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Investment and Expected Stock Returns

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Valuation theory predicts that, all else equal, expected investment should be negatively related to expected returns. To empirically test this relation, we need a reliable proxy for expected investment. We show that, consistent with prior academic research, recent asset growth is a reliable proxy for expected investment. Using this proxy, we find a negative investment effect across developed and emerging markets as well as across sectors, consistent with the prediction of valuation theory. The effect is much stronger among small caps than large caps and is mainly driven by the underperformance of high investment firms. Examining the different components of asset growth related to raising of capital (equity issuance, debt issuance, and growth in retained earnings) as well as those related to use of capital (growth in physical capital and growth in intangible capital), we find that all of these components contribute to the investment effect.

1. INTRODUCTION

Valuation theory provides a framework for analyzing the drivers of expected returns, linking expectations about a firm's future cash flows to investors to its current value through a discount rate. Algebraically, the valuation equation says that, for a given firm's value, lower expected cash flows indicate lower discount rates, as shown in Equation 1:

$$Market\ Value\ (t) = \sum_{\tau=1}^{\infty} \frac{E\big(Cash\ Flow(t+\tau)\big)}{(1+r)^{\tau}}, \quad (1)$$

where r denotes the discount rate. A firm's expected future cash flows to shareholders can be expressed as expected future profits less changes in retained earnings and equity issuance, and hence Equation 1 can be expressed as:[1]

1. See Appendix for the derivation.

$$Market\ Value(t) = \sum_{\tau=1}^{\infty} \frac{E(Profits(t+\tau)) - E(\Delta Retained\ Earnings(t+\tau)) - E(Equity\ Issuance(t+\tau))}{(1+r)^{\tau}}. \quad (2)$$

The latter two components of expected cash flows are part of expected growth in assets, which is a broader measure of expected investment that also captures debt issuance. Therefore, a firm's expected future cash flows to shareholders can be expressed as the difference between expected future profits and investment.

$$Market\ Value\ (t) = \sum_{\tau=1}^{\infty} \frac{E(Profits(t+\tau)) - E(Investment(t+\tau))}{(1+r)^{\tau}}. \quad (3)$$

This equation implies that expected future investment should be negatively related to discount rates, controlling for a firm's market value and expected profitability. Simply put, a company that must invest heavily to sustain its profits should have lower cash flows to investors than a company with similar profits but lower investment. If both companies trade at the same price today, the implication is that the company with higher investment and, thus, lower cash flows has a lower discount rate.

The negative relation between expected investment and expected stock returns is discussed and tested in many academic studies. For example, motivated by valuation theory, Fama and French (2006) examine the investment effect in the US market. They find that, controlling for price-to-book ratios and expected profitability, expected stock returns are negatively related to expected investment, as proxied by current asset growth. They subsequently examine quintiles sorted on asset growth using data for the US and developed ex US markets and find that the investment premium is stronger among small cap firms and mainly driven by the underperformance of high asset growth firms (Fama and French 2015, 2017); and it helps explain some of the previously reported average return patterns such as those related to share repurchases and issues (Fama and French 2016). Cooper *et al.* (2008) examine US asset growth deciles based on name counts and report a reliable negative return effect for asset growth, primarily driven by the underperformance of high asset growth firms. They also report similar results for the components of asset growth related to the left- and right-hand side of the balance sheet.[2] Our study extends prior research by examining globally the relation between investment and average stock returns through many different lenses (e.g., across size, value, and profitability groups, across sectors, across time periods). The insights gained through this research allow us to evaluate the most efficient way to incorporate the investment effect in practical equity solutions.

2. DATA

We use CRSP, Compustat, and Bloomberg data from July 1974 to December 2018 in the US, from January 1990 to December 2018 in developed ex US markets, and from January 1994 to December 2018 in emerging markets.[3] The US analysis starts in 1974 since NASDAQ joined the US stock market universe in the early 1970s, increasing the cross-section greatly. Year-on-year asset growth is a broad and comprehensive measure of investment commonly used in the academic literature; it is our primary specification of investment in this paper, although we also examine the components of asset growth related to raising of capital (equity issuance, debt issuance, and growth in retained earnings) as well as those related to use of capital (growth in physical capital and growth in intangible capital).

3. PROXY FOR EXPECTED INVESTMENT

Valuation theory points to differences in expected returns across firms with different levels of expected future investment. To capture these differences, we need an observable proxy for expected investment. **Exhibit 1** shows regressions of future year-on-year asset growth on current asset growth in the US. Current asset growth is defined as *[Assets (t) – Assets(t-1)]/Assets(t-1)*. Asset growth one year into the future is defined as *[Assets (t+1) – Assets(t)]/Assets(t)*. Asset growth three years into the future is defined as *[Assets (t+3) – Assets(t+2)]/Assets(t)*. Similarly, asset growth five years into the future is defined as *[Assets (t+5) – Assets(t+4)]/Assets(t)*. We scale future changes in assets by current assets to be consistent with the definition of expected future investment in the valuation equation (see Appendix for more detail). The regressions of future investment on current investment also include firm size, relative price, and profitability as explanatory variables, thereby controlling for other known drivers of expected returns.[4] We find a positive and reliable relation between current and future asset growth, as suggested by positive regression coefficients and high t-statistics. We also examine the relation between current asset growth and cumulative future asset growth, defined as *[Assets (t+3) – Assets(t)]/Assets(t)*, and find qualitatively the same results.

2. See also Richardson and Sloan (2003), Titman *et al.* (2003), Fama and French (2008), Lyandres *et al.* (2008), Watanabe *et al.* (2013), and Hou *et al.* (2014).
3. Bloomberg Barclays data provided by Bloomberg. All rights reserved.
4. Relative price is defined as price-to-book equity. Profitability is defined as operating profits before depreciation and amortization less interest expense, scaled by book equity.

These observations are consistent with the findings of Fama and French (2006). Using Fama-MacBeth regressions and defining future asset growth in a cumulative manner, they find that current asset growth has reliable explanatory power for asset growth over the next three years even when controlling for other firm characteristics such as firm size, relative price, profitability, and accruals.

We also examine the relation between current and future year-on-year asset growth by sorting firms into market-capitalization quartiles based on current asset growth and tracking how the weighted average asset growth of each quartile changes in the five years after the sort. **Exhibit 2** shows that the top asset growth quartile tends to have higher asset growth relative to the rest of the market one, three, and five years into the future both within small and large caps, in US, developed ex US, and emerging markets. For example, among US small cap firms, the top quartile invests about 11–18% more than the other quartiles in the first year after the sort, and 9–15% more in the third and fifth year. Naturally, the dispersion in investment between the top quartile and the rest of the market tends to decline from year one to year five into the future since a firm is unlikely to continue doubling or tripling their assets year on year.

It is important to note that, in general, small caps exhibit a larger dispersion of asset growth than large caps. This is driven mainly by differences between the top investment quartiles. For example, US large cap firms in the top investment quartile grow their assets by 47% on average in the sorting year, while for small cap firms in the top investment quartile, that growth rate is 73% on average. The more extreme asset growth for small caps is consistent with small cap firms having a lower asset base on average. As a result, it is more feasible for small cap firms to grow their assets substantially through the raising of capital. In summary, the results in Exhibits 1 and 2 suggest current asset growth is a systematic and reliable proxy for future asset growth.

4. HISTORICAL RETURNS

Having laid out the theoretical foundations for investment and the empirical persistence of asset growth, we now examine the relation between asset growth and average stock returns.

4.1 Large Caps

We first examine the investment effect in the returns of large cap firms. We sort the large cap universe in each country into asset growth quartiles, each representing approximately 25% of the market capitalization of large caps in that country. **Exhibit 3** reports the results for US, developed ex US, and emerging markets. The spreads in annualized compound returns between the top and bottom quartiles are negative in all three markets, as predicted by valuation theory. However, these return spreads are not reliably different from zero, as indicated by their low t-statistics. To further explore the link between asset growth and subsequent returns in large caps, we also examine decile sorts on asset growth (**Exhibit 4**). While the return spreads are wider and sometimes reliable when we examine finer sorts, the results for large cap firms are generally weak. One explanation for the weaker evidence is that the dispersion of asset growth among large cap firms is low relative to that among small cap firms as observed in the previous section.

4.2 Small Caps

Next, we examine the performance of small cap firms sorted into quartiles based on asset growth, reported in **Exhibit 5**. In the US, we observe similar performance for the bottom three quartiles (annualized compound returns of 14.3% to 16.5%), whereas the annualized compound return for the top quartile is substantially lower (7.2%). The spread in average monthly returns between the bottom and top quartiles is 50 basis points (bps) and is reliably different from zero. The results for developed ex US and emerging markets are similar. In all three regions, we observe a reliably positive investment premium that is driven primarily by the significant underperformance of small cap firms with high asset growth. The pattern is even stronger when we examine deciles based on asset growth (**Exhibit 6**). In each region, the top decile greatly underperforms the other deciles. The strong nonlinear pattern in the performance of small caps is consistent with the strong nonlinear pattern in their weighted average asset growth. For US small caps in the bottom three quartiles, assets grow on average by –10%, 5%, and 15% per year, while for US small caps in the top quartile, assets grow on average by a staggering 72% per year. The dispersion in asset growth is even more dramatic in the decile sorts. For example, the average asset growth for US small caps in the top decile is 128% per year. Based on this analysis, from here on we mainly focus on the top decile to study high asset growth firms.

Overall, our results for the investment premium are consistent with Fama and French (2006, 2008, 2015, 2017) and Cooper *et al.* (2008). Although the methodologies differ slightly—for example, Fama and French (2015, 2017) examine asset growth quintiles based on name counts, and Cooper *et al.* (2008) examine deciles based on name counts—they also find that the investment premium is stronger among small cap firms and driven by the underperformance of high asset growth firms.

How pervasive and persistent is that underperformance? To answer this question, we plot the annual performance of small high asset growth firms in excess of the remaining small cap market. **Exhibit 7** shows the underperformance of small high asset growth firms is pervasive across regions and persistent over time. The top asset growth decile underperforms the rest of the small cap market 84% of the years in the US market, 72% of the years in developed ex US, and 76% of the years in emerging markets.

The persistent and pervasive nature of the underperformance suggests that investors might benefit from incorporating investment in their equity strategies. To do so effectively, investors need to know how long the underperformance of small cap high investment firms tends to last. To examine the rate at which the underperformance decays, **Exhibit 8** plots the average excess monthly return of the small cap firms in the top decile for the first to the 36th month after sorting firms into deciles. The underperformance of the top decile persists on average for about two years after sorting. In comparison, the size, value, and profitability premiums tend to last longer, while the momentum effect tends to disappear six to 12 months after sorting.

Our results thus far have focused on univariate sorts within small and large caps on investment. However, it is also important to examine whether asset growth contains additional information about differences in expected returns beyond that contained in company size, relative price, and profitability. For example, there is ample empirical evidence of historical underperformance of small growth low profitability firms in small cap markets, so it is important to examine whether the investment effect is driven primarily by the underperformance of these firms.[5] To address this question, we divide the small cap universe in each developed and emerging market into four groups based on price-to-book and profitability (value/high profitability, value/low profitability, growth/high profitability, and growth/low profitability) and study the performance of high asset growth firms in each quadrant. **Exhibit 9** compares the performance of high asset growth firms to that of the rest of the firms in each quadrant by region. We observe underperformance of high asset growth firms across the relative price and profitability spectra. Further, high asset growth firms are well represented across quadrants. These observations suggest that the investment premium can add value across the small cap market if incorporated in a strategy that already considers the size, value, and profitability premiums.

4.3 Investment Premium by Sector

In this section we examine the performance of small cap firms sorted on asset growth by sector. The analysis provides insights as to whether the investment effect is driven by certain sectors and what types of sectors a strategy might systematically over- or underweight after excluding high asset growth firms. **Exhibit 10** shows that the historical investment premium is positive across different sectors in US, developed ex US, and emerging markets. We define broad sectors by collapsing GICS and Bloomberg sectors as described in the Appendix in order to have a large enough cross-section in each country-sector pair over time. Consistent with the marketwide results, the investment premium is primarily driven by the underperformance of high asset growth firms. The pervasiveness of the underperformance of small high asset growth firms across sectors in different regions provides additional support for the prediction of valuation theory that firms with higher expected investment have lower expected returns.

4.4 Asset Growth and Sources of Capital

There are three ways in which firms can raise capital to grow their assets. Firms can issue equity, issue debt (by selling bonds or taking on loans), or retain earnings. If one of these sources of capital is the main driver of the investment effect in the data, a strategy that efficiently targets the investment premium should consider a measure that directly focuses on that source.

To examine the role of the three sources of capital, we break down asset growth into an equity issuance component (net equity issuance scaled by lagged assets), a debt issuance component (net new borrowing scaled by lagged assets), and a growth in retained earnings component (change in retained earnings scaled by lagged assets).[6] We then explore the role of those three components in the poor performance of the top asset growth decile. To do that, we assign firms in the top decile of asset growth into subsets based on which component of asset growth is dominant for them. In particular, we consider a firm's high asset growth to be mainly

5. See, for example, Fama and French (1993, 2015); Clark and Rodriguez (2010); Rizova (2012).

6. Equity issuance is defined as the change in the sum of preferred stock and common stock less treasury stock, scaled by lagged assets. Debt issuance is defined as the change in long-term debt plus debt in current liability, scaled by lagged assets.

driven by equity issuance if the equity issuance of the firm accounts for greater than half of its asset growth. We use the same approach to identify firms whose asset growth is primarily driven by debt issuance and growth in retained earnings. If the high asset growth of a firm is not dominated by one source of capital, we assign the firm to the category "No dominant driver of high asset growth." Thus, we obtain four non-overlapping subsets of the top asset growth decile.

Exhibit 11 shows that firms for which equity issuance dominates represent on average 33% of the weight in the top decile, while firms for which debt issuance dominates represent on average 26% of the weight in the top decile, and firms for which growth in retained earnings is the main source of asset growth represent about 6%. Therefore, equity issuance is the most prominent individual driver of high asset growth among US small caps, followed by debt issuance. We also observe that many firms achieve high growth in assets through two or three of the methods to raise capital. This is consistent with Fama and French (2008), who find that both net stock issue and asset growth net of growth in shares outstanding are powerful predictors of the cross-section of stock returns in small caps. Similarly, Cooper *et al.* (2008) also find that both equity and debt issuance are negatively related to expected returns of small caps. Examining the performance of the four subsets of high asset growth firms, we find that all of the subsets substantially underperform the small cap market. For July 1974 to December 2018, the annualized compound return for the small cap market was 12.6% while it was only –0.5% for equity issuance, 4.5% for debt issuance, 1.8% for retained earnings growth, and 4.0% for the subset with no dominant source of asset growth. The underperformance is reliable for all subsets except for growth in retained earnings. The t-statistic for the average monthly return in excess of the small cap market is –4.2 for equity issuance, –4.0 for debt issuance, –1.5 for growth in retained earnings, and –5.1 for the subset with no dominant source of asset growth. The lower t-statistic for growth in retained earnings appears to be driven by the high volatility of that subset (over 35% per year), as the average level of underperformance is similar to that of the other subsets. Overall, the results in Exhibit 11 suggest that all sources of asset growth contribute to the investment effect.

4.5. Asset Growth and Use of Capital

Capital raised through equity issuance, debt issuance, and growth in retained earnings may be used for growth of physical capital (change in physical assets such as inventory and property, plant, and equipment, scaled by lagged assets) or for growth of intangible capital (change in intangible assets on the balance sheet, such as externally acquired intangibles and goodwill, scaled by lagged assets). Again, if one of these components is the primary driver of the investment effect, a strategy that seeks to efficiently target the investment premium should use that specific component.

Following the same approach as the previous section, we identify firms within the top asset growth deciles with their asset growth primarily driven by growth in physical assets, those with their asset growth primarily driven by growth in intangible assets, and those with their asset growth not driven by a single component. Thus, we obtain three non-overlapping subsets of the top asset growth decile based on the use of capital and evaluate the effectiveness of these components in uncovering differences in expected returns.

Exhibit 12 shows that firms for which growth in physical assets dominates represent on average 23% of the weight in the top decile, while firms for which growth in intangible assets dominates represent on average 13% of the weight in the top decile. Examining the performance of the three subsets of high asset growth firms, we find that all of the subsets substantially underperform the small cap market. This suggests that growth in both physical and intangible capital contributes to the investment effect.

The dominance of firms whose high asset growth is not driven by a single use-of-capital component is in part due to the low data availability of growth in intangibles and in part due to many firms growing both physical and intangible capital when they invest. The latter explanation is consistent with our examination of firm-level data, which suggests that M&A activity is often the main reason for high asset growth. It is reasonable to expect some high asset growth firms to be engaged in M&A activity because an M&A transaction can be financed with cash, equity issuance, or debt issuance, and the latter two cases result in growth of the acquirer's total assets—usually both physical and intangible assets. A natural question, then, is whether the investment effect is primarily driven by M&A activity.

To address this question, we test whether the underperformance of small high asset growth firms persists if we exclude firms with M&A activity from the analysis. To identify firms with M&A activity over the trailing one year, we use two variables: positive year-on-year change in goodwill and net cash outflow for acquisitions. Neither measure captures M&A activity completely. For example, goodwill goes up in a year if there is an acquisition at a premium and the firm assigns a portion of the purchase consideration to inseparable intangibles, i.e., goodwill. However, any transaction at a discount would not change goodwill. Moreover, we observe the annual growth of goodwill net of any impairments and, hence, a large impairment might exceed a rise in goodwill due to an acquisition and result in a net decrease in goodwill. Similarly, net cash flow for acquisitions can be zero or negative for a company with M&A activity if the transaction is not financed with cash or if the cash outflow for one acquisition financed with cash is smaller than the cash inflow from another acquisition financed in stock. While neither measure is perfect, they provide us with different ways to identify M&A activity, allowing us to examine the consistency of the results across the measures. We start the analysis in July 1995 as the goodwill data on Compustat are well populated from the early 1990s on. **Exhibit 13** shows US high asset growth firms have poor historical returns regardless of whether firms with M&A activity are included or excluded, which suggests M&A activity is not the only driver of the investment effect. In tests not reported in this paper, we also use a Bloomberg data field that reports the total amount paid for M&A, and we obtain similar results to those shown in Exhibit 13.

In summary, all the capital sources of asset growth appear to contribute to the overall investment effect. The same is true for growth in physical and intangible assets. We also find that M&A is not the sole driver of the investment effect either. In other words, none of these components is the sole driver of the investment effect,[7] suggesting that investors would benefit most from using asset growth as a broad and comprehensive measure of investment.

CONCLUSIONS

Valuation theory predicts that expected investment is negatively related to expected returns, holding all else fixed. Using current asset growth as a proxy for expected investment, we find that high asset growth firms tend to underperform the market and that small cap firms are the primary driver of this underperformance. The investment premium is pervasive across markets and persistent over time. Moreover, it is present across the relative price and profitability segments as well as across sectors. Considering these empirical findings as well as the tradeoffs among expected returns, costs, and diversification, an efficient way to improve the expected performance of an equity strategy investing in small caps might be to systematically exclude small cap firms with high asset growth.

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7. In addition, we also examine book equity growth, change in external financing (equity financing + debt financing) scaled by lagged assets, change in liabilities scaled by lagged assets, change in capital expenditure (capex) scaled by lagged capex, capex scaled by lagged assets, R&D scaled by lagged assets, and net stock issue (growth in split-adjusted shares outstanding). Further, we also examine many of these variables scaled not only by lagged assets but also by lagged book equity. We find small firms ranking highly on these measures of investment also tend to underperform.

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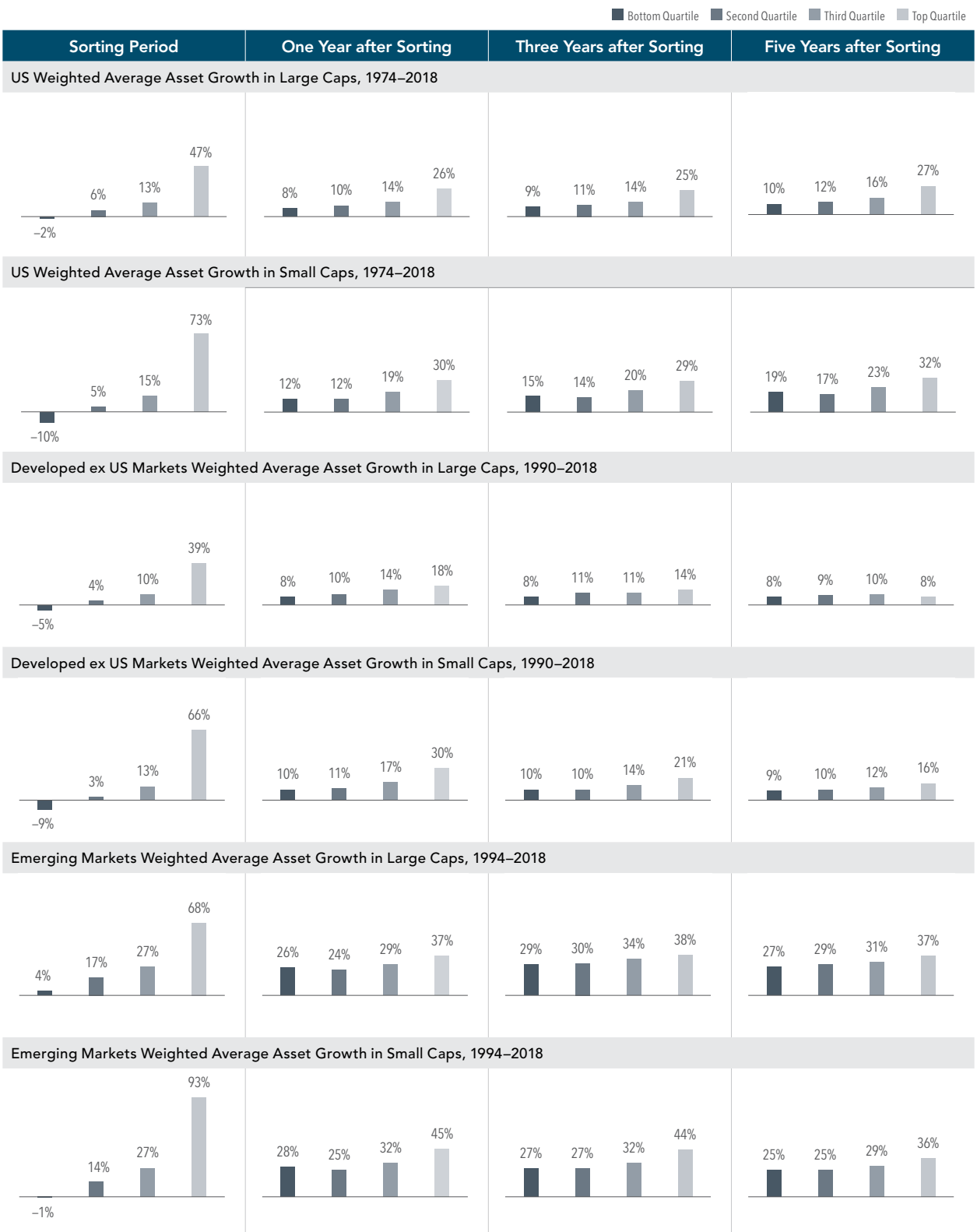
EXHIBITS

Exhibit 1: Fama-MacBeth Cross-Sectional Regressions of Future on Current Asset Growth in the US, *1975–2018*

	Large Caps			Small Caps		
	dA(t)/A(t–1)	t-Statistic	R^2	dA(t)/A(t–1)	t-Statistic	R^2
dA(t+1)/A(t)	0.14	6.0	0.21	0.07	5.8	0.16
dA(t+2)/A(t)	0.13	6.7	0.15	0.05	4.1	0.09
dA(t+3)/A(t)	0.14	6.8	0.11	0.04	3.5	0.06

*Source: Dimensional, using CRSP and Compustat. The regression coefficients, t-statistics, and R^2 values are estimated through Fama-MacBeth regressions of future investment on current firm characteristics: dA(t+y)/A(t) = a + b1 * LN Mcap(t) + b2 * LN BtM(t) + b3 * dA(t)/A(t–1) + b4*Profitability(t) + e, where Mcap, BtM, and A stand for market capitalization, book-to-market ratio, and assets, respectively. dA(t+y) is computed as A(t+y)-A(t+y–1). Annual regressions are performed as of July each year. The standard errors are Newey-West adjusted for three lags. Large and small caps are defined as the top 92% and bottom 8% of the market capitalization, respectively.*

Exhibit 2: Evolution of Weighted Average Asset Growth of Firms Sorted on Current Asset Growth over the Subsequent Five Years



Source: Dimensional, using CRSP, Compustat, and Bloomberg. Eligible stocks are sorted into quartiles based on current year-on-year growth in assets (dA/A) within each size group in the sorting period. The weighted average characteristics of each quartile are examined over the subsequent five years. Future year-on-year growth in assets is scaled by the most recent assets available at the time of sorting. Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical; are not representative of indices, actual investments, or actual strategies managed by Dimensional; and do not reflect costs and fees associated with an actual investment. See Appendix for additional important information.

Exhibit 3: Quartile Sort of Large Cap Firms on Asset Growth

	Large Cap Market	Bottom Quartile	2	3	Top Quartile
US, July 1974–December 2018					
Annualized Compound Return (%)	11.4	13.3	11.6	10.6	9.6
Annualized Standard Deviation (%)	15.3	14.6	14.4	15.7	19.0
Average Monthly Return (%)	1.0	1.1	1.0	0.9	0.9
t-Statistic for Top-Bottom	—	—	—	—	−1.8
Average % of the Market Capitalization within the Large Cap Market	100%	25%	24%	25%	25%
Weighted Average Market Capitalization (USD MM)	54,241	40,974	51,594	63,029	63,236
Weighted Average Book-to-Market Ratio	0.53	0.65	0.57	0.47	0.40
Weighted Average Profitability	0.35	0.33	0.35	0.37	0.35
Weighted Average Asset Growth	0.16	−0.02	0.06	0.13	0.46
Developed ex US Markets, January 1990–December 2018					
Annualized Compound Return (%)	4.3	5.1	4.8	3.8	3.7
Annualized Standard Deviation (%)	16.6	16.5	16.2	17.0	17.8
Average Monthly Return (%)	0.5	0.5	0.5	0.4	0.4
t-Statistic for Top-Bottom	—	—	—	—	−0.9
Average % of the Market Capitalization within the Large Cap Market	100%	24%	25%	24%	24%
Weighted Average Market Capitalization (USD MM)	39,717	33,544	42,253	42,288	36,624
Weighted Average Book-to-Market Ratio	0.51	0.56	0.53	0.51	0.46
Weighted Average Profitability	0.28	0.26	0.28	0.28	0.28
Weighted Average Asset Growth	0.12	−0.04	0.04	0.10	0.37
Emerging Markets, January 1994–December 2018					
Annualized Compound Return (%)	5.0	5.6	6.0	5.5	3.6
Annualized Standard Deviation (%)	21.9	21.4	21.5	22.6	24.4
Average Monthly Return (%)	0.6	0.6	0.7	0.7	0.5
t-Statistic for Top-Bottom	—	—	—	—	−0.7
Average % of the Market Capitalization within the Large Cap Market	100%	24%	24%	24%	24%
Weighted Average Market Capitalization (USD MM)	30,821	21,755	36,117	33,811	25,813
Weighted Average Book-to-Market Ratio	0.53	0.64	0.60	0.50	0.44
Weighted Average Profitability	0.27	0.25	0.27	0.27	0.28
Weighted Average Asset Growth	0.29	0.06	0.18	0.27	0.66

Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower.

Source: Dimensional, using CRSP, Compustat, and Bloomberg. Eligible large cap stocks are sorted into quartiles based on year-on-year growth in assets (dA/A). Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical; are not representative of indices, actual investments, or actual strategies managed by Dimensional; and do not reflect costs and fees associated with an actual investment. See Appendix for additional important information.

Exhibit 4: Decile Sort of Large Cap Firms on Asset Growth

	Large Cap Market	Bottom Decile	2	3	4	5	6	7	8	9	Top Decile
US, July 1974–December 2018											
Annualized Compound Return (%)	11.4	14.2	12.9	11.9	11.1	12.0	11.4	10.0	10.2	9.7	8.7
Annualized Standard Deviation (%)	15.3	16.2	14.9	13.8	14.8	15.7	15.3	17.0	18.0	19.2	20.7
Average Monthly Return (%)	1.0	1.2	1.1	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9
t-Statistic for Top-Bottom	—	—	—	—	—	—	—	—	—	—	–2.3
Developed ex US Markets, January 1990–December 2018											
Annualized Compound Return (%)	4.3	4.9	5.0	4.1	4.2	5.8	4.4	3.6	4.3	4.3	2.6
Annualized Standard Deviation (%)	16.6	17.1	16.8	16.2	16.7	16.8	17.0	17.0	17.8	17.9	18.8
Average Monthly Return (%)	0.5	0.5	0.5	0.4	0.5	0.6	0.5	0.4	0.5	0.5	0.4
t-Statistic for Top-Bottom	—	—	—	—	—	—	—	—	—	—	–1.2
Emerging Markets, January 1994–December 2018											
Annualized Compound Return (%)	5.0	5.5	5.1	7.7	6.3	6.4	6.1	4.8	7.0	3.4	1.5
Annualized Standard Deviation (%)	21.9	21.8	21.8	22.0	22.0	22.3	22.6	23.4	23.6	24.2	25.4
Average Monthly Return (%)	0.6	0.6	0.6	0.8	0.7	0.7	0.7	0.6	0.8	0.5	0.4
t-Statistic for Top-Bottom	—	—	—	—	—	—	—	—	—	—	–1.3

Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower.

Source: Dimensional, using CRSP, Compustat, and Bloomberg. Eligible large cap stocks are sorted into deciles based on year-on-year growth in assets (dA/A). Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical; are not representative of indices, actual investments, or actual strategies managed by Dimensional; and do not reflect costs and fees associated with an actual investment. See Appendix for additional important information.

Exhibit 5: Quartile Sort of Small Cap Firms on Asset Growth

	Small Cap Market	Bottom Quartile	2	3	Top Quartile
US, July 1974–December 2018					
Annualized Compound Return (%)	12.6	14.3	16.5	14.7	7.2
Annualized Standard Deviation (%)	20.3	21.5	17.6	18.9	23.0
Average Monthly Return (%)	1.2	1.3	1.4	1.3	0.8
t-Statistic for Top-Bottom	—	—	—	—	−5.2
Average % of the Market Capitalization within the Small Cap Market	100%	22%	22%	22%	22%
Weighted Average Market Capitalization (USD MM)	539	498	550	563	546
Weighted Average Book-to-Market Ratio	0.68	0.83	0.79	0.66	0.51
Weighted Average Profitability	0.20	0.09	0.24	0.26	0.22
Weighted Average Asset Growth	0.20	−0.10	0.05	0.15	0.72
Developed ex US Markets, January 1990–December 2018					
Annualized Compound Return (%)	5.2	6.0	7.3	5.5	1.9
Annualized Standard Deviation (%)	17.8	18.5	17.0	17.6	19.7
Average Monthly Return (%)	0.6	0.6	0.7	0.6	0.3
t-Statistic for Top-Bottom	—	—	—	—	−2.9
Average % of the Market Capitalization within the Small Cap Market	100%	23%	23%	23%	23%
Weighted Average Market Capitalization (USD MM)	1,073	1,036	1,125	1,109	1,048
Weighted Average Book-to-Market Ratio	0.70	0.78	0.76	0.69	0.57
Weighted Average Profitability	0.22	0.17	0.23	0.24	0.23
Weighted Average Asset Growth	0.18	−0.07	0.04	0.13	0.62
Emerging Markets, January 1994–December 2018					
Annualized Compound Return (%)	5.0	6.3	7.3	4.9	1.1
Annualized Standard Deviation (%)	22.4	22.0	22.4	22.5	24.2
Average Monthly Return (%)	0.6	0.7	0.8	0.6	0.3
t-Statistic for Top-Bottom	—	—	—	—	−3.3
Average % of the Market Capitalization within the Small Cap Market	100%	23%	24%	23%	23%
Weighted Average Market Capitalization (USD MM)	926	852	973	925	903
Weighted Average Book-to-Market Ratio	0.83	0.95	0.94	0.81	0.65
Weighted Average Profitability	0.25	0.19	0.25	0.28	0.33
Weighted Average Asset Growth	0.33	0.01	0.15	0.28	0.89

Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower.

Source: Dimensional, using CRSP, Compustat, and Bloomberg. Eligible small cap stocks are sorted into quartiles based on year-on-year growth in assets (dA/A). Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical; are not representative of indices, actual investments, or actual strategies managed by Dimensional; and do not reflect costs and fees associated with an actual investment. See Appendix for additional important information.

Exhibit 6: Decile Sort of Small Cap Firms on Asset Growth

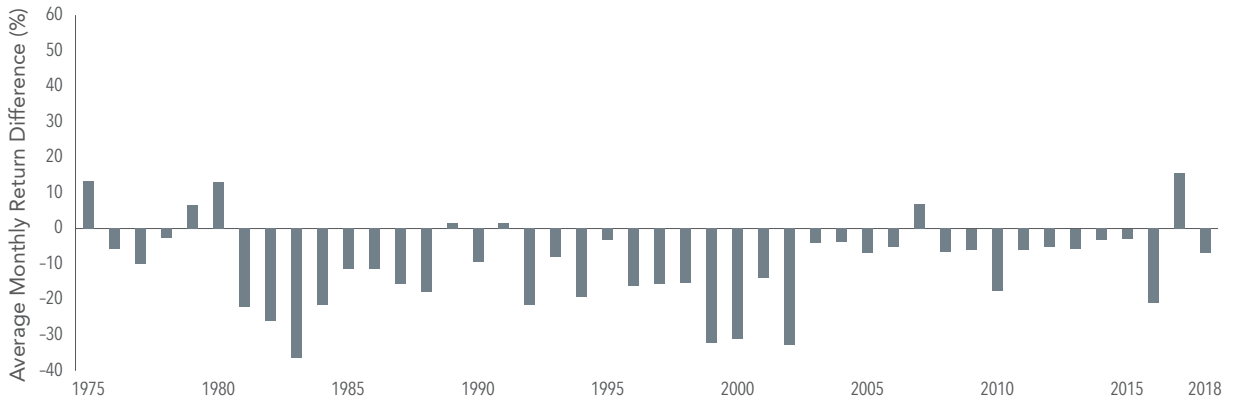
	Small Cap Market	Bottom Decile	2	3	4	5	6	7	8	9	Top Decile
US, July 1974–December 2018											
Annualized Compound Return (%)	12.6	11.9	15.5	16.4	16.3	16.4	15.1	14.3	13.0	10.2	1.9
Annualized Standard Deviation (%)	20.3	25.2	20.2	18.2	17.6	17.7	18.2	19.3	21.1	22.1	25.5
Average Monthly Return (%)	1.2	1.2	1.4	1.4	1.4	1.4	1.3	1.3	1.2	1.0	0.4
t-Statistic for Top-Bottom	—	—	—	—	—	—	—	—	—	—	−5.6
Developed ex US Markets, January 1990–December 2018											
Annualized Compound Return (%)	5.2	4.9	6.7	6.5	7.6	7.3	6.1	4.9	4.8	2.6	−0.1
Annualized Standard Deviation (%)	17.8	19.8	18.1	17.6	17.3	16.8	17.5	17.7	18.6	19.1	21.3
Average Monthly Return (%)	0.6	0.6	0.7	0.7	0.7	0.7	0.6	0.5	0.5	0.4	0.2
t-Statistic for Top-Bottom	—	—	—	—	—	—	—	—	—	—	−2.7
Emerging Markets, January 1994–December 2018											
Annualized Compound Return (%)	5.0	5.4	7.0	6.5	8.0	6.6	5.1	5.7	3.3	2.0	−1.2
Annualized Standard Deviation (%)	22.4	23.0	22.2	22.2	22.7	22.8	22.4	23.0	23.5	24.4	25.1
Average Monthly Return (%)	0.6	0.7	0.8	0.7	0.9	0.8	0.6	0.7	0.5	0.4	0.2
t-Statistic for Top-Bottom	—	—	—	—	—	—	—	—	—	—	−3.0

Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower.

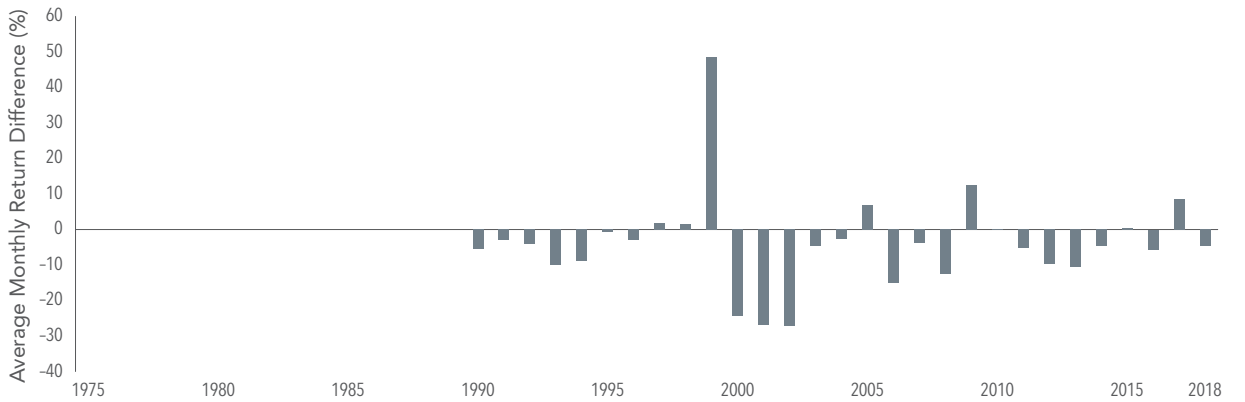
Source: Dimensional, using CRSP, Compustat, and Bloomberg. Eligible small cap stocks are sorted into deciles based on year-on-year growth in assets (dA/A). Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical; are not representative of indices, actual investments, or actual strategies managed by Dimensional; and do not reflect costs and fees associated with an actual investment. See Appendix for additional important information.

Exhibit 7: Annual Returns of Top Asset Growth Deciles in Excess of the Rest of the Small Cap Market

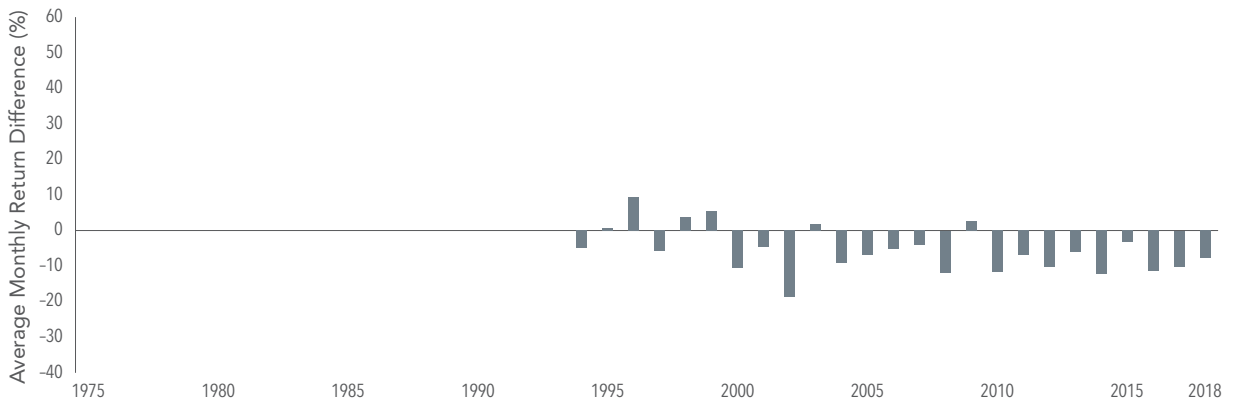
US, July 1974–December 2018



Developed ex US Markets, January 1990–December 2018



Emerging Markets, January 1994–December 2018

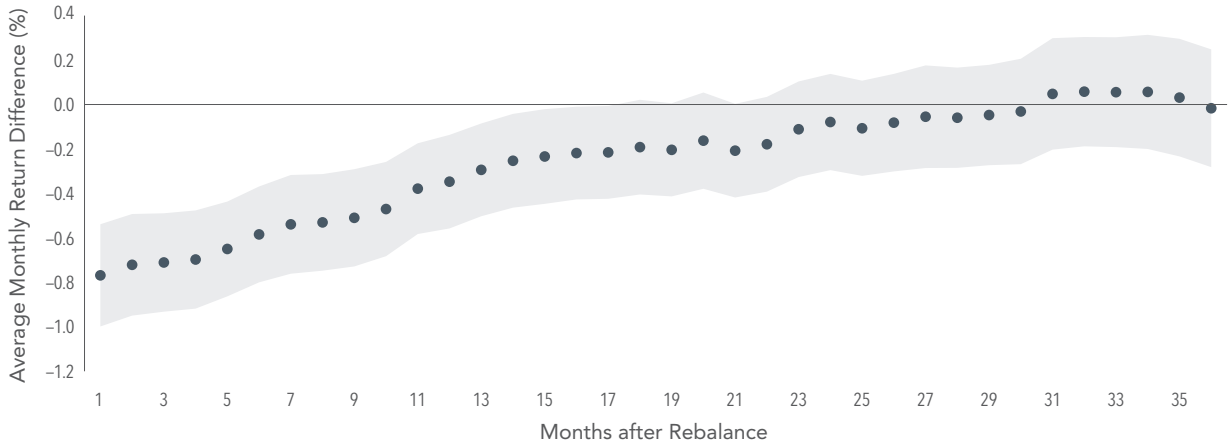


Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower.

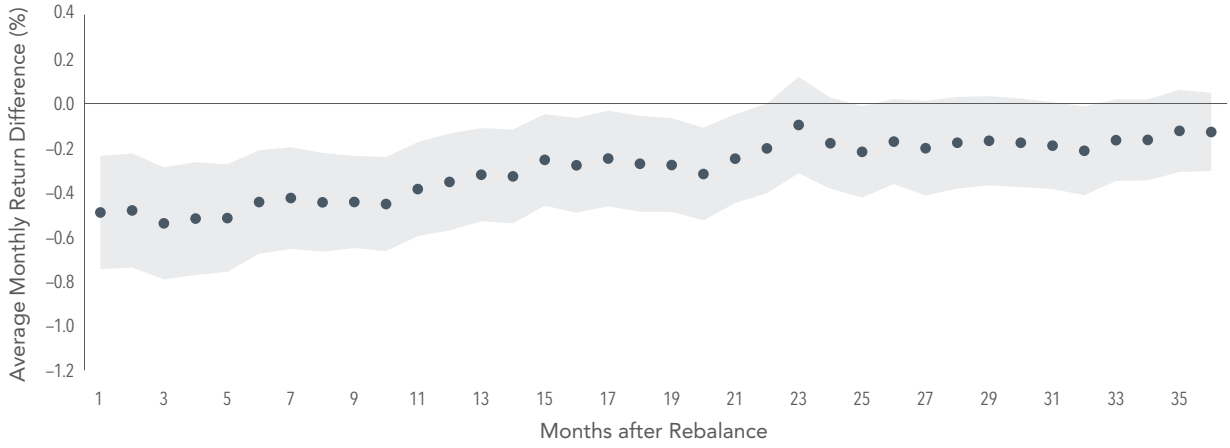
Source: Dimensional, using CRSP, Compustat, and Bloomberg. Eligible small cap stocks are sorted into deciles based on year-on-year growth in assets (dA/A). Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical; are not representative of indices, actual investments, or actual strategies managed by Dimensional; and do not reflect costs and fees associated with an actual investment. See Appendix for additional important information.

Exhibit 8: Evolution of Monthly Return Difference between Top Asset Growth Decile and the Rest of Small Cap Market

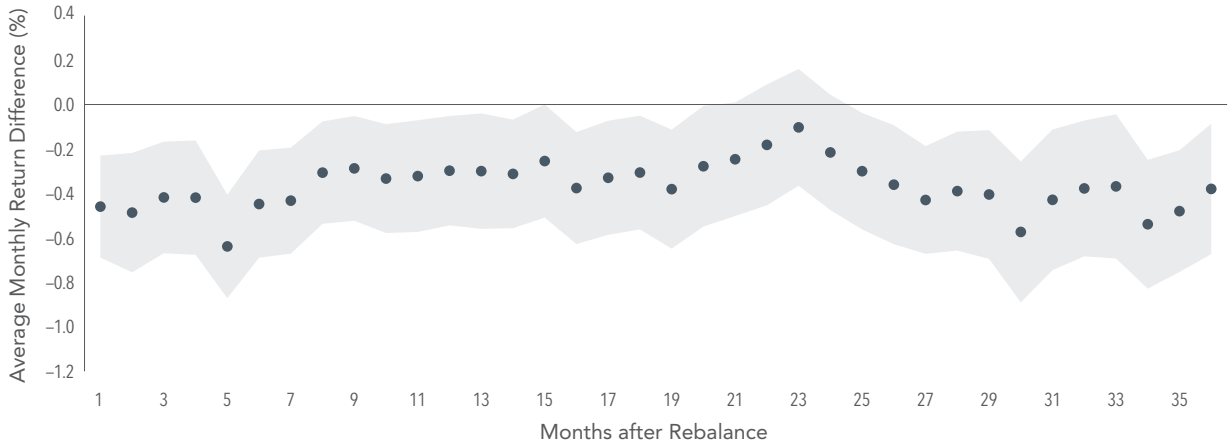
US, July 1974–December 2018



Developed ex US Markets, January 1990–December 2018



Emerging Markets, January 1994–December 2018



Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower.

Source: Dimensional, using CRSP, Compustat, and Bloomberg. The dots represent the average returns, and the shaded areas represent the two standard errors of these averages. Eligible small cap stocks are sorted monthly into deciles based on year-on-year growth in assets (dA/A). The monthly returns on the top deciles are examined relative to the rest of the small cap market over the subsequent three years. Small cap is defined as the bottom 10% of the market capitalization. Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical; are not representative of indices, actual investments, or actual strategies managed by Dimensional; and do not reflect costs and fees associated with an actual investment. See Appendix for additional important information.

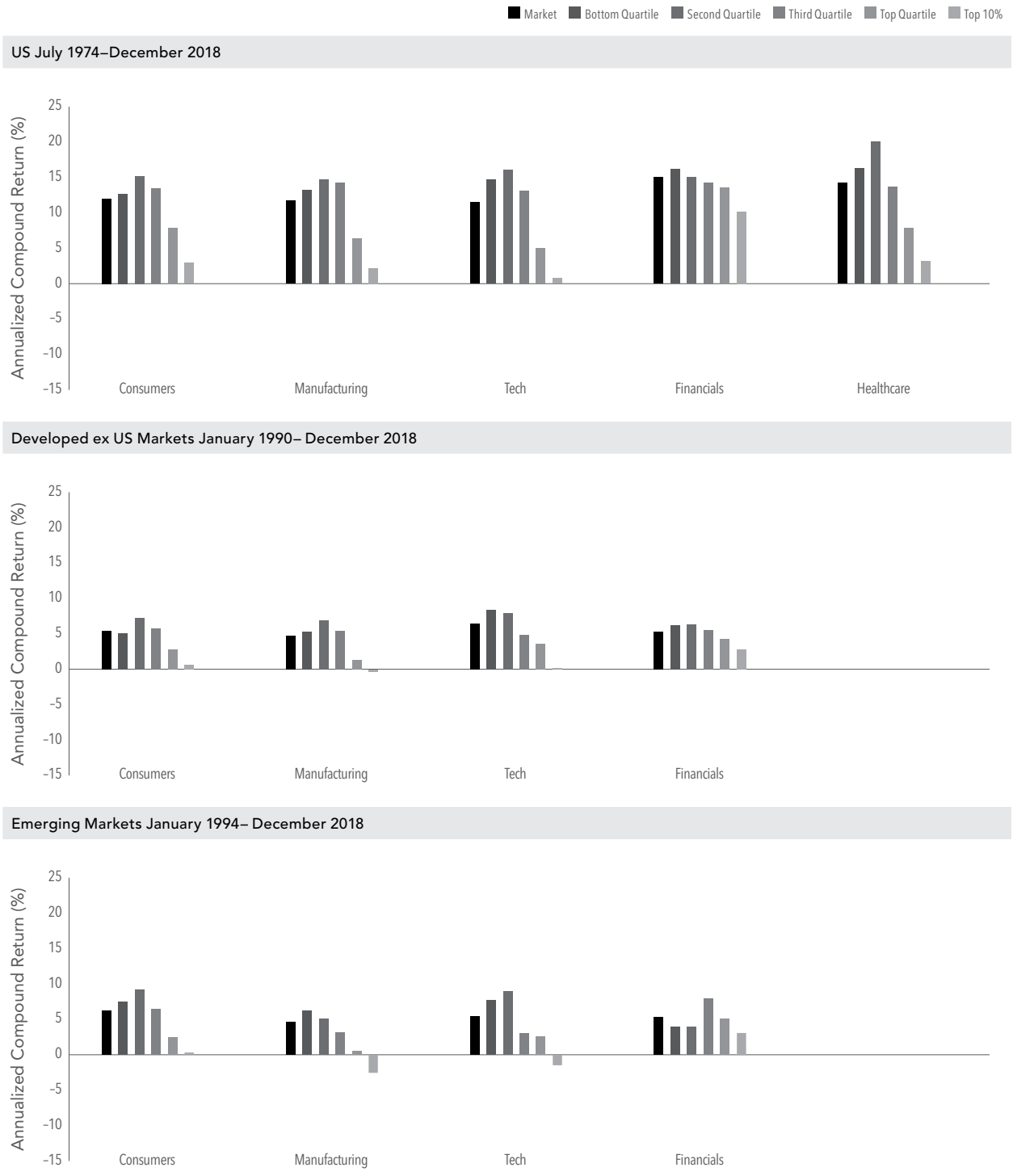
Exhibit 9: Investment Premium across Value and Profitability Groups

	Growth Low Prof		Growth High Prof		Value Low Prof		Value High Prof	
US, July 1974–December 2018								
Annualized Compound Return (%)	6.9	–3.5	14.5	4.2	14.1	4.8	17.0	11.8
Average % of the Market Capitalization within the Small Cap Market	15%	3%	25%	3%	26%	2%	19%	1%
Developed ex US Markets, January 1990–December 2018								
Annualized Compound Return (%)	1.2	–3.7	6.3	3.2	5.8	–0.2	9.1	1.9
Average % of the Market Capitalization within the Small Cap Market	13%	2%	28%	4%	29%	2%	15%	1%
Emerging Markets, January 1994–December 2018								
Annualized Compound Return (%)	1.3	–6.0	6.7	1.6	7.4	0.2	12.6	4.9
Average % of the Market Capitalization within the Small Cap Market	15%	3%	29%	4%	30%	2%	17%	1%

Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower.

Source: Dimensional, using CRSP, Compustat, and Bloomberg. Eligible small cap stocks are sorted on price-to-book ratio into two groups (value and growth), each representing half of the market capitalization. Similarly, eligible small cap stocks are sorted into two profitability groups. Within each of the four intersections created from these two independent sorts, we examine the annualized compound returns on stocks in the top asset growth deciles relative to the rest of the relevant market segment. Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical; are not representative of indices, actual investments, or actual strategies managed by Dimensional; and do not reflect costs and fees associated with an actual investment. See Appendix for additional important information.

Exhibit 10: Sort of Small Cap Firms on Asset Growth by Sector



Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower.

Source: Dimensional, using CRSP, Compustat, and Bloomberg. Eligible small cap stocks are sorted based on year-on-year growth in assets (dA/A) within each country-sector pair. See Sector Definition in Appendix for details. Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical; are not representative of indices, actual investments, or actual strategies managed by Dimensional; and do not reflect costs and fees associated with an actual investment. See Appendix for additional important information.

Exhibit 11: Performance of Top Asset Growth Decile and Four Subsets Grouped by the Drivers of High Asset Growth Based on Capital Sources, *July 1974–December 2018*

	Small Cap Market	Top Asset Growth Decile	High Asset Growth Driven by Equity Issuance	High Asset Growth Driven by Debt Issuance	High Asset Growth Driven by Growth in Retained Earnings	No Dominant Driver of High Asset Growth
Annualized Compound Return (%)	12.6	1.9	−0.5	4.5	1.8	4.0
Annualized Standard Deviation (%)	20.3	25.5	30.5	24.8	35.5	24.7
Average Monthly Return (%)	1.2	0.4	0.4	0.6	0.7	0.6
t-Statistic vs. Small Cap Market	—	−6.9	−4.2	−4.0	−1.5	−5.1
Average % of the Market Capitalization within the Small Cap Market	100%	9%	3%	2%	1%	3%
Average % of the Market Capitalization within Top Asset Growth	—	100%	33%	26%	6%	35%

Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower.

Source: Dimensional, using CRSP and Compustat. Eligible US small cap stocks are sorted into deciles based on asset growth. Firms that are in the top decile are categorized into one of four groups according to the primary driver of their high asset growth: equity issuance, debt issuance, growth in retained earnings, and no dominant driver. Equity issuance is defined as the change in the sum of preferred stock and common stock less treasury stock, scaled by lagged assets. Debt issuance is defined as the change in long-term debt plus debt in current liability, scaled by lagged assets. Growth in retained earnings is defined as the change in retained earnings scaled by lagged assets. Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical; are not representative of indices, actual investments, or actual strategies managed by Dimensional; and do not reflect costs and fees associated with an actual investment. See Appendix for additional important information.

Exhibit 12: Performance of Top Asset Growth Decile and Three Subsets Grouped by the Drivers of High Asset Growth Based on Use of Capital, *July 1984–December 2018*

	Small Cap Market	Top Asset Growth Decile	High Asset Growth Driven by Growth in Physical Capital	High Asset Growth Driven by Growth in Intangible Capital	No Dominant Driver of High Asset Growth
Annualized Compound Return (%)	9.7	−0.8	−2.4	−1.2	−0.8
Annualized Standard Deviation (%)	19.6	24.5	26.3	28.4	25.8
Average Monthly Return (%)	0.9	0.2	0.1	0.2	0.2
t-Statistic vs. Small Cap Market	—	−6.2	−4.0	−2.5	−4.9
Average % of the Market Capitalization within the Small Cap Market	100%	9%	2%	1%	5%
Average % of the Market Capitalization within Top Asset Growth	—	100%	23%	13%	64%

Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower.

Source: Dimensional, using CRSP and Compustat. Eligible US small cap stocks are sorted into deciles based on asset growth. Firms that are in the top decile are categorized into one of three groups according to the primary driver of their high asset growth: growth in intangible capital, defined as the change in intangibles, scaled by lagged assets; growth in physical capital, defined as the change in property, plant, and equipment plus inventory, scaled by lagged assets; no dominant driver. The sample period starts in July 1984 to avoid empty sorts resulting from certain months having no stocks that meet the criteria. Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical; are not representative of indices, actual investments, or actual strategies managed by Dimensional; and do not reflect costs and fees associated with an actual investment. See Appendix for additional important information.

Exhibit 13: Impact of M&A on Investment Premium in the US
July 1995–December 2018

		Top Asset Growth Decile		
	Small Cap Market	No M&A Exclusion	Excluding Firms with Positive Change in Goodwill	Excluding Firms with Positive Cash Flow for Acquisition
Annualized Compound Return (%)	9.1	-1.4	-0.5	-0.3
Average % of the Market Capitalization within the Small Cap Market	100%	9%	6%	6%

Past performance, including hypothetical performance, is no guarantee of future results. Actual investment returns may be lower.

Source: Dimensional, using CRSP and Compustat. "M&A exclusion" excludes stocks with positive values of the relevant M&A measure: change in goodwill scaled by lagged assets and net cash outflow for acquisition scaled by assets. The exclusion is applied to both the computation of asset growth break points and sorts. The sample period starts in July 1995 due to data availability. Filters were applied to data retroactively and with the benefit of hindsight. Groups of stocks and their returns are hypothetical; are not representative of indices, actual investments, or actual strategies managed by Dimensional; and do not reflect costs and fees associated with an actual investment. See Appendix for additional important information.

APPENDIX

Valuation Equation

According to Modigliani-Miller (1961) the price per share at time t can be written as

$$p(t) = \frac{E(d(t+1))+E(p(t+1))}{1+r},$$

where $d(t+1)$ is the dividend per share to current shareholders at time t, paid at time $t+1$, and r is the discount rate or the internal rate of return. Multiplying by $n(t)$, the number of shares at time t, gives the total market value of equity as

$$M(t) = \frac{E(D(t+1))+E(n(t)p(t+1))}{1+r},$$

where $D(t+1)$ is the dividend at the firm level at time $t+1$. We can define $m(t+1)=n(t+1)-n(t)$, the number of shares issued/repurchased at time $t+1$, at the ex-dividend closing price of $p(t+1)$. Replacing $n(t)=n(t+1)-m(t+1)$ in the above, we get:

$$M(t) = \frac{E(D(t+1)) + E((n(t+1) - m(t+1))p(t+1))}{1+r}$$

$$= \frac{E(D(t+1))-E(m(t+1))p(t+1)+E(M(t+1))}{1+r}.$$

Let us define $EQFIN(t+1)=m(t+1)p(t+1)$, the net equity financing at time $t+1$. Moreover, by clean surplus accounting, all the changes to retained earnings flow though the income statement and thus

$$\Delta RE(t+1) = Y(t+1) - D(t+1),$$

where $\Delta RE(t+1)$ is the change in retained earnings from time t to time $t+1$ and $Y(t+1)$ is the income after interest and taxes assumed to be received at time $t+1$.

Substituting *D(t+1)* and *m(t+1)p(t+1)* in the valuation equation, we get

$$M(t) = \frac{E(Y(t+1) - \Delta RE(t+1)) - E(EQFIN(t+1)) + E(M(t+1))}{1+r}.$$

Recursively,

$$M(t) = \sum_{\tau=1}^{\infty} \frac{E\big(Y(t+\tau)\big) - E\big(\Delta RE(t+\tau)\big) - E\big(EQFIN(t+\tau)\big)}{(1+r)^{\tau}}.$$

Dividing the both sides by book equity at time *t*, *B(t)*, and recognizing that a change in book equity results from a change in retained earnings and equity issuance, we obtain:

$$\frac{M(t)}{B(t)} = \sum_{\tau=1}^{\infty} \frac{E(Y(t+\tau) - dB(t+\tau))/(1+r)^{\tau}}{B(t)}.$$

Sector Definition

Sectors are based on SIC classification, which is mapped to GICS classification using a proprietary mapping and combined as follows for the US.

Broader Sector Category	GICS
Consumers	Consumer Discretionary Consumer Staples
Healthcare	Healthcare
Manufacturing	Energy Materials Industrial Utilities
Technologies	Information Technology Telecommunication Services
Financials	Financials

Sectors are based on Bloomberg classification and combined as follows for non-US markets.

Broader Sector Category	Bloomberg Industry Sector
Consumers	Consumer Cyclical Consumer Non-Cyclical
Manufacturing	Basic Materials Energy Industrial Utilities Diversified
Technologies	Technology Communication
Financials	Financials

Investment Premium Disclosure

The eligible universe includes all stocks in relevant regions. REITs, tracking stocks, and investment companies are excluded from the universe. In addition, to be included in the international analyses, stocks need to meet certain minimum market capitalization and liquidity requirements. Unless otherwise specified, we use the following definitions and methodologies. Small cap is defined as approximately the bottom 8%, 12.5%, and 15% in US, developed ex US, and emerging markets, respectively. Large cap is defined as approximately the top 92%, 87.5%, and 85% in US, developed ex US, and emerging markets, respectively. Stocks are sorted annually in the US and semiannually outside the US. Quartile and decile sorts are based on market capitalization.

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