
Assessing Alternative Value Metrics

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KEY TAKEAWAYS

- ▶ Our 1963–2022 analysis shows no reliable performance differences across value portfolios formed on price-to-book (P/B) and nine other metrics.
- ▶ We find that P/B separates the value and profitability premiums effectively, allowing investors to better manage exposure to those premiums.
- ▶ A P/B strategy integrating profitability and sector diversification can achieve similar performance to other metrics, with less turnover.

Many stock investors consider the value premium in their pursuit of higher expected returns. It is supported by valuation theory as well as by empirical evidence covering nearly a century of data in the US and several decades in other developed and emerging markets. The theory, however, does not specify which metric to use when pursuing the value premium. In this article, we compare 10 different value metrics proposed in academia and the financial industry and find price-to-book to be a superior choice for practical investment solutions.

What Does the Theory Say?

Valuation theory provides a framework for identifying the drivers of expected returns. It says that expected returns are driven by the prices investors pay and the cash flows they expect to receive. However, the theory does not tell us the best way to extract information about expected returns from current market values and proxies for expected cash flows. A simple approach is to look at current market values scaled by proxies for expected future cash flows. Examples include price-to-earnings and price-to-cash flow ratios. However, the magnitude and frequency of the changes in market values and proxies for expected future cash flows are very different. Market values change by the minute, while earnings and cash flows tend to change quarterly or semiannually. As a result, in a metric like price-to-earnings or price-to-cash flow, the signal from the market value could overwhelm the signal from the proxy of expected future cash flows, resulting in a loss of information. Because both market values and proxies for expected future cash flows contain valuable information about expected returns, it is better to compare companies' market values and cash flows separately.

The same applies to buying a rental property. Investors would not be satisfied with just knowing the rental yield, i.e., the price-to-rent ratio of a property on the market. They would want to know both the house price and the expected rent on the property. Since both prices and rents vary with property characteristics like property size, it is helpful to scale both the price and expected rent by the square footage of the property.

Similarly, it is helpful to scale both sides of the valuation equation by a company fundamental. This allows us to identify reliable differences in expected returns based on differences in valuation ratios and profitability ratios (profits scaled by a fundamental). Ample academic research uses stable fundamentals from the balance sheet, such as assets or book equity, to scale market prices and profits (e.g., Fama and French 1992, 1993, 2015; Novy-Marx 2013). For this reason, using price-to-book as a valuation ratio (along with profits-to-book as a profitability ratio) is a reasonable way to extract information about expected returns.

Letting the Data Speak

Does price-to-book (P/B) also have strong empirical support? Using US stock data from July 1963 to December 2022, we compare the historical performance of a hypothetical value portfolio formed on P/B with the performance of nine other value portfolios formed on alternative value metrics. See **Exhibit 1** for the definitions of the variables.

EXHIBIT 1: Definitions of Variables¹

Name	Abbreviation	Definition
Price-to-Book	P/B	Market capitalization divided by book equity.
Price-to-Cash Flow	P/CF	Market capitalization divided by earnings before extraordinary items, adding back depreciation and amortization, deferred taxes, and accruals.
Price-to-Earnings	P/E	Market capitalization divided by earnings before extraordinary items.
Blend of Price-to-Book, Price-to-Cash Flow, and Price-to-Earnings	BLEND	An equally weighted average of ranks based on P/B, P/CF, and P/E.
Price-to-Retained Earnings	P/RE	Market capitalization divided by retained earnings.
Price-to-Contributed Capital	P/(B-RE)	Market capitalization divided by book equity less retained earnings.
Price-to-Book less Goodwill	P/(B-GDWL)	Market capitalization divided by book equity less goodwill.
Price-to-Book with Estimated Intangibles	P/(B+INTAN)	Market capitalization divided by book equity plus estimated internally developed intangibles.
Price-to-Book with Estimated Knowledge Capital	P/(B+KNOW)	Market capitalization divided by book equity plus estimated knowledge capital.
Price-to-Book with Estimated Organizational Capital	P/(B+ORG)	Market capitalization divided by book equity plus estimated organizational capital.

Each value portfolio targets the lowest 30% of the US market based on its value metrics definition. In **Exhibit 2**, we present the average monthly return of the value portfolios. Panel A shows the results for the full sample period, July 1963 to December 2022, while Panel B and Panel C show the same results for July 1963 to December 1992 (we call this the pre-1993 period) and for January 1993 to December 2022 (we call this the post-1993 period), respectively. Over the full period, all value portfolios outperformed the US market, which delivered 0.92% for average monthly return.² Therefore, all 10 value metrics captured the value premium. This highlights the robustness of the value premium across many specifications.

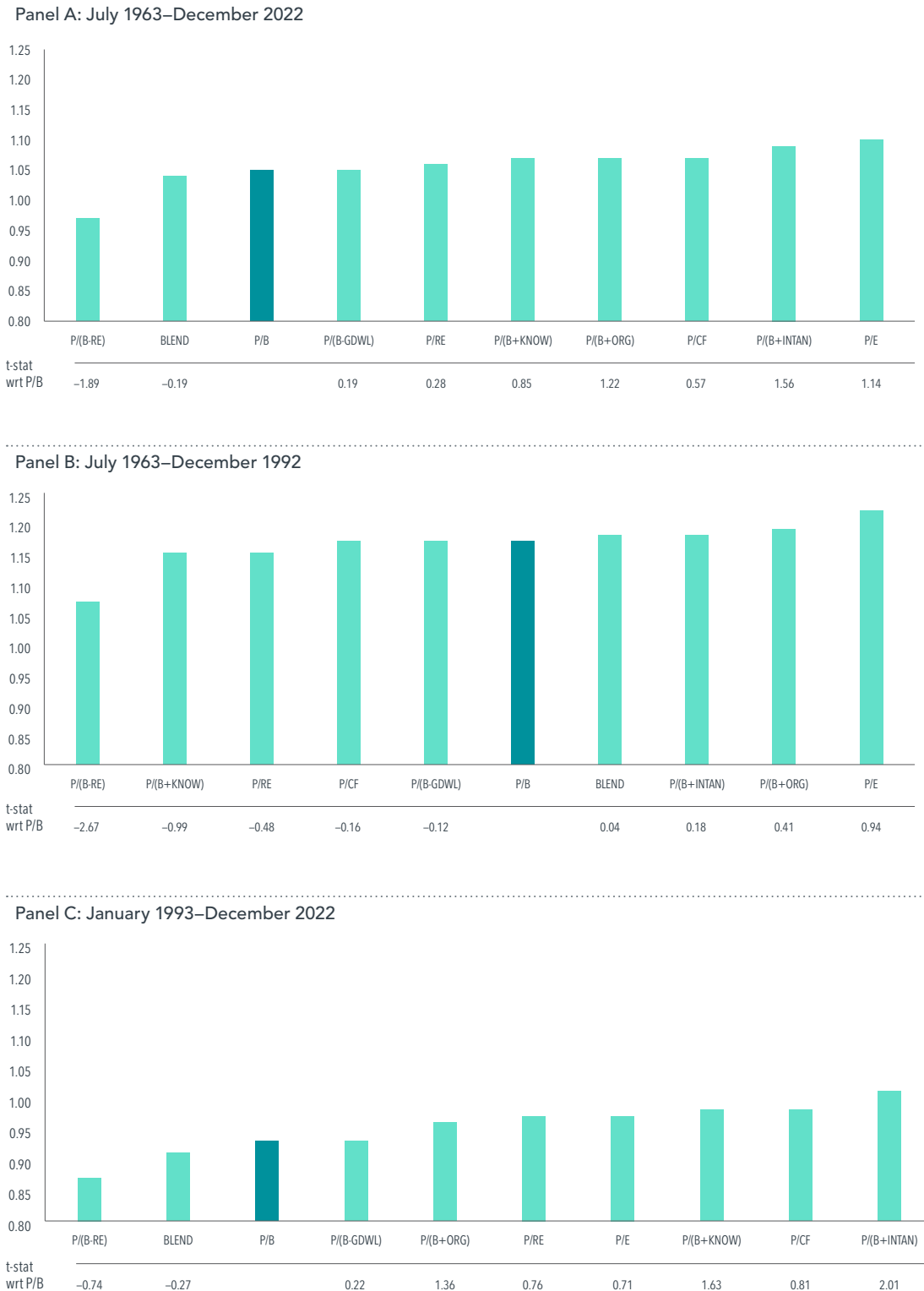
While some of the alternative value metrics outperformed P/B, others underperformed. None of the differences in performance relative to P/B, however, is statistically reliable, as suggested by the low absolute value of the t-statistics on the average monthly return differences. The results are also similar in the subsamples, with two exceptions. In the pre-1993 period, P/B reliably

1. Stattman (1980) and Rosenberg, Reid, and Lanstein (1985) find a positive relation between average stock returns on US stocks and their book value of equity. Basu (1977) finds that low P/E securities outperform high P/E stocks, and Wilson (1986) finds incremental information content of cash flows for a given amount of earnings. Ball, Gerakos, Linnainmaa, and Nikolaev (2020) find the retained earnings component of the book value of equity predicts the cross-section of average stock returns. Choi, So, and Wang (2021) propose subtracting goodwill from firms' reported book values. Eisfeldt and Papanikolaou (2014) argue that intangible capital/B should reflect estimates of organizational capital. Peters and Taylor (2017) propose incorporating internally developed intangible assets into P/B. Rizova and Saito (2021) also explore alternative value metrics that adjust for estimates of internally developed intangibles.

2. See Additional Information in Appendix.

outperformed P/(B-RE), while in the post-1993 period P/(B+INTAN) outperformed P/B with a t-statistic of 2.01. Panel D examines the relative performance of the different value metrics year by year. None of the valuation ratios has been a consistent winner over time.

EXHIBIT 2: Average Monthly Return (%)



Panel D: Calendar-Year Return of Value Portfolios Formed on Alternative Metrics, 1964–2022

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Highest Return	23.7	21.5	-4.8	33.2	24.3	-17.5	11.4	11.7	16.0	-6.6	-17.5	48.1	43.4	3.5	10.8	32.5	34.2	8.9	28.6	36.0	17.4	35.2	19.6	5.3	26.2	34.8	-10.9	36.3	19.6
	21.8	21.5	-5.4	32.8	24.3	-17.8	11.3	11.7	15.8	-6.6	-18.3	46.8	43.4	3.1	10.4	30.9	30.7	8.9	26.7	35.5	16.8	34.0	18.9	4.7	26.0	33.3	-11.3	31.7	18.9
	21.4	21.1	-5.4	31.6	24.3	-18.2	10.8	11.7	15.4	-7.4	-19.8	46.3	43.4	3.1	10.2	29.4	28.0	8.1	26.1	34.9	13.2	32.2	18.8	4.7	26.0	30.0	-13.7	30.5	17.4
	21.4	21.0	-5.5	30.5	24.2	-18.3	10.8	11.6	15.3	-8.5	-20.3	42.8	42.6	3.0	10.0	28.8	27.6	7.3	24.2	33.8	10.0	31.8	18.2	3.9	25.7	29.9	-14.6	30.2	16.4
	20.4	21.0	-5.6	30.0	22.5	-18.4	10.4	10.8	14.8	-8.8	-20.5	41.6	42.4	2.9	9.7	26.6	26.8	7.2	23.4	33.4	9.8	31.6	17.7	3.7	25.4	29.7	-14.6	30.0	16.2
	20.3	20.7	-6.8	27.3	22.5	-18.6	10.2	10.7	14.4	-10.1	-20.5	41.2	42.2	2.9	9.6	26.6	23.4	6.7	23.4	33.4	9.7	30.5	17.6	3.4	24.5	27.8	-14.6	29.3	16.0
	20.3	20.7	-7.0	25.7	22.4	-19.4	10.1	10.3	14.4	-10.5	-21.2	41.2	42.0	2.7	9.4	24.9	23.4	6.7	16.7	32.5	8.9	30.5	17.6	3.4	23.7	27.0	-14.9	28.6	15.8
	20.1	20.5	-7.2	25.2	22.3	-19.4	9.3	10.3	13.0	-10.9	-21.4	39.1	41.8	2.4	9.4	24.2	21.7	5.2	16.4	31.3	8.9	30.4	17.6	2.3	23.5	25.3	-15.5	28.3	15.5
	20.0	19.3	-12.5	25.2	21.9	-19.9	6.5	10.0	12.9	-11.0	-21.5	39.0	41.6	2.4	9.2	24.2	20.1	3.5	14.1	30.9	8.9	28.7	16.9	1.4	23.2	24.1	-16.8	27.1	15.3
Lowest Return	15.0	10.9	-12.9	23.3	21.7	-20.4	4.7	9.6	12.9	-12.2	-23.4	35.0	40.8	0.1	8.8	23.1	19.8	2.2	11.1	30.4	6.2	28.0	13.1	0.4	23.0	21.0	-17.5	26.2	15.1

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Highest Return	23.2	3.7	44.2	31.1	41.4	16.2	20.5	17.6	3.5	-10.3	44.1	19.4	10.7	22.9	6.1	-35.8	33.2	19.7	4.8	26.8	41.0	12.8	-3.2	25.0	22.5	-10.0	31.8	21.1	35.2	-1.7
	23.0	3.2	43.6	27.1	41.3	13.2	19.4	12.2	3.4	-14.0	42.2	18.8	10.5	21.9	-0.2	-35.9	30.0	19.1	0.9	23.4	40.8	12.7	-3.3	24.0	22.4	-10.5	28.9	6.6	31.6	-2.1
	22.2	3.1	41.7	26.8	37.3	13.1	16.6	9.9	3.0	-14.1	41.0	18.3	10.0	21.0	-1.2	-37.2	28.1	19.0	-1.0	22.5	40.0	12.0	-3.4	23.9	22.2	-10.7	28.2	0.6	30.0	-2.6
	21.6	3.0	39.2	26.5	36.3	12.7	14.6	8.2	2.7	-15.9	40.9	17.8	10.0	20.9	-1.9	-37.5	25.8	18.7	-1.5	21.9	39.9	11.3	-4.3	23.5	18.2	-11.1	27.1	-0.2	28.9	-3.8
	21.5	1.2	39.0	26.4	35.7	12.2	12.9	7.3	1.6	-16.0	40.0	17.0	9.6	20.8	-2.1	-38.9	25.1	18.2	-5.9	21.7	38.6	10.5	-4.3	23.4	18.0	-11.9	26.2	-0.6	28.3	-4.6
	20.1	1.0	39.0	26.3	34.8	11.0	10.5	6.8	1.2	-16.1	38.4	16.5	9.5	20.7	-2.5	-39.7	24.5	17.7	-5.9	20.2	38.6	9.4	-4.7	23.4	17.1	-13.1	26.0	-0.9	27.5	-4.9
	19.4	0.7	39.0	26.0	33.7	9.1	9.1	6.3	1.1	-16.2	34.0	15.9	8.7	19.9	-3.1	-41.9	21.6	17.6	-6.2	17.6	38.4	9.2	-6.0	22.6	16.6	-13.2	25.9	-1.1	27.3	-6.1
	18.9	0.0	38.5	25.2	33.6	8.8	7.9	4.9	1.1	-16.5	32.3	15.1	8.5	18.9	-3.9	-42.7	19.6	15.5	-6.7	16.7	38.3	8.2	-6.3	22.4	16.2	-13.2	25.6	-1.1	26.9	-7.5
	15.5	-0.4	38.2	23.5	33.0	8.2	6.3	4.6	1.0	-17.5	30.6	14.7	7.0	18.8	-4.7	-43.6	19.3	15.3	-8.5	15.5	36.8	8.2	-8.8	21.8	15.6	-13.7	24.8	-1.5	26.5	-8.2
Lowest Return	12.9	-1.8	37.5	17.6	32.1	7.1	5.6	-7.4	-4.7	-24.1	29.1	14.7	5.6	17.7	-4.9	-44.0	16.7	12.5	-10.5	14.7	36.5	6.4	-9.1	19.9	14.7	-14.0	23.8	-1.8	16.9	-17.1

P/B	P/CF	P/E	BLEND	P/RE	P/(B-RE)	P/(B-GDWL)	P/(B+INTAN)	P/(B+KNOW)	P/(B+ORG)
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Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower. In USD. Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical, are not representative of indices, actual investments, or actual strategies managed by Dimensional, and do not reflect costs and fees associated with an actual investment. See Additional Information in Appendix.

Next we examine the average monthly characteristics of the different hypothetical value portfolios. As shown in Panels A and B of **Exhibit 3**, most alternative metrics provide additional profitability exposure at the expense of value exposure. This explains why the value portfolios based on those alternative metrics outperform the one based on price-to-book post-1993, when the profitability premium was stronger than the value premium.³

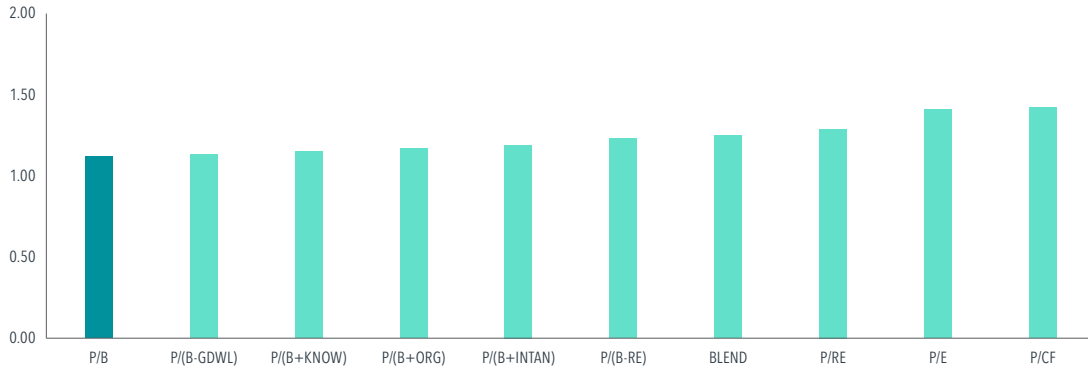
This insight is consistent with the Fama-French (2015) five-factor regression loadings shown in **Exhibit 4**. The performance of the value portfolios based on various metrics is effectively explained by their exposure to the five factors, as indicated by the small t-statistics associated with the intercepts and the high R-squares.

In addition, the value portfolios based on different metrics have different sector weights (**Exhibit 3**, Panel C). The weight differences are especially pronounced in financials, energy, telecommunication services, information technology, and health care. For example, price-to-book with estimated intangibles tends to result in a greater weight in information technology and a lower weight in financials than price-to-book. While there is no compelling evidence of systematic differences in expected returns across sectors, sector differences across value strategies might affect relative returns in a period with meaningful differences in sector performance.

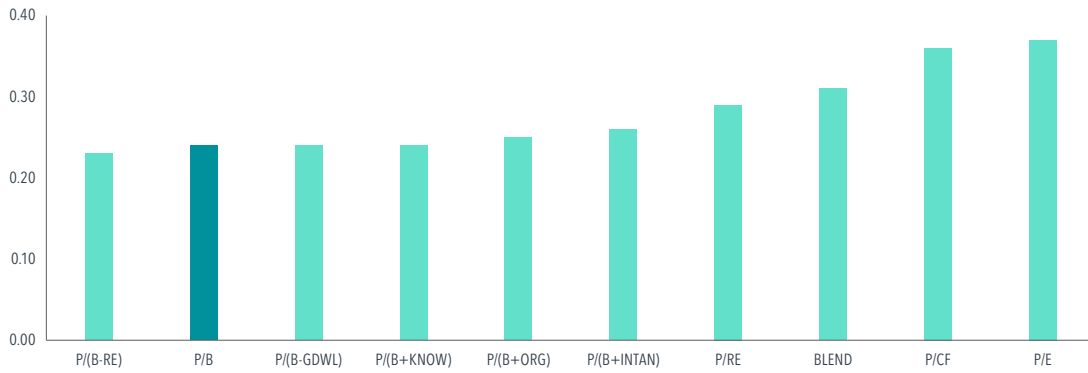
3. The average monthly value (profitability) premium is measured by the Fama-French High Minus Low (Robust Minus Weak) factor. See Additional Information in Appendix.

EXHIBIT 3: Average Monthly Characteristics for Value Portfolios, July 1963–December 2022

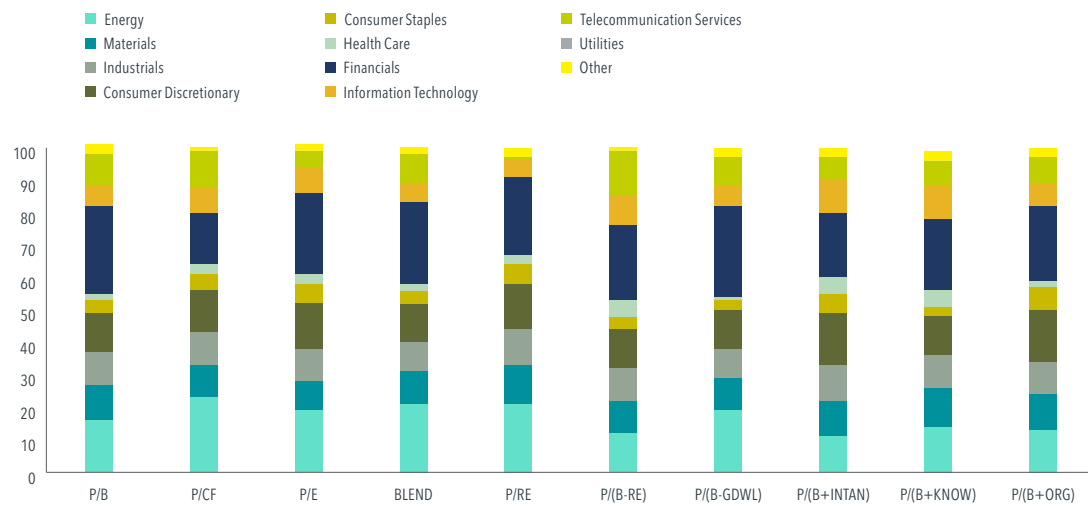
Panel A: Aggregate Price-to-Book



Panel B: Weighted Average Profitability



Panel C: Sector Weights (%)



See Additional Information in Appendix.

EXHIBIT 4: Fama-French Five-Factor Model Loadings for Value Portfolios, July 1963–December 2022

	P/B	P/CF	P/E	BLEND	P/RE	P/(B-RE)	P/(B-GDWL)	P/(B+INTAN)	P/(B+KNOW)	P/(B+ORG)
Intercept (Not annualized)	-0.06	-0.01	-0.01	-0.06	-0.09	-0.04	-0.05	-0.02	-0.02	-0.07
t-Statistic (Intercept)	-1.62	-0.23	-0.29	-1.45	-2.29	-1.00	-1.24	-0.63	-0.42	-1.86
Market	1.04	1.00	1.02	1.01	1.04	1.05	1.05	1.04	1.04	1.04
Size (SmB)	0.07	0.01	0.04	0.03	0.05	0.14	0.08	0.15	0.10	0.13
Value (HmL)	0.52	0.35	0.44	0.49	0.41	0.32	0.53	0.42	0.44	0.47
Profitability (RmW)	-0.04	0.17	0.19	0.11	0.13	-0.20	-0.07	-0.02	-0.10	0.03
Investment (CmA)	0.02	0.06	-0.05	-0.02	0.14	-0.02	-0.01	0.08	0.06	0.07
R ²	0.96	0.94	0.94	0.95	0.95	0.97	0.96	0.96	0.96	0.96

See Additional Information in Appendix.

Overall, the evidence in Exhibits 3 and 4 suggests that these alternative metrics provide indirect exposure to the profitability premium and a sector allocation closer to the US market. For example, the hypothetical P/B portfolio holds financials at 27%, more than twice as much as the US market. On the other hand, the P/CF portfolio’s financial weight is 16%, compared to the market’s 13%. These considerations, however, can be applied more directly by integrating the profitability premium in the weighting scheme and/or security selection and by managing sector diversification. We believe a robust real-world value strategy should integrate multiple premiums and provide broad diversification at the security and sector level. Consider a price-to-book strategy that incorporates the size, value, profitability, and investment premiums while managing sector- and security-level diversification. The strategy focuses on the stocks in the market with the lowest P/B. Within this value universe, it emphasizes stocks with lower P/B, lower market capitalization, and higher profitability, and excludes high-investment firms within small caps. The strategy manages sector diversification by limiting the weight of any given sector to at most 10% over its weight in the market and manages stock diversification.

As shown in Exhibit 5, such a hypothetical strategy (P/B Strategy) can meaningfully increase the exposure to the profitability premium while maintaining a sharp focus on the value premium. As a result, the average monthly return differences against the price-to-book strategy are much smaller in Exhibit 6 than in Exhibit 2. Most of the alternatives underperform the hypothetical price-to-book strategy. In Exhibit 6, Panels B and C, we split the data pre- and post-1993 to examine the performance variation over time and find that the performance of the price-to-book strategy improves noticeably in the post-1993 period.

So far, we have examined the broad US market, but the findings are also applicable for investors pursuing higher expected returns within large and small cap markets. As shown in Exhibit 7, Panels A and B, the hypothetical price-to-book strategy is one of the top-performing value strategies in both small and large caps while maintaining a sharp focus on the value premium.

EXHIBIT 5: Average Monthly Characteristics for Price-to-Book Strategy and Value Portfolios Formed on Alternative Metrics, July 1963–December 2022



EXHIBIT 6: Average Monthly Return (%)

Panel A: July 1963–December 2022



Panel B: July 1963–December 1992



Panel C: January 1993–December 2022



EXHIBIT 7: Average Monthly Return (%) of Portfolios Formed on Alternative Metrics and Hypothetical Price-to-Book Strategy, July 1963–December 2022

Panel A: Large Value Portfolios



Panel B: Small Value Portfolios



Past performance, including simulated performance, is no guarantee of future results, and there is always the risk that a client may lose money. Simulated strategy returns are based on model/backtested performance. The performance was achieved with the retroactive application of a model designed with the benefit of hindsight; it does not represent actual investment performance. Backtested model performance is hypothetical (it does not reflect trading in actual accounts) and is provided for informational purposes only. The securities in the model may differ significantly from those in client accounts. Model performance may not reflect the impact that economic and market factors might have had on the advisor's decision making if the advisor had been actually managing client money. We report t-statistics vs. the hypothetical price-to-book (P/B) strategy at the bottom. See Additional Information in Appendix.

Practical Considerations

When evaluating alternative ways to target the value premium in practical investment solutions, it is also important to consider the expected differences in trading costs. Our analysis shows that the alternative value metrics generally result in higher turnover. For example, price-to-earnings and price-to-cash flow yield an annual one-way turnover that is about 15 percentage points higher than that of the hypothetical strategy using price-to-book. This makes sense because earnings and cash flows tend to be more volatile than book equity. Higher turnover can lead to higher implementation costs in real-world investment solutions.

Having separate measures for the value and profitability premiums can offer a few additional advantages from a practical investment standpoint. First, it allows for more flexibility in customizing the focus on different premiums to meet specific investor needs. For example, some investors may want to dial up or down the profitability exposure in their value strategy depending on what else they hold in their overall portfolio. Second, separate value and profitability measures allow investors to manage the interactions between the premiums more effectively and have steadier premium exposure over time. In contrast, having a single measure for multiple premiums would leave the balance between the value and profitability premiums at the mercy of the market. When value stocks exhibit higher profitability, you end up with more profitability exposure; when they exhibit lower profitability, you have less profitability exposure.

Price-to-Book: Standing the Test of Time

Investors should always keep an open mind and look for better ways to extract information about differences in expected returns between value and growth stocks. However, when evaluated based on conceptual, empirical, and practical considerations, price-to-book—one of the original value metrics (Stattman 1980; Rosenberg, Reid, and Lanstein 1985)—still offers several advantages over alternative metrics. Our analysis shows price-to-book can provide a similar expected return with lower turnover and more control over the exposures to multiple premiums in a systematic investment solution.

REFERENCES

- Ball, Ray, Joseph Gerakos, Juhani T. Linnainmaa, and Valeri Nikolaev. 2020. "Earnings, Retained Earnings, and Book-to-Market in the Cross Section of Expected Returns." *Journal of Financial Economics* 135, no. 1: 231–254.
- Basu, Sanjoy. 1977. "Investment Performance of Common Stocks in Relation to Their Price-Earnings Ratios: A Test of the Efficient Market Hypothesis." *Journal of Finance* 32, no. 3: 663–682.
- Choi, Ki-Soon, Eric C. So, and Charles C. Y. Wang. 2021. "Going by the Book: Valuation Ratios and Stock Returns." Available at SSRN 3854022.
- Eisfeldt, Andrea L., and Dimitris Papanikolaou. 2014. "The Value and Ownership of Intangible Capital." *American Economic Review* 104, no. 5: 189–94.
- Fama, Eugene F., and Kenneth R. 1992. "The Cross-Section of Expected Stock Returns." *Journal of Finance* 47, no. 2: 427–465.
- Fama, Eugene F., and Kenneth R. 1993. "Common Risk Factors in the Returns on Stocks and Bonds." *Journal of Financial Economics* 33, no. 1: 3–56.
- Fama, Eugene F., and Kenneth R. 2015. "A Five-Factor Asset Pricing Model." *Journal of Financial Economics* 116, no. 1: 1–22.
- Novy-Marx, Robert, 2013. "The Other Side of Value: The Gross Profitability Premium." *Journal of Financial Economics* 108, no. 1: 1–28.
- Peters, Ryan, and Lucian A. Taylor. 2017. "Intangible Capital and the Investment-q Relation." *Journal of Financial Economics* 123, no. 2: 251–272.
- Rizova, Savina, and Namiko Saito. 2021. "Internally Developed Intangibles and Expected Stock Returns." Available at SSRN 3697452.
- Rosenberg, Barr, Kenneth Reid, and Ronald Lanstein. 1985. "Persuasive Evidence of Market Inefficiency." *Journal of Portfolio Management* 11: 9–17.
- Stattman, Dennis. 1980. "Book Values and Stock Returns." *Chicago MBA: A Journal of Selected Papers* 4, no. 1: 25–45.
- Wilson, G. Peter. 1986. "The Relative Information Content of Accruals and Cash Flows: Combined Evidence at the Earnings Announcement and Annual Report Release Date." *Journal of Accounting Research* 24: 165–200.

APPENDIX

Additional Information

Source: Dimensional, using CRSP and Compustat data. The eligible universe includes US firms of all market capitalization, excluding REITs, utilities, tracking stocks, and investment companies. Profitability is measured as operating income before depreciation and amortization minus interest expense, scaled by book equity. The portfolios are rebalanced semiannually at the end of each June and December.

The US market includes eligible firms of all market capitalization at their market cap.

A hypothetical value portfolio is formed by including eligible firms in the bottom 30% of the market capitalization based on the relevant price-to-fundamental ratio at the market-cap weights. A large (small) value portfolio is formed by including eligible large (small) cap firms in the bottom 30% of the large (small) cap market based on the relevant price-to-fundamental ratio at the market-cap weights. The large (small) cap market approximately represents the top 92% (bottom 8%) of the market capitalization.

The hypothetical value P/B strategy includes eligible firms in the bottom 33% of the market capitalization based on price-to-book and emphasizes those with lower market capitalization, lower price-to-book, and higher profitability. In addition, it also excludes firms in the lowest profitability group as well as small cap firms with higher asset growth. The hypothetical large value P/B strategy includes eligible large cap firms in the bottom 30% of the large cap market based on price-to-book and emphasizes those with lower market capitalization, lower price-to-book, and higher profitability. The hypothetical small value P/B strategy includes eligible small cap firms in the bottom 35% of the small cap market based on price-to-book and excludes those with lower profitability and those with higher asset growth. The weight of any sector in those strategies is limited to 10 percentage points above the weight of that sector in the market.

Sectors are based on standard industrial classification (SIC), which is mapped to the global industry classification standard (GICS) using a proprietary mapping.

See detailed Fama-French five-factor definition in [Kenneth R. French—Description of Fama/French Factors](#).

The simulated and hypothetical performance is "gross performance," which includes the reinvestment of dividends and other earnings but does not reflect the deduction of investment advisory fees and other expenses. A client's investment returns will be reduced by the advisory fees and other expenses that may be incurred in the management of the advisory account. The performance is hypothetical, does not reflect trading in actual accounts, and is provided for informational purposes only. The performance may not reflect the impact

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