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Optimizing Value

RAN LESHEM, LISA R. GOLDBERG, AND ALAN CUMMINGS

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RAN LESHEM, LISA R. GOLDBERG, AND ALAN CUMMINGS

RAN LESHEM
is chief investment
officer at Aperio Group
in Sausalito, CA.
rleshem@aperiogroup.com

LISA R. GOLDBERG
is director of research at
Aperio Group in Sausalito,
CA, and adjunct professor
of economics and statistics
at the University of
California, Berkeley in
Berkeley, CA.
lgoldberg@aperiogroup.com

ALAN CUMMINGS
is chief systems architect
at Aperio Group in
Sausalito, CA.
acummings@aperiogroup.com

Since Graham and Dodd [1934], top finance professionals have argued that value investing—the orderly pursuit of underpriced securities—delivers a premium by outperforming the market over time.¹ Today, value strategies are popular with equity investors. However, there is no single way to construct a value strategy, and the magnitude of the value premium depends on the value metric used, the implementation, and the investment period.

Value stocks are not glamorous. Rather, they are low-profile securities that fail to make headlines. Finance professionals use a variety of metrics based on market data, accounting statements, and other public information to identify value stocks. The most familiar metrics rely on book-to-price ratio (B/P), which is the ratio of a firm's balance sheet valuation to its market price, or earnings-to-price ratio (E/P), which is the ratio of either trailing or forecast earnings to market price.² Stocks with high B/P or E/P are considered value stocks. A question of interest to theorists and practitioners alike is which is the better factor, and we address that question in the empirical studies presented here.³ We find that neither of the two metrics uniformly dominated the other between 1951 and 2013, but rather that a blend of the two metrics outperformed both single-factor strategies.⁴

We begin our study by analyzing value strategies constructed from portfolio returns posted on Ken French's website.⁵ The portfolios are constructed with a rank-and-chop method: stocks are ranked according to a prescribed metric, such as B/P or E/P, everything below a fixed percentile is chopped off, and a portfolio is constructed by capitalization-weighting the remaining stocks. French's website features returns to portfolios of the top 30% of stocks, which we use in the initial part of our study.

The second part of our study is based on the constituents of the S&P 500 Index, which is an investable universe.⁶ We apply the rank-and-chop methodology to construct top 30% portfolios from S&P 500 stocks, and we compare these portfolios with tilted portfolios constructed with factor models and optimization.⁷ Tracking error measures an important difference between the two approaches, which factor-based optimization cuts roughly in half. Another important difference is turnover, which factor-based optimization cuts by a factor of three. Finally, we look at sector constraints, which improved performance during our study period.

Since the value premium's drivers play an important role in investment decisions, we begin with a brief review of that topic.

WHAT DRIVES THE VALUE PREMIUM?

The value premium's drivers have important implications for investment decisions. However, there is no consensus among academics or practitioners about what drives the value premium.⁸ Candidate explanations fall into three categories: hidden risk, market inefficiency, and statistical anomaly.

Proponents of the risk-based explanation argue that a stock's low price may be compensation for a subtle defect or unknown risk. An investor who blindly purchases this stock because it appears to be inexpensive may eventually regret it. An investor who can identify a value risk factor and quantify the value risk premium can decide whether the premium is worth the risk. Candidate value risk factors range from financial distress to cash flow timing.⁹ To date, however, researchers have failed to identify a concrete, universally accepted risk factor that drives the value premium.

Behaviorists and other advocates of market inefficiency argue that investors who purchase underpriced stocks profit as prices revert to true market values. But what might cause a stock's underpricing? The finance literature considers a range of potential explanations.¹⁰ For instance, the human proclivity for lotteries may lead an investor to neglect a solid stock in favor of a long shot. Investment policy or career risk can also play a role—an asset manager with a mandate to track a benchmark may avoid a promising stock in order to keep tracking error within an acceptable range.¹¹ An unconstrained investor can take advantage of the situation.

Still others argue that the value premium is a statistical anomaly, in which case there is no reason for it to persist in the future.

EARNINGS-TO-PRICE VERSUS BOOK-TO-PRICE: AN ACADEMIC PERSPECTIVE

More than 30 years ago, Sanjoy Basu documented a positive relationship between E/P and the return for stocks that traded on the New York Stock Exchange.¹² That study relied on data from 1963 to 1980, and it found that stocks with high E/P earned more return and had lower volatility than did stocks with low E/P.

Nine years later, in 1992, French and Eugene Fama popularized the book-to-price ratio in a study that relied

on data from July 1963 to December 1990.¹³ That study found that B/P, in combination with size (as measured by market capitalization), explained cross-sectional differences in returns to U.S. equities. As part of the study, Fama and French considered E/P, but decided that B/P was a more fundamental metric:

... the combination of size and book-to-market equity seems to absorb the roles of leverage and E/P in average stock returns, at least during our 1963-1990 sample period.¹⁴

Having identified a stock's size and its B/P as the key drivers of cross-sectional equity return in the U.S., Fama and French reinforced the point with a series of influential academic articles and also a website that featured size and B/P data histories. Today, the Fama-French three-factor model, which is based on market, size, and B/P, is a foundational component of the empirical academic literature on equity markets.

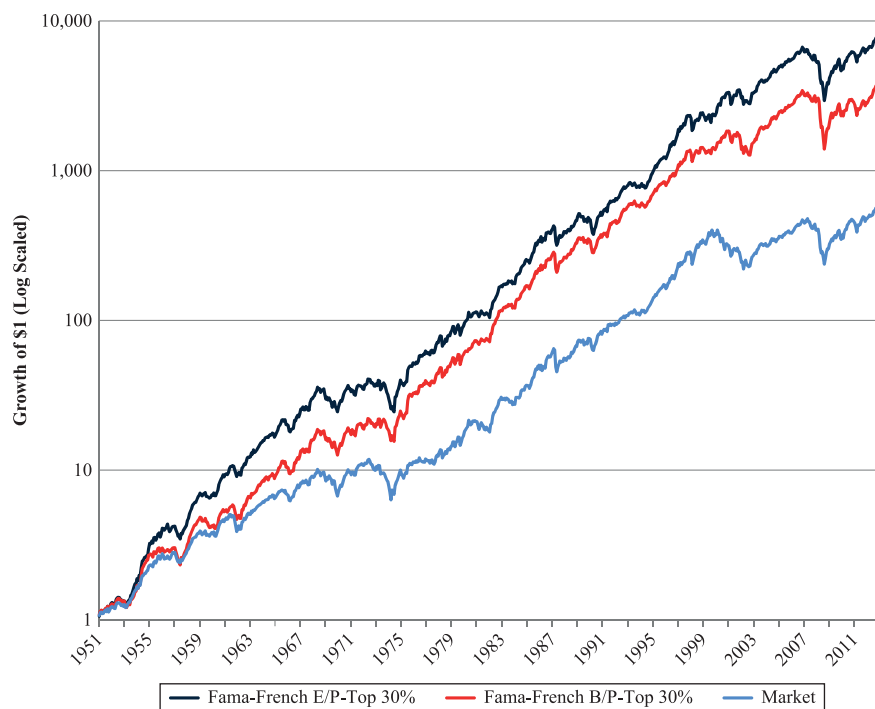
We can get a broader perspective on B/P and E/P by examining performance over a longer time. Exhibit 1 extends Fama and French's 1963 to 1990 study [1992] by considering strategies based on B/P (red curve) and E/P (blue curve) over the 62-year period from 1951 to 2013. Using data from French's website, we looked at portfolios consisting of the top 30% of stocks ranked either by B/P or E/P in a broad collection of stocks trading on NYSE, AMEX, and NASDAQ between January 1951 and December 2013.¹⁵ Over this 62-year period, E/P outperformed B/P by 1.41% per year on average, as reported in Exhibit 2.

However, the results are not uniform over the 62-year horizon. Exhibit 2 reports that B/P outperformed E/P by 1.18% per year from July 1963 to December 1990, which is featured in Fama and French [1992]. Exhibit 3 (panel A) illustrates this outperformance.

In the subsequent period, January 1991 to December 2013, E/P outperformed B/P by 2.17% per year, as reported in Exhibit 2 and illustrated in Exhibit 3 (panel B). Had Fama and French waited a few years to run what has become one of the most famous studies in financial economics, the academic literature might look different today.

EXHIBIT 1

Value of a Dollar Invested in Strategies Based on E/P and B/P from January 1951 to December 2013



Notes: Each month, stocks in the NYSE, AMEX, and NASDAQ are ranked by E/P and B/P. Portfolios are capitalization-weighted composites of the top 30% of stocks.

Source: Ken French's website. Past performance is not a guarantee of future returns. Returns are gross of transaction costs and fees. Performance is hypothetical, and is not based on an actual portfolio or account. Please refer to important disclosures at the end of this article.

EXHIBIT 2

Performance Statistics for Value-Weighted Portfolios Consisting of the Top 30% of Stocks Ranked by E/P and B/P

Time Period	1951–2013			1963–1990			1991–2013		
	E/P	B/P	Market	E/P	B/P	Market	E/P	B/P	Market
Geometric Return	15.80%	14.39%	11.01%	13.75%	14.93%	9.99%	14.56%	12.39%	10.46%
Arithmetic Return	15.99%	14.82%	11.61%	14.29%	15.35%	10.82%	14.91%	13.09%	11.14%
Standard Deviation	15.72%	16.09%	14.93%	16.45%	16.53%	15.83%	15.64%	16.29%	15.12%
Sharpe Ratio	0.73	0.64	0.48	0.46	0.52	0.26	0.77	0.62	0.54
Return/Risk	1.02	0.92	0.78	0.87	0.93	0.68	0.95	0.80	0.74

Source: Ken French's website. Past performance is not a guarantee of future returns. Returns are gross of transaction costs and fees. Performance is hypothetical, and is not based on an actual portfolio or account. Please refer to important disclosures at the end of this article.

IMPLEMENTATION OF VALUE STRATEGIES: A PRACTITIONER PERSPECTIVE

We ran the B/P and E/P strategies shown in Exhibit 1, Exhibit 3, panel A, and Exhibit 3, panel B, in an ideal setting. We ignored transaction costs, liquidity,

and other issues that can materially affect results. Now we take account of these practical issues.¹⁶ When we implement a value strategy, our first consideration is the investable universe. We construct value strategies from S&P 500 stocks and that guarantees liquidity.¹⁷ Our second consideration is strategy definition, and we

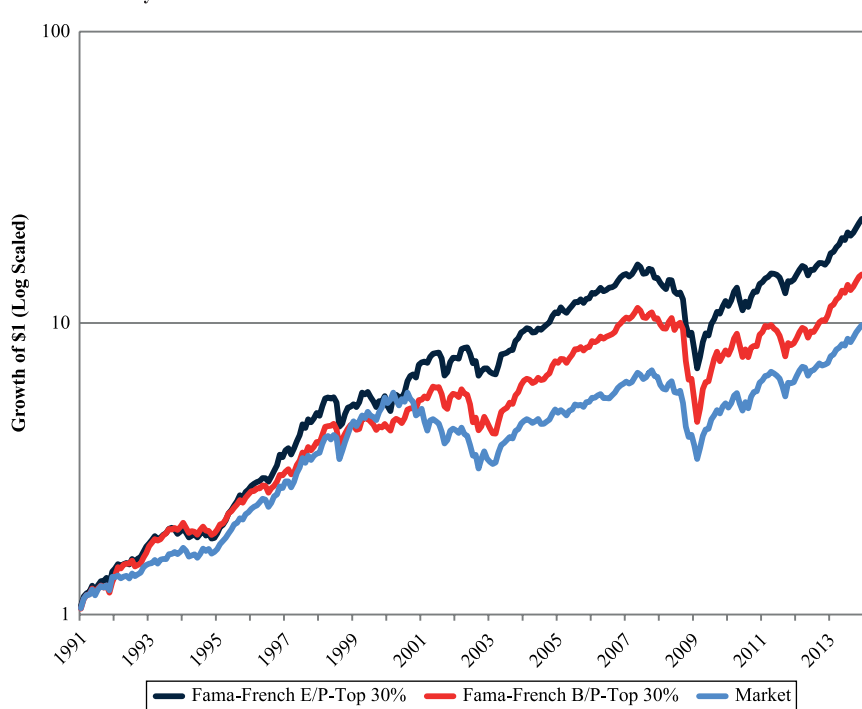
EXHIBIT 3

Period Dependence of the Value of a Dollar Invested in Strategies Based on E/P and B/P

Panel A: July 1963–December 1990



Panel B: January 1991–December 2013



Notes: Stocks in the NYSE, AMEX, and NASDAQ are ranked by E/P and B/P each month. Portfolios are capitalization-weighted composites of the top 30% of stocks.

Source: Ken French's website. Past performance is not a guarantee of future returns. Returns are gross of transaction costs and fees. Performance is hypothetical, and is not based on an actual portfolio or account. Please refer to important disclosures at the end of this article.

compare B/P and E/P portfolios constructed with the top 30% rule (used also in the academic study described in the previous section) with factor-based optimization, which allows us to minimize tracking error and turnover.¹⁸ In addition to analyzing the B/P and E/P separately, we construct strategies that use a blend of the two measures. We also analyze the effect of sector neutrality on value investing. Our third consideration is strategy drift, which we address with quarterly rebalancing, a standard approach for long-term investors.¹⁹

Top 30% Approach

Exhibit 4 shows the December 2013 value of a dollar invested in January 1973 in each of three top 30% value strategies and the S&P 500 (green curve). The B/P strategy (red curve) dominated the E/P strategy (blue curve) until early in 2002. Starting then,

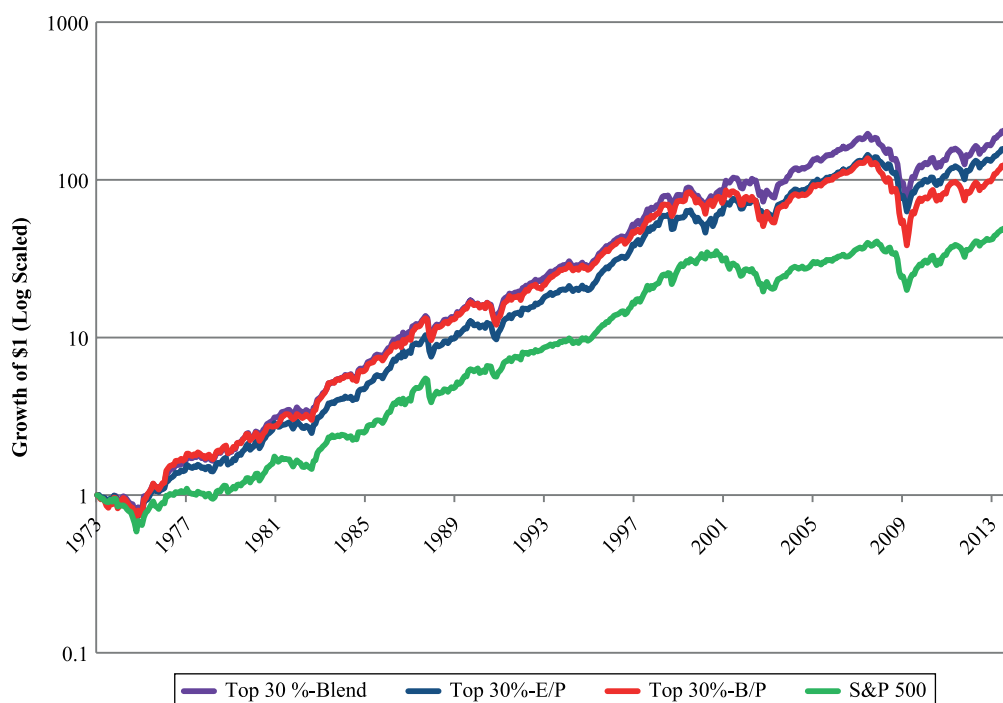
the two strategies had similar performance until the onset of the financial crisis in 2008. Between 2008 and 2013, E/P dominated the B/P. The top performer in our study was the blended strategy (purple curve), which chose the top 30% of stocks based on a blended signal of 50% B/P and 50% E/P.²⁰

Exhibit 5 shows the rolling 10-year active returns of the top 30% strategies relative to the S&P 500. The B/P (red curve) outperformed E/P (blue curve) in the early period, while E/P outperformed B/P in the later period. The blended strategy (purple curve) outperformed both B/P and E/P for most 10-year periods since January 1973.

Performance statistics for the top 30% strategies are in Exhibit 6, columns 2, 3, and 4. The blended strategy had the highest annualized return, 14.21% per year from January 1973 to December 2013, followed by the earnings-to-price ratio, with 13.48% per year, and then

EXHIBIT 4

Value of a Dollar Invested in the Top 30% Portfolios Based on E/P and B/P from January 1973 to December 2013

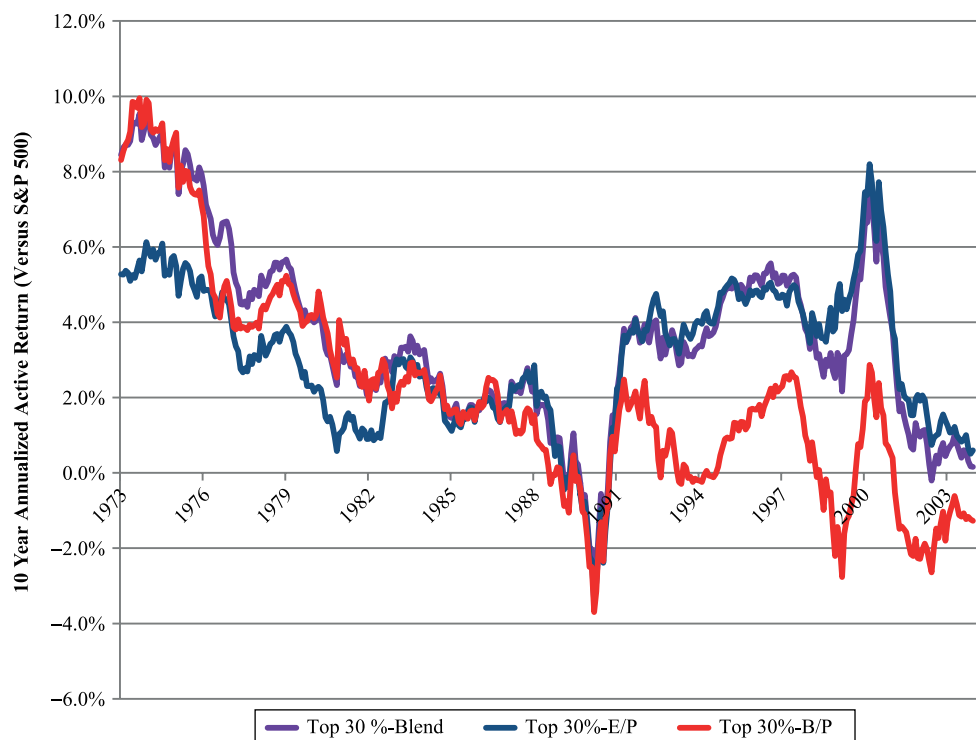


Notes: Each quarter, stocks in the S&P 500 are ranked by E/P, B/P, or an average of the two indicators. Portfolios are capitalization-weighted composites of the top 30% of stocks.

Source: Aperio Group. Past performance is not a guarantee of future returns. Returns are gross of fees and we assume a round-trip trading cost of 0.12%. Performance is hypothetical, and is not based on an actual portfolio or account. Please refer to important disclosures at the end of this article.

EXHIBIT 5

Rolling 10-Year Returns of Top 30% Portfolios Based on E/P and B/P from January 1973 to December 2013



Notes: Each quarter, stocks in the S&P 500 are ranked by E/P, B/P, or an average of the two indicators. Portfolios are capitalization-weighted composites of the top 30% of stocks.

Source: Aperio Group. Past performance is not a guarantee of future returns. Returns are gross of fees and we assume a round-trip trading cost of 0.12%. Performance is hypothetical, and is not based on an actual portfolio or account. Please refer to important disclosures at the end of this article.

EXHIBIT 6

Performance Statistics for Value Strategies and the S&P 500 Benchmark from January 1973 to December 2013

Strategy	Top 30%: B/P	Top 30%: E/P	Top 30%: Blend	S&P 500
Geometric Return (%)	12.79	13.48	14.21	10.30
Active Geo Return (%)	2.49	3.18	3.90	0.00
Arithmetic Return (%)	13.86	14.07	14.86	11.05
Standard Deviation	18.79	16.41	17.36	15.49
Beta	1.05	0.96	0.99	1.00
Tracking Error (%)	9.27	7.03	8.13	0.00
Max Down Year (%)	-50.55	-39.04	-42.33	-36.98
Max Down Month (%)	-22.78	-18.62	-18.28	-21.49
Upside Capture (%)	109.12	103.60	107.50	100.00
Downside Capture (%)	100.47	88.12	90.28	100.00
Sharpe Ratio	0.44	0.52	0.53	0.35
Information Ratio	0.30	0.43	0.47	0.00
Turnover (%)	114.5	110.0	119.4	
Transaction Cost (BPS)	14.07	13.46	14.5	

Source: Aperio Group. Past performance is not a guarantee of future returns. Returns are gross of fees and we assume a round-trip trading cost of 0.12%. Performance is hypothetical, and is not based on an actual portfolio or account. Please refer to important disclosures at the end of this article.

the book-to-price ratio, with 12.79% per year. Turning to risk, E/P had the lowest standard deviation, 16.41% versus 17.36% for the blended strategy and 18.79% for B/P. The earnings-to-price ratio also had the lowest tracking error against the S&P 500 benchmark, 7.04% versus 8.13% for the blended strategy and 9.27% for B/P.

We pause to consider tracking error, which measures the average dispersion of the return difference between a strategy and its benchmark. Between January 1973 and December 2013, top 30% strategies' tracking errors ranged from 7.0% to 9.3%. A strategy with a tracking error in this range can deviate substantially from its benchmark. Although this might seem like a wonderful thing when the deviation is positive, a large negative deviation can be fatal to an asset manager's career. This leads us to look at alternative value strategy constructions in which tracking error can be controlled.

FACTOR-BASED OPTIMIZATION APPROACH: RISK-CONTROLLED VALUE STRATEGIES

The top 30% implementation considered in the previous section has the virtue of simplicity, but it fails to control risk. To lower tracking error and turnover in value strategies, we turn to factor-based optimization. In this approach, we tilt a portfolio toward value stocks

while minimizing tracking error to a benchmark. The magnitude of the tilt can be tailored to an investor's risk appetite; a heavier value tilt leads to a higher tracking error. In this study, we use a moderate value tilt that corresponds to a tracking error of 2%–4%.

Exhibit 8 shows the December 2013 value of a dollar invested in January 1973 in each of three optimized value strategies and in the S&P 500 (green curve). In this implementation, the E/P strategy (blue curve) dominated the B/P strategy (red curve) throughout most of the period. The blended strategy (purple curve) dominated both single-signal strategies throughout the entire period.

Exhibit 9 shows rolling 10-year active returns of optimized value strategies relative to the S&P 500. Comparing the optimized value strategies to their top 30% analogs shown in Exhibit 4, we see that optimization had a smoothing effect and mitigated the deep underperformance of value strategies in the 1990s.

Performance statistics on the optimized value strategies shown in Exhibit 5 are in Exhibit 7, columns 5 to 7. Over the study period, both return and risk were slightly lower for the optimized value strategies than for the top 30% strategies. This led to similar risk-adjusted returns.

Exhibit 7 extends Exhibit 6 by inserting columns for optimized value strategies, and this table highlights

EXHIBIT 7

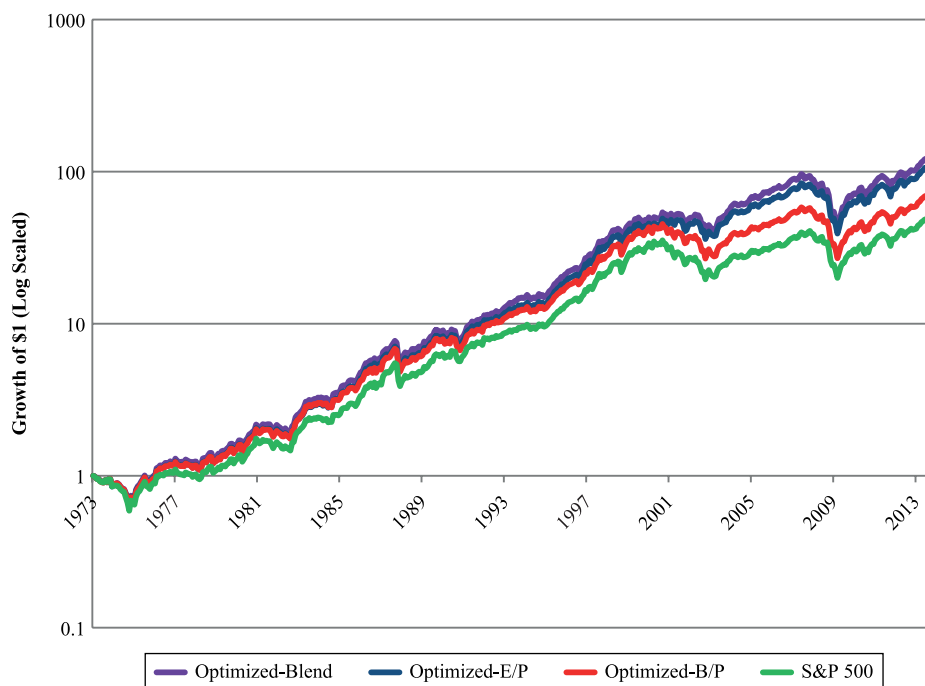
Performance Statistics for Value Strategies and the S&P 500 Benchmark, Including Optimized Factor-Tilted Strategies, from January 1973 to December 2013

Strategy	Top 30%: B/P	Top 30%: E/P	Top 30 %: Blend	Optimized: B/P	Optimized: E/P	Optimized: Blend	Optimized: Sector- Constrained Blend	S&P 500
Geometric Return (%)	12.79	13.48	14.21	11.25	12.46	12.81	13.63	10.30
Active Geo Return (%)	2.49	3.18	3.90	0.95	2.15	2.51	3.33	0.00
Arithmetic Return (%)	13.86	14.07	14.86	11.93	13.00	13.35	14.11	11.05
Standard Deviation	18.79	16.41	17.36	15.57	15.48	15.66	15.86	15.49
Beta	1.05	0.96	0.99	1.00	0.98	0.99	1.00	1.00
Tracking Error (%)	9.27	7.03	8.13	1.83	2.99	3.48	3.79	0.00
Max Down Year (%)	-50.55	-39.04	-42.33	-38.64	-37.00	-38.49	-40.56	-36.98
Max Down Month (%)	-22.78	-18.62	-18.28	-21.55	-20.47	-20.50	-21.36	-21.49
Upside Capture (%)	109.12	103.60	107.50	101.94	103.25	104.23	106.33	100.00
Downside Capture (%)	100.47	88.12	90.28	97.77	93.17	92.74	91.54	100.00
Sharpe Ratio	0.44	0.52	0.53	0.41	0.48	0.49	0.54	0.35
Information Ratio	0.30	0.43	0.47	0.48	0.65	0.66	0.81	0.00
Turnover (%)	114.5	110.0	119.4	30.0	30.0	30.0	31.4	
Transaction Cost (BPS)	14.1	13.5	14.5	2.8	2.8	2.8	2.9	

Source: Aperio Group. Past performance is not a guarantee of future returns. Returns are gross of fees and we assume a round-trip trading cost of 0.12%. Performance is hypothetical, and is not based on an actual portfolio or account. Please refer to important disclosures at the end of this article.

EXHIBIT 8

Value of a Dollar Invested in Optimized Value Portfolios Based on E/P and B/P From January 1973 to December 2013



Source: Aperio Group. Past performance is not a guarantee of future returns. Returns are gross of fees and we assume a round-trip trading cost of 0.12%. Performance is hypothetical, and is not based on an actual portfolio or account. Please refer to important disclosures at the end of this article.

the strategy features that most definitively distinguish optimized value strategies from top 30% strategies: tracking error and transaction costs.²¹

For the optimized value strategies, tracking error was 1.8% for the B/P strategy, 3.0% for the E/P strategy, and 3.5% for the blended strategy between January 1973 and December 2013. In contrast, for the top 30% strategies, tracking error was 9.3% for the B/P strategy, 7.0% for the E/P strategy, and 8.1% for the blended strategy over the same period. The information ratio, which is active return per unit of tracking error, reflects these differences. Information ratios for the optimized value strategies were roughly one-and-a-half times the size of the information ratios for the top 30% strategies, and the blended strategies dominated the B/P and E/P strategies under both implementations.

Similarly, the transaction costs of optimized value strategies were less than 3 basis points, with approximately 30% turnover. The transaction costs of top 30% strategies were more than four times higher, with turnover rates of more than 100% per year.

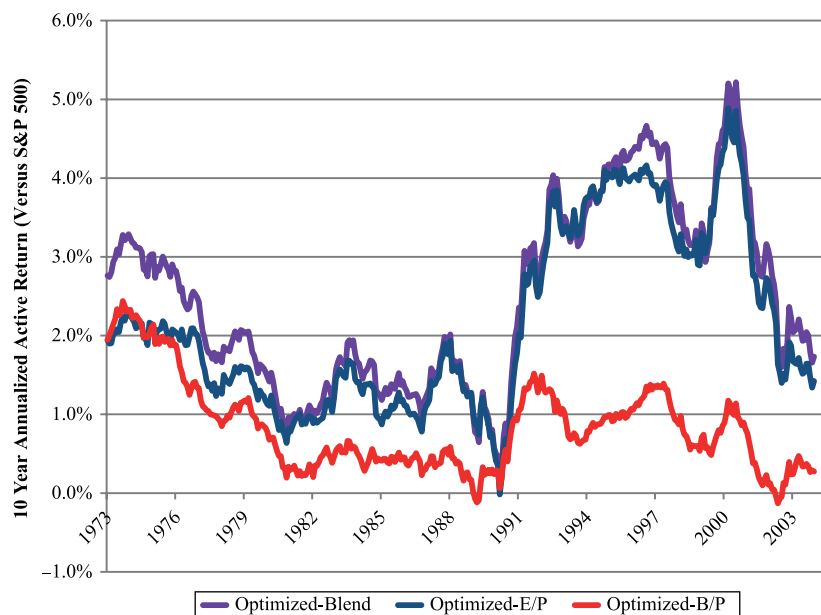
FINDING VALUE WITHIN SECTORS

Value-tilted portfolios may contain sector biases, because some sectors consistently trade at lower valuations than do others. Exhibit 10 shows the average sector exposures from January 1973 to December 2013 for the top 30% and optimized value strategies based on a blend of E/P and B/P. In both implementations, financials and utilities were overweighted and technology, healthcare, and consumer discretionary were underweighted. The effects are muted in the optimized value strategies relative to the top 30% strategies.

By constraining the exposures to more closely match the S&P 500 benchmark, we retained the value tilt while neutralizing unwanted sector bets in the portfolio. We constrained the strategy to stay within $\pm 1\%$ of the benchmark's sector exposure. Exhibit 11 shows the December 2013 value of a dollar invested in January 1973 in optimized E/P-B/P blended strategies with sector constraints (blue curve) and without (purple curve), and in the S&P 500 (green curve). Exhibit 12 shows rolling

EXHIBIT 9

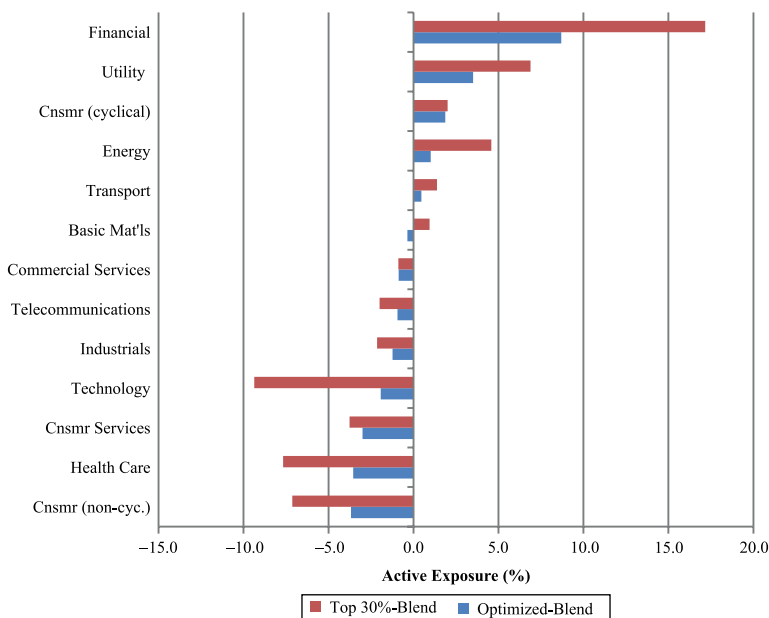
Rolling 10-year Returns of Optimized Value Portfolios Based on E/P and B/P from January 1973 to December 2013, versus the S&P 500



Source: Aperio Group. Past performance is not a guarantee of future returns. Returns are gross of fees and we assume a round-trip trading cost of 0.12%. Performance is hypothetical, and is not based on an actual portfolio or account. Please refer to important disclosures at the end of this article.

EXHIBIT 10

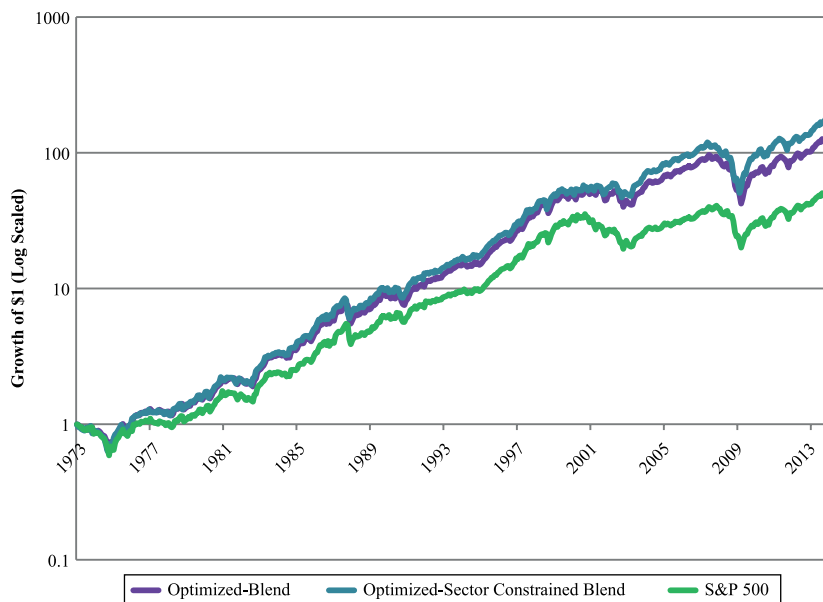
Average Sector Exposures in Value Portfolios Based on Blended Signals Relative to the S&P 500 from January 1973 to December 2013



Source: Aperio Group.

EXHIBIT 11

Value of a Dollar Invested in Optimized Value Portfolios Based on a Blend of E/P and B/P with and without Sector Constraints from January 1973 to December 2013



Source: Aperio Group. Past performance is not a guarantee of future returns. Returns are gross of fees and we assume a round-trip trading cost of 0.12%. Performance is hypothetical, and is not based on an actual portfolio or account. Please refer to important disclosures at the end of this article.

EXHIBIT 12

Rolling 10-Year Returns of Optimized Value Portfolios Based on a Blend of E/P and B/P with and without Sector Constraints from January 1973 to December 2013



Source: Aperio Group. Past performance is not a guarantee of future returns. Returns are gross of fees and we assume a round-trip trading cost of 0.12%. Performance is hypothetical, and is not based on an actual portfolio or account. Please refer to important disclosures at the end of this article.

10-year active returns of optimized E/P-B/P blended strategies with sector constraints (blue curve) relative to the S&P 500. The sector-neutral strategy outperformed the unconstrained strategy for most 10-year periods.

CONCLUSION

Value investing relies on the art and science of identifying underpriced securities, and the practice dates back at least to Graham and Dodd [1934]. Quantitative investors have used a variety of different metrics to identify value stocks, with book-to-price ratios and earnings-to-price ratios among the most popular. In this article, we considered the important question of which metric leads to better performance. We found that from January 1951 to December 2013, E/P outperformed B/P, but neither metric uniformly dominated the other. However, strategies based on a blend of the two factors outperformed both single-factor strategies, and sector constraints made a positive difference.

Turning to practical considerations, we compared two standard implementations of value strategies: top 30% strategies based on a rank-and-chop methodology, and optimized tilts constrained to minimize tracking error and turnover. We found that from January 1973 to December 2013, these strategies' risk/return profiles were similar. However, the optimized value portfolios' tracking errors were roughly half the size of top 30% portfolios' tracking errors, which ranged from 7.0% to 9.3%. Tracking errors of this magnitude should concern asset managers, whose careers may be damaged by severe deviations from a benchmark.

Decades of observation, study, and debate have failed to unmask the value premium's mysterious drivers. Nevertheless, the strategy remains popular with investors. The empirical studies in this article elucidate the period dependence of book-to-price and earnings-to-price ratios, as well as the benefits of diversification and risk control. An investor who believes that value delivers a premium may want to blend factors. An investor who wants to hug a benchmark, control turnover, or constrain sector exposures may consider the use of quantitative optimization based on a factor model. More generally, studies (such as ours) that compare performance of different implementations over different horizons can help value investors choose the strategies that best suit their financial goals.

ENDNOTES

¹Some argue that "you can't beat the market," and a well-known specification of that sentiment is the capital asset pricing model (CAPM) developed by Treynor [1962] and Sharpe [1964]. In the CAPM, the market portfolio has the highest risk-adjusted excess return (Sharpe ratio). A related idea is the efficient market hypothesis (EMH), which is a collection of technical assertions that at any given time, market prices reflect all available information. If the EMH is true, there are no bargains to be had. The EMH has been debated for decades. Still there are no signs either of a decline in interest or the emergence of a consensus view. We need to look only as far as Sweden to see the magnitude of the disagreement. Among the three 2014 Nobel laureates in economics are Eugene Fama, who is credited with the efficient markets hypothesis, and Robert Shiller, who argues that the cyclically adjusted price earnings ratio (CAPE) forecasts long-term returns. More information is in Liebowitz and Bova [2014].

²The cash-flow-to-price ratio is a familiar value metric, but it is less popular than B/P and E/P. The three value metrics are also commonly known as book to market, earnings yield, and dividend yield.

³Many empirical studies, including the studies described in this article, rely on back tests. Although back tests of investment strategies can be informative, there are good reasons to be skeptical about them. It is difficult to reliably account for transaction costs in a back test, and it is impossible to account for market impact. Arnott et al. [2013] provided an entertaining parody in which random strategies outperform the market. Ioannidis [2005] argued that "for most study designs and settings, it is more likely for a research claim to be false than true."

⁴Atif, Katz, and Richardson [2013] provided examples where blended value metrics have been beneficial in the past. Goldberg, Leshem, and Branch [2015] showed that E/P played a significant role in the replication of a gross-profitability strategy, while B/P did not.

⁵French's website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

⁶In this article, references to the S&P 500 mean the S&P 500 Total Return Index, an investable universe.

⁷Aperio's tilted portfolios are constructed with the Barra USE3 model and mean-variance optimizer (note that other Aperio strategies may use other Barra models).

⁸There is disagreement about whether value strategies' apparent outperformance arises from behavioral effects (in which case bargain stocks are real bargains) or whether value is compensation for risk. In addition, some argue that value is a statistical anomaly. Fama and French [2004] summarized the situation: "The conflict between the behavioral irrational pricing story and the rational risk story for the empirical failures of the CAPM leaves us at a timeworn impasse."

⁹The literature contains numerous attempts to identify risk factors that explain the value premium. For example, Vassalou and Xing [2004] argued that the book-to-price ratio premium is, in part, compensation for default risk. Lettau and Wachter [2007] provided a duration-based explanation for the value premium. Berk [1995] argued that the value and size premiums are inevitable in any market that prices risk.

¹⁰Kahneman and Twersky [1979] and Kahneman [2011] documented standard behavioral anomalies. Lakonishok, Shleifer, and Vishny [1994] argued that the value premium is due to behavioral effects.

¹¹Tracking error measures the variation, or standard deviation, in the return difference between a portfolio and an index. If a portfolio's tracking error is sufficiently low, portfolio returns tend to mirror index returns.

¹²More information is in Basu [1983].

¹³More information is in Fama and French [1992].

¹⁴The quotation is taken from Fama and French [1992], page 428. Support for the preference of B/P over E/P is in Fama and French, Table 4, which shows returns to decile portfolios sorted on the two value metrics over the July 1963 to December 1990 period.

¹⁵As explained on French's website, breakpoints are based on NYSE stocks.

¹⁶The practical strategies we consider are back-tested, so the results are less reliable than are reports of live strategies. These strategies lie somewhere on the continuum between ideal strategies that ignore market realities and live strategies.

¹⁷The benchmark in the academic study was much broader than the S&P 500 Index, which excludes small stocks that may be illiquid.

¹⁸We construct optimized portfolios with the Barra USE3 multi-factor model.

¹⁹In the academic study considered in the previous section, returns are reported on a monthly basis but the portfolio is rebalanced annually.

²⁰To rank stocks for the blended strategy, we averaged the Barra USE3 exposures to E/P and B/P.

²¹In all of Aperio's strategies, we assume a round-trip trading cost of 0.12%. This includes a 0.08% bid-ask spread and a 0.04% commission. Although trading costs were higher historically than they are today, our estimate reflects current conditions. Had we adjusted returns for historically accurate trading costs, the distinctions between optimized and top 30% strategies would be more pronounced.

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Back-testing involves simulating a quantitative investment model by applying all rules, thresholds, and strategies to a hypothetical portfolio during a specific market period and measuring the hypothetical portfolio's changes in value based on the portfolio securities' actual market prices. Investors should be aware of the following: 1) Back-tested performance does not represent actual trading in an account and should not be interpreted as such, 2) back-tested performance does not reflect the effect that material economic and market factors might have had on the manager's decision-making process if the manager were actually managing client's assets, and 3) there is no indication that a manager would have achieved back-tested performance had the program been activated during the periods presented above. For back-tested performance comparisons, we simulate the benchmark returns using historical constituents' weights and total returns.

The S&P 500 Total Return Index is an unmanaged group of equities representing the large-cap sector of the U.S. domestic market. Index returns reflect dividend reinvestment but not fees, brokerage commissions, or other investment expenses.

Beta: A measure of a portfolio's sensitivity to changes in a benchmark.

Downside capture ratio: A measurement of portfolio performance in a down market (defined as monthly, quarterly, or annual performance of less than zero) compared to a selected index or benchmark (average portfolio return divided by average benchmark return).

Information ratio (IR): A measure of a portfolio manager's ability to consistently generate excess returns relative to a benchmark (average portfolio return relative to a benchmark divided by the volatility of relative return).

Risk/return ratio: A ratio used to compare an investment's expected returns to the amount of risk undertaken to capture these returns (average portfolio return divided by portfolio risk, which is usually represented by volatility).

Sharpe ratio: The average portfolio return in excess of the risk-free rate divided by the volatility of portfolio excess return. The Sharpe Ratio is a type of information ratio in which the benchmark is the risk-free rate.

Standard deviation: A statistical measure used to quantify the dispersion level in a variable data set, such as portfolio return.

Tracking error: A measure of how closely a portfolio tracks its benchmark. In technical language, tracking error is the standard deviation of the return difference between a portfolio and its benchmark.

Upside capture ratio: A measurement of portfolio performance during up markets (defined as monthly, quarterly, or annual performance of greater than zero) compared to a selected index or benchmark (average portfolio return divided by average benchmark return).