	-0.25	-0.15	-0.23	-0.33	-0.36
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Low volatility	0.15	0.06	0.20	0.21	0.09	0.16	0.22	0.20
P-value	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
High profitability	0.03	-0.04	0.40	0.56	-0.11	0.47	0.38	0.26
P-value	0.46	0.26	0.00	0.00	0.02	0.00	0.00	0.00
Low investment	0.86	0.85	0.64	0.47	0.52	0.55	0.70	0.86
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

We always exclude firms with a negative book value in the main analysis, as is common in the literature. The limited liability structure of firms means that shareholder value cannot be negative, so it is difficult to interpret a negative book value of equity. When constructing portfolios based on earnings or cash flows, firms with a negative or zero value for these variables are also sometimes excluded[22]. Exhibit A20 shows results when firms with a negative or zero value for sales, earnings or cash flows are excluded from the respective factors. This change does not materially influence our results or conclusions.

22 - See for example the construction details of the bivariate sorts on size, E/P, CF/P, and D/P on the K. French database.

Appendix

Exhibit A20: Factor exposure analysis – six factor model when excluding non-positive scores
The table shows the results of a factor regression of the alternative value factors on the market, size, momentum, low volatility, high profitability and low investment factors. The analysis is based on monthly returns from July 1976 to December 2018. The value factors are created based on Fama and French (2018) according to an adapted version of the different value score adjustments presented in Exhibit 1. The subscript P indicates that firms with a non-positive value score are excluded from the sample for the individual valuation ratios, in the case of the composites it means that they are based only on positive constituent value scores. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are always excluded. The explanatory factors are obtained from the K. French database and AQR (for low volatility). Data source: CRSP, Compustat, K. French database, AQR.

Factor exposures – excluding non-positive scores	B/P	iB/P	S/P_P	E/P_P	D/P	CF/P_P	Comp. exc. B/P_P	Comp. inc. B/P_P
Ann. unexplained	-0.72%	2.09%	-1.24%	0.52%	1.77%	0.42%	0.15%	0.28%
P-value	0.50	0.02	0.23	0.62	0.09	0.68	0.89	0.80
Market	0.00	0.04	0.12	-0.05	-0.27	-0.08	-0.08	-0.06
P-value	0.94	0.03	0.00	0.01	0.00	0.00	0.00	0.02
Size	-0.05	0.15	0.16	-0.06	-0.22	-0.04	-0.05	-0.03
P-value	0.12	0.00	0.00	0.04	0.00	0.21	0.12	0.44
Momentum	-0.17	-0.12	-0.17	-0.15	-0.15	-0.13	-0.23	-0.23
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Low volatility	0.16	0.07	0.19	0.17	0.09	0.15	0.23	0.20
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
High profitability	0.09	-0.01	0.43	0.22	-0.11	0.21	0.36	0.26
P-value	0.05	0.75	0.00	0.00	0.02	0.00	0.00	0.00
Low investment	0.85	0.77	0.60	0.50	0.52	0.52	0.63	0.71
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Exhibit A21 shows the results of the spanning regressions when using return data from the K. French database for the alternative value factors that are available there. These results are very similar as the results obtained in Exhibit A20 and serve as a sanity check for our factor construction process.

Exhibit A21: Factor exposure analysis - 6 Factor model for value factors from the K. French database
The table shows the results of a factor regression of the alternative value factors on the market, size, momentum, low volatility, high profitability and low investment factors. The analysis is based on monthly returns from July 1976 to December 2018. The subscript F indicates that the value factors are based on returns obtained from the K. French database. The explanatory factors are obtained from the K. French database and AQR (for low volatility). Data source: K. French database, AQR.

Factor exposures – value factors from K. French database	B/P_F	E/P_F	D/P_F	CF/P_F
Ann. unexplained	-0.38%	0.47%	1.71%	-0.23%
P-value	0.72	0.66	0.10	0.82
Market	-0.01	-0.05	-0.27	-0.05
P-value	0.73	0.03	0.00	0.02
Size	-0.04	-0.07	-0.21	-0.04
P-value	0.18	0.03	0.00	0.24
Momentum	-0.17	-0.15	-0.15	-0.11
P-value	0.00	0.00	0.00	0.00
Low volatility	0.16	0.17	0.08	0.15
P-value	0.00	0.00	0.00	0.00
High profitability	0.08	0.22	-0.09	0.24
P-value	0.07	0.00	0.03	0.00
Low investment	0.88	0.52	0.51	0.56
P-value	0.00	0.00	0.00	0.00

Appendix

The results when only considering different subsets of the full stock universe can also give interesting insights. For example, this can give an indication whether or not they are mostly influenced by small or large stocks. First, we show results based on the large-cap and small-cap portfolios from the six double-sorted portfolios separately in Exhibit A22 and Exhibit A23. Then, Exhibit A24 and Exhibit A25 show results that are based on the largest 500 stocks in the universe only. These factors are constructed based on both cap-weighted and equal-weighted portfolios. The results show that the intangible adjustment increases the unexplained return of the book-to-price factor in all settings. However, the conclusions regarding the comparison of the intangible adjustment with the other alternatives are not confirmed when moving away from the broad sample.

Exhibit A22: Factor exposure analysis – six factor model using only small-size portfolios
The table shows the results of a factor regression of the alternative value factors on the market, size, momentum, low volatility, high profitability and low investment factors. The analysis is based on monthly returns from July 1976 to December 2018. The value factors are based on Fama and French (2018), using only the small size portfolios from the six double-sorted portfolios, according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The explanatory factors are obtained from the K. French database and AQR (for low volatility). Data source: CRSP, Compustat, K. French database, AQR.

Factor exposures – small-cap universe	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Ann. unexplained	0.83%	3.81%	-0.53%	0.99%	1.78%	0.99%	0.23%	-0.10%
P-value	0.46	0.00	0.65	0.39	0.09	0.37	0.84	0.93
Market	-0.07	-0.03	0.11	-0.17	-0.27	-0.14	-0.10	-0.11
P-value	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00
Size	-0.15	0.05	0.04	-0.27	-0.30	-0.21	-0.19	-0.20
P-value	0.00	0.08	0.28	0.00	0.00	0.00	0.00	0.00
Momentum	-0.15	-0.05	-0.24	-0.17	-0.13	-0.19	-0.26	-0.25
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Low volatility	0.19	0.07	0.23	0.24	0.04	0.25	0.26	0.27
P-value	0.00	0.01	0.00	0.00	0.12	0.00	0.00	0.00
High profitability	0.25	0.04	0.62	0.77	-0.16	0.73	0.66	0.58
P-value	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Low investment	0.84	0.78	0.65	0.40	0.34	0.40	0.50	0.67
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix

Exhibit A23: Factor exposure analysis – six factor model using only large-size portfolios
The table shows the results of a factor regression of the alternative value factors on the market, size, momentum, low volatility, high profitability and low investment factors. The analysis is based on monthly returns from July 1976 to December 2018. The value factors are based on Fama and French (2018), using only the large size portfolios from the six double-sorted portfolios, according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The explanatory factors are obtained from the K. French database and AQR (for low volatility). Data source: CRSP, Compustat, K. French database, AQR.

Factor exposures – large-cap universe	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Ann. unexplained	-2.25%	0.40%	-1.95%	-1.51%	1.76%	-1.19%	-0.39%	-0.71%
P-value	0.11	0.75	0.12	0.27	0.22	0.38	0.78	0.62
Market	0.07	0.11	0.13	-0.06	-0.27	-0.12	-0.13	-0.07
P-value	0.02	0.00	0.00	0.03	0.00	0.00	0.00	0.02
Size	0.04	0.25	0.29	-0.01	-0.15	-0.01	0.08	0.09
P-value	0.30	0.00	0.00	0.80	0.00	0.77	0.07	0.05
Momentum	-0.18	-0.18	-0.10	-0.09	-0.18	-0.08	-0.24	-0.26
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Low volatility	0.14	0.08	0.15	0.17	0.13	0.14	0.21	0.19
P-value	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
High profitability	-0.08	-0.07	0.26	0.38	-0.05	0.25	0.12	0.05
P-value	0.19	0.20	0.00	0.00	0.36	0.00	0.05	0.38
Low investment	0.85	0.76	0.57	0.46	0.70	0.53	0.76	0.83
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Exhibit A24: Factor exposure analysis – Six factor model using only the top 500 stocks with capitalisation weighting
The table shows the results of a factor regression of the alternative value factors on the market, size, momentum, low volatility, high profitability and low investment factors. The analysis is based on monthly returns from July 1976 to December 2018. The value factors are returns from a cap-weighted portfolio that is long the 30% of stocks with the highest value score and short the 30% of stocks with the lowest value score, according the different value score adjustments presented in Exhibit 1, when considering only the 500 largest stocks in the universe. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The explanatory factors are obtained from the K. French database and AQR (for low volatility). Data source: CRSP, Compustat, K. French database, AQR.

Factor exposures - top 500 universe CW	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Ann. unexplained	-2.52%	-1.12%	-4.50%	-2.81%	1.66%	-2.80%	0.27%	-1.78%
P-value	0.06	0.36	0.00	0.04	0.26	0.05	0.84	0.18
Market	0.02	0.05	0.14	-0.03	-0.27	-0.11	-0.18	-0.08
P-value	0.37	0.04	0.00	0.23	0.00	0.00	0.00	0.00
Size	0.03	0.14	0.27	0.00	-0.14	0.03	0.01	0.00
P-value	0.44	0.00	0.00	0.95	0.00	0.47	0.79	0.95
Momentum	-0.18	-0.09	-0.07	-0.10	-0.17	-0.08	-0.18	-0.20
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Low volatility	0.23	0.15	0.19	0.21	0.14	0.17	0.17	0.21
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
High profitability	-0.08	0.00	0.39	0.46	0.00	0.41	0.04	0.07
P-value	0.17	0.97	0.00	0.00	0.95	0.00	0.43	0.22
Low investment	0.85	0.93	0.80	0.65	0.75	0.68	0.64	0.89
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix

Exhibit A25: Factor exposure analysis – six factor model using only the top 500 stocks with equal weighting
The table shows the results of a factor regression of the alternative value factors on the market, size, momentum, low volatility, high profitability and low investment factors. The analysis is based on monthly returns from July 1976 to December 2018. The value factors are returns from an equal-weighted portfolio that is long the 30% of stocks with the highest value score and short the 30% of stocks with the lowest value score, according the different value score adjustments presented in Exhibit 1, when considering only the 500 largest stocks in the universe. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The explanatory factors are obtained from the K. French database and AQR (for low volatility). Data source: CRSP, Compustat, K. French database, AQR.

Factor exposures – top 500 universe EW	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Ann. unexplained	-3.83%	-2.50%	-4.85%	-3.26%	1.93%	-4.22%	-0.67%	-2.70%
P-value	0.00	0.02	0.00	0.01	0.13	0.00	0.55	0.03
Market	-0.01	0.03	0.11	-0.07	-0.29	-0.12	-0.19	-0.12
P-value	0.65	0.13	0.00	0.00	0.00	0.00	0.00	0.00
Size	-0.07	0.02	0.17	-0.06	-0.19	-0.04	-0.09	-0.10
P-value	0.04	0.47	0.00	0.10	0.00	0.32	0.01	0.01
Momentum	-0.21	-0.16	-0.17	-0.17	-0.18	-0.16	-0.22	-0.25
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Low volatility	0.30	0.22	0.25	0.28	0.14	0.28	0.24	0.30
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
High profitability	0.21	0.29	0.68	0.61	-0.07	0.62	0.19	0.30
P-value	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00
Low investment	0.87	0.88	0.77	0.61	0.59	0.65	0.54	0.77
P-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

A5. Additional Tests of Alternative Value Factor Definitions: Different Asset Pricing Tests and Significance Hurdles

In the main part of this paper, we focus our discussion of the performance of the alternative value factors on the unexplained returns from spanning regressions using six explanatory factors. We then assess these results based on standard significance tests. The exhibits below present both additional asset pricing tests and additional ways of assessing the significance of the results. They expand on the analysis of the alternative value factors presented above.

We report results of spanning regressions that also include the standard book-to-price factor as an explanatory factor in Exhibit A26. This analysis provides a more direct view of the added value of the alternatives over and above the standard value factor. The conclusions from these results are consistent with the ones presented in the main analysis. The intangible adjustment adds significant value over the standard book-to-price value factor, whereas the other alternatives do not. The only exception is that the unexplained return from the dividend yield factor also becomes significantly positive now, albeit less strong than in the case of the intangible-adjusted book-to-price factor.

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Exhibit A26: Factor exposure analysis – seven factor model
The table shows the results of a factor regression of the alternative value factors on the market, size, value, momentum, low volatility, high profitability and low investment factors. The analysis is based on monthly returns from July 1976 to December 2018. The value factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The value factor in the regressors is always the standard one. The non-value factors are obtained from the K. French database and AQR (for low volatility). Data source: CRSP, Compustat, K. French database, AQR.

Factor exposures – seven factor model	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Ann. unexplained	0.00%	2.54%	-0.90%	0.26%	2.05%	0.36%	0.40%	0.23%
P-value	-	0.00	0.31	0.72	0.04	0.63	0.63	0.72
Market	0.00	0.04	0.12	-0.11	-0.27	-0.13	-0.11	-0.09
P-value	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Size	0.00	0.18	0.19	-0.10	-0.20	-0.08	-0.02	-0.01
P-value	-	0.00	0.00	0.00	0.00	0.00	0.35	0.60
Value	1.00	0.61	0.48	0.73	0.38	0.65	0.66	0.88
P-value	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Momentum	0.00	-0.01	-0.09	-0.01	-0.09	-0.03	-0.14	-0.10
P-value	-	0.23	0.00	0.48	0.00	0.07	0.00	0.00
Low volatility	0.00	-0.03	0.11	0.09	0.02	0.09	0.13	0.09
P-value	-	0.13	0.00	0.00	0.36	0.00	0.00	0.00
High profitability	0.00	-0.07	0.39	0.51	-0.14	0.43	0.33	0.24
P-value	-	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Low investment	0.00	0.25	0.20	-0.19	0.20	-0.08	0.07	0.01
P-value	-	0.00	0.00	0.00	0.00	0.07	0.13	0.79

Next to the spanning regressions, a second way to account for implicit exposures to other factors is via the results of model fit tests. Spanning regressions give a direct view on what the unexplained performance of the alternative value factors is. The measures of model fit, on the other hand, indicate the ability of a factor model to explain the returns on a set of test assets. This allows us to assess whether using an alternative factor instead of book-to-price improves the explanatory power.

Next to the spanning regressions, a second way to account for implicit exposures to other factors is via the results of model fit tests. Spanning regressions give a direct view on what the unexplained performance of the alternative value factors is. The measures of model fit, on the other hand, indicate the ability of a factor model to explain the returns on a set of test assets. This allows us to assess whether using an alternative factor instead of book-to-price improves the explanatory power. This is interesting because a better explanatory power means that the investment opportunity set of the selected factors becomes wider. Therefore, they can be combined in a portfolio with a better performance than one including book-to-price. In this sense, these results give an answer to the same question as the spanning regression results, but from another angle.

Appendix

Exhibit A27 presents the results of these tests. The first three rows show measures of model misfit. The higher these measures, the worse the performance of the factor model in explaining the returns on the test assets. The average adjusted R^2 is a measure of model fit; a higher value indicates a model that better captures the variability in the returns of the test assets. These results lead to similar conclusions as our main analysis. The average adjusted R^2 and the average absolute alphas are very similar across the alternatives. Intangible-adjusted book-to-price has the lowest GRS statistic, which indicates that the alphas of the regressions on the model including this factor are closer to zero on aggregate. The average absolute alpha divided by the return dispersion more directly indicates the proportion of total return dispersion between the test assets that is explained by the factor model. Intangible-adjusted book-to-price again has the lowest value, with almost 50% of the return dispersion explained. Some other alternatives also improve the performance over the standard value factor, although the differences are less pronounced.

Exhibit A27: Tests of model fit
The table shows measures of model fit for regressions of a set of test assets on a seven-factor model. The factors are the market, size, value, momentum, low volatility, high profitability and low investment factors. The test assets are 60 cap-weighted, decile sorted portfolios based on the variables that correspond to the latter six factors. Every column of the table uses a different variable to define the value factor and the corresponding decile sorted portfolios. GRS is the test statistic of Gibbons, Ross and Shanken (1989) and the return dispersion in the test assets is defined as in Fama and French (2016). The analysis is based on monthly returns from July 1976 to December 2018. The value factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The non-value factors and non-value decile sorted portfolios are obtained from the K. French database and AQR (for low volatility). Data source: CRSP, Compustat, K. French database, AQR.

Model fit	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
GRS	1.65	1.48	1.67	1.60	1.86	1.65	1.71	1.68
Avg. abs. α	0.08%	0.07%	0.08%	0.08%	0.09%	0.08%	0.08%	0.08%
Avg. abs. α / return dispersion	63.23%	51.51%	59.23%	60.82%	79.84%	66.93%	62.37%	64.97%
Avg. adj. R^2	91.26%	91.33%	91.35%	91.16%	90.80%	90.99%	91.18%	91.16%

The performance analysis and related inferences in the main part of this paper test eight different factors, so we should account for the fact that we do multiple hypothesis tests. There are several standard ways to adjust for multiple testing proposed in the literature. We apply the methodologies presented by Bonferroni (1936), Holm (1979) and Benjamini and Hochberg (1995).

The adjusted p-values of the unexplained returns from the spanning regression are presented in Exhibit A28. Given that only the intangible-adjusted book-to-price factor had significantly positive returns at the 5% level according to the standard p-values, it is not surprising to find that none of the factors pass these higher significance hurdles. This finding, however, does not change any of our conclusions concerning the merits of the various alternatives relative to the standard book-to-price factor.

Appendix

Exhibit A28: Multiple testing adjustments for six factor alphas
The table shows the unexplained returns from a factor regression of the alternative value factors on the market, size, momentum, low volatility, high profitability and low investment factors, as in Exhibit 6. The standard p-values are presented next to p-values that are adjusted for multiple testing, according to Bonferroni (1936), Benjamini and Hochberg (1995) and Holm (1979). The analysis is based on monthly returns from July 1976 to December 2018. The value factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. The explanatory factors are obtained from the K. French database and AQR (for low volatility). Data source: CRSP, Compustat, K. French database, AQR.

Multiple testing adjustments	B/P	iB/P	S/P	E/P	D/P	CF/P	Comp. exc. B/P	Comp. inc. B/P
Ann. unexplained return	-0.72%	2.09%	-1.24%	-0.27%	1.77%	-0.11%	-0.08%	-0.41%
Standard P-value	0.50	0.02	0.22	0.80	0.09	0.92	0.94	0.72
Bonferroni	1.00	0.18	1.00	1.00	0.76	1.00	1.00	1.00
Benjamini-Hochberg	0.94	0.18	0.59	0.94	0.38	0.94	0.94	0.94
Holm	1.00	0.18	1.00	1.00	0.66	1.00	1.00	1.00

While the standard statistical analysis used in our main analysis is well accepted, it also suffers from some downsides. First, t-statistics or p-values are only an indirect answer to the actual question of interest. Second, these tests ignore any economic rationale for a result. Third, the cut-off to declare a result significant is arbitrary. Harvey (2017) argues in favour of the adoption of a so-called Bayesian p-value, which addresses these downsides, to complement standard t-statistics or p-values. He proposes a computationally simple way to transform a t-statistic that allows to take into account prior expectations regarding the plausibility of finding a significant result. We should be aware of the fact that the price for this simplicity is a bias towards finding strong results. The prior plausibility allows for the incorporation of a strong economic rationale, or the lack thereof, when analysing the performance. The Bayesian p-value can be interpreted as the likelihood that there is no significant unexplained return. This more directly answers the question that we are actually interested in, as opposed to a standard p-value that indicates the probability of observing the data under the assumption that there is no effect. This makes it easier for readers to judge for themselves whether a certain likelihood is high or low.

Exhibit A29 reports the results of this analysis. The first column indicates the assumed prior likelihood that there is no positive unexplained return. We use a range of values, since defining the prior likelihood can be quite subjective. The other columns show the likelihood that there is a positive unexplained return for each alternative after observing the data. Since we are interested in factors that add value in the factor menu and thus exhibit a positive unexplained return, we only show the results for the intangible-adjusted book-to-price factor and the dividend yield factor. This information provides an idea of how much the observed evidence changes the likelihood that there is no actual added value. The results show that the evidence in favour of the intangible-adjusted book-to-price factor has a bigger impact on the likelihood of no unexplained returns than the evidence in favour of the dividend yield. For example, if we start from a 50% prior likelihood, the likelihood after observing the evidence decreases to 6.7% for the intangible adjustment compared to 19.8% for the dividend yield.

Appendix

Exhibit A29: Likelihood of no unexplained return before and after observing the data
The table shows the likelihood of no significant unexplained return following the methodology proposed by Harvey (2017). The 'Before evidence' column corresponds to the prior plausibility of no unexplained returns. The 'After evidence' columns correspond to the Bayesianised p-values, using the minimum Bayes factor. The values are based on the unexplained returns of the factor regression presented in Exhibit 6. The value factors are created following Fama and French (2018) according to the different value score adjustments presented in Exhibit 1. The sample consists of all NYSE, Amex and NASDAQ companies for which data is available in both CRSP and Compustat. Stocks need to have been at least two years in the Compustat database before being included in the sample and stocks with a negative book value are excluded. Data source: CRSP, Compustat, K. French database, AQR.

Likelihood of no unexplained returns	iB/P	D/P
Ann. unexplained return	2.09%	1.77%
Before evidence	After evidence	
10%	0.8%	2.7%
20%	1.8%	5.8%
30%	3.0%	9.6%
40%	4.6%	14.1%
50%	6.7%	19.8%
60%	9.7%	27.0%
70%	14.3%	36.5%
80%	22.3%	49.6%
90%	39.2%	68.9%

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