The Quality Dimension of Value Investing

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Buying high quality assets without paying premium prices is just as much value investing as buying average quality assets at discount prices. Strategies that exploit the quality dimension of value are profitable on their own, and accounting for both dimensions of value by trading on combined quality and price signals yields dramatic performance improvements over traditional value strategies. Accounting for quality also yields significant performance improvements for investors trading momentum as well as value.

Benjamin Graham will always be remembered as the father of value investing. Today he is primarily associated with selecting stocks on the basis of valuation metrics like price-to-earnings or market-to-book ratios. But Graham never advocated just buying cheap stocks. He believed in buying undervalued firms, which means buying high quality firms cheaply.

Graham was just as concerned with the quality of a firm's assets as he was with the price that one had to pay to purchase them. According to Graham, an equity investor should "…apply a set of standards to each [stock] purchase, to make sure that he obtains (1) a minimum of *quality* in the past performance and current financial position of the company, and also (2) a minimum of *quantity* in terms of earnings and assets per dollar of price" (Graham 1973, pp. 183). Of the seven "quality and quantity criteria" that Graham suggested a firm should meet for inclusion in an investor's portfolio, five were directly concerned with firm quality, while only two were related to valuation.

While Graham devoted as much attention to the quality dimension of value as its price dimension, he is nevertheless primarily associated with buying firms cheaply because it is his valuation metrics that have delivered

exceptional returns. Value investing is on average quite profitable, but the quality metrics Graham employed have not reliably forecast relative stock performance.

The last decade has seen resurgent interest, however, in quality investing. Quality is often viewed as an attractive alternative to traditional growth, which performed terribly during and after the dot-com bust. Its leading industry proponents include GMO's Jeremy Grantham, whose high quality indicators of "high return, stable return, and low debt" have shaped the design of MSCI's Quality Indices, and Joel Greenblatt, whose "Little Book that Beats the Market" has encouraged a generation of value investors to pay attention to capital productivity, measured by return on invested capital, in addition to valuations.

There has also been increased interest in incorporating academic measures of quality into value strategies. BlackRock, the earliest adopter (when still BGI) of Sloan's (1996) accruals-based measure of earnings quality, is currently promoting the benefits of integrating earnings quality into global equities strategies (Kozlov and Petajisto, 2013). Piotroski and So (2012) argue that strategies formed jointly on valuations and another accounting based measure of financial strength, the Piotroski's (2000) F-score (which uses both Sloan's accruals and aspects of Grantham's quality among its nine components), have dramatically outperformed traditional value strategies. Societe General has appropriated Piotroski's F-score (without attribution) as the primary screen it employs when constructing its Global Quality Income Index, launched in 2012 (Lapthorne et. al., 2012).

Novy-Marx (2013) finds that a simpler quality measure, gross profitability (revenues minus cost of goods sold, scaled by assets), has as much power predicting stock returns as traditional value metrics. Strategies based on gross profitability are highly negatively correlated with strategies based on price signals, making them particularly attractive to traditional value investors. Novy-Marx's results have influenced the design of both DFA's growth funds and

AQR Capital Management's core equity funds. DFA believes that "…the research breakthrough in this case is not the discovery of expected profitability as a dimension of expected returns per se… [but] the discovery of reasonable proxies for expected profitability, which allow us to use profitability as another dimension of expected returns in the creation of investment solutions" (Chi and Fogdall, 2012). Cliff Asness of AQR, which is using profitability in conjunction with value and momentum signals, says that:

> Profitability is sometimes, not inaccurately but confusingly, referred to as a 'growth' strategy. This is confusing as for a long time 'growth' has come to mean simply the opposite of value, and obviously that is a bad idea! Rather, a simple value strategy does not distinguish between an expensive stock that is high quality (profitable), and one that is low quality (unprofitable). Nothing in theory, Graham and Dodd, or the basic discounting equation says this is a good idea. It turns out to work because the value effect is so strong that it can afford to ignore quality, but that doesn't mean that ignoring quality is optimal. Including measures of profitability along with measures of value in the same portfolio effectively makes 'value' into a better value strategy, as it's one that distinguishes between stocks at low or high multiples for a reason (profitability) from those at similar multiples without such a reason. Whether one thinks of the two together as simply a better value strategy, or as two separate effective strategies, the end result is the same. A portfolio of value stocks constructed with some additional consideration of profitability is a better portfolio. (Private correspondence, 2013)

All these strategies, whether suggested by industry or academia, select stocks partly on the basis of prices, and thus tilt strongly toward value. The quality metrics they employ favor profitable companies with strong prospects, however, so tend to favor growth companies. Combining quality and value signals thus helps find stocks that are both expected to grow and reasonably priced. All these strategies thus fit comfortably under the general rubric of "growth at a reasonable price" (GARP) strategies.

While quality and value metrics generally favor very different firms, quality investing is not distinct, philosophically, from value investing. It can

even be viewed as an alternative implementation of value—buying high quality assets without paying premium prices is just as much value investing as buying average quality assets at a discount. Warren Buffet, Graham's most famous student and the most successful value investor of all time, is fond of saying that it is "far better to buy a wonderful business at a fair price than to buy a fair business at a wonderful price." In fact, Frazzini, Kabiller, and Pedersen (2012) show that the performance of the publicly traded companies held by Berkshire Hathaway, Buffet's primary investment vehicle, can largely be explained by his commitment to buying high quality stocks.

With so many claims regarding the synergies between quality and value investing it is natural to ask which quality measure, in conjunction with valuations, is best at helping investors design successful equity portfolios. This paper attempts to answer this question, by assessing the performance of the best known joint quality and value strategies.

It finds that for small cap strategies incorporating any of the most popular quality metrics into value strategies delivers some performance improvement over traditional value, but that the clear winners are the strategies that incorporate quality measured using Piotroski's F-score or Novy-Marx's gross profitability. These two strategies yield much larger abnormal returns relative to traditional value than any of the other joint value and quality strategies. They also both subsume all the other joint value and quality strategies, in the sense that none of the other strategies delivers abnormal returns relative to the Piotroski and So strategy or the joint value and profitability strategy.

Quality driven performance improvements are more elusive, however, in the large cap universe. Among large cap (Russell 1000) stocks, which account for almost 90% of total market cap, only Greenblatt's magic formula and the strategies that measure quality using the F-score or gross profitability outperform traditional value. These improvements are by far the greatest using gross profitability, which has highly significant abnormal returns relative to all

the other joint value and quality strategies. None of the other strategies, with the exception of the Piotroski and So strategy, generates significant abnormal returns relative to the joint value and profitability strategy, and the value and profitability strategy's abnormal returns relative to the Piotroski and So strategy are much larger than the Piotroski and So strategy's abnormal returns relative to the value and profitability strategy. This suggests that large cap investors trading on value and profitability have little to gain by incorporating other measures of quality.

Investors trading on value and profitability can, however, realize significant improvements by also incorporating momentum signals into their trading strategy. Gross profitability is complimentary to past performance metrics, and thus provides an additional valuable signal to managers running momentum together with value. Incorporating gross profitability into a value and momentum strategy increases the strategy's gross returns, while reducing turnover and transaction costs, and dramatically improving the strategy's drawdown characteristics.

The rest of the paper explores these issues in greater detail, and is organized as follows. Section 2 compares the performance of traditional value strategies, formed solely on the basis of Graham's quantity criteria (price signals alone), to strategies formed on the basis of both Graham's quality and quantity criteria. Section 3 considers the performance of joint quality and value strategies formed using the concepts of quality best known on the street—Grantham's notion of "high return, stable return, low debt," and Greenblatt's return on invested capital. Section 4 analyzes the performance of joint quality and value strategies formed using established concepts of quality from academia—Sloan's accruals-based measure of earnings quality and Piotroski's F-score measure of financial strength. Section 5 considers strategies that incorporate Novy-Marx's more recent academic notion of quality, gross profitability. Section 6 formally compares the performance of the various joint value and quality strategies, and shows that the strategies that incorporate Piotroski's F-score or gross profitability outperform all the other strategies in

the small cap universe, while the strategy that incorporates gross profitability outperforms all others in the large cap universe. Section 7 shows significant advantages to incorporating profitability signals into joint value and momentum strategies. Section 8 concludes.

Traditional Value and the Benjamin Graham Strategies

Graham suggested seven "quality and quantity criteria" that a firm should meet for inclusion in an investor's portfolio. These criteria are:

1. "Adequate" enterprise size, as insulation against the "vicissitudes" of the economy;
2. Strong financial condition, measured by current ratios that exceed two and net current assets that exceed long term debt;
3. Earnings stability, measured by 10 consecutive years of positive earnings;
4. A dividend record of uninterrupted payments for at least 20 years;
5. Earnings-per-share growth of at least one-third over the last ten years;
6. Moderate price-to-earnings ratios, which typically should not exceed 15; and
7. Moderate price-to-book ratios, which typically should not exceed 1½.

The first five screens attempt to ensure that one buys only high quality firms, while the last two ensure that one buys them only at reasonable prices.

In order to turn these into a trading strategy, I create price and quality signals for each stock based on Graham's seven criteria. A stock's price signal, based on Graham's last two criteria, is the average of a firms' book-to-price and earnings-to-price ranks among all stocks (Appendix A provides detailed

descriptions of all variable employed in the paper).[1] A stock's quality signal, based on the first five criteria, depends on its "G-score" (Graham score) composite of Graham's quality criteria. A firm's G-score gets one point if a firm's current ratio exceeds two, one point if net current assets exceed long term debt, one point if it has a ten year history of positive earnings, one point if it has a ten year history of returning cash to shareholders, and one point if its earnings-per-share are at least a third higher than they were 10 years ago.[2] This results in a score from zero to five, with higher scores signaling higher quality firms. The quality signal employed for stock selection is the rank of a firm's G-score among all stocks.

Table 1 shows the performance of traditional value strategies, based on Graham's price criteria alone (Panel A), and "Graham strategies," based on both Graham's price and quality criteria (Panel B). These are formed by sorting stocks at the end of each June into "high" and "low" portfolios, on the basis of either the price signal described above (average book-to-price and earnings-to-price ranks), or the average of the price and quality signals. I consider both large and small cap strategies, defined roughly by the Russell 1000 and the Russell 2000, respectively.[3] The high (low) portfolio buys the top (bottom) 30% of the appropriate universe by signal, and at that time sells stocks that it had owned if their signals no longer exceed the 70th percentile of the applicable

[1] Graham believed that an investor could occasionally, in good conscience, violate the prohibitions against buying stocks of firms with price-to-book ratios above 1.5 or price-to-earnings ratios above 15, provided the other price signal was sufficiently favorable. He suggested, however, that the product of the two ratios should never exceed 22.5. I've chosen the sum-rank procedure, as opposed to looking at the product of the two valuation metrics, to avoid complications arising from negative book firms, something that did not exist when Graham started writing, and remained quite rare into the mid-70s.

[2] This methodology is similar to that employed by Piotroski (2000) to calculate his financial strength F-score, which in investigated in greater detail in later sections. In calculating the G-score I have reduced the required earnings history from 20 to 10 years to get more variation in this component of measure. I have also relaxed the dividend condition to include net repurchases, because share repurchases have gained popularity as a means for returning cash to shareholders. Graham also preferred large firms, but I have ignored this criterion as the universes in which the strategies are constructed will be determined by market cap considerations.

[3] Formally, stocks are considered large if they are among the largest 1,000 by capitalization (86.2% of total market capitalization at the end of the sample), while small stocks consist of the next 2,000 largest stocks (11.7% of total market capitalization at the end of the sample). The universes the strategies actually trade in exclude financial firms (those with one-digit Standard Industrial Classifications of six), because the quality measures often employ accounting variables that are hard to compare across financials and non-financials. At the end of the sample stocks in the large cap, non-financial universe had average market caps of $16.7 billion, while the smallest of these had a market cap of $2.8 billion, and stocks in the small cap, non-financial universe had average market caps of $1.1 billion, while the smallest of these had a market cap of $363 million.

universe. In order to ensure that the accounting data used in the signals are available at the time of portfolio formation, rebalancing occurs at the end of June employing accounting data for the fiscal year ending in the previous calendar year. The sample covers July 1963 to December 2012, with the start date determined by the availability of high quality accounting data (this same sample will be used throughout the paper). Portfolio returns are value weighted. I consider both long-only strategies, which hold the high portfolio, and long/short strategies, which buy the high portfolio and sell the low portfolio.

Panel A shows the performance of the traditional value strategies, selected purely on the basis of price signals.[4] The first two columns show the performance of the high portfolios (i.e., value stocks) in the large and small cap universes. These portfolios realized average annual gross returns of 7.9% and 11.0% per year, respectively, from mid-1963 to the end of 2012. Only about one third of the names they hold change each year, so the strategy realizes low transaction costs, and net returns are only 0.2-0.4% per year lower than the gross returns.[5] These correspond to net active returns (i.e., portfolio returns minus benchmark returns) of 2.3% and 2.7% per year in the large and small cap universes, despite the fact that these stocks have betas to their benchmarks significantly below one. Both portfolios have tracking error volatilities of roughly 6%, yielding information ratios (i.e., tracking error Sharpe ratios) of 0.35 and 0.44, respectively.

[4] While these strategies are formed on the basis of price signals alone, they are nevertheless not pure value strategies from the perspective of an investor that also trades quality. Strategies that trade purely on value metrics tend to hold low quality stocks, so are short quality. This is similar to the way that value strategies tilt toward small caps, because lower equity valuations increase valuation ratios, or the way that value strategies based on valuation ratios formed using current prices are typically short momentum, because recent losers tend to look cheap. If high quality stocks actually outperform low quality stocks, then this fact should impair the performance of simple value strategies.

[5] Transaction costs are calculated using effective spreads on individual stocks derived from Hasbrouck's (2009) Bayesian Gibbs sampling procedure for estimating the Roll (1984) model. Hasbrouck (2009) shows these estimates are 96.5% correlated with estimates derived from the Trade and Quote (TAQ) data. These estimates basically correspond to the costs faced by traders making average size market orders. They thus underestimate the total implementation slippage incurred on very large trades, but are nevertheless generally conservative because they reflect the cost of trading when demanding liquidity. They imply, for example, somewhat higher average trading costs than those found by Frazzini, Isreal, and Moskowitz (2012) in their study of the trading costs realized by a large institutional money manager. For more details on the transaction cost estimates employed here, see Novy-Marx and Velikov (2013).

The last two columns show the performance of long/short strategies, formed by buying the high (value) portfolio and shorting the low (growth) portfolio. Because simple long/short value strategies have significant negative betas to their benchmarks, which impairs their absolute performance, these strategies are hedged of this exposure using 36-month trailing beta estimates. The beta-hedged long/short value strategies generate significant excess returns in both the large and small cap universes, but are more profitable among small caps, where both spreads and Sharpe ratios are about 50% higher.

Panel B shows results of identical tests for "Graham strategies," which select stocks using a signal that puts half its weight on valuations and half on the G-score aggregate of Graham's five quality criteria.[6] Incorporating the Graham quality metric reduces the signal's power to select stocks with high average returns, especially in the large cap universe, so hurts long-only investors. The G-score appears to help pick small cap stocks expected to significantly underperform the small cap benchmark, so improves the performance of the long/short strategy constructed in the small cap universe.

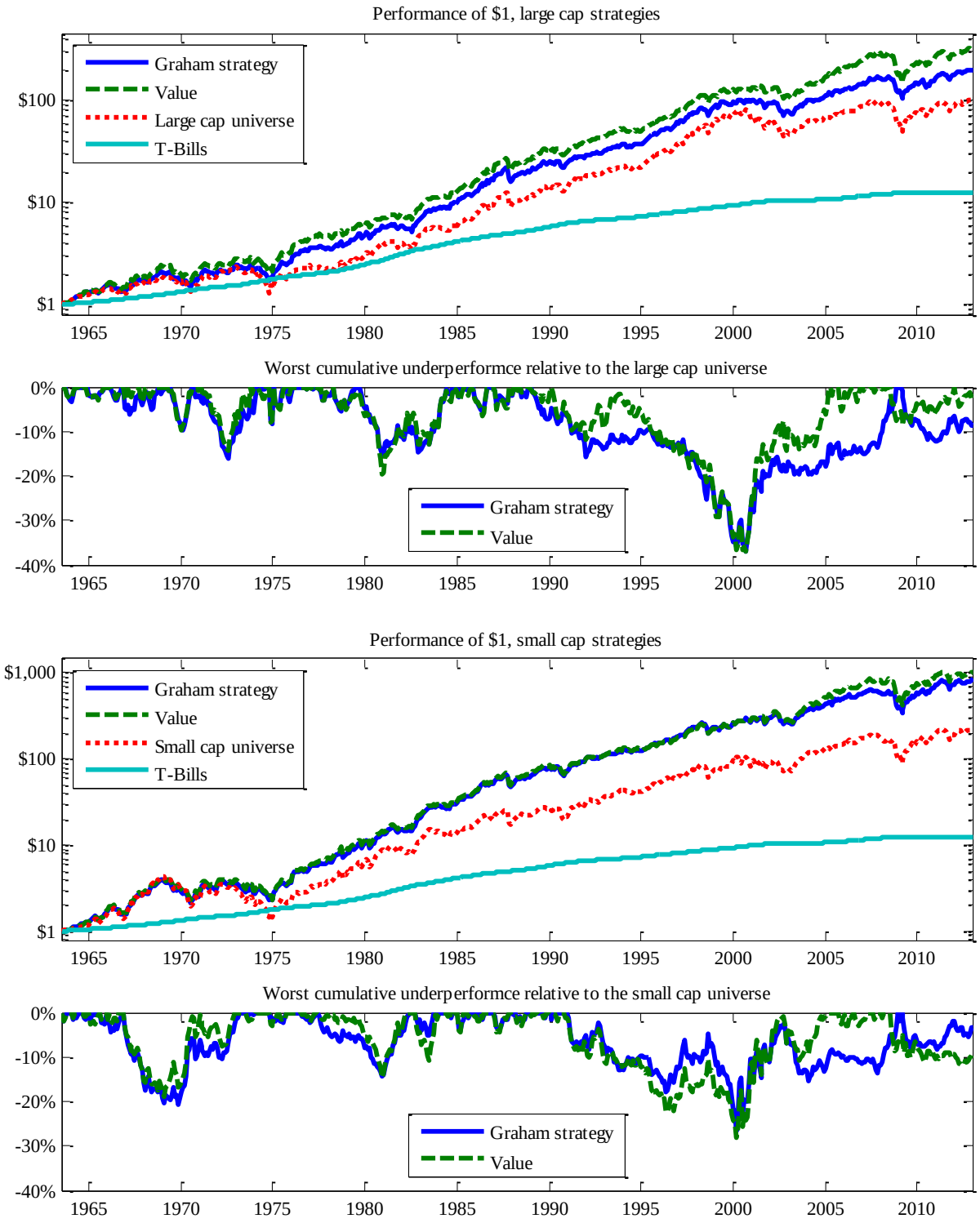
Figure 1 shows the growth (log scale) of a dollar invested in the high portfolios (value stocks and high Graham-quality value stocks) in mid-1963, and includes the performance of dollars invested in T-bills and the benchmarks for comparison. The figure also shows drawdowns (worst cumulative underperformance relative to the benchmark, where the long/short strategies are evaluated on an absolute basis). The figure shows that while the large cap Graham strategy outperformed its benchmark, it underperformed value. Among the small caps the performance of the two strategies (value and Graham's high quality value) was almost indistinguishable.

[6] Strategies formed on the basis of quality signals alone are considered in Appendix B.

Table 1. Performance of Value and the Graham Strategies

Portfolio	Long Side		Short Side		L - S (β-hedged)	
Universe	Large	Small	Large	Small	Large	Small
Panel A: Value strategy (sorted on average B/P and E/P ranks)						
Gross Excess Return	7.9%	11.0%	4.7%	6.0%	4.1%	7.2%
	|3.78|	|4.35|	|1.85|	|1.60|	|2.55|	|3.88|
Annual Turnover	31.8%	32.9%	24.4%	23.3%	56.3%	56.2%
Trading Costs	0.2%	0.4%	0.1%	0.3%	0.3%	0.7%
Net Excess Return	**7.7%**	**10.6%**	4.6%	5.7%	**3.8%**	**6.5%**
	[3.70]	**[4.19]**	|1.80|	|1.52|	**[2.34]**	**[3.50]**
Vol.	14.7%	17.8%	18.0%	26.2%	11.3%	13.2%
S.R.	0.53	0.60	0.26	0.22	**0.33**	**0.50**
β to benchmark	0.87	0.85	1.11	1.20	-0.02	0.01
Growth of $1 (nom.)	$323.93	$1,040.71			$57.65	$202.09
Growth of $1 (real)	$43.92	$141.12			$7.82	$27.40
Net Active Return	**2.3%**	**2.7%**	-0.8%	-2.3%		
	[2.43]	**[3.10]**	[-0.96]	[-1.43]		
T.E. Vol.	6.6%	6.1%	6.2%	11.1%		
I.R.	**0.35**	**0.44**	-0.14	-0.20		
Max. Drawdown	-37.0%	-28.3%			-32.7%	-56.5%
1 year underperf.	38.9%	38.1%			26.9%	23.3%
5 year underperf.	30.5%	23.9%			6.0%	5.6%
Panel B: Graham strategy (sorted on average value and Graham's G-score ranks)						
Gross Excess Return	6.8%	10.4%	4.7%	5.4%	3.0%	7.6%
	|3.37|	|4.19|	|1.81|	|1.50|	|2.42|	|5.05|
Annual Turnover	33.0%	25.1%	30.2%	26.6%	63.2%	51.7%
Trading Costs	0.2%	0.3%	0.2%	0.4%	0.4%	0.6%
Net Excess Return	**6.7%**	**10.2%**	4.5%	5.1%	**2.7%**	**7.0%**
	[3.28]	**[4.07]**	[1.73]	[1.40]	**[2.12]**	**[4.62]**
Vol.	14.3%	17.5%	18.3%	25.4%	8.8%	10.6%
S.R.	0.47	0.58	0.25	0.20	**0.30**	**0.66**
β to benchmark	0.87	0.84	1.14	1.19	-0.02	0.01
α to value and	-0.1%	0.7%	-1.0%	-1.7%	0.4%	2.3%
the benchmark	|-0.17|	|1.84|	|-1.56|	|-3.06|	|0.52|	|3.15|
Growth of $1 (nom.)	$198.5	$850.9			$37.6	$286.2
Growth of $1 (real)	$26.9	$115.4			$5.1	$38.8
Net Active Return	**1.2%**	**2.2%**	-0.9%	-2.9%		
	[1.51]	**[2.82]**	|-1.14|	|-2.20|		
T.E. Vol.	5.6%	5.6%	5.8%	9.2%		
I.R.	**0.21**	**0.40**	-0.16	-0.31		
Max. Drawdown	-36.9%	-26.9%			-25.8%	-46.6%
1 year underperf.	43.1%	40.7%			24.4%	17.2%
5 year underperf.	38.9%	30.5%			6.2%	0.2%

Figure 1. Performance of Traditional Value and the Graham Strategies



Grantham's Quality and Greenblatt's "Magic Formula"

Incorporating Graham's quality criteria into the stock selection procedure does not improve the performance of value strategies, but this is not the only way to account for quality. Other well-known industry proponents of quality investing, include Jeremy Grantham and Joel Greenblatt, employ different measures.

Grantham's views on quality investing are espoused by his firm, GMO, which argues the merits of quality investing in its 2004 white paper "The Case for Quality—The Danger of Junk." This paper defines quality companies as those that meet the criteria of low leverage, high profitability, and low earnings volatility, and suggests that stocks of firms with these characteristics "have always won over longer holding periods." In a later study, "Profits for the Long Run: Affirming the Case for Quality" (Joyce and Mayer, 2012), GMO shows that since 1965 the least levered firms (lowest 25%) have had average return on equity 5% higher than the most levered firms (highest 25%), and claims that "profitability is the ultimate source of investment returns."

These ideas have been highly influential. MSCI Quality Indices, launched in December 2012, are based on Grantham's basic principles. According to MSCI their Quality Indices "identify quality growth stocks by calculating a quality score for each security in the eligible equity universe based on three main fundamental variables: high return on equity (ROE), stable year-over-year earnings growth and low financial leverage." The Grantham criteria of "high returns, stable returns, low leverage" also make up half of the score (together with low volatility) used by Russell when constructing their Defensive Indexes, and two of the three criteria (high ROE and low leverage) form the basis of the Dow Jones Quality Index.

Others have argued that the benefits of incorporating quality concerns into equity strategies accrue primarily to value investors. In a recent white paper, "Power Couple: Quality and Value are Strong Drivers of Long-Term Equity Returns" (Mead et. al., 2013), MFS Investment Management studies the

performance of strategies based on Grantham's notions of quality, both as a stand-alone investment strategy and in conjunction with value. They conclude that while "…investing in quality without regard for valuation is not a compelling way to drive alpha over time… owning companies that are both high quality and inexpensively valued is… the most compelling way to generate sustainable, long-term performance."

Joel Greenblatt's "Little Book that Beats the Market" has been equally influential in getting investors, especially value investors, to pay attention to quality. The logic of Greenblatt's "magic formula investing" is clearly that of combining quality and value, in the spirit of Graham's belief in buying good firms at low prices. Magic formula investing entails ranking firms on the basis of return on invested capital (ROIC) and earnings yield (EY), respectively, and only buying stocks with the highest combined ranks. In Greenblatt's formula ROIC serves as the quality metric, while EY serves as the value metric. The formula is explicitly intended to ensure that investors are "buying good companies… only at bargain prices" (Greenblatt 2010, p.47).

Table 2 compares the performance of "Grantham value" and "Greenblatt's magic formula" strategies. These are formed, as with the Graham strategy, by sorting stocks on the basis of their average quality and price signals. The Grantham strategy uses the rank of a firm's average ROE, assets-to-equity, and inverse five-year ROE volatility ranks among all stocks as its quality signal, and I follow MFS in employing earnings-to-price when constructing the price signal. The Greenblatt strategy uses return on invested capital (ROIC) rank as it quality signal and earnings yield (EY) rank as its price signal, where ROIC and EY are defined, as in Greenblatt (2010), as the ratio of earnings before interest and taxes (EBIT)-to-tangible capital (net working capital plus net fixed assets) and EBIT-to-enterprise value [market value of equity (including preferred stock) plus debt]. Strategies are again formed as value-weighted portfolios that hold stocks in the top (bottom) 30% by signal with the applicable universe, and rebalancing each year at the end of June.

Panel A of Table 2 shows the performance of the Grantham value strategies. The long-only Grantham value strategies had lower returns than traditional value strategies, generating only roughly half the net active returns. The large cap strategy did, however, perform remarkably steadily, never experiencing cumulative underperformance relative to the large cap benchmark greater than 15.5%, a maximum drawdown less than half that experienced by large cap value by the peak of the tech bubble.

Small cap long/short investors did, however, realize Sharpe ratio improvements relative to traditional value. The strategy generated lower returns, but nevertheless realized a higher Sharpe ratio (0.58 vs. 0.50), because the long/short Grantham value strategy averaged only three quarters the volatility of the traditional small cap value strategy.

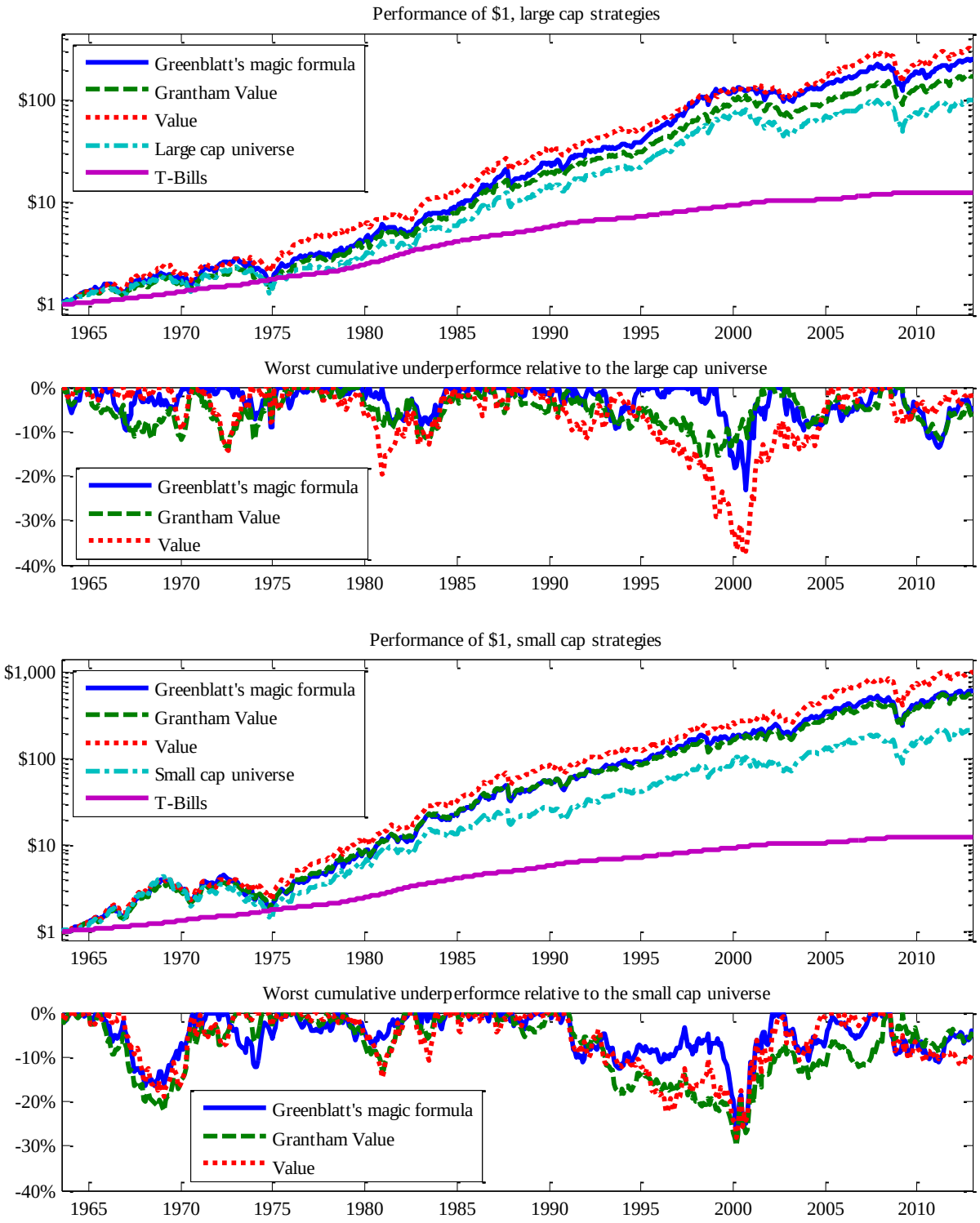
Panel B shows the performance of Greenblatt's magic formula strategies. Here we see more dramatic improvements within the large cap universe. The large cap magic formula strategy had net active returns that averaged almost 2% per year and were statistically significant (t-stat over 2.5), while the strategy's biggest drawdown relative to the large cap universe was only 23.0%, only two thirds as large as the worst drawdown experienced by traditional value. For the small cap strategies, however, we again see deterioration in performance relative to traditional value.

Figure 2 shows the growth of a dollar and drawdowns for long-only Grantham value, Greenblatt's magic formula, and traditional value strategies. The top half of the figure shows that while the overall performance of the large cap strategies was similar, the joint quality and value strategies had better drawdown performance. The bottom half of the figure shows that while small cap Grantham value and Greenblatt's magic formula strategies both beat the small cap benchmark, in this universe they both lagged behind traditional value stocks.

Table 2. Performance of Grantham Value and Greenblatt's Magic Formula

Portfolio	Long Side		Short Side		L - S (β-hedged)	
Universe	Large	Small	Large	Small	Large	Small
Panel A: Grantham value (sorted on average E/P and MSCI quality score ranks)						
Gross Excess Return	6.6% [3.21]	9.9% [3.82]	5.0% [1.92]	6.4% [1.76]	2.8% [2.61]	6.2% [4.85]
Annual Turnover	34.7%	35.8%	41.6%	37.0%	76.4%	72.7%
Trading Costs	0.2%	0.4%	0.2%	0.5%	0.4%	0.9%
Net Excess Return	**6.4% [3.12]**	**9.5% [3.66]**	4.8% [1.82]	5.8% [1.62]	**2.4% [2.22]**	**5.3% [4.10]**
Vol.	14.5%	18.3%	18.5%	25.4%	7.6%	9.1%
S.R.	0.44	0.52	0.26	0.23	**0.32**	**0.58**
β to benchmark	0.90	0.88	1.16	1.22	-0.01	0.01
α to value and the benchmark	0.5% [0.86]	0.3% [0.56]	-1.1% [-1.63]	-2.3% [-2.90]	1.3% [1.31]	2.6% [2.43]
Growth of $1 (nom.)	$173.5	$580.4			$34.9	$135.8
Growth of $1 (real)	$23.5	$78.7			$4.7	$18.4
Net Active Return	**1.0% [1.46]**	**1.6% [2.23]**	-0.7% [-0.82]	-2.1% [-1.81]		
T.E. Vol.	4.7%	5.0%	5.7%	8.1%		
I.R.	**0.21**	**0.32**	-0.12	-0.26		
Max. Drawdown	-15.5%	-29.8%			-24.7%	-32.7%
1 year underperf.	45.6%	42.7%			22.1%	20.2%
5 year underperf.	34.4%	28.0%			4.9%	
Panel B: Greenblatt's "magic formula" strategy (sorted on average earnings yield [EBIT/enterprise value] and return on invested capital [EBIT/tangible capital] ranks)						
Gross Excess Return	7.5% [3.41]	10.3% [3.66]	3.8% [1.49]	5.4% [1.48]	4.0% [3.09]	6.7% [4.20]
Annual Turnover	31.0%	28.2%	31.3%	33.5%	62.3%	61.6%
Trading Costs	0.2%	0.3%	0.2%	0.5%	0.4%	0.8%
Net Excess Return	**7.3% [3.33]**	**10.0% [3.55]**	3.6% [1.41]	4.9% [1.35]	**3.6% [2.82]**	**5.9% [3.69]**
Vol.	15.5%	19.8%	17.7%	25.7%	9.1%	11.2%
S.R.	0.47	0.50	0.20	0.19	**0.40**	**0.52**
β to benchmark	0.96	0.95	1.07	1.20	-0.04	0.00
α to value and the benchmark	1.2% [1.82]	0.3% [0.46]	-2.1% [-2.24]	-2.4% [-2.50]	3.2% [2.54]	2.7% [2.05]
Growth of $1 (nom.)	$250.1	$634.3			$60.4	$162.8
Growth of $1 (real)	$33.9	$86.0			$8.2	$22.1
Net Active Return	**1.9% [2.59]**	**2.1% [2.68]**	-1.9% [-1.98]	-3.0% [-2.17]		
T.E. Vol.	5.1%	5.4%	6.7%	9.8%		
I.R.	**0.37**	**0.38**	-0.28	-0.31		
Max. Drawdown	-23.0%	-28.7%			-31.5%	-55.2%
1 year underperf.	29.7%	36.7%			16.6%	21.4%
5 year underperf.	7.3%	16.6%			0.0%	5.4%

Figure 2. Performance of Grantham Value and the Greenblatt's Magic Formula



Earnings Quality and Financial Strength

Grantham's and Greenblatt's notions of quality are not the only alternatives to Graham's. Two accounting based quality measures that came out of academia, Sloan's accruals-based measure of earnings quality and Piotroski's F-score measure of financial strength, are both also widely employed by practitioners.

BlackRock has probably been the biggest proponent of incorporating earnings quality signals into value strategies. According to Sloan, who developed the best known and most widely used earnings quality measure, BlackRock (then BGI) "… was the first place to really pick up on my work" (Businessweek 2007). BGI hired Sloan in 2006, presumably at least in part for his earnings quality expertise. More recently BlackRock researchers have been promoting the benefits of trading earnings quality in conjunction with value in equity markets around the world, in a paper titled "Global Return Premiums on Earnings Quality, Value, and Size" (Kozlov and Petajisto, 2013). Strategies based on earnings quality are also readily available to long-only investors. The Forensic Accounting ETF (FLAG), for example, is designed to track the Del Vecchio Earnings Quality Index, which "uses financial statement analysis in an attempt to avoid companies with aggressive revenue recognition while investing in companies that have high earnings quality."

Piotroski's F-score measure of financial strength, another accounting based measure of firm quality, is also commonly employed by professional money managers and widely available on internet stock screeners. Societe General uses the F-score as its primary screen when constructing its Global Quality Income Index, while Morgan Stanley has offered products linked to strategies that combine the F-score with Greenblatt's magic formula (Ng 2009).

The F-score is constructed by summing nine binary variables, and includes elements of both Grantham's quality and Sloan's earnings quality. Four of these variables are designed to capture profitability, three to capture liquidity, and two to capture operating efficiency. Each component takes on the

value zero, indicating weakness, or one, indicating strength.[7] The F-score thus takes a value from zero to nine, with higher numbers indicating stronger financial performance. While Piotroski (2000) originally analyzed stand-alone strategies based on the F-score, Piotroski and So (2012) shows that strategies that trade jointly on valuation and the F-score perform even better.

Table 3 shows the performance of high earnings quality value strategies (Panel A) and Piotrosk and So strategies (Panel B). The high earnings quality value strategies use inverse accruals-to-asset rank as its quality signal, while the Piotroski and So strategies use Piotroski's F-score rank as its quality signal. Both strategies use book-to-price rank for their value signals.

Panel A shows that adding the earnings quality signal (accruals) to the price signal hurts the performance of the large cap strategies, but slightly improves the performance of the small cap strategies (though this improvement is insignificant). Panel B shows that while adding the F-score financial strength signal to the price signal does not help the large cap strategies, it does significantly improve the performance of the small cap strategies. The long-only small cap Piotroski and So strategy generated annual net active returns of 3.4% per year, and significant abnormal returns relative to small cap value and the small cap benchmark of 1.3%/year (t-stat of 2.77). The joint value-financial strength signal was even better at picking small cap losers, so long/short investors fared even better. The small cap long/short Piotroski and So strategy earned average net excess returns of 7.3% per year, while running at an average volatility of 9.2%, for a realized Sharpe ratio of 0.79. This strategy's abnormal returns relative to small cap value and the small cap universe was 3.8% per year, and highly significant (t-stat of 4.48).

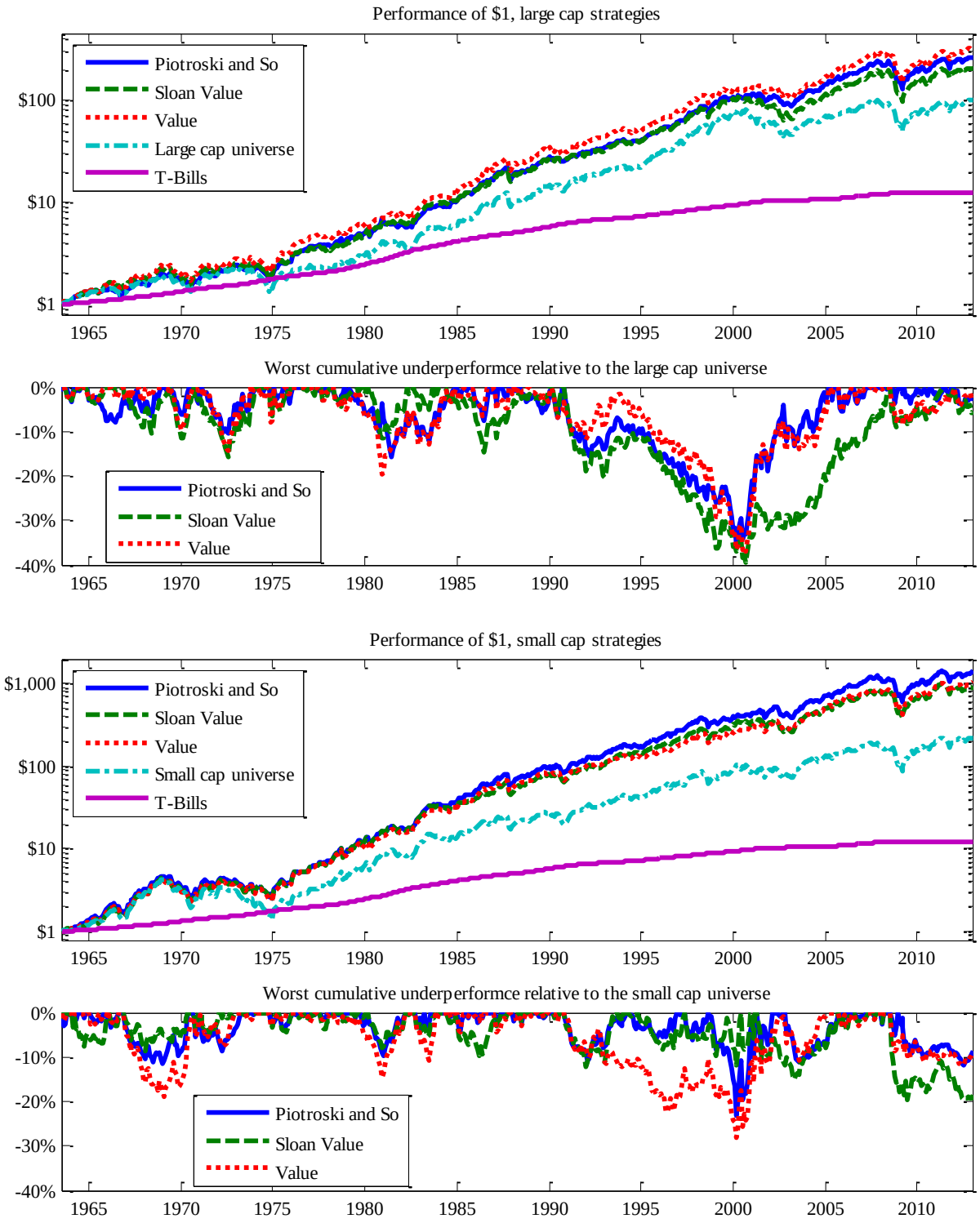
[7] A firm's F-score can get one point for each of four profitability signals [positive earnings, positive cash flows from operations, increasing returns-on-assets, and negative accruals (cash flows from operations that exceed earnings)]; one point for each of three liquidity signals (decreasing debt, increasing current ratio, and no equity issuance); and one point for each of two efficiency signals (increasing gross margins and increasing asset turnover).

3. Performance of Sloan Value and the Piotroski and So strategies

Portfolio	Long Side		Short Side		L - S (β-hedged)	
Universe	Large	Small	Large	Small	Large	Small
Panel A: Sloan value (sorted on average B/M and accruals ranks)						
Gross Excess Return	7.0%	11.3%	4.5%	5.5%	3.5%	6.6%
	[3.31]	[4.02]	[1.86]	[1.60]	[2.55]	[4.35]
Annual Turnover	33.6%	43.0%	34.0%	39.7%	67.6%	82.7%
Trading Costs	0.2%	0.5%	0.2%	0.5%	0.4%	1.0%
Net Excess Return	**6.8%**	**10.8%**	4.3%	5.0%	**3.2%**	**5.6%**
	[3.22]	**[3.82]**	[1.78]	[1.45]	**[2.28]**	**[3.65]**
Vol.	14.9%	19.8%	17.0%	24.4%	9.8%	10.8%
S.R.	0.46	0.54	0.25	0.21	**0.32**	**0.52**
β to benchmark	0.90	0.95	1.06	1.15	0.00	0.01
α to value and	-0.1%	0.2%	-0.6%	-1.9%	0.5%	1.4%
the benchmark	[-0.24]	[0.43]	[-1.12]	[-2.62]	[0.60]	[1.44]
Growth of $1 (nom.)	$205.2	$926.9			$46.4	$146.3
Growth of $1 (real)	$27.8	$125.7			$6.3	$19.8
Net Active Return	**1.4%**	**2.8%**	-1.1%	-2.9%		
	[1.62]	**[3.48]**	[-1.53]	[-2.45]		
T.E. Vol.	6.0%	5.8%	5.3%	8.3%		
I.R.	**0.23**	**0.49**	-0.22	-0.35		
Max. Drawdown	-39.5%	-19.8%			-23.2%	-43.3%
1 year underperf.	38.8%	35.7%			24.7%	21.3%
5 year underperf.	34.6%	8.6%				6.0%
Panel B: Piotroski and So strategy (sorted on average B/M and F-score ranks)						
Gross Excess Return	7.5%	11.9%	4.1%	5.5%	4.5%	8.5%
	[3.69]	[4.57]	[1.72]	[1.59]	[3.61]	[6.53]
Annual Turnover	55.1%	50.7%	53.6%	52.0%	108.6%	102.6%
Trading Costs	0.3%	0.6%	0.3%	0.6%	0.6%	1.2%
Net Excess Return	**7.3%**	**11.4%**	3.9%	4.8%	**3.9%**	**7.3%**
	[3.54]	**[4.34]**	[1.60]	[1.40]	**[3.12]**	**[5.55]**
Vol.	14.4%	18.4%	17.0%	24.3%	8.8%	9.2%
S.R.	0.50	0.62	0.23	0.20	**0.44**	**0.79**
β to benchmark	0.87	0.88	1.07	1.16	-0.02	0.00
α to value and	0.6%	1.3%	-1.2%	-2.6%	1.7%	3.8%
the benchmark	[1.15]	[2.77]	[-2.40]	[-3.91]	[2.09]	[4.48]
Growth of $1 (nom.)	$262.8	$1,409.6			$69.2	$355.9
Growth of $1 (real)	$35.6	$191.1			$9.4	$48.3
Net Active Return	**1.8%**	**3.4%**	-1.6%	-3.1%		
	[2.20]	**[4.14]**	[-2.32]	[-2.95]		
T.E. Vol.	5.8%	5.8%	4.8%	7.4%		
I.R.	**0.31**	**0.59**	-0.33	-0.42		
Max. Drawdown	-35.4%	-23.1%			-20.6%	-37.2%
1 year underperf.	42.2%	28.6%			19.9%	16.3%
5 year underperf.	31.6%	6.0%			0.0%	3.2%

Figure 3 shows the growth of a dollar and drawdowns for the long-only high earnings quality value, Piotroski and So, and traditional value strategies. The top half of the figure shows that among large caps traditional value slightly outperformed the Piotroski and So strategy, which in turn outperformed high earnings quality value. It also shows that all the strategies experienced similar drawdowns at similar times. The bottom half of the figure shows that among small caps traditional value and high earnings quality value performed similarly, though the high earnings quality value experienced less severe drawdowns, but neither strategy performed as well as the Piotroski and So strategy.

Figure 3. Performance of Sloan Value and the Piotroski and So strategies



Gross Profitability

Novy-Marx (2013) shows that a much simpler quality metric, gross profits-to-assets, has roughly as much power predicting the relative performance of different stocks as tried-and-true value measures like book-to-price. Buying profitable firms and selling unprofitable firms, where profitability is measured by the difference between a firm's total revenues and the costs of the goods or services it sells, yields a gross profitability premium. Just as importantly, the performance of strategies based on gross profitability is strongly negatively correlated with value, so profitability strategies not only deliver high average returns, but also provide a valuable hedge to value investors.

Why gross profitability? Financial economists have long believed that profitability *should* forecast returns, and puzzled over ROE's poor performance predicting cross sectional differences in average stock performance. This belief that profitability should matter follows from the simplest of economic reasoning. A stock's current price reflects market expectations of its future payouts, discounted at the rate of return investors require to hold it. If two companies have the same expected future profitability (i.e., payoffs), but are priced differently, this must reflect the fact that investors require a higher rate of return for holding the low priced stock (Ball 1978, Berk 1995). That is, simple dividend discounting predicts the value premium. Similarly, if two firms have different expected future profitabilities, and thus different expected future payoffs, but are priced the same, this must reflect the fact that investors require a higher rate of return for holding the stock of the more profitable firm. The same economic reasoning that predicts the value premium thus also predicts a profitability premium, suggesting that the quality and value phenomena are two sides of the same coin.

These arguments for the value and profitability premiums are not predicated on investor rationality. Differences in required rates of return could partially reflect mispricings (a stock is mispriced if and only if investors require

the wrong rate of return to hold it). Trading on value and profitability may thus simply be a crude but effective way of exploiting mispricings in the cross section.

Fama and French (2006) use the reasoning of the dividend discount model to motivate their empirical investigation of profitability as a stock return predictor. They find that cross-sectional regressions, which identify primarily off of small cap stocks, suggest that profitability is "related to average returns in the manner expected" (Fama and French 2006), but Fama and French (2008) finds that portfolio tests, which better approximate the performance of trading strategies available to investors, "do not provide much basis for the conclusion that, with controls for market cap and B/M, there is a positive relation between average returns and book to market."[8] The surprising fact, from the point of view of the model, is the poor empirical performance of profitability predicting returns.

Novy-Marx (2013) argues that gross profitability performs better predicting future stock returns than ROE, the profitability variable most frequently employed in earlier academic studies, because it is a better proxy for true economic profitability. In particular, the study points to the fact that accountants treat many forms of economic investment (e.g., R&D, advertisement, sales commissions, and human capital development) as expenses, so these activities lower net income but increase future expected profitability. This makes earnings a poor proxy for true expected economic profitability.

Alternatively, gross profitability may perform better predicting future returns because it is better at recognizing firms with competitive advantages. Warren Buffett frequently reminds Berkshire shareholders that he is only interested in investing in "economic castles protected by unbreachable 'moats.'"

[8] Haugen and Baker (1996) also finds that return on equity is an important determinant of future stock returns, employing tests that identify their results primarily off of small cap stocks.

“Wide moats” companies’ competitive advantages create high barriers to entry that discourage competition, extending the period over which they can generate abnormally high economic rents. Grantham’s reasoning for his “high return, stable return, low debt” definition of quality is predicated on the same basic principles. In a 2009 interview he told Morningstar that “If you have high stable returns, you're fixing the price. You're a price-setter. And you can only do that if you're a great franchise company. And if you can do that, you don't need any debt, and so they don't have it. So it tends to go as a package.” A firm can only have pricing power if it is somehow insulated from competition because, for example, its customers are loyal to its brand, it is a low cost producer, or there are high switching costs or network externalities in the product market in which it operates. High, stable returns and low leverage thus help identify “wide mote” firms, which is attractive if quality is not fully priced in the cross section. If firms with pricing power are underpriced, then their stock should outperform going forward.

Economic theory, however, predicts that gross margins (gross profits-to-sales) is the single best measure of pricing power—in fact economists studying industrial organization commonly refer to gross margins as market power. And gross margins is much better at identifying high quality growth firms (i.e., firms with high valuations expected to significantly outperform growth firms identified using price signals) than the “high returns, stable returns, low leverage” measure of quality. Gross margins is one half of gross profitability.

The other half of gross profitability, asset turnover (the dollar value of annual sales generated by each dollar of book assets), is an accounting measure of capital productivity known to predict returns. Multiplying gross margins by asset turnover yields gross profitability. Gross profitability has more power predicting differences in expected returns across stocks than either gross margins or asset turnover alone, and subsumes the predictive power of both its components in regressions that employ all three measures as explanatory variables.

Ultimately, however, the real justification for employing gross profitability as a quality metric is its empirical success. While analysts spend a lot of time thinking about bottom line earnings, and to a lesser extent free cash flow or EBIT, empirically gross profitability, which appears almost at the top of the income statement, is a much better predictor of a firm's future stock performance. According to Chi and Fogdall (2012), the co-heads of portfolio management at Dimensional Fund Advisors, "the research breakthrough in this case is not the discovery of expected profitability as a dimension of expected returns per se, something that financial economists have suggested for quite some time… rather, it is the discovery of reasonable proxies for expected profitability, which allow us to use profitability as another dimension of expected returns in the creation of investment solutions." Firms with high gross profitability outperform the market despite having high average valuation, and this is the real reason that DFA employs profitability, not price metrics, when selecting stocks for their growth funds.

Table 4 shows the performance of strategies sorted on average gross profits-to-assets and book-to-price ranks.[9] The large cap profitable value stocks earned net active returns of 3.1% per year, almost a full point higher than any of the other large cap strategies. It earned these impressive returns despite running at tracking error volatility of only 4.7%. The resulting information ratio, 0.66, was almost 80% higher than the 0.37 realized on Greenblatt's magic formula strategy, which realized the second highest information ratio of any of the large cap strategies. Perhaps the most impressive aspect of the strategy, however, was its drawdown performance—the worst cumulative underperformance the profitable value stocks ever realized relative to the large cap universe was 13.4%, only about a third as large as the largest drawdown realized by the Piotroski and So or traditional value strategies. Profitable small

[9] Value and profitability can also be successfully combined at the portfolio level (i.e., can be run as pure strategies side-by-side), but the benefits then come primarily through volatility reductions. The integrated strategy, which combines the strategies at the signal level, is able to obtain greater exposures to the high information ratio opportunities the factors provide. Running the long-only strategies at higher tracking errors translates these high information ratio opportunities into higher realized returns.

cap value stocks also performed strongly. They earned net active returns of 3.9% per year, 0.5% per year more than the Piotroski and So's small cap winners. These stocks also ran a tracking error volatility under 5%, resulting in an information ratio of 0.80.

The long/short strategies performed even better. The strategies earned net excess returns of 5.6% and 8.5% per year in the large and small cap universes, respectively, running at volatilities of just over 8% and 10%, for Sharpe ratios of 0.68 and 0.83. These strategies both had abnormal returns relative to value and their benchmarks of nearly 5% per year, with t-stats larger than four.

Table 4. Performance of Joint Value and Profitability Strategies

Portfolio	Long Side		Short Side		L - S (β-hedged)	
Universe	Large	Small	Large	Small	Large	Small
Panel B: Joint value and profitability (sorted on average B/M and GP/A ranks)						
Gross Excess Return	8.7% [3.87]	12.1% [4.31]	3.0% [1.23]	3.6% [1.09]	5.9% [5.07]	9.1% [6.30]
Annual Turnover	29.1%	25.8%	25.5%	21.3%	54.6%	47.1%
Trading Costs	0.2%	0.3%	0.2%	0.3%	0.3%	0.6%
Net Excess Return	**8.6%** **[3.80]**	**11.8%** **[4.20]**	2.9% [1.17]	3.4% [1.00]	**5.6%** **[4.80]**	**8.5%** **[5.85]**
Vol.	15.8%	19.8%	17.4%	23.6%	8.2%	10.2%
S.R.	0.54	0.60	0.17	0.14	**0.68**	**0.83**
β to benchmark	0.99	0.95	1.09	1.11	-0.01	0.01
α to val., mom., and the benchmark	2.5% [3.79]	2.2% [3.90]	-2.8% [-3.95]	-3.3% [-4.75]	4.8% [4.28]	4.9% [4.66]
Growth of $1 (nom.)	$445.4	$1,538.3			$165.9	$616.6
Growth of $1 (real)	$60.4	$208.6			$22.5	$83.6
Net Active Return	**3.1%** **[4.61]**	**3.9%** **[5.63]**	-2.6% [-3.49]	-4.6% [-4.03]		
T.E. Vol.	4.7%	4.8%	5.2%	8.0%		
I.R.	**0.66**	**0.80**	-0.50	-0.57		
Max. Drawdown	-13.4%	-18.2%			-17.4%	-34.7%
1 year underperf.	31.4%	20.8%			13.6%	14.2%
5 year underperf.	14.0%	3.0%				0.9%

Figure 4 shows the growth of a dollar and the drawdowns for the long-only joint profitability and value strategies. For comparison it also includes the best performing strategies from Tables 2 and 3, Greenblatt's magic formula and the Piotroski and So strategies, respectively. The top half of the figure shows that large profitable value stocks outperformed those picked by either Greenblatt's or Piotroski and So's methodologies. The strategies also experienced much smaller drawdowns, especially in the late 1990s. The bottom half of the figure shows that the small profitable value stocks performed as well as those picked by Piotroski and So's methodology, and better than those picked by Greenblatt's magic formula. The profitable value stocks also experienced the smallest drawdowns. Figure 5 shows similar results for the long/short strategies.

Figure 4. Performance of Long-Only Joint Value and Profitability Strategies

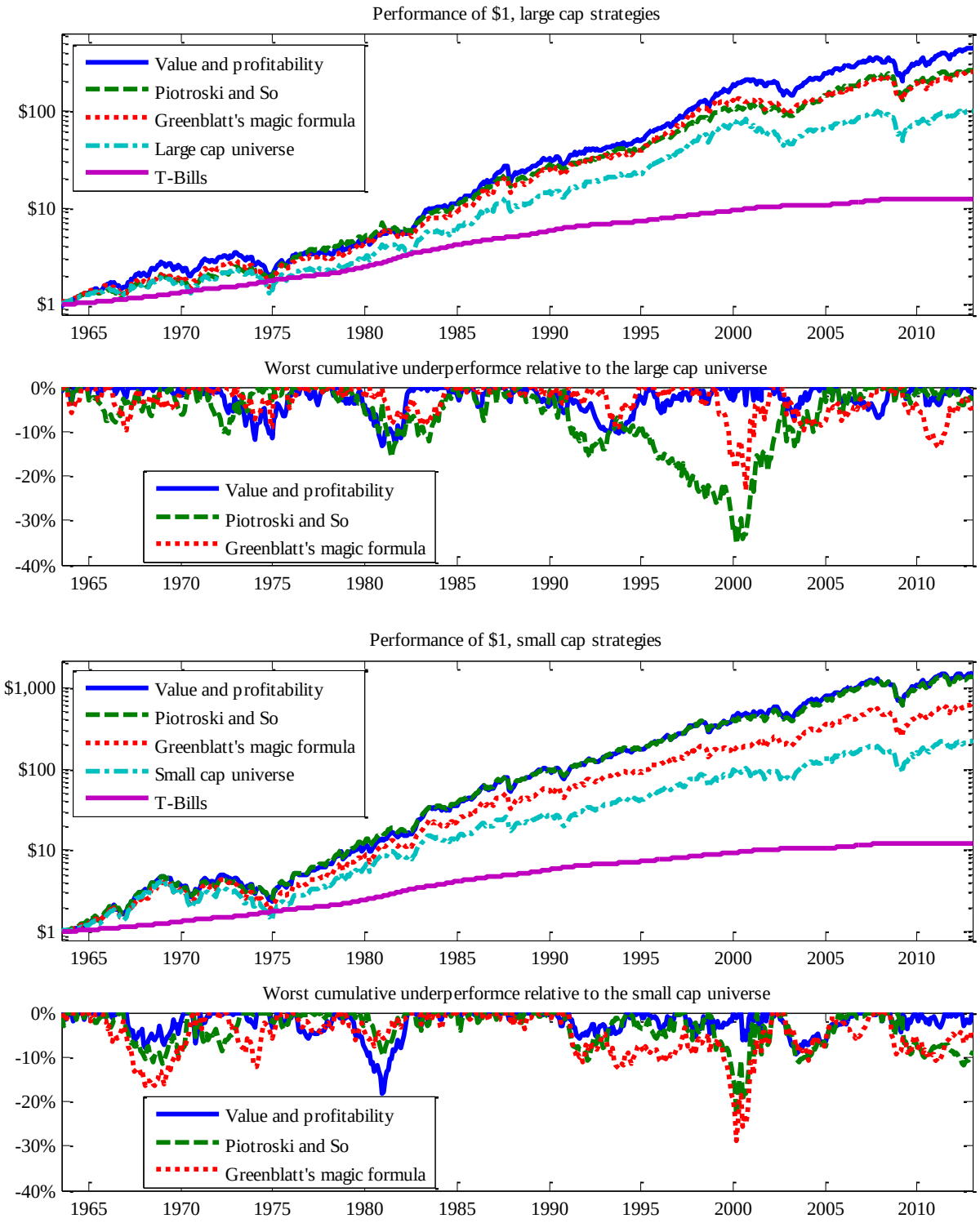
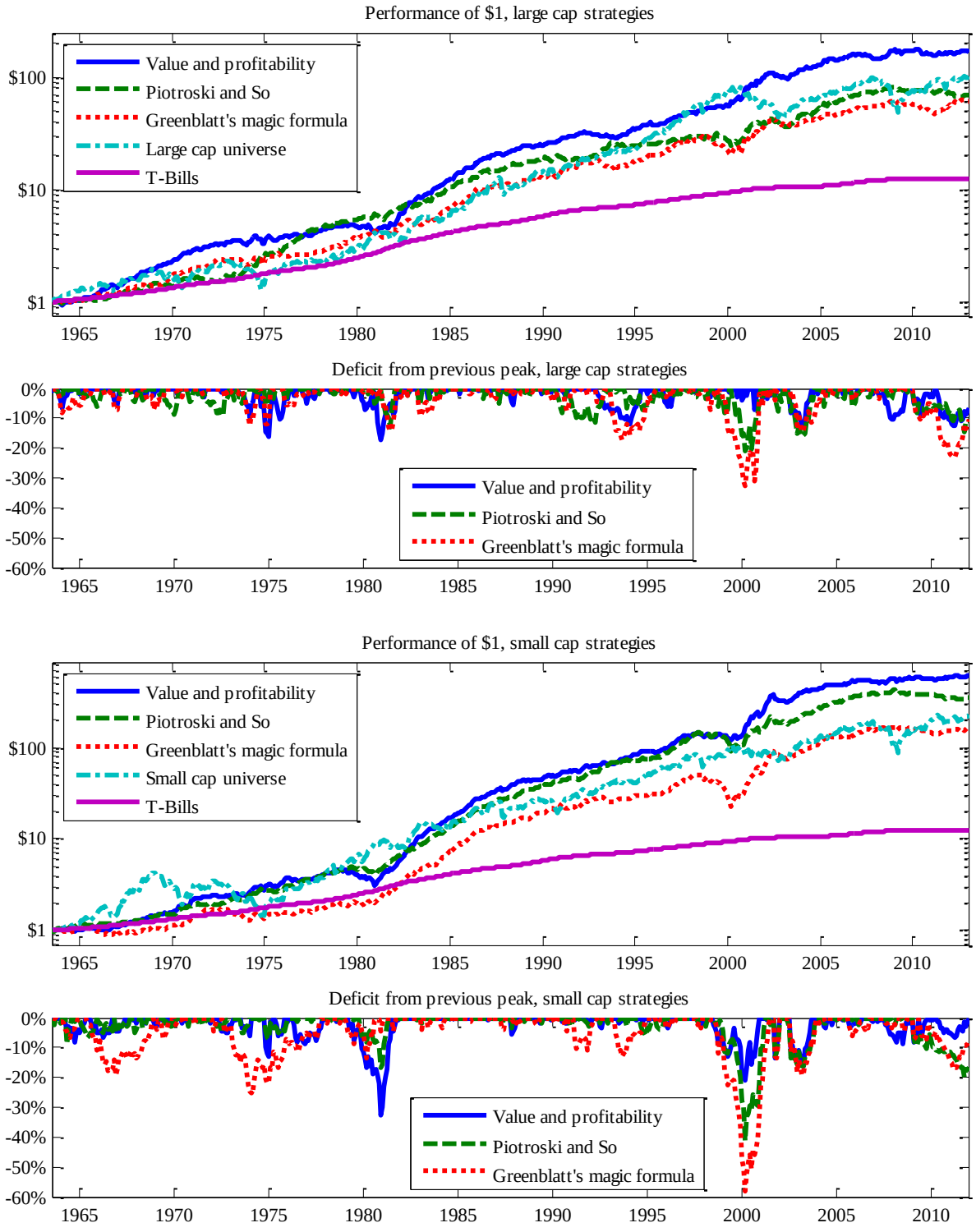


Figure 5. Performance of Long/Short Quality and Value Strategies



Spanning Tests

The results of the previous section suggest that strategies based jointly on valuations and gross profitability outperform joint value and quality strategies constructed using other quality metrics. This section shows this formally, through a series of spanning tests employing the long/short value and quality strategies. These ask which of these strategies generate significant alpha relative to the others, by regressing the returns of a test strategy (the dependent variable) on the returns of potential explanatory strategies and the benchmark (the independent variables). Significant abnormal returns suggest an investor already trading the explanatory strategy and the benchmark could realize significant gains by starting to trade the test strategy. Insignificant abnormal returns suggest that the investor has little to gain by starting to trade the test strategy.

Table 5 shows the abnormal returns (i.e., the alphas) of each of the joint value and quality strategies relative to each of the others and the benchmark, in both the large or small cap universes. The rows of panel A show that among large caps only Greenblatt's magic formula, Piotroski and So's strategy, and the joint value and profitability strategy generate significant abnormal returns relative to traditional value. These are also the only strategies that generally have positive alphas relative to the other joint value and quality strategies. These abnormal returns are always most significant for the joint value and profitability strategy. The penultimate column shows that the Piotroski and So strategy is able to price all the other strategies except the magic formula strategy and the joint value and profitability strategy. The last column shows that the joint value and profitability strategy is able to price all the other strategies except for the Piotroski and So strategy. The bottom right corner shows that the joint value and profitability strategy's alpha relative to the Piotroski and So strategy and the large cap benchmark is much larger than the Piotroski and So strategy's alpha relative to the joint value and profitability strategy and the large cap benchmark (5.3% per year with a t-stat of 4.48, compared to 3.4% per year with a t-stat of 2.68).

Table 5. Value/Quality Strategy αs Relative to the Benchmark and Each Other

	Independent strategy						
Dependent Strategy	V	GV1	GV2	GMF	SV	PS	GPV
Panel A: Large cap strategies							
Straight value (V)		1.1%	2.2%	2.9%	1.0%	0.0%	1.6%
		[1.10]	[1.50]	[1.82]	[0.98]	[-0.03]	[1.00]
Graham strategy (GV1)	0.4%		1.0%	1.4%	1.1%	0.5%	0.1%
	[0.52]		[0.97]	[1.16]	[1.10]	[0.49]	[0.05]
Grantham value (GV2)	1.3%	1.0%		0.9%	1.9%	1.4%	0.8%
	[1.31]	[1.16]		[0.96]	[1.78]	[1.35]	[0.74]
Magic formula (GMF)	3.2%	2.8%	2.4%		4.3%	3.5%	0.6%
	[2.54]	[2.33]	[2.14]		[3.30]	[2.71]	[0.50]
Sloan value (SV)	0.5%	1.4%	2.4%	3.7%		0.2%	2.4%
	[0.60]	[1.24]	[1.76]	[2.67]		[0.15]	[1.66]
Piotroski and So (PS)	1.7%	2.5%	3.1%	3.7%	2.1%		3.4%
	[2.09]	[2.36]	[2.60]	[2.93]	[2.24]		[2.68]
Value + profitability (GPV)	4.8%	4.5%	4.8%	3.8%	5.3%	5.3%	
	[4.28]	[4.27]	[4.28]	[3.78]	[4.55]	[4.48]	
Panel B: Small cap strategies							
Straight value (V)		-1.1%	1.9%	2.5%	1.2%	-1.6%	-1.2%
		[-1.16]	[1.23]	[1.62]	[1.03]	[-1.34]	[-0.88]
Graham strategy (GV1)	2.3%		2.7%	3.3%	3.5%	0.7%	0.2%
	[3.15]		[2.39]	[2.81]	[2.90]	[0.68]	[0.18]
Grantham value (GV2)	2.6%	1.2%		1.4%	3.8%	1.1%	0.5%
	[2.43]	[1.26]		[1.82]	[3.01]	[1.01]	[0.46]
Magic formula (GMF)	2.7%	1.2%	0.7%		4.2%	0.8%	-0.5%
	[2.05]	[0.97]	[0.72]		[2.69]	[0.62]	[-0.38]
Sloan value (SV)	1.4%	1.1%	3.5%	3.9%		-0.6%	0.9%
	[1.44]	[0.93]	[2.38]	[2.59]		[-0.51]	[0.63]
Piotroski and So (PS)	3.8%	2.9%	4.2%	4.5%	3.9%		2.6%
	[4.48]	[3.16]	[3.84]	[4.12]	[4.17]		[2.43]
Value + profitability (GPV)	4.9%	3.4%	4.7%	4.8%	5.7%	3.5%	
	[4.66]	[3.50]	[4.08]	[4.41]	[4.50]	[2.93]	

The first column of panel B show that among the small cap stocks all the strategies, exception for Sloan value, have significant information ratios relative to traditional value. The rows show that the Piotroski and So and joint value and profitability strategies are the clear winners, in terms of generating large abnormal returns relative to all the others—but in every case the joint value and profitability strategy generates larger and more significant alphas than the

Piotroski and So strategy. The last two columns show that these two strategies also price all the other strategies, with the exception of each other.

Incorporating Momentum

Price momentum is, along with value, the most robust capital market anomaly. It has been extremely profitable on its own. It also tends to perform well when value underperforms, providing significant diversification benefits to value investors. Because of these well-known synergies, and the synergies we observe between quality and value, it is natural to ask how quality, value, and momentum perform all together.

Table 6 shows the performance of strategies formed on the basis of past performance (returns over the first 11 months of the year preceding portfolio formation); average book-to-market and past performance ranks; and average gross profits-to-assets, book-to-price, and past performance ranks. Portfolios are rebalanced monthly. Book-to-price is constructed each month using current prices, which tends to reduce the performance of value as a stand-alone strategy but greatly increases value strategies' negative correlations with momentum (Asness and Frazzini, 2013). In order to reduce turnover they are constructed, using the methodology of Novy-Marx and Velikov (2013), as "20-40" strategies. These strategies buy stocks when their signals move into the top 20% of the applicable universe, but hold stocks they already own until their signals fall below the 40% threshold for the applicable universe. These portfolios hold roughly 30% of names, and realize similar gross returns to strategies that always hold the top 30%, but have turnovers, and consequently incur transaction costs, that are roughly only half as large.[10]

Panel A shows the performance of pure momentum strategies, and serves as a point of comparison for the strategies that combine momentum signals with either value signals or quality and value signals. Winners outperformed their benchmarks by large margins—roughly 3.5% per year after accounting for

[10] Appendix C shows results for identical tests that employ strategies constructed using the conventional methodology (i.e., strategies that incorporate momentum signals but always hold the top 30% of names).

transaction costs in both the large and small cap universe, but these active returns came with large tracking error volatilities (~10%) and large drawdowns (especially for the small cap strategy). As a result the information ratios on the winners' portfolios were only about one-third. The small cap long/short strategy was more profitable, because past performance was particularly good at identifying stocks expected to underperform the small cap universe.

Panel B shows the performance of strategies that combine momentum and traditional value (i.e., price) signals. It shows that cheap winners outperformed their benchmarks by 2.6% per year and 3.9% per year in the large and small cap universes, respectively, after accounting for transaction costs. Because value and momentum are negatively correlated, and thus hedge each other, this outperformance came with much lower tracking errors than the pure momentum strategies (~6% volatility), so realized larger information ratios than the pure momentum strategies (0.41 and 0.68 in the large and small cap universes, respectively). These strategies also experienced dramatically smaller drawdowns than the pure momentum winners, especially among the small caps (maximum cumulative underperformance of 24.0% for small cheap winners, as opposed to 63.0% for the small winners).

The long/short joint value and momentum strategies realized net excess returns of 5.8% per year (large caps) and 10.7% per year (small caps), running at less than two-thirds the volatilities of the pure momentum strategies, so realized much higher Sharpe ratios—0.52 and 1.04 in the large and small cap universes, respectively.

Panel C shows the performance of strategies that combine momentum with both quality (gross profits-to-assets) and value (book-to-market) signals. Cheap, profitable winners beat their benchmarks, after accounting for transaction costs, by 3.9% per year (large caps) and 5.0% per year (small caps), while running tracking error volatilities of 6%, yielding information ratios of 0.65 and 0.82. These are very similar to the 0.66 and 0.80 information ratios observed on the cheap, profitable stocks selected without concern for past

performance considerations. The portfolios that select cheap, profitable winners run at higher tracking error volatilities, however, allowing long-only investors to translate the high information ratio opportunities into higher realized returns. The long only-value, momentum and profitability strategies consequently generate positive active returns relative to the strategies based on value and profitability alone, though these active returns are not statistically significant.

Accounting for momentum in joint quality and value strategies provides greater advantages to long/short investors. In the large caps the long/short strategy that trades on all three signals realized Sharpe ratios about 10% higher than the strategy formed on the basis of profitability and value signals alone, and almost 50% higher than the strategy formed on the basis of momentum and value signals alone (0.74, compared to 0.68 and 0.52, respectively), and generates abnormal returns relative to these other strategies of 4.2 and 5.4%/year (t-stats of 3.16 and 3.93, respectively). Among the small caps the Sharpe ratio improvements realized by accounting for all three signals were smaller (1.09, vs. 0.83 for value and profitability and 1.04 for value and momentum), but the joint value, momentum and profitability strategies' abnormal returns relative to the value and profitability or value and momentum strategies were just as large (5.8 and 5.0%/year, with t-stats of 5.00 and 3.60, respectively). The strategy that incorporated profitability also had a maximum drawdown that was less than half as large as the worst drawdown on the value and momentum strategy that ignored profitability (16.0% vs. 35.4%).

Table 6. Performance of Strategies that Incorporate Momentum

Portfolio	Long Side		Short Side		L - S (β-hedged)	
Universe	Large	Small	Large	Small	Large	Small
Panel A: Momentum (sorted on past performance rank)						
Gross Excess Return	9.9% [3.60]	13.0% [3.64]	3.1% [1.15]	1.1% [0.29]	7.6% [3.05]	12.9% [5.17]
Annual Turnover	153.3%	111.8%	164.1%	156.0%	317.4%	267.8%
Trading Costs	0.9%	1.4%	1.0%	2.2%	1.8%	3.6%
Net Excess Return	**9.0%** **[3.28]**	**11.6%** **[3.25]**	2.1% [0.79]	-1.2% [-0.31]	**5.8%** **[2.32]**	**9.3%** **[3.72]**
Vol.	19.3%	25.0%	18.9%	26.2%	17.6%	17.5%
S.R.	0.47	0.46	0.11	-0.04	**0.33**	**0.53**
β to benchmark	1.09	1.13	1.08	1.22	-0.07	-0.09
Growth of $1 (nom.) Growth of $1 (real)	$408.33 $55.37	$760.32 $103.10			$99.58 $13.50	$536.59 $72.76
Net Active Return	**3.5%** **[2.57]**	**3.6%** **[2.35]**	-3.3% [-2.53]	-9.1% [-6.31]		
T.E. Vol.	9.7%	10.9%	9.3%	10.1%		
I.R.	**0.36**	**0.33**	-0.36	-0.90		
Max. Drawdown 1 year underperf. 5 year underperf.	-37.2% 35.7% 13.3%	-63.0% 35.7% 18.3%			-48.7% 25.9% 4.1%	-56.0% 16.0% 7.7%
Panel B: Joint value and momentum (sorted on average B/M and past performance ranks)						
Gross Excess Return	8.6% [3.89]	12.9% [4.82]	3.0% [1.23]	1.2% [0.34]	6.8% [4.25]	13.3% [9.11]
Annual Turnover	88.4%	89.7%	88.2%	117.2%	176.6%	206.9%
Trading Costs	0.5%	1.1%	0.5%	1.5%	1.0%	2.6%
Net Excess Return	**8.1%** **[3.66]**	**11.8%** **[4.41]**	2.5% [1.02]	-0.4% [-0.10]	**5.8%** **[3.63]**	**10.7%** **[7.35]**
Vol.	15.5%	18.8%	17.0%	24.6%	11.3%	10.2%
S.R.	0.52	0.63	0.14	-0.01	**0.52**	**1.04**
β to benchmark	0.93	0.90	1.04	1.18	-0.03	-0.02
α to val., mom., and the benchmark	-0.2% [-0.37]	1.1% [2.25]	-0.8% [-1.57]	-2.8% [-5.03]	0.3% [0.39]	3.0% [3.81]
Growth of $1 (nom.) Growth of $1 (real)	$359.8 $48.8	$1,674.5 $227.1			$158.0 $21.4	$1,815.1 $246.1
Net Active Return	**2.6%** **[2.90]**	**3.9%** **[4.78]**	-3.0% [-3.45]	-8.3% [-7.63]		
T.E. Vol.	6.4%	5.7%	6.1%	7.6%		
I.R.	**0.41**	**0.68**	-0.49	-1.09		
Max. Drawdown 1 year underperf. 5 year underperf.	-28.0% 36.5% 23.6%	-24.0% 24.9% 9.2%			-29.0% 20.2% 3.6%	-35.4% 9.9% 6.4%

Table 6 (continued).

Portfolio	Long Side		Short Side		L - S (β-hedged)	
Universe	Large	Small	Large	Small	Large	Small
Panel C: Joint quality, value, and momentum (sorted on average GP/A, B/M, and past performance ranks)						
Gross Excess Return	9.9% [4.23]	13.8% [4.61]	1.6% [0.64]	2.0% [0.58]	8.9% [5.90]	12.6% [8.91]
Annual Turnover	105.3%	75.4%	90.0%	69.1%	195.3%	144.5%
Trading Costs	0.6%	0.9%	0.5%	0.9%	1.1%	1.8%
Net Excess Return	**9.3%** **[3.99]**	**12.9%** **[4.32]**	1.1% [0.42]	1.1% [0.32]	**7.8%** **[5.18]**	**10.8%** **[7.65]**
Vol.	16.5%	21.0%	17.5%	24.2%	10.6%	9.9%
S.R.	0.57	0.61	0.06	0.04	**0.74**	**1.09**
β to benchmark	1.00	1.00	1.08	1.15	-0.03	-0.01
α to val., mom., and the benchmark	2.5% [3.97]	2.7% [4.31]	-3.0% [-5.01]	-3.6% [-4.60]	4.9% [4.82]	5.5% [4.73]
Growth of $1 (nom.) Growth of $1 (real)	$625.3 $84.8	$2,327.2 $315.6			$432.3 $58.6	$1,936.9 $262.6
Net Active Return	**3.9%** **[4.54]**	**5.0%** **[5.74]**	-4.4% [-5.22]	-6.8% [-6.21]		
T.E. Vol.	6.0%	6.1%	5.9%	7.8%		
I.R.	**0.65**	**0.82**	-0.74	-0.88		
Max. Drawdown	-18.6%	-18.0%			-17.0%	-16.0%
1 year underperf.	21.1%	18.2%			11.8%	10.3%
5 year underperf.	1.5%	6.4%			0.6%	0.0%

Figure 6 shows the growth of a dollar and drawdowns for the long-only strategies that incorporate momentum signals. The top half shows that among large caps the cheap, profitable, winners outperformed both the cheap winners and the winners selected without regard to price, while simultaneously experiencing much smaller drawdowns. The bottom half shows similar results in the small cap universe, though here the disparity in performance between the strategies based on quality, value and momentum and the strategies based on value and momentum ignoring profitability is less remarkable. Both these strategies, however, significantly outperformed the strategy based on past performance alone, and experienced dramatically smaller drawdowns, especially following the dot-com bust and during the momentum crash of 2009. Figure 7 shows similar results for the long/short strategies.

Figure 6. Performance of Long-Only Strategies that Incorporate Momentum

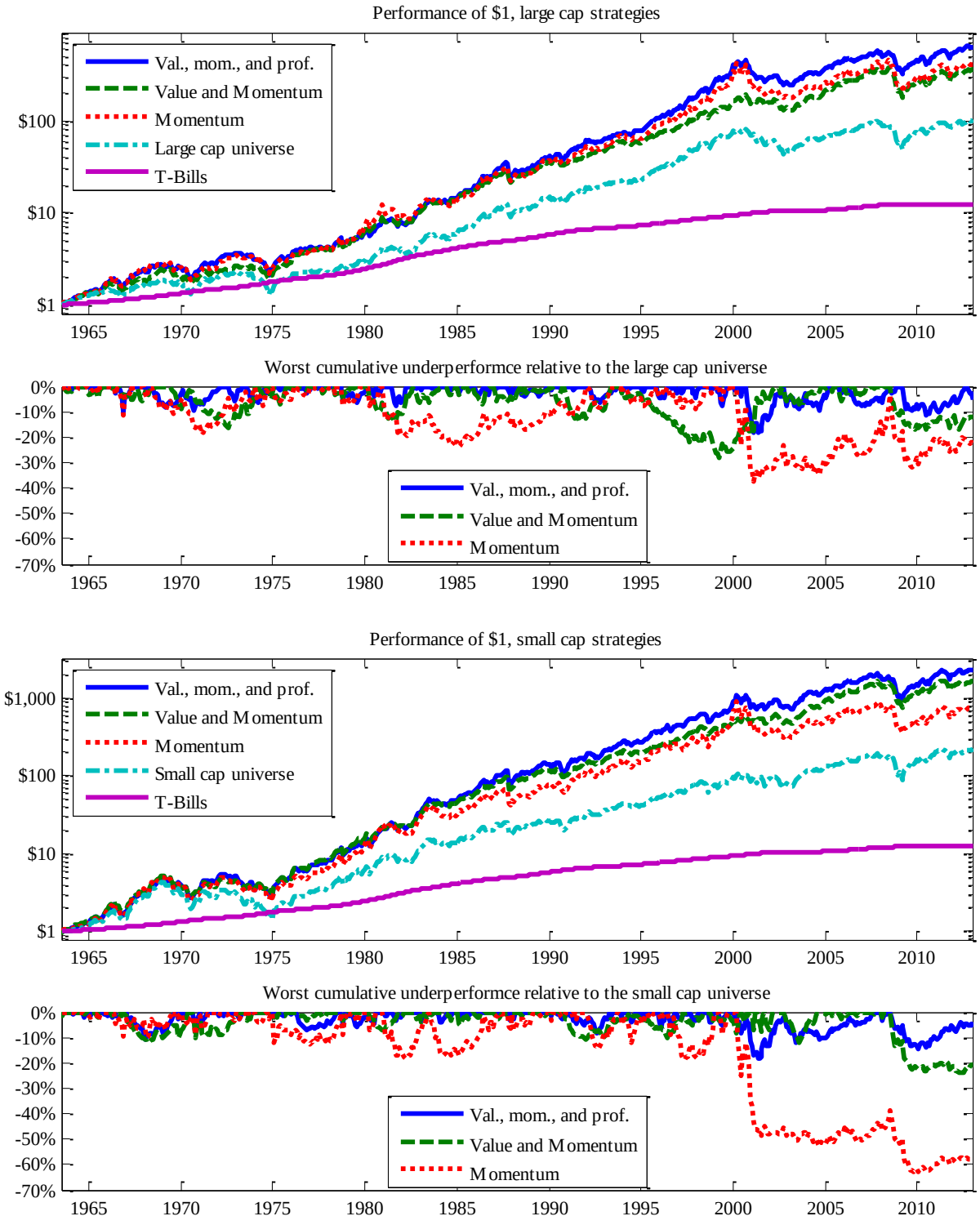
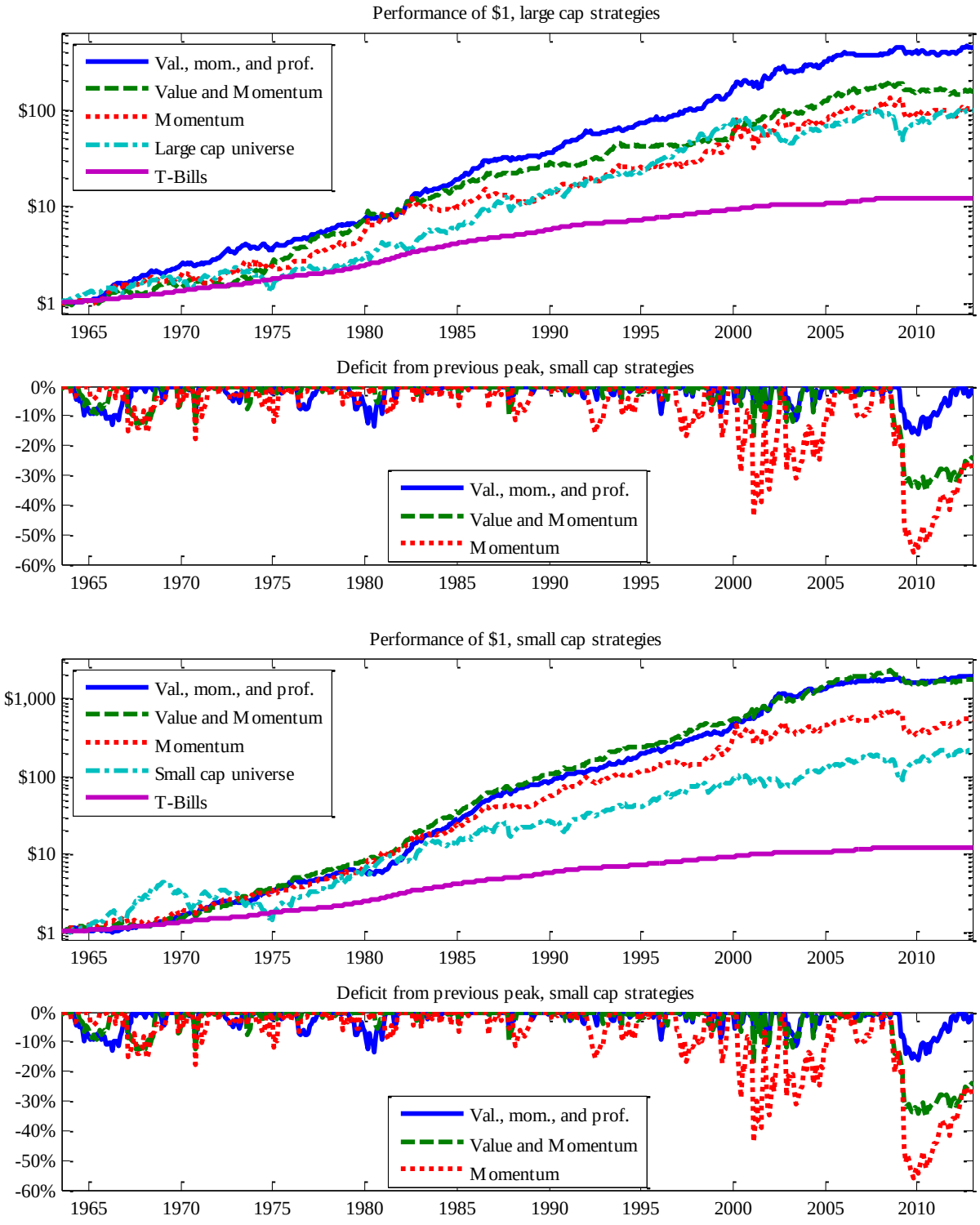


Figure 7. Performance of Long/Short Strategies that Incorporate Momentum



Conclusion

Quality investing exploits another dimension of value. Value strategies endeavor to acquire productive capacity cheaply. Traditional value strategies do this by buying assets at bargain prices; quality strategies do this by buying uncommonly productive assets. Strategies based on either of value's dimensions generate significant abnormal returns, but the real benefits of value investing accrue to investors that pay attention to *both* price and quality. Attention to quality, especially measured by gross profitability, helps traditional value investors distinguish bargain stocks (i.e., those that are undervalued) from value traps (i.e., those that are cheap for good reasons). Price signals help quality investors avoid good firms that are already fully priced. Trading on both signals brings the double benefit of increasing expected returns while decreasing volatility and drawdowns. Cheap, profitable firms tend to outperform firms that are just cheap or just profitable. Quality tends to perform best when traditional value suffers large drawdowns, and *vice versa*, so strategies that trade on both signals generate steadier returns than do strategies that trade on quality or price alone. These benefits are available to long-only investors as well as long/short investors. Accounting for quality also significantly improves the performance of strategies that incorporate momentum as well as price signals.

Several practical considerations make joint quality and value strategies look even more attractive. The signal in gross profitability is extremely persistent—even more persistent than that in valuations—and works well in the large cap universe. Joint quality and value strategies thus have low turnover, and can be implemented using liquid stocks with the capacity to absorb large trades. The joint profitability and value signal is also less susceptible to industry biases that are uninformative about future stock returns. Both the value and profitability premiums are largely intra-industry phenomena, reducing the informativeness of simple, univariate measures of value and profitability. This is less of a problem for strategies that trade on the

combined quality and value signal. Because industry capital intensity is positively correlated with value signals (which have book values in the numerator) but negatively correlated with profitability signals (which have book values in the denominator), systematic industry variation in the value and quality metrics tend to cancel in the joint signal. Joint quality and value strategies can thus be implemented effectively while paying less attention to industry controls.

The basic message is that investors, in general but especially traditional value investors, leave money on the table when they ignore the quality dimension of value.

Keywords: Value Investing, Quality Investing, Gross Profitability, GARP, Asset Pricing.

References

Asness, Cliff, and Andrea Frazzini. 2012. "The Devil in HML's Details." Working paper, AQR Capital Management.

Ball, Ray. 1978. "Anomalies in relationships between securities' yields and yield-surrogates." *Journal of Financial Economics,* 103-126.

Berk, Jonathan B. 1995. "A critique of size-related anomalies." *Review of Financial Studies,* 275-286.

Chi, Joseph, and Jed Fogdall 2012. "Integrated Equity Solutions," Dimensional Fund Advisors Quarterly Institutional Review, Fourth Quarter.

Graham, Benjamin. 1973. *The Intelligent Investor* (4th Rev. ed.). *Harpers & Row,* New York, New York.

Frazzini, Andrea, David Kabiller, and Lasse H. Pedersen. 2012. "Buffet's Alpha." Working paper.

Frazzini, Andrea, Ronen Israel, and Tobias Moskowitz. 2012. "Trading costs of asset pricing anomalies." Working paper.

Fama, Eugene F., and Kenneth R. French. 1993. "Common risk factors in the returns of stocks and bonds." *Journal of Financial Economics,* pp. 3-56.

Fama, Eugene F., and Kenneth R. French. 2006. "Profitability, investment and average returns." *Journal of Financial Economics,* pp. 491-518.

Fama, Eugene F., and Kenneth R. French. 2008. "Dissecting anomalies." *Journal of Finance,* pp. 1653-1678.

GMO. 2004. "The Case for Quality—The Danger of Junk." GMO White Paper.

Greenblatt, Joel. 2010. "The Little Book That Beats the Market." *John Wiley & Sons,* Hoboken, New Jersey.

Haugen, Robert A., and Nardin L.Baker. 1996. “Commonality in the determinants of expected stock returns.” *Journal of Financial Economics,* pp. 401-439.

Joyce, Chuck, and Kimball Mayer. 2012. “Profits for the Long Run: Affirming the Case for Quality.” GMO White Paper.

Lapthorne, Andrew, Rui Antunes, John Carson, Georgios Oikonomou, and Charles Malafosse. 2012. “Global Quality Income Index: The Methodology.” Societe General White paper. http://www.structured-solutions.de/downloads/DE000SLA0SG2_leitfaden.pdf

Mead, Katrina, Jonathan Sage, and Mark Citro. 2013. “Power Couple: Quality and Value are Strong Drivers of Long-Term Equity Returns.” MFS White Paper Series.

Ng, Edmund. 2009. “A “New Magic” Formula—a ‘Combo’ Strategy Inspired By Greenblatt & Piotroski.” Morgan Stanley Research Paper.

Novy-Marx, Robert. 2013. “The Other Side of Value: The Gross Profitability Premium.” *Journal of Financial Economics,* forthcoming.

Novy-Marx, Robert, and Mihail Velikov. 2013. “Anomalies and their Trading Costs. ” Working paper.

Piotroski, Joseph D. 2000. “Value Investing: The Use of Historical Financial Statement Information to Separate Winners from Losers.” *Journal of Accounting Research,* pp. 1-41.

Piotroski, Joseph D., and So, Eric C. 2012. “Identifying Expectation Errors in Value/Glamour Strategies: A Fundamental Analysis Approach.” *Review of Financial Studies,* forthcoming.

Appendix A: Variable Definitions

Variables employed in this paper are constructed primarily from Compustat data, which is assumed to be publically available by the end of June in the calendar year following that in which each firms' fiscal year ends. Detailed definitions, as well as the Compustat data items employed in the construction of tehse variables, are given below.

- **Book-to-price (B/P):** Book equity scaled by market equity, where market equity is lagged six months in the strategies that do not trade momentum to avoid taking unintentional positions in momentum. Book equity is shareholder equity, plus deferred taxes, minus preferred stock, when available. For the components of shareholder equity, I employ tiered definitions largely consistent with those used by Fama and French (1993) to construct their high minus low factor (HML). Stockholders equity is as given in Compustat (SEQ) if available, or else common equity plus the carrying value of preferred stock (CEQ + PSTX) if available, or else total assets minus total liabilities (AT - LT). Deferred taxes is deferred taxes and investment tax credits (TXDITC) if available, or else deferred taxes and/or investment tax credit (TXDB and/or ITCB). Preferred stock is redemption value (PSTKR) if available, or else liquidating value (PSTKRL) if available, or else carrying value (PSTK)**.**

- **Earnings-to-price (E/P):** Net income (NI) scaled by market equity.

- **Greenblatt's earnings yield (EY):** Earnings before interest and taxes (EBIT) scaled by enterprise value (EV). Enterprise value is market equity, plus long term debt (DLTT), plus debt in current liabilities (DLC), plus preferred stock (as defined above), minus cash and short term investments (CHE).

- **Graham G-score:** The G-score gets one point if current assets (ACT) exceeds twice current liabilities (LCT) , one point if net current assets (WCAP) exceed long term debt (DLTT), one point if net earnings have been positive each of

the last ten years, one point if dividends plus buy-backs have been positive each of the last ten years, and one point if current earnings per share are at least 33% higher than 10 years ago.

- **Grantham quality rank:** Average ranks of returns-on-equity (ROE), asset-to-book equity, and the inverse of ROE volatility. ROE is net income-to-book equity. ROE volatility is the standard deviation of ROE over the preceding five years.

- **Greenblatt's return on invested capital:** EBIT-to-tangible capital, where tangible capital is property, plant and equipment (PPEGT) plus working capital (WCAP).

- **Sloan's accruals:** Measured as the year-over-year change in current assets (ACT) excluding cash and short term liabilities (CHE), minus the change in long term liabilities (LCT) excluding debt in current liabilities (LCT) and income taxes payable (TXP), minus the depreciation and amortization (DPC). Following Sloan (1996), accruals are scaled by the average of total assets and total assets lagged one year.

- **Piotroski's F-score:** Constructed as the sum of nine binary variables that take the value zero (indicating weakness) or one (indicating strength). The F-score can get gets one point for each of four profitability signals [positive earnings before extraordinary items (IB), positive cash flows from operations (OANCF), increasing returns-on-assets (IB/AT that exceeds that of the previous year), and negative accruals]; one point for each of three liquidity signals [decreasing debt, increasing current ratio, and no equity issuance]; and one point for each of two efficiency signals [increasing gross margins (revenues (REVT) minus cost of goods sold (COGS) scaled by revenues) and increasing asset turnover (revenues scaled by assets)].

Gross profits-to-assets (GP/A): Revenues minus cost of goods sold (REVT - COGS) scaled by total book assets (AT).

Appendix B: Strategies Based on Quality Alone

Table A1 shows the performance of strategies based purely on the six different quality metrics employed in this paper (the G-score aggregate of the Graham quality criteria, Grantham quality [aggregate of high ROE, low leverage and low ROE volatility ranks], Greenblatt's return on invested capital, Sloan's accruals to assets [low = high quality], Piotroski's F-score measure of financial strength, and gross profits-to-assets). Strategies are value-weighted and rebalanced annually, at the end of June. Portfolios are formed using the standard 30% signal cutoffs for the universe in which they are formed employed in the rest of this paper. The sample runs from July 1963 to December 2012.

Panels A and B show that the strategies based purely on the G-score aggregate of Graham's quality criteria and the Grantham quality aggregate of high returns, steady returns and low leverage all failed to generate significant net active returns (long-only strategies) or significant net excess returns (long/short strategies), though the small cap long/short Grantham quality strategy did earn marginally significant abnormal returns relative to small cap value and the small cap benchmark. In Table 5 we saw that both the Graham strategy and the Grantham value strategy, which selected stocks on the basis of value signals combined with the G-score or the Grantham quality metric, had significant alphas relative to value and the benchmark in the small cap universe. This suggests that combining these quality metrics with valuations at the signal level (i.e., selecting stocks on the basis of a signal that puts weight on both quality and price) is more effective than combining the strategies at the portfolio level (i.e., running value and quality side-by-side).

Panel C shows that the all the strategies formed purely on the basis of Greenblatt's return on invested capital quality metric failed to deliver abnormal returns relative to value and the benchmark, except for the large-cap long-only strategy, which earned marginally significant abnormal returns despite earning

active returns close to zero. This suggests that the benefits from ROIC derive from the hedging it provides for value strategies.

Panel D shows that long-only strategies based on Sloan's accruals generated significant active returns among the small caps, while the long/short strategies earned significant net excess returns in both the large and small cap universes. In all cases abnormal returns relative to value and the benchmark were smaller than the unadjusted returns. This suggests that the accruals strategies are at least to a small degree value strategies themselves, and calls into question whether earnings quality strategies really quality strategies at all.

Panel E shows that long-only strategies based on Piotroski's F-score generated significant active returns among the small caps, while the long/short strategies earned significant net excess returns in both the large and small cap universes, though spreads were only half as large and marginally significant for the large stock strategies.

Panel F shows that while the long-only strategies based on gross profitability generated positive net active returns and the long/short strategies generated positive net excess returns, none of these was statistically significant. All the strategies did generate significant abnormal returns, however, relative to value and their benchmarks, and these abnormal returns were quite large for the large cap strategies. This suggests that the primary benefit from gross profitability, similar to Greenblatt's ROIC, come primarily through the hedge it provides for value strategies. Unlike ROIC, however, this is not the only benefit gross profitability provides. Integrating gross profitability into value strategies reduces the strategies volatilities while simultaneously increasing the size of the returns they generate (Tables 1 and 4).

Table A1. Performance of Strategies Based on Quality Alone

Portfolio	Long Side		Short Side		L - S (β-hedged)	
Universe	Large	Small	Large	Small	Large	Small
Panel A: Graham quality (sorted on G-score aggregate of Grantham's quality criteria)						
Gross Excess Return	5.3% |2.46|	8.0% |2.69|	6.4% |2.60|	7.2% |2.32|	-0.8% |-0.63|	1.2% |0.93|
Annual Turnover	15.4%	10.3%	28.6%	30.5%	44.0%	40.8%
Trading Costs	0.1%	0.1%	0.2%	0.4%	0.3%	0.5%
Net Excess Return	**5.2%** **[2.43]**	**7.9%** **[2.65]**	6.2% [2.52]	6.8% [2.20]	**-1.0%** **[-0.86]**	**0.7%** **[0.54]**
Vol.	15.2%	21.0%	17.4%	21.9%	8.4%	8.7%
S.R.	0.34	0.38	0.36	0.31	**-0.12**	**0.08**
β to benchmark	0.97	1.01	1.05	1.03	0.00	0.00
α to value and the benchmark	0.3% |0.76|	0.5% |0.67|	0.2% |0.26|	-1.1% |-1.08|	-0.1% |-0.12|	2.3% |1.94|
Growth of $1 (nom.) Growth of $1 (real)	$92.0 $12.5	$201.9 $27.4			$6.2 $0.8	$14.1 $1.9
Net Active Return	**-0.2%** **[-0.51]**	**0.0%** **[-0.03]**	0.8% |0.81|	-1.1% |-1.10|		
T.E. Vol.	2.9%	5.5%	6.9%	7.0%		
I.R.	**-0.07**	**0.00**	0.12	-0.16		
Max. Drawdown	-29.9%	-48.2%			-30.7%	-52.6%
1 year underperf.	55.1%	49.9%			34.0%	33.1%
5 year underperf.	58.3%	57.8%			27.9%	16.6%
Panel B: Grantham quality (sorted on average ROE, A/BE and inverse ROE vol. ranks)						
Gross Excess Return	5.6% |2.53|	8.2% |2.79|	6.1% |2.39|	7.3% |2.15|	0.0% |0.01|	2.5% |2.29|
Annual Turnover	19.2%	23.7%	30.6%	28.0%	49.8%	51.8%
Trading Costs	0.1%	0.3%	0.2%	0.4%	0.3%	0.7%
Net Excess Return	**5.5%** **[2.48]**	**7.9%** **[2.69]**	6.0% |2.32|	6.9% |2.04|	**-0.3%** **[-0.24]**	**1.9%** **[1.67]**
Vol.	15.5%	20.8%	18.1%	24.0%	8.0%	7.9%
S.R.	0.35	0.38	0.33	0.29	**-0.03**	**0.24**
β to benchmark	0.97	0.99	1.13	1.16	0.00	-0.01
α to value and the benchmark	0.9% |1.70|	0.6% |0.73|	-0.4% |-0.46|	-1.7% |-2.19|	0.9% |0.89|	2.7% |2.47|
Growth of $1 (nom.) Growth of $1 (real)	$100.2 $13.6	$210.0 $28.5			$9.2 $1.2	$26.5 $3.6
Net Active Return	**0.0%** **[-0.00]**	**0.0%** **[-0.00]**	0.5% |0.63|	-1.0% |-1.09|		
T.E. Vol.	4.2%	5.6%	5.7%	6.4%		
I.R.	**0.00**	**0.00**	0.09	-0.15		
Max. Drawdown	-34.6%	-42.0%			-54.9%	-22.9%
1 year underperf.	50.9%	51.1%			29.8%	25.6%
5 year underperf.	46.0%	55.9%			11.6%	6.0%

Table A1 (continued).

Portfolio	Long Side		Short Side		L - S (β-hedged)	
Universe	Large	Small	Large	Small	Large	Small
Panel C: Greenblatt quality (sorted on return on invested capital)						
Gross Excess Return	5.8% |2.54|	8.4% |2.80|	4.6% |1.91|	5.4% |1.54|	0.8% |0.60|	4.2% |2.91|
Annual Turnover	15.8%	18.5%	25.1%	32.2%	40.9%	50.7%
Trading Costs	0.1%	0.2%	0.2%	0.5%	0.2%	0.7%
Net Excess Return	**5.8%** **[2.50]**	**8.1%** **[2.73]**	4.4% |1.84|	5.0% |1.41|	**0.6%** **[0.43]**	**3.5%** **[2.43]**
Vol.	16.2%	21.0%	16.9%	24.8%	9.5%	10.2%
S.R.	0.36	0.39	0.26	0.20	**0.06**	**0.35**
β to benchmark	1.01	1.00	1.02	1.16	-0.01	-0.01
α to value and the benchmark	1.4% |2.33|	0.1% |0.16|	-1.4% |-1.51|	-2.5% |-2.56|	2.3% |2.01|	2.8% |1.92|
Growth of $1 (nom.) Growth of $1 (real)	$110.1 $14.9	$226.0 $30.7			$13.1 $1.8	$54.0 $7.3
Net Active Return	**0.3%** **[0.46]**	**0.2%** **[0.24]**	-1.0% |-1.10|	-2.9% |-2.33|		
T.E. Vol.	4.7%	5.8%	6.6%	8.9%		
I.R.	**0.07**	**0.03**	-0.16	-0.33		
Max. Drawdown 1 year underperf. 5 year underperf.	-35.6% 46.0% 47.1%	-29.5% 51.6% 49.7%			-48.2% 31.9% 24.3%	-42.8% 25.0% 9.2%
Panel D: Earnings quality (sorted on accruals)						
Gross Excess Return	6.0% |2.61|	10.3% |3.30|	3.8% |1.54|	5.4% |1.61|	3.0% |2.85|	5.3% |5.43|
Annual Turnover	41.6%	51.1%	51.6%	54.9%	93.2%	106.0%
Trading Costs	0.2%	0.6%	0.3%	0.7%	0.5%	1.3%
Net Excess Return	**5.8%** **[2.51]**	**9.7%** **[3.09]**	3.5% |1.43|	4.7% |1.41|	**2.5%** **[2.37]**	**4.0%** **[4.04]**
Vol.	16.3%	22.1%	17.4%	23.6%	7.5%	7.0%
S.R.	0.36	0.44	0.20	0.20	**0.34**	**0.57**
β to benchmark	1.02	1.07	1.10	1.14	0.00	0.01
α to value and the benchmark	0.2% [0.35]	0.6% [0.77]	-2.0% [-3.24]	-3.4% [-4.91]	2.1% [1.94]	3.3% [3.30]
Growth of $1 (nom.) Growth of $1 (real)	$112.4 $15.2	$428.9 $58.2			$37.2 $5.0	$78.1 $10.6
Net Active Return	**0.4%** **[0.55]**	**1.8%** **[2.25]**	-1.9% |-2.74|	-3.2% |-3.66|		
T.E. Vol.	4.8%	5.5%	4.9%	6.1%		
I.R.	**0.08**	**0.32**	-0.39	-0.52		
Max. Drawdown 1 year underperf. 5 year underperf.	-31.2% 45.6% 46.7%	-28.9% 36.9% 28.8%			-20.9% 15.4% 0.0%	-18.1% 14.6% 2.1%

Table A1 (continued).

Portfolio	Long Side		Short Side		L - S (β-hedged)	
Universe	Large	Small	Large	Small	Large	Small
Panel E: Financial strength (sorted on Piotroski's F-score)						
Gross Excess Return	6.4% |2.98|	10.5% |3.67|	4.0% |1.62|	5.9% |1.71|	3.0% |2.75|	6.3% |5.75|
Annual Turnover	58.8%	55.8%	80.6%	77.0%	139.4%	132.8%
Trading Costs	0.3%	0.6%	0.4%	1.0%	0.7%	1.7%
Net Excess Return	**6.1%** **[2.83]**	**9.8%** **[3.44]**	3.6% |1.44|	4.8% |1.41|	**2.3%** **[2.06]**	**4.7%** **[4.14]**
Vol.	15.1%	20.1%	17.5%	24.1%	7.8%	7.9%
S.R.	0.40	0.49	0.20	0.20	**0.29**	**0.59**
β to benchmark	0.96	0.98	1.07	1.15	-0.01	-0.02
α to value and the benchmark	0.8% |1.57|	1.1% |1.99|	-2.1% |-2.39|	-3.5% |-3.82|	2.5% |2.28|	4.1% |3.64|
Growth of $1 (nom.) Growth of $1 (real)	$139.5 $18.9	$568.1 $77.0			$32.7 $4.4	$104.6 $14.2
Net Active Return	**0.6%** **[1.22]**	**1.9%** **[3.25]**	-1.9% |-2.12|	-3.1% |-2.96|		
T.E. Vol.	3.5%	4.1%	6.2%	7.4%		
I.R.	**0.17**	**0.46**	-0.30	-0.42		
Max. Drawdown 1 year underperf. 5 year underperf.	-15.5% 45.5% 32.9%	-11.5% 30.5% 10.5%			-17.0% 15.1%	-17.8% 14.2% 1.5%
Panel F: Gross profitability (sorted on GP/A)						
Gross Excess Return	6.5% |2.86|	9.6% |3.22|	4.2% |1.91|	6.7% |2.31|	2.0% |1.44|	3.0% |2.11|
Annual Turnover	10.7%	12.4%	17.4%	16.8%	28.1%	29.3%
Trading Costs	0.1%	0.2%	0.1%	0.2%	0.2%	0.4%
Net Excess Return	**6.5%** **[2.84]**	**9.4%** **[3.17]**	4.1% |1.87|	6.5% |2.23|	**1.8%** **[1.32]**	**2.6%** **[1.84]**
Vol.	16.1%	20.9%	15.4%	20.4%	9.7%	10.1%
S.R.	0.40	0.45	0.27	0.32	**0.19**	**0.26**
β to benchmark	0.98	0.97	0.95	0.97	-0.01	-0.01
α to value and the benchmark	2.5% [3.59]	2.3% [2.00]	-1.6% [-2.37]	-0.2% [-0.31]	4.1% [3.87]	3.5% [2.44]
Growth of $1 (nom.) Growth of $1 (real)	$158.9 $21.5	$432.1 $58.6			$24.1 $3.3	$35.2 $4.8
Net Active Return	**1.0%** **[1.28]**	**1.5%** **[1.36]**	-1.4% |-1.81|	-1.5% |-1.69|		
T.E. Vol.	5.7%	7.8%	5.3%	6.1%		
I.R.	**0.18**	**0.19**	-0.26	-0.24		
Max. Drawdown 1 year underperf. 5 year underperf.	-40.0% 42.5% 34.6%	-45.4% 43.7% 37.2%			-47.0% 28.6% 15.1%	-35.7% 26.9% 10.7%

Table A2 shows the correlations between book-to-prices and the quality measures used to construct the strategies in Table A1 (Panel A), as well as return correlations between the long/short strategies constructed using these variables in both the large and small cap universes (Panels B and C). The Table helps explain the results observed in Table A1. The Table shows that gross profitability and ROIC are the quality measures most negatively correlated with book-to-price, and that the strategies based on these two measures have the strongest negative correlations with traditional value strategies, especially among large cap stocks. The table also shows that all the quality measure, with the exception of earnings quality, are negatively correlated with book-to-price and positively correlated with each other. Earnings quality is positively correlated with book-to-price, and negatively correlated with other measures of quality, suggesting it is perhaps not really a quality measure at all.

Table A2. Correlations Between Book-to-Price and Quality Variable

Variable	B/P	GQ1	GQ2	ROIC	EQ	F
Panel A: Variable rank correlations						
Graham G-score (GQ1)	0.04					
Grantham quality (GQ2)	-0.08	0.34				
Return on Invested Capital (ROIC)	-0.21	0.17	0.51			
Earnings quality (EQ)	0.07	-0.13	-0.19	-0.27		
Piotroski's F-score (F)	0.02	0.14	0.33	0.34	-0.03	
Gross profitability (GP)	-0.16	0.25	0.25	0.47	-0.10	0.18
Panel B: Correlations of returns to large cap strategies based on the variables						
Graham G-score (GQ1)	-0.34					
Grantham quality (GQ2)	-0.45	0.61				
Return on Invested Capital (ROIC)	-0.61	0.32	0.50			
Earnings quality (EQ)	0.27	-0.04	-0.04	-0.45		
Piotroski's F-score (F)	-0.11	-0.01	0.22	0.27	-0.04	
Gross profitability (GP)	-0.71	0.45	0.51	0.76	-0.33	0.10
Panel C: Correlations of returns to small cap strategies based on the variables						
Graham G-score (GQ1)	-0.35					
Grantham quality (GQ2)	-0.18	0.44				
Return on Invested Capital (ROIC)	0.13	0.02	0.50			
Earnings quality (EQ)	0.35	-0.28	-0.20	-0.32		
Piotroski's F-score (F)	0.22	-0.12	0.34	0.58	0.04	
Gross profitability (GP)	-0.24	0.41	0.43	0.60	-0.42	0.21

Appendix C: Momentum Strategies that Hold 30% of Names

Table A3 reproduces the results of Table 6, using strategies that always buy the top 30% of stocks by relevant signal instead of the 20-40 methodology of Novy-Marx and Velikov (2013). Portfolios constructed this way using signals the incorporate relatively transient momentum information turnover 200-300%/year (i.e., they sell about a quarter of all the stocks they hold each month), about twice the turnover of strategies constructed using the 20-40 methodology. They consequently incur substantial higher trading costs, ranging on the long/short strategies from 2.7-3.3% per year for large caps and 4.3-6.2% per year for small caps, as opposed to 1.0-1.8% for large caps and 1.8-3.6% per year for small caps. The gross performances of strategies constructed using the two different methodologies are, however, quite similar. As a result the net returns to the strategies constructed using the 20-40 all have highly significant information ratios relative to the net returns of the strategies that always buy the top 30%.

Table A3. Strategies that Incorporate Momentum and Hold 30% of Names

Portfolio	Long Side		Short Side		L - S (β-hedged)	
Universe	Large	Small	Large	Small	Large	Small
Panel A: Momentum (sorted on past performance rank)						
Gross Excess Return	9.7% [3.62]	13.8% [3.94]	3.6% [1.38]	1.5% [0.40]	6.8% [2.87]	13.3% [5.37]
Annual Turnover	295.7%	204.9%	301.0%	269.5%	596.7%	474.4%
Trading Costs	1.6%	2.4%	1.7%	3.7%	3.3%	6.2%
Net Excess Return	**8.1%** **[3.02]**	**11.3%** **[3.23]**	1.9% [0.74]	-2.2% [-0.60]	**3.5%** **[1.49]**	**7.1%** **[2.88]**
Vol.	18.8%	24.7%	18.5%	26.1%	16.8%	17.4%
S.R.	0.43	0.46	0.11	-0.09	**0.21**	**0.41**
β to benchmark	1.07	1.11	1.07	1.21	-0.07	-0.09
Growth of $1 (nom.) Growth of $1 (real)	$274.33 $37.20	$707.93 $95.99			$35.64 $4.83	$189.84 $25.74
Net Active Return	**2.6%** **[2.00]**	**3.4%** **[2.23]**	-3.5% [-2.83]	-10.2% [-7.11]		
T.E. Vol.	9.3%	10.7%	8.7%	10.0%		
I.R.	**0.28**	**0.32**	-0.40	-1.01		
Max. Drawdown 1 year underperf. 5 year underperf.	-37.8% 40.0% 18.9%	-56.1% 37.9% 16.1%			-51.6% 29.7% 7.5%	-55.0% 21.1% 8.2%
Panel B: Joint value and momentum (sorted on average B/M and past performance ranks)						
Gross Excess Return	8.4% [3.77]	13.5% [5.02]	2.9% [1.20]	0.5% [0.13]	6.6% [4.08]	14.8% [9.93]
Annual Turnover	225.3%	206.6%	219.7%	236.1%	445.0%	442.8%
Trading Costs	1.3%	2.4%	1.2%	3.0%	2.5%	5.4%
Net Excess Return	**7.1%** **[3.19]**	**11.1%** **[4.12]**	1.7% [0.71]	-2.5% [-0.73]	**4.1%** **[2.56]**	**9.3%** **[6.30]**
Vol.	15.7%	18.9%	17.0%	24.7%	11.4%	10.4%
S.R.	0.45	0.59	0.10	-0.10	**0.36**	**0.90**
β to benchmark	0.94	0.91	1.04	1.18	-0.04	-0.02
α to val., mom., and the benchmark	-1.0% [-2.02]	0.5% [1.17]	-1.4% [-2.79]	-4.0% [-7.16]	-0.4% [-0.68]	2.5% [3.54]
Growth of $1 (nom.) Growth of $1 (real)	$223.4 $30.3	$1,165.9 $158.1			$69.2 $9.4	$911.0 $123.5
Net Active Return	**1.7%** **[1.84]**	**3.2%** **[4.13]**	-3.7% [-4.34]	-10.5% [-9.33]		
T.E. Vol.	6.5%	5.4%	6.1%	7.9%		
I.R.	**0.26**	**0.59**	-0.62	-1.33		
Max. Drawdown 1 year underperf. 5 year underperf.	-32.8% 41.5% 39.3%	-24.1% 27.8% 11.6%			-36.9% 24.5% 6.0%	-37.0% 10.6% 6.7%

Table A3 (continued).

Portfolio	Long Side		Short Side		L - S (β-hedged)	
Universe	Large	Small	Large	Small	Large	Small
Panel C: Joint quality, value, and momentum (sorted on average GP/A, B/M, and past performance ranks)						
Gross Excess Return	10.0% [4.29]	14.4% [4.85]	1.3% [0.51]	1.6% [0.44]	9.4% [6.13]	13.9% [9.85]
Annual Turnover	259.3%	182.2%	235.1%	171.2%	494.5%	353.4%
Trading Costs	1.3%	2.1%	1.3%	2.2%	2.7%	4.3%
Net Excess Return	**8.7%** **[3.71]**	**12.4%** **[4.16]**	-0.1% [-0.03]	-0.7% [-0.19]	**6.7%** **[4.39]**	**9.6%** **[6.84]**
Vol.	16.5%	20.9%	17.5%	24.6%	10.7%	9.9%
S.R.	0.53	0.59	0.00	-0.03	**0.62**	**0.97**
β to benchmark	1.00	1.00	1.08	1.17	-0.04	-0.02
α to val., mom., and the benchmark	2.1% [3.62]	2.4% [4.03]	-3.8% [-7.15]	-4.0% [-5.37]	4.6% [4.93]	4.8% [4.50]
Growth of $1 (nom.)	$452.5	$1,796.3			$250.3	$1,104.1
Growth of $1 (real)	$61.4	$243.6			$33.9	$149.7
Net Active Return	**3.2%** **[3.68]**	**4.4%** **[5.50]**	-5.5% [-6.63]	-8.6% [-7.54]		
T.E. Vol.	6.2%	5.7%	5.9%	8.0%		
I.R.	**0.52**	**0.78**	-0.94	-1.07		
Max. Drawdown	-20.1%	-15.8%			-18.3%	-22.9%
1 year underperf.	26.9%	18.0%			13.2%	10.8%
5 year underperf.	4.5%	8.4%			2.2%	0.0%