The Innovation Factor

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Abstract

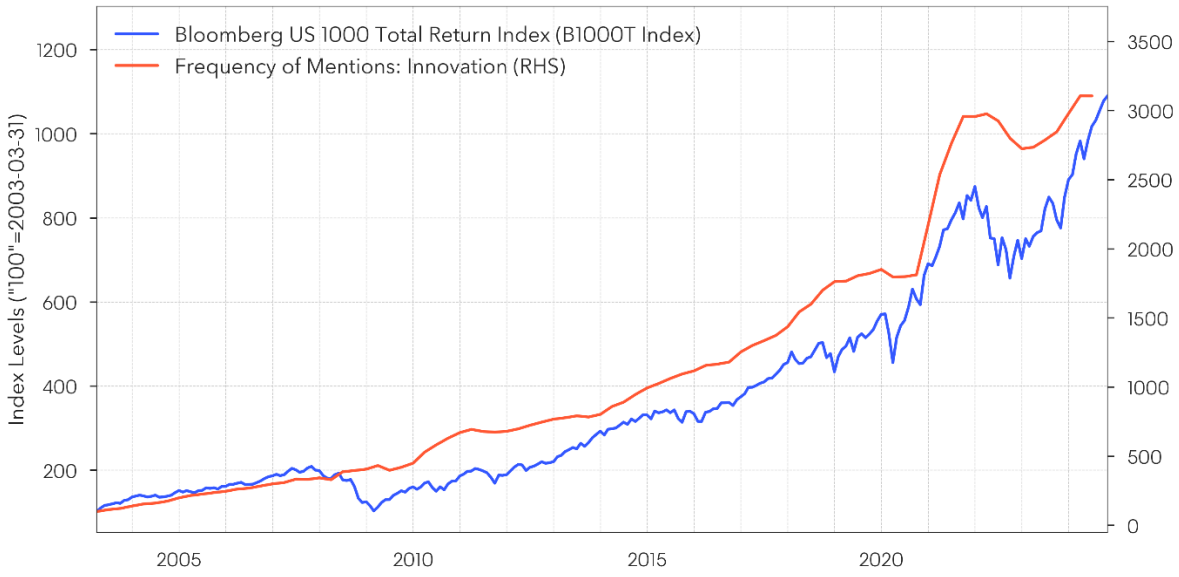
Everyone loves talking about innovation these days. In earnings calls or public speeches, mentions of the word “innovation” by corporate executives have grown exponentially. But what does "innovation" mean exactly? And how much of a difference does it make for returns? In public markets, is there a way to identify genuinely innovative companies versus those that are merely perceived that way? To answer these questions, we have identified a new factor that systematically identifies innovation. The innovator factor has dramatically evolved over the past two decades and been richly rewarded across geographies including Asia, Europe, and the US. The key finding is that persistent commitment to research and development (R&D), more than the intensity of spending on it, is the key determinant of innovation success and future stock returns. The innovation factor offers growth investors a superior and systematic way of understanding and gaining exposure to an increasingly indispensable source of return.

Introduction

We live in a golden age of innovation and scientific discovery. The unveiling of ChatGPT in November 2022 and the subsequent wave of AI applications were a Sputnik moment that instantaneously caught the attention and the imagination of everyone on the planet. Just about every day there's news about yet another ancillary benefit from the weight-loss wonders drug GLP-1, developed by Eli Lilly and Novo Nordisk among others. These advancements are just the tip of the iceberg; from autonomous vehicles to humanoid robots to CRISPR gene editing and AI-driven drug discovery, groundbreaking technologies are emerging at an astonishing pace, reshaping our understanding of what's possible.

These technological breakthroughs are becoming more important for investors too. Over the past two decades, mentions of the word "innovation" by US public companies have surged, closely mirroring the remarkable growth of the broader stock market index. This upward trend was briefly interrupted only during the COVID-19 pandemic before surging upward again. As will be shown below, much of the stock market growth can be indeed attributed to the performance of innovative companies, which have experienced extraordinary growth in revenue and profitability, and accumulated valuable intangible capital.

Figure 1: Frequency of Mentions of "Innovation" by US Public Companies



Note: B1000T Index is a float market-cap-weighted benchmark of the 1000 most highly capitalized US companies. Mentions of the word "Innovation" index is derived using data from the Document Search function DS <GO> on the Bloomberg Terminal.

Meanwhile, the out-performance of the Magnificent 7 stocks[1] such as Nvidia, Apple and other technology heavyweights, has kicked off a conversation over whether these companies may be overvalued and even in bubble territory. The concern is that these new technologies are over-hyped, or too expensive to continue to generate outsized returns.

[1] See Bloomberg indices blog on the Magnificent 7: https://www.bloomberg.com/professional/insights/markets/can-the-magnificent-7-ride-again-rescue-the-u-s-stock-rally/

So how should investors understand and measure innovation and distinguish hype from reality? Put differently, how should investors identify truly innovative companies and how has innovation as a firm characteristic been priced and rewarded in the cross-section of stock returns over time? What risk characteristics should investors expect when they invest in innovation? And finally, across the globe, where has innovation occurred and been rewarded?

We answer these questions by examining public company research and development (R&D) expenditures across the globe, as well as their impact on returns over the past 20 years. Corporate innovation efforts may be captured in a myriad of exotic ways -- like counting patents or tallying employees with advanced degrees -- but our research focuses on how much money companies spend on R&D, because it is the most commonly and uniformly reported accounting metric. Apart from acquisitions, we believe that demonstrated commitment to R&D is the ultimate source of innovation within a company.

We compare two different ways of identifying corporate innovation using R&D expenditures. The first metric is *R&D intensity* (or R&D expenditures normalized by revenue so that big and small companies are comparable). This metric is historically commonly used in the academic literature and indeed has been found to be associated with higher stock returns as discussed in the Literature Review section below. The second and our preferred metric is *R&D persistence* or at least three consecutive years of R&D expenditures growth. We find that R&D persistence is a superior predictor of corporate innovation success and has consistently delivered much stronger excess returns than R&D intensity alone.

We show that stocks of innovative companies have earned significant risk-adjusted excess returns relative to the broader market over the last twenty years. While this outperformance is most notably observed in US Large Cap stocks, as exemplified by the Bloomberg R&D Leaders Select Index (Figure 1), we find that the strong equity returns to innovation are pervasive across different market cap segments (in fact arguably stronger in mid-small cap) and across global markets from Europe to China. We find that persistent R&D investments by companies have led to large improvements to their subsequent operating performances, most notably in the US, but also in other geographical markets, thereby shedding light on the differences of stock market performances across global markets. In equity factors lingo, portfolios of innovative companies tend to consistently load on *growth* and *quality*.

So why should the persistence of R&D spending predict innovation success and stronger stock returns? By nature, R&D is an expensive and risky investment. It's time and resource-consuming and tends to have low external visibility, high uncertainty, and low success rates. As a result, companies tend to struggle to raise external financing, whether debt or equity, to fund R&D. Only companies with healthy cash flows and a strong belief in its ability[2] to conduct R&D successfully tend to persistently grow its R&D expenditures. By construction, this embeds a screen for quality. We believe our research has discovered a new and systematic way of identifying innovation and offers a superior way for investors to gain exposure to high quality growth through the innovation factor.

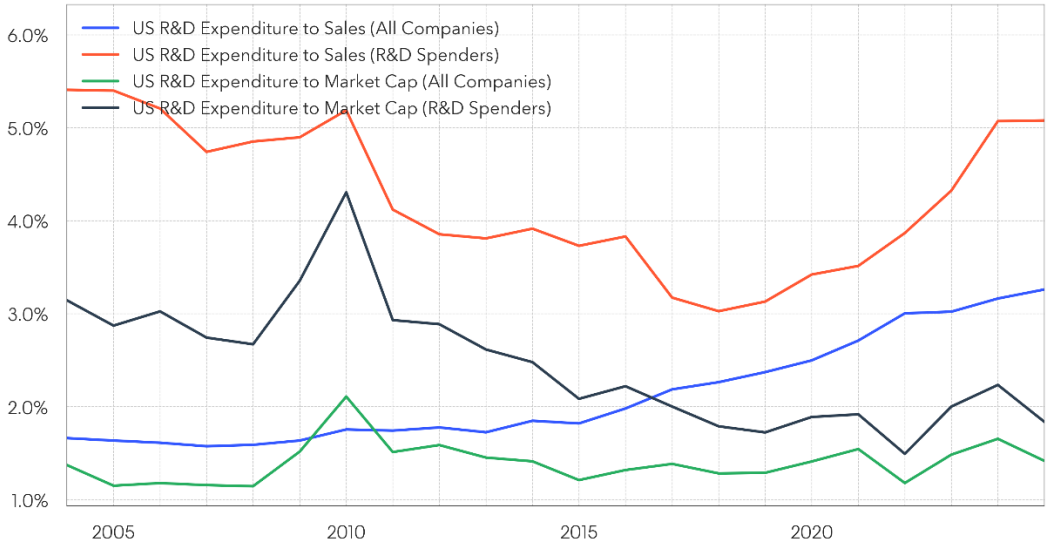
[2] Cohen et al. 2013 documents the existence of persistent R&D skills in converting R&D investments into valuable innovation.

Literature Review

This article adds to a long literature of academic research on innovation. There are generally two strands of literature on the economics and asset pricing of corporate innovation. The first strand of research leverages auxiliary data such as the counts of patent filings or the education credentials of employees to assess the production of innovation and the accumulation of intangible capital. This approach has its strengths and weaknesses[3]: it's a richer and more granular data on the types of innovation, but harder to collect accurately and contains biases since not all public companies are equally incentivized to file for patents.

This article follows a second strand of literature and uses R&D expenditures[4] as a signal for identifying innovation. Two widely cited papers related to our article are Cohen et al. 2013 and Chan et al. 2001, which are published 10 years apart, but both documented the embedded signal value of R&D expenditures for identifying underappreciated corporate innovation. Chan et al. finds that firms with high ratios of R&D relative to market cap earn higher subsequent stock returns. Cohen et al discovers that firms' ability to conduct successful R&D is predictable and persistent and that investing in strong R&D ability firms yields higher returns. Our finding about the superior returns of firms with R&D persistence is consistent and complementary to existing research. It is also interesting if not somewhat shocking that innovative firms identified by R&D continue to strongly outperform the broader market in the last 10 years after the publications of these papers. It likely reflects a continued underestimation of earnings growths especially in the US and the rise of intangible capital.

Figure 2: US Public Companies R&D Expenditures Ratios



Note: US R&D Expenditures to Sales is the total R&D expenditures of companies in the Bloomberg United States Large, Mid & Small Cap Total Return Index (USLST) divided by their total revenue. US R&D Expenditures to Market Cap is the total R&D expenditures of companies in the USLST Index divided by their total market capitalization.

[3] Lerner and Seru, 2021, *Use and Misuse of Patent Data: Issues for Finance and Beyond*, document the portfolio construction biases created by patent filing and citation biases.

[4] R&D and SG&A are two income statement fields that are commonly used for capturing "intangible capital". Eisfeldt et al, 2021 leverages SG&A recently to form an intangible value factor that better reflects firm value including all forms of intangible capital. We focus on R&D spending as a signal to predict innovation hence future fundamental growth.

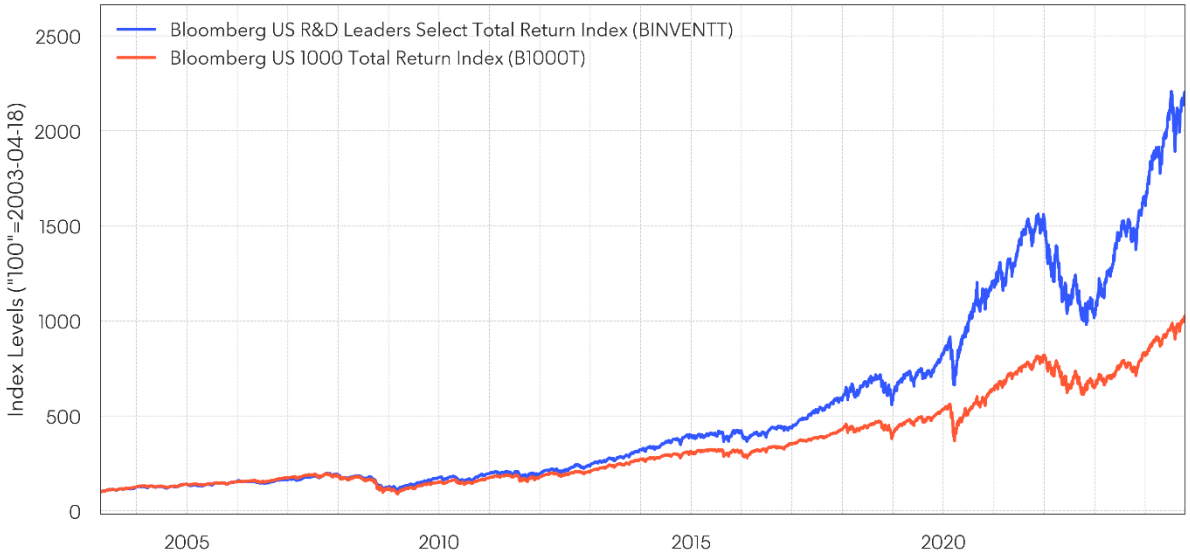
The Rise of Innovation

Innovation of course is nothing new to the US or the global economy. Since the industrial revolution, economic growth has always been accompanied by waves of new technologies. What makes technological innovation distinct in the modern economy is the transition from an industrial towards a knowledge-based economy. Incumbent companies are increasingly heavily investing in the research and development of new ideas and new product categories in-house in addition to refining existing business lines.

Since 2003, US public companies have more than doubled the amount of R&D expenditures as a share of total revenue, from 1.5% to 3.25%. Meanwhile, R&D expenditure as a share of market capitalization has remained stable over the same period. In other words, while US public companies' total R&D spending has grown more rapidly than their aggregate revenue, it has grown roughly on pace with their total market cap. Figure 2 in a way gives away the story: innovative (R&D spending) US companies saw their market cap (hence stock returns) grow much more rapidly than the less innovative (R&D non-spending) companies.

The rapid expansion of the market cap of the R&D spending companies also means that the last twenty years have been extremely rewarding for the investors of innovative companies. From venture capital in start-ups to mega-cap technology and pharmaceutical companies, the stocks of innovative companies have delivered eye-popping returns. Since 2003, the Bloomberg R&D Leaders Select Index has achieved an annualized return of 15.4%, which is a whopping 3.6% higher than the benchmark B1000 index and 2.8% higher than the B1000 Growth index. In turn, the strong returns have attracted even more performance chasing investors. But do investors know how to identify truly innovative companies?

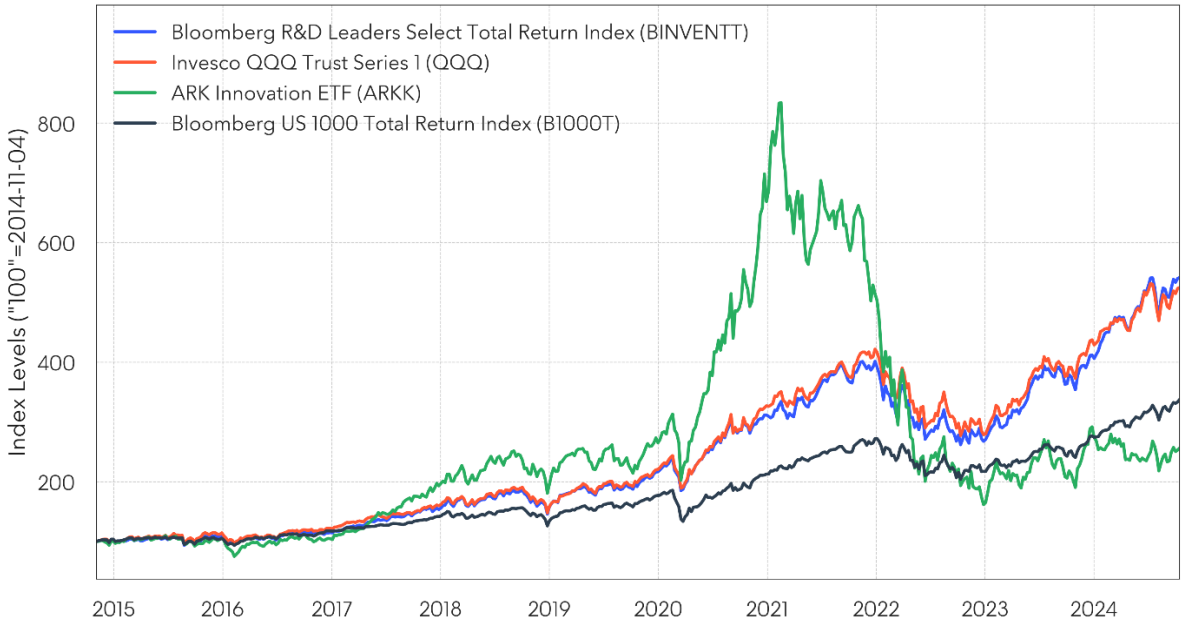
Figure 3: Performance of the Bloomberg R&D Leaders Index



Note: BINVENTT Index selects from the benchmark B1000T Index securities with three consecutive years of R&D spending growth, top 90th percentile R&D intensity, and top 50 by market cap. Additional liquidity screens and security & sector weight caps applied. USD returns. See whitepaper for details. B1000GT Index comprises an selection of growth stocks out of the B1000T Index.

When individual investors are asked about investment vehicles for "innovation", the Invesco QQQ ETF and the ARKK Innovation ETF are both popular answers [See Figure 4]. QQQ is a passive ETF based on the Nasdaq-100 index or roughly the largest 100 companies listed on the Nasdaq exchange. Despite a history of being the home to technology companies, the Nasdaq exchange has no explicit screen for innovation in its listing criteria and there are innovative companies, such as the pharmaceutical giant Eli Lilly, that are not listed on the exchange. ARKK is an actively managed ETF portfolio, which does not disclose its methodology for picking innovative stocks. Is there a way for investors to systematically identify innovation? Indeed, there is and that is the focus of this article.

Figure 4: Performance of the Bloomberg R&D Leaders Index



Note: BINVENTT Index selects from the benchmark B1000T Index companies with three consecutive years of R&D spending growth, top 90th percentile R&D intensity, and top 50 by market cap. Additional liquidity screens and security & sector weight caps applied. Returns are in USD. See index methodology for details.

We start with identifying innovative companies in the US Large and Mid-cap universe. The Bloomberg R&D Leaders Select Total Return Index (BINVENTT Index) selects securities from the Bloomberg B1000 Index[5] and identifies innovative companies as those companies that have R&D persistence or three consecutive years of positive R&D expenditures growth and are in top 90th percentile of R&D intensity (R&D spending normalized by net sales)[6]. We will go into the details in the article why these are the steps chosen to identify innovation, but it is worth pointing out that the BINVENTT Index lies almost exactly on top of the QQQ and in fact meaningfully outperforms it over the past two years. Is this a sheer coincidence or does it reflect something more systematic?

[5] Bloomberg B1000 Index is the market-cap weighted benchmark index comprising the 1000 largest companies by market capitalization. See methodology of the index here.

[6] The securities are further weighted by company market cap and for diversification reasons subject to individual security weight cap (8% for the top 5 securities, 4% cap for all others) and sector weight cap of 40%. [For additional details of the index methodology, visit LINK HERE.]

Intensity Good, Persistence Better!

We consider two ways of leveraging R&D expenditures as a signal for corporate innovation. The first and a naïve way is to screen companies with the high R&D intensity or normalized R&D spending[7]. This is also the typical way in which most of the academic literature has used R&D spending to identify innovation. In this article, we also consider a second way: R&D persistence or three consecutive years of R&D spending growth, regardless of the level of spending.

Table 1: US Corporate R&D Spending Intensity and Persistence

	R&D Intensity Median			R&D Persistence Percentage		
	2003	2013	2023	2003	2013	2023
All	7%	4%	4%	10%	17%	18%
Communications	8%	4%	7%	4%	21%	27%
Consumer Discretionary	2%	0%	0%	3%	8%	8%
Consumer Staples	0%	0%	0%	5%	6%	4%
Energy	3%	1%	0%	5%	5%	4%
Financials	3%	0%	1%	0%	1%	3%
Health Care	11%	14%	16%	35%	33%	40%
Industrials	2%	1%	1%	7%	14%	10%
Materials	2%	1%	1%	6%	17%	11%
Real Estate	0%	1%	0%	1%	1%	1%
Technology	15%	14%	17%	28%	56%	53%
Utilities	0%	0%	0%	0%	0%	0%

Note: The table displays 3 snapshots of the R&D spending patterns across Bloomberg Industry Classification Standards (BICS) sectors. R&D Intensity median is the sector median of R&D Intensity. R&D Persistence percentage is the percentage of companies in a sector that have 3 years of consecutive R&D spending growth. The companies in the sample are members of the Bloomberg US Large, Mid and Small Cap index (USLST).

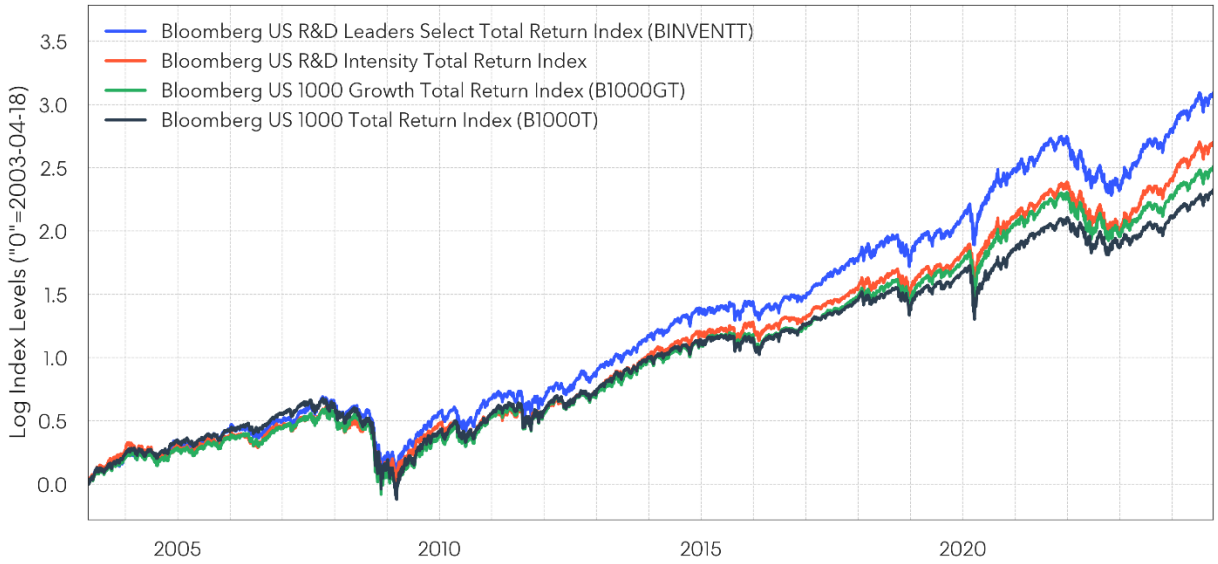
Before diving into the details of constructing investment portfolios using R&D spending, it is worth examining some high-level statistics over time. Table 1 displays three snapshots of the median R&D intensity and the percentages of companies with R&D persistence in each sector in the Bloomberg US Large, Mid, and Small Cap (USLST Index <GO>)[8]. Across sectors, there is a high degree of variance (and co-variances) of intensities and persistence percentages. Technology, health care and communications sectors notably have the highest intensities and persistence shares. Sector median intensities have remained about the same between 2003 and 2013 while the percentages of R&D persistent firms have sharply increased and since 2013 have either grown more slowly, plateaued, or outright decreased.

We use four equity indices to demonstrate the value of R&D persistence. Three of them are familiar or previously introduced: the B1000 Index, the B1000G Growth Index and the BINVENT Index[9]. We create an additional research backtest "Bloomberg US R&D Intensity Index" for contrast. From the B1000 index, which is the same benchmark universe as the BINVENT Index, the R&D Intensity index screens securities whose R&D intensities are in the top 50th percentile of B1000 and selects the top 50 stocks by market cap for comparability[10].

[7] Typically, R&D spending is normalized by net sales. There are other approaches such as normalizing by market cap, e.g., Chan et al 2001.
[8] See in the appendix detailed summary statistics of different universes across different sectors and market segments. Sector median R&D intensities and persistence percentages are quite similar across market segments in the US but are markedly difference across segments.
[9] All indices are shown here with their "Total Return" versions, typically with an additional "T" affixed to the end of the tickers (unless otherwise specified), to display the levels of the indices with all dividends fully reinvested.
[10] We apply the same liquidity screens, individual security weight capping and sector weight capping rules as BINVENT for maximal comparability.

In Table 1 and Fig. 5, we display the total returns versions of the four indices in logs over the last twenty years. Growth stocks (B1000GT Index) have strongly outperformed the broad benchmark B1000T index by .8% per year. High R&D intensity stocks have in turn consistently outperformed the growth stocks and beat the benchmark by 1.7% per year. Finally, the BINVENTT Index, comprising the R&D persistent stocks, has remarkably outperformed the US R&D Intensity index by 0.9% per year and beat B1000T by 3.6% per year with steadily growing outperformances. All four indices have roughly the same levels of volatility and market beta. Higher intensity of R&D is good, but persistent R&D spending is even better! So why should R&D persistence outperform R&D intensity? How do we know they capture "innovation"? We will answer both questions. But, before we do, let's take a brief detour.

Figure 5: Performances of R&D Persistence vs Intensity Portfolios



Note: BINVENTT Index selects from the benchmark B1000T Index securities with three consecutive years of R&D spending growth, top 90th percentile R&D intensity, and top 50 by market cap. Bloomberg US R&D Intensity Total Return Index selects from the benchmark B1000T Index securities in the top 50th percentile of R&D intensity and top 50 by market cap. Additional liquidity screens and security & sector weight caps applied. USD returns. Both indices are research backtests and for indicative purposes only. See whitepaper for details.

Table 2: Performance Summary Statistics

	Bloomberg US R&D Leaders Select Total Return Index (BINVENTT)	Bloomberg US R&D Intensity Total Return Index	Bloomberg B1000 Growth Total Return Index (B1000GT)	Bloomberg B1000 Total Return Index (B1000T)
CAGR	15.50%	13.40%	12.40%	11.40%
Volatility	20.30%	19.10%	19.20%	18.90%
Ann. Return/Vol	0.76	0.7	0.64	0.61
Ann. Excess Return	3.60%	1.70%	0.80%	0.00%
Tracking Error	7.60%	6.60%	3.60%	0.00%
Information Ratio	0.47	0.26	0.24	
Max Drawdown	-47.00%	-45.50%	-50.60%	-55.00%

Note: The performance summary statistics are derived from returns between 2003-Apr-18 and 2024-Oct-17. The returns of the strategy indices come from research backtests and are for illustrative purposes only.

What About Those Weight Caps?

We have mentioned "weight capping" as a part of the index construction process several times now. Specifically, the weight capping rules we have applied are 8% cap on the largest five securities, 4% cap on all remaining securities, and finally a maximum sector weight cap of 40%. While most whitepapers on indices would just brush the whole issue under the rug as "standard diversification" and not say anything, not us! We want to take a quick detour to discuss the rationale and the non-neutral and indeed non-trivial impact of weight capping. Why do we need weight capping at all? And how much of the outperformance of the R&D indices comes from the weight capping scheme vs the underlying innovation signals?

Table 3: Top Holdings Comparison

Company Name	R&D Persistent Index (BINVENT)		R&D Intensity Index		B1000 Index	B1000G Index
	Capped Weight	Uncapped Weight	Capped Weight	Uncapped Weight	Index Weight	Index Weight
Apple Inc	8.00%	14.05%	8.00%	11.93%	5.47%	7.88%
Amazon.com Inc	8.00%	9.29%	8.00%	7.89%	3.62%	5.22%
Alphabet Inc	8.00%	9.20%	8.00%	7.81%	3.63%	5.23%
Microsoft Corp	8.00%	17.61%	8.00%	14.96%	6.67%	9.61%
NVIDIA Corp	8.00%	12.09%	8.00%	10.26%	4.46%	6.42%
Eli Lilly & Co	4.00%	3.72%	4.00%	3.16%	1.36%	1.96%
Meta Platforms Inc	4.00%	6.07%	4.00%	5.16%	2.42%	3.48%
Tesla Inc	4.00%	2.75%	3.77%	2.33%	1.01%	1.46%

Note: Common top holdings of the four indices as of 2024-04-12 semi-annual rebalance. They are all in the top 10 holdings not necessarily the top 8 holdings of each index.

The rationale for the weight caps is diversification but also "signal amplification". In the index construction rules, top 50 securities with the largest market cap are selected after the signal screen. As a result, the R&D persistent (BINVENT) and R&D intense indices in fact have mostly the same largest holdings. If we simply market cap weighted both indices, the top 5 securities alone would comprise 50-60% of the index weight and the index returns would simply reflect the returns of the top few common stocks with minimal contributions from the rest of the portfolios. With the weight caps, the weights of the top holdings become closer to the benchmark B1000. Nevertheless, we observe a large, persistent, and in fact growing difference in the cumulative levels between the two R&D indices? Why? The difference must lie in the different selections of the smaller companies according to the two R&D-based measures, which will be further clarified through the lens of equity factor analysis below.

Innovation or Hype?

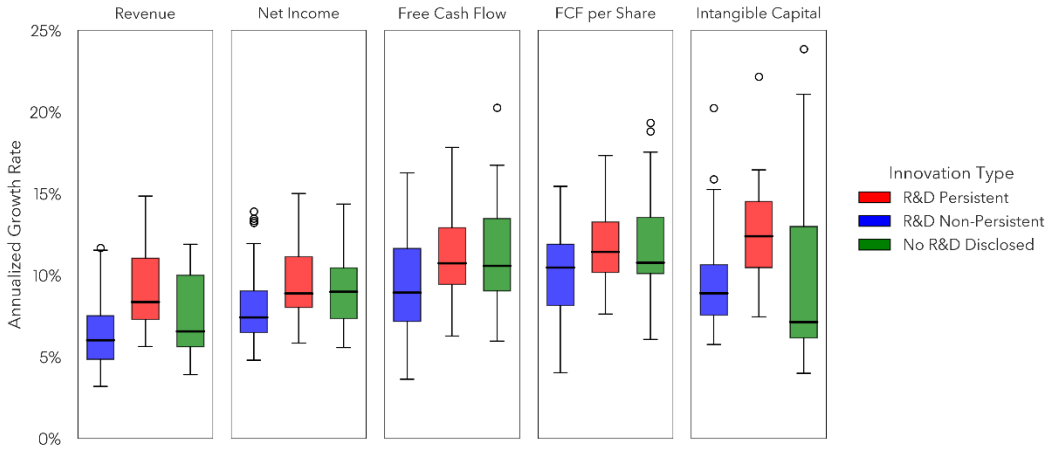
A natural question arises at this point: how do we know these so called "innovative companies" are genuinely innovative rather than simply hype? Innovation is candidly a relatively vague concept that is very difficult to pin down much less evaluate precisely. However, we do know that successful innovation tends to manifest in intangible capital, like the invention of a new product, drug formula or even a new automated manufacturing

process that eventually delivers tangible benefits to its corporate owners in the forms of higher revenues, profits or cash flows and more recorded intangible capital like patents.

To reveal the tangible impact of innovation, we pre-identify innovative (R&D persistent) and non-innovative companies and compare their realized operating performances. We start by sorting the US Large and Mid-Cap companies into 3 different groups: 1) companies that grow R&D spending over 3 prior years consecutively; 2) companies that report R&D spending, but do not grow R&D consistently over the prior 3 years; and 3) companies that do not disclose any R&D spending[11]. We then proceed to calculate the growth rates of each company's key fundamentals[12] annualized over the next five years. Figure 6 displays the medians and interquartile ranges of the median company's annualized growth rates across the five fields.

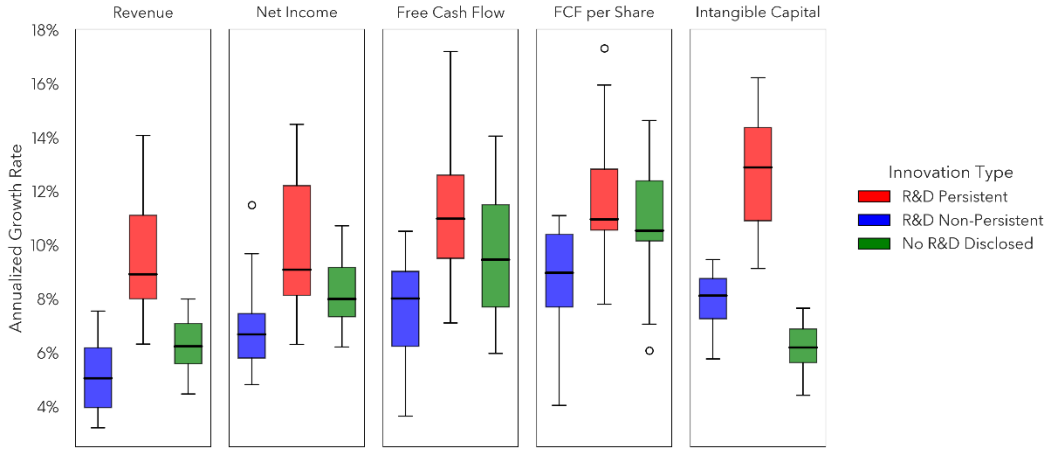
Figure 6: R&D Persistence Leads to Better Operating Performances

US Large-Mid Cap Stocks Next 5-Year Median Growth Rates: 2003 - 2024



Note: This chart compares the ex-post operating performances of innovative and non-innovative companies from 2003 to 2024. Each box displays by R&D spending type the median and interquartile range of the 5-year forward realized median annualized growth rates of key fundamental fields. The securities are members of the Bloomberg US Large-Mid caps. A company is R&D Persistent if its R&D expenditure grows consecutively for three years.

US Large-Mid Cap Stocks Next 5-Year Median Growth Rates: 2014 - 2024



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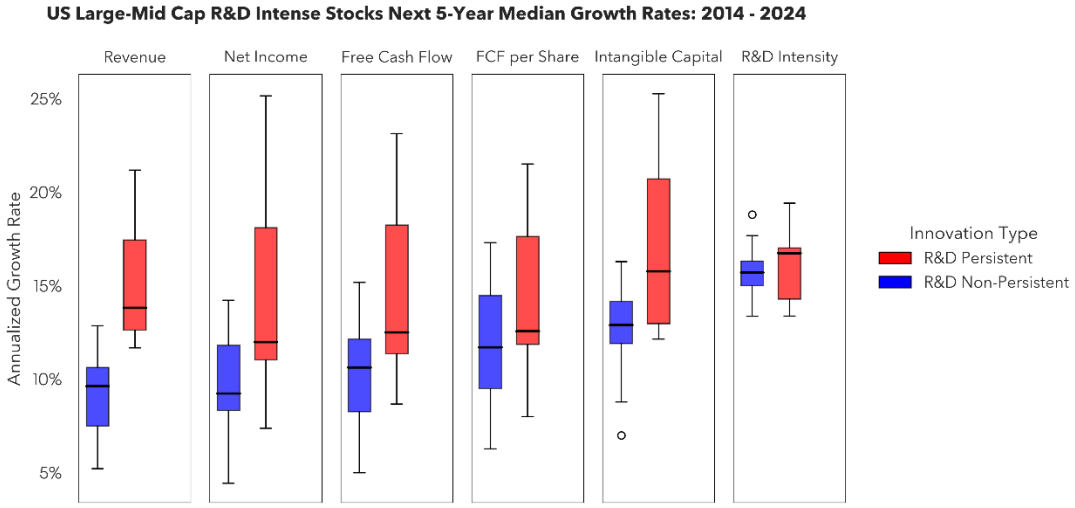
[11] Not disclose R&D spending does not necessarily mean that a company does not do R&D or isn't innovative. See Goyal and Wahal 2024 for discussion of the substitution between R&D disclosure and patent filings.

[12] We have selected here a small set of fundamentals fields including revenue, net income, free cash flow (FCF), FCF per share and Intangible and Other Assets (including goodwill). We have other looked at a set of other related metrics and the patterns are qualitatively similar.

The pattern that emerges from the two panels in Figure 6 is revealing: innovative companies with persistent R&D growths have experienced generally faster subsequent growths in key operating performance metrics over the next five years: higher sales growth, higher net income growth and higher free cash flow growth as well as accumulation of self-reported intangible assets. Moreover, the differentials in growth rates appear to only have significantly widened over time when we compare the growth rates of last 10 years with the entire 20 year period. Unsurprisingly, the last ten years also coincide with the stronger equity returns outperformance. In other words, the strong equity returns are indeed tightly linked to the fundamentals, lending credence to the genuine accumulation of valuable intangible capital.

To further highlight the marginal impact of R&D persistence, we isolate companies that are the top half of companies by R&D Intensity and compare their subsequent operating performances across the same set of fundamentals. Over the last 10 years, US Large and Mid-Cap companies, whose R&D intensities are in the top half of the R&D spenders, are about 50-50 in terms of having persistence. Indeed, while there is a general positive correlation between R&D persistence and R&D intensity, among this group of R&D relatively intense US companies, the distributions of their R&D intensities are very similar (Fig. 7 rightmost panel). Nevertheless, we observe distinct differences in their operating performances (Fig. 7 panels 1-5) that R&D persistent firms consistently grew faster than non-persistent firms in the following 5 years (red bars higher than blue bars), albeit with a great degree of variances.

Figure 7: R&D Persistence Leads to Better Operating Performances For R&D Intense Stocks



Note: This chart compares the ex-post operating performances of innovative and non-innovative companies from 2014 to 2024. Each box displays by R&D spending type the median and interquartile range of the 5-year forward realized median annualized growth rates of key fundamental fields. The securities are members of the Bloomberg US Large-Mid caps. A company is R&D Persistent if its R&D expenditure grows consecutively for three years. A company is R&D Intense if its R&D Intensity is in the top half of securities disclosing R&D spending.

We now have evidence that US Large and Mid-Cap companies have innovated successfully in turning R&D into valuable intangible capital and further highlight the value of persistence. This is reassuring but also brings about its own puzzle. The famous 1997 book "The Innovator's Dilemma" by Clayton Christensen argues that large companies historically struggled to innovate because of the strong incentive to focus on existing profitable customers and improve products for them. Such focus tends to bind or blind them from

disruptive technologies that do not meet the needs of their primary market or existing customers. As such, internal bureaucracies and corporate politics tend to prevent sufficient resources being committed to the funding of new projects such as in the form of R&D. So how did US Large-Mid Cap companies seemingly overcome the Innovator's Dilemma over the last 20 years? Did US tech founders all read Christensen's book and discovered ways to overcome the dilemma? Is this phenomenon unique to the tech industry? These are reasonable questions that we seek to shed light on in the follow sections.

Is Innovation Simply Sector Luck?

So far, we have presented evidence that R&D persistence identifies innovation and is better way to do it than simply looking at R&D intensity. But could the outperformance of R&D persistent stocks simply be a lucky selection on a handful of sectors that happen to have done well? In other words, is the outperformance simply a selection on technology or health care that carry out more R&D than other sectors? We will dive specifically into factor analysis in the next section. But given the large variations of R&D spending patterns across sectors as shown in Table 1, we want to explicitly address the influence of sector selection right now.

One way to differentiate the returns of R&D persistence from sector selection is to form portfolios of stocks *with* and *without* R&D persistence within individual sectors and compare their performances. In Table 4, we show the results of this exercise. From securities from the Bloomberg USLST Index, we select six sectors with at least moderate amounts of R&D activities and form R&D persistent and non-persistent portfolios. The portfolios are all market cap value weighted. Nearly in all six sectors, R&D persistent portfolios significantly outperform the non-persistent portfolios. Healthcare is the only exception, where innovative stocks have strictly underperformed (t-stat = -2.99) over the 20 years period. However, between 2014-2024, R&D persistent stocks have significantly outperformed non-persistent stocks over the past 10 years in all six sectors. Innovation is not simply sector luck!

Table 4: R&D Persistent vs Non-Persistent Portfolios Within Sectors

	Technology	Health Care	Communications	Materials	Industrials	Consumer Discretionary
Sector Backtests: 2003 - 2024						
Persistent Mean	18.8%	11.3%	19.4%	12.4%	14.7%	20.8%
Non-Persistent Mean	13.9%	11.7%	14.8%	11.1%	14.6%	14.1%
Mean Difference	4.9%	-0.4%	4.6%	1.0%	0.1%	6.8%
Persistent SD	25.3%	17.7%	29.3%	24.3%	22.9%	29.7%
Non-Persistent SD	23.2%	16.8%	27.6%	22.0%	21.4%	32.6%
t statistic	31.13	-2.99	13.60	4.65	0.91	17.79
Sector Backtests: 2014 - 2024						
Persistent Mean	24.6%	12.8%	22.0%	10.0%	14.6%	23.2%
Non-Persistent Mean	16.8%	11.1%	18.7%	8.8%	12.5%	16.3%
Mean Difference	7.8%	1.7%	3.3%	1.0%	2.1%	7.0%
Persistent SD	25.8%	18.8%	26.9%	21.9%	21.5%	29.8%
Non-Persistent SD	23.3%	16.0%	26.4%	19.8%	21.7%	35.0%
t statistic	32.52	9.23	8.17	4.02	9.19	11.04

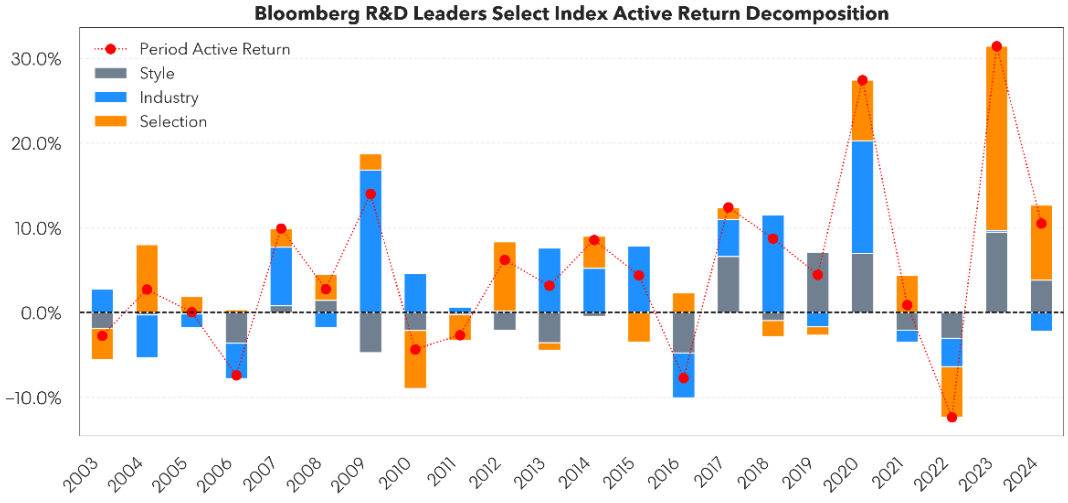
Note: each panel features portfolios formed from constituent securities of the Bloomberg US Large, Mid and Small Cap Index (USLST) in the six sectors with meaningful R&D spending. Within each the six sectors, two portfolios are formed from securities with R&D persistence and R&D non-persistence. All portfolios are market-cap weighted, semi-annual reconstituted and rebalanced. See appendix for the equal-weighted version.

Innovation Through a Factor Lens

The above two sections have provided validation of R&D persistence as a source of innovation success hence the rationale of stock outperformance. In this section we dive deeper into why the innovation factor may have worked from an equity factor perspective. Given the relative brevity of the time series sample in this article[13], this is not an exercise to try to validate innovation as an exogenous equity factor. Existing academic literature has to various extent already established R&D intensity as a risk premium factor. We focus on the rationale of why R&D persistence has delivered the strong returns over the past twenty years.

One way to understand the stocks returns of R&D persistent companies is through a factor-based attribution of the returns of the innovation index into equity risk factors. Using the Bloomberg MAC3 equity risk model, we decompose the excess returns of the BINVENTT index into contributions of well-known equity style and industry factors. Over the last twenty years, the outperformance of the BINVENTT Index over the B1000T Index comes from a roughly equal mixture of style and industry factors as well as some large so-called selection effect or non-factor returns[14]. The latter may be viewed as either BINVENT containing factors missing from MAC3 or the sum of idiosyncratic returns or a combination thereof.

Figure 6: Factor-Based Active Return Attribution



Source: Bloomberg MAC3 Risk model. Note: active return is the total return of the backtested Bloomberg R&D Leaders Select Index less the total return of the benchmark Bloomberg US 1000 Total Return Index. Attributed factor returns are obtained from the MAC3 risk model. All returns are USD returns.

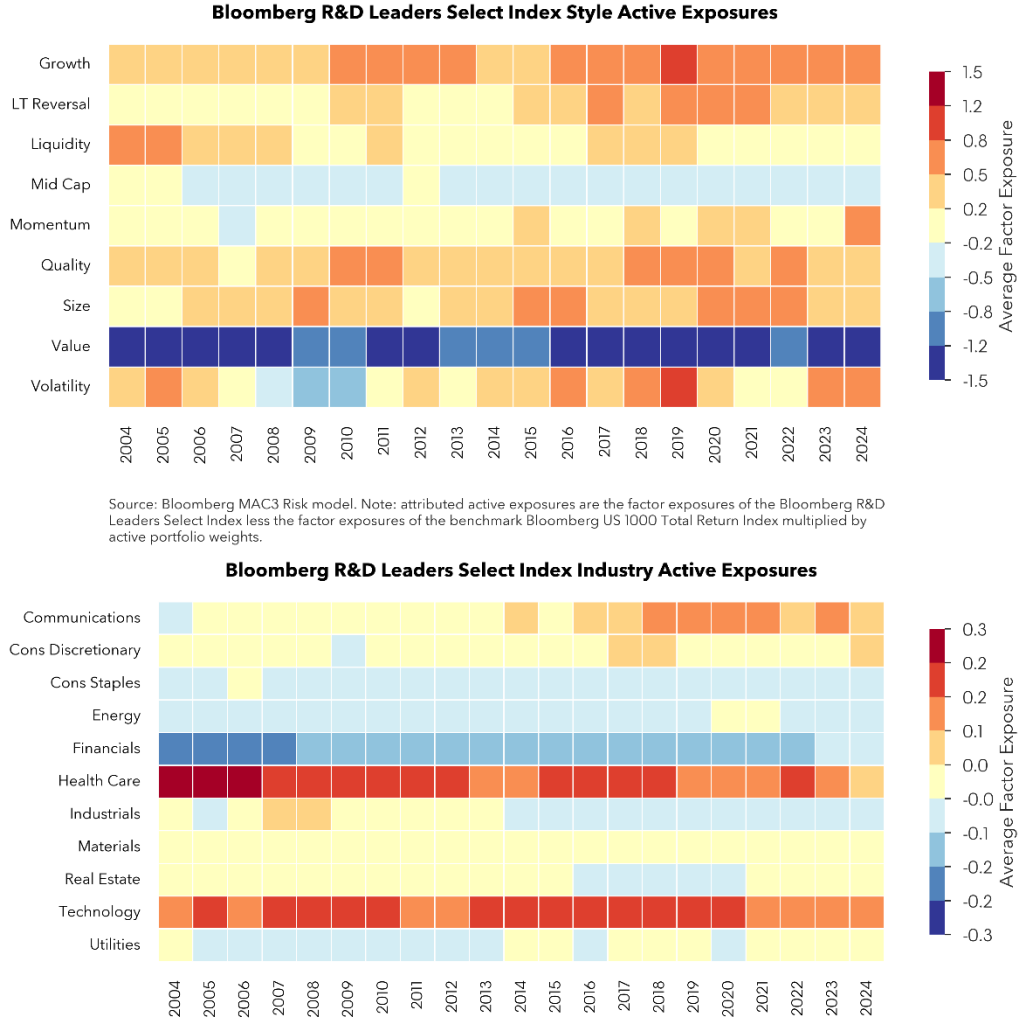
Since factor returns vary greatly over time, we find it more informative to focus on the persistent active style and factor exposures. Relative to the benchmark B1000 Index, innovative companies in the BINVENT Index have particularly large and positive active exposures[15] to the growth, quality, and size[16] (large bias) and volatility factors. Interestingly,

[13] While US GAAP mandated disclosure of R&D above 1% materiality threshold the disclosure with high quality was not common until the 1990s.
[14] The large quantity of the so-called "selection effect" non-factor returns are particularly prominent in the past two years. We include the attribution results of the small-mid cap R&D leaders index, which do not show similarly large positive selection effect, which suggests that returns are likely due to idiosyncratic returns of large- or mega-cap stocks or at least some latent factors associated with being these stocks.
[15] Bloomberg MAC3 risk model sorts all factors from "big to small" instead of in the directions of the commonly known signs of the risk premiums, which can change over time.

they have also picked up a strong active exposure to the long-term reversal while exposure to momentum has been very muted until 2024.

Unsurprisingly, innovative companies have consistently negative exposures to the value factor or in other words tend to be more expensively priced than the broader market. This set of factor correlations is not surprising given what we have already shown in previous sections. Innovative companies, as identified by R&D persistence, have experienced faster revenue growth and stronger profitability. In equilibrium, innovation stocks are expensive because they possess desirable characteristics that are sought after by investors.

Figure 7: R&D Leaders Select Index Active Factor Exposures



Source: Bloomberg MAC3 Risk model. Note: attributed active exposures are the factor exposures of the Bloomberg R&D Leaders Select Index less the factor exposures of the benchmark Bloomberg US 1000 Total Return Index multiplied by active portfolio weights.

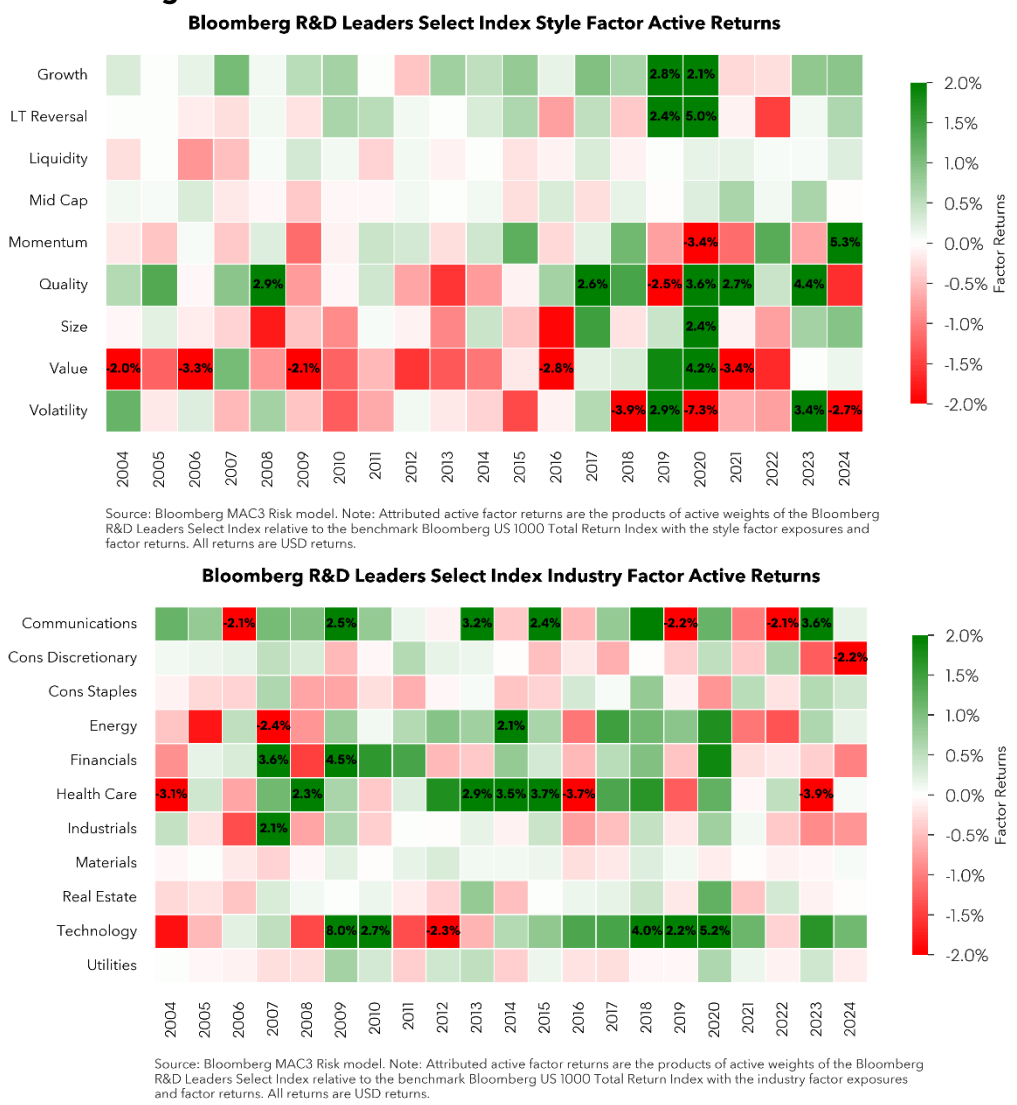
Source: Bloomberg MAC3 Risk model. Note: attributed active exposures are the factor exposures of the Bloomberg R&D Leaders Select Index less the factor exposures of the benchmark Bloomberg US 1000 Total Return Index multiplied by active portfolio weights.

The industry exposures of the BINVENT index are also unsurprising. Technology and health

[16] Asness et al 2018 documents a strong historical correlation between size (small cap) and low quality, or junk. In other words, it is not surprising that a positive exposure to larger cap stocks would be associated with more positive exposure to quality. Nonetheless, we show that the innovative companies are indeed higher quality above and beyond size.

care sectors have consistently had high active or over-weights over the benchmark followed by communications in recent years. One notable observation is that innovation is not solely confined to the technology sector. In fact, the sector compositions of innovation have evolved significantly over time. In the early 2000s, the health care carried a heavy overweight, while communications did not emerge significantly until the second half of the last decade.

Figure 8: R&D Leaders Select Index Active Factor Returns



The diverse and emergent nature of the sources of innovation is also visible from the factor return attributions, which reflects the value of systematic identification of innovation over sector selection. Fig. 6 shows that the innovation excess returns are predominantly earned through factor returns. Over the last twenty years, outperformance is most persistently derived from a broad set of industry factor exposures ranging from technology, health care and communications [Fig.8 Panel 2]. Style factor active returns, which are particularly significant since 2015, are more often earned from the quality factor than the growth factor while losing from unsurprisingly from when the value factor is outperforming.

The Exchanges of Ideas

Over the last twenty years, the Nasdaq has had tremendous success in attracting innovative companies to its exchanges. Using the Bloomberg R&D Leaders Select Index (BINVENT) as an example, the share of innovative companies listed on the Nasdaq has risen dramatically from about 40% to 70%. Yet not all the innovative companies are listed on the Nasdaq exchange. A snapshot of the holdings of the BINVENT index (Table 5: Panel B) reveals a more complex picture of American innovation.

While Nasdaq-listed companies dominate the top holdings, several crucial innovators maintain NYSE listings. Consider Eli Lilly, whose GLP-1 breakthroughs are reshaping healthcare, or Caterpillar, whose autonomous vehicle technology is transforming industrial equipment. Looking forward, as the lines between technology and traditional sectors continue to blur, with companies across all sectors increasing R&D investments, the importance of looking beyond a single exchange and identifying innovation systematically becomes ever more valuable.

Table 5: Bloomberg R&D Leaders Select Index (BINVENT) Listed Exchanges and Holdings

Panel A: Count and Index Weight Share by Listed Exchange

	Exchange Share (Count)			Exchange Share (Weight)		
	2003	2013	2023	2003	2013	2023
NASDAQ	44%	40%	66%	41%	52%	71%
New York	56%	60%	34%	59%	48%	29%

Panel B: Top and Bottom 10 Holdings

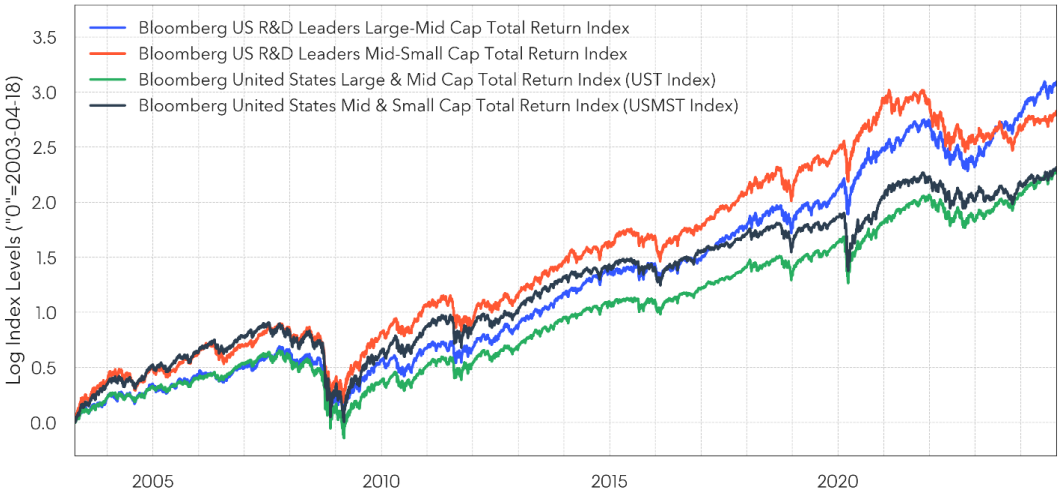
Name	Ticker	Primary Exchange	Weights	Sector
Top 10 Holdings				
Microsoft Corp	MSFT	Nasdaq	8.00%	Technology
Apple Inc	AAPL	Nasdaq	8.00%	Technology
NVIDIA Corp	NVDA	Nasdaq	8.00%	Technology
Amazon.com Inc	AMZN	Nasdaq	8.00%	Consumer Discretionary
Alphabet Inc	GOOGL	Nasdaq	8.00%	Communications
Meta Platforms Inc	META	Nasdaq	4.00%	Communications
Eli Lilly & Co	LLY	New York	4.00%	Health Care
Tesla Inc	TSLA	Nasdaq	4.00%	Consumer Discretionary
Caterpillar Inc	CAT	New York	4.00%	Industrials
Intuitive Surgical Inc	ISRG	Nasdaq	3.29%	Health Care
Bottom 10 Holdings				
NXP Semiconductors NV	NXPI	Nasdaq	0.33%	Technology
Marvell Technology Inc	MRVL	Nasdaq	0.32%	Technology
Roper Technologies Inc	ROP	Nasdaq	0.31%	Technology
Motorola Solutions Inc	MSI	New York	0.30%	Technology
Workday Inc	WDAY	Nasdaq	0.29%	Technology
Autodesk Inc	ADSK	Nasdaq	0.29%	Technology
Super Micro Computer Inc	SMCI	Nasdaq	0.25%	Technology
Microchip Technology Inc	MCHP	Nasdaq	0.25%	Technology
Snowflake Inc	SNOW	New York	0.24%	Technology
Block Inc	SQ	New York	0.24%	Financials

Note: US Large-Mid Cap R&D Leaders top holdings and bottom holdings as of 2024-04-12 semi-annual rebalance.

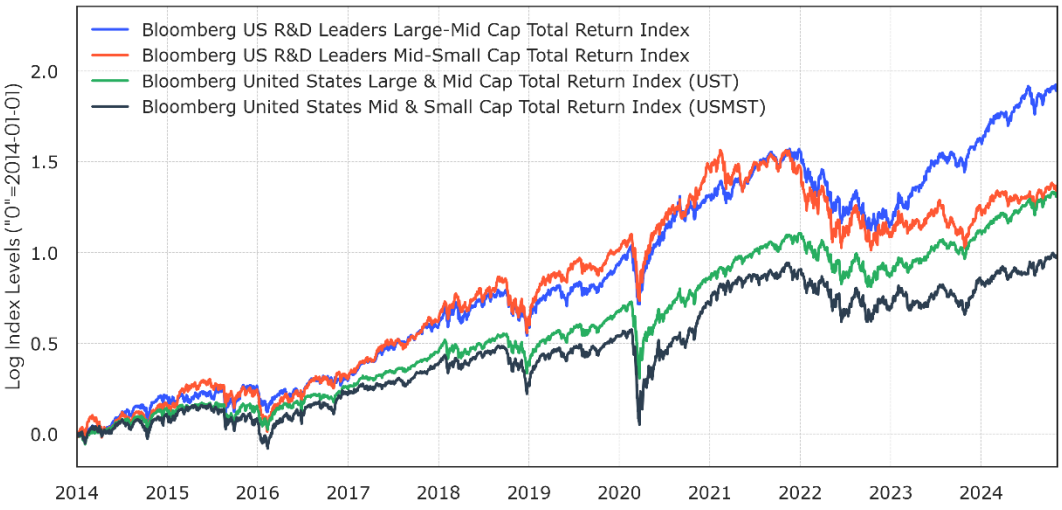
The Triumph of the Little Guys

In previous sections, the article has focused on identifying and validating the innovation factor within the US Large and Mid-Cap public companies. Is the innovation factor predominantly a large cap phenomenon? No! In fact, the returns to the innovation may have been stronger in the US Small-Mid Cap segment than the Large-Mid Cap segment. Using the same methodology as the BINVENT index, we create a research index from the Bloomberg US Mid-Small Cap Index (USMS Index), which we call the Bloomberg US R&D Leaders Mid-Small Index. Their performances over the last twenty and ten years are shown in Figure 9.

Figure 9: R&D Leaders Index Across US Market Segments



Note: Bloomberg US R&D Leaders Large-Mid Cap Total Return Index (Bloomberg US R&D Leaders Mid-Small Cap Total Return Index) selects from the benchmark UST Index (USMST Index) companies with three consecutive years of R&D spending growth, top 90th percentile R&D intensity, and top 50 by market cap. Additional liquidity screens and security & sector weight caps applied. All returns are in USD. Both indices are research backtests and for indicative purposes only. See whitepaper for details.



Note: Bloomberg US R&D Leaders Large-Mid Cap Total Return Index (Bloomberg US R&D Leaders Mid-Small Cap Total Return Index) selects from the benchmark UST Index (USMST Index) companies with three consecutive years of R&D spending growth, top 90th percentile R&D intensity, and top 50 by market cap. Additional liquidity screens and security & sector weight caps applied. All returns are in USD. Both indices are research backtests and for indicative purposes only. See whitepaper for details.

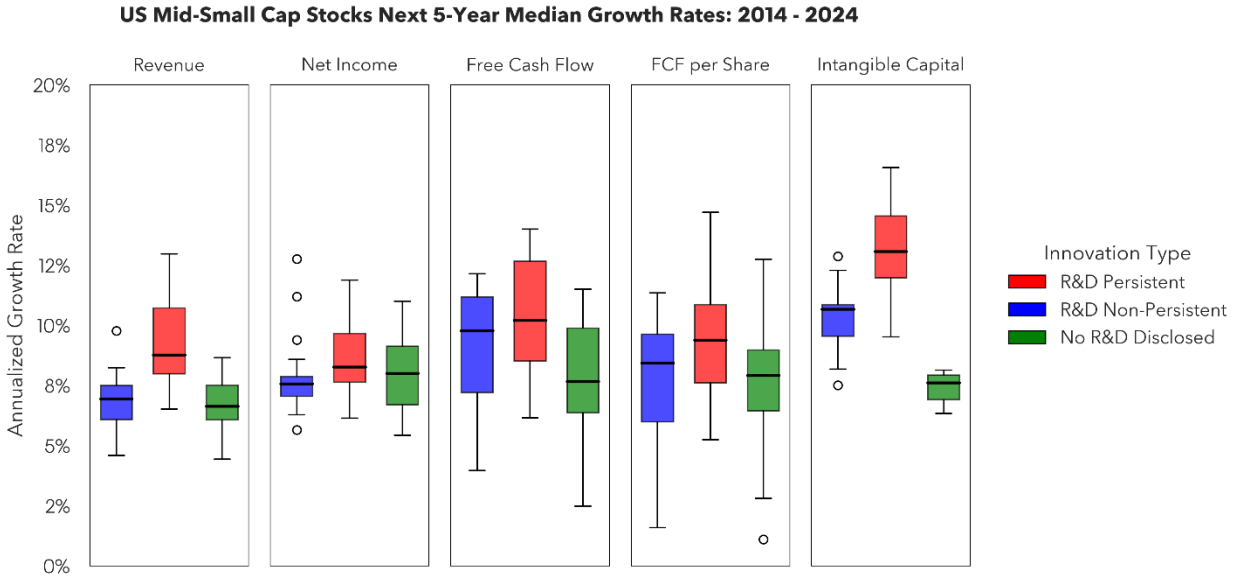
Given the prominence of the mega-cap tech companies like the "Magnificent 7", one could be forgiven to think that innovation is exclusively a story about glamorous large cap stocks. And indeed, the large cap innovative stocks have done extremely well especially over the last few years. However, over a longer horizon Mid-Small cap innovative stocks have done just as well if not much significantly better than their Large-Mid cap counterparts. In Fig. 9 Panel 1, the R&D Leaders Mid-Small Cap index significantly outperformed the Large-Mid Cap version of the index until roughly 2023. Even over the last 10 years (Panel 2), the R&D Leaders Mid-Small Cap Index has kept pace with the Large-Mid cap version until 2023 and earned the same returns as the US Large-Mid cap index over this period. And in any event, Mid-Small Cap innovative stocks have vastly outperformed the USMST benchmark.

Table 6: Performance Summary Statistics R&D Leaders Indices Across Market Segments

	Bloomberg US R&D Leaders Large-Mid Cap Total Return Index	Bloomberg US Large-Mid Cap Total Return Index	Bloomberg US R&D Leaders Mid-Small Cap Total Return Index	Bloomberg US Mid-Small Cap Total Return Index
CAGR	15.40%	11.10%	14.10%	11.30%
Volatility	20.20%	18.80%	22.40%	21.30%
Ann. Return/Vol	0.76	0.59	0.63	0.53
Ann. Excess Return	3.80%	0.00%	2.60%	0.00%
Tracking Error	7.50%	0.00%	10.30%	0.00%
Information Ratio	0.51		0.25	
Max Drawdown	-46.90%	-54.90%	-49.90%	-59.50%

Note: The performance summary statistics are derived from returns between 2003-Apr-18 and 2024-Oct-31. The returns of the strategy indices come from research backtests and are for illustrative purposes only.

Figure 10: R&D Persistence Leads to Better Operating Performances for Mid-Small Cap.

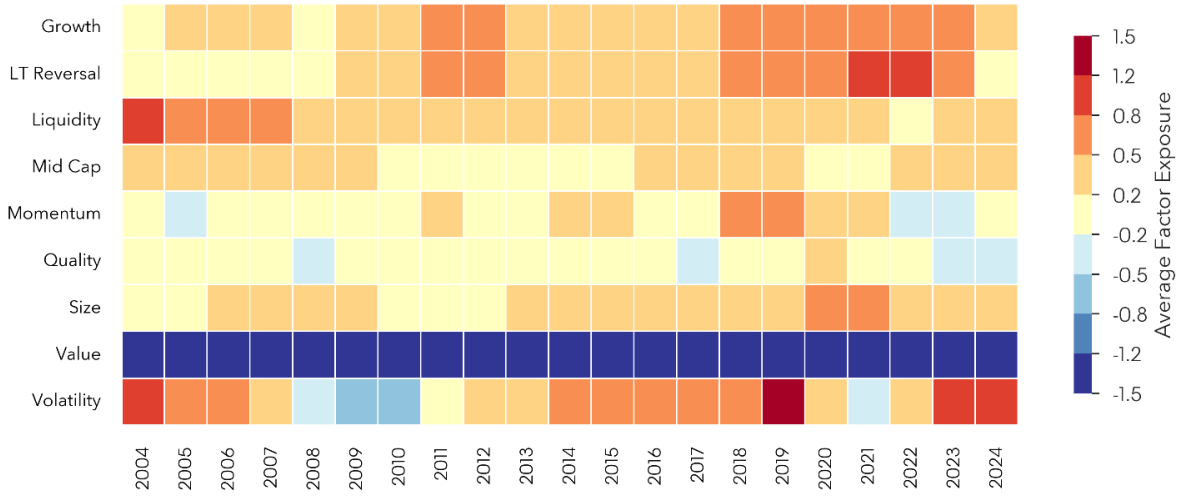


Note: This chart compares the ex-post operating performances of innovative and non-innovative companies from 2014 to 2024. Each box displays by R&D spending type the median and interquartile range of the 5-year forward realized median annualized growth rates of key fundamental fields. The securities are members of the Bloomberg US Mid-Small caps. A company is R&D Persistent if its R&D expenditure grows consecutively for three years.

Consistent with what we saw with the Large-Mid-Cap stocks, R&D persistent companies experiences stronger subsequent operating performances [Fig. 10]. In terms of the equity factor exposures, the Mid-Small Cap R&D Leaders stocks have positive active exposures to growth, long-term reversal, size, volatility, and liquidity and very negative exposure to the value. One noticeable difference is a muted exposure to the quality factor in either direction. A deeper investigation reveals a positive exposure to profitability but negative exposure to financial leverage, which likely reflects the heavy exposure to healthcare especially biotech.

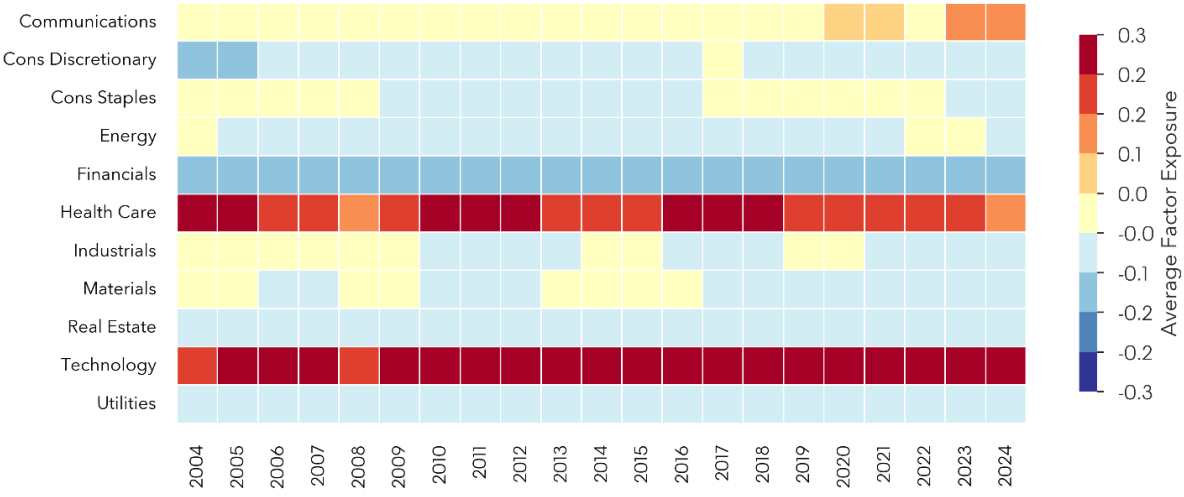
Figure 11: R&D Leaders Mid-Small Cap Index Active Factor Exposures.

Bloomberg R&D Leaders Mid & Small Cap Strategy Style Active Exposures



Source: Bloomberg MAC3 Risk model. Note: attributed active exposures are the factor exposures of the Bloomberg R&D Leaders Mid & Small Cap Strategy less the factor exposures of the benchmark Bloomberg United States Mid & Small Cap Total Return Index multiplied by active portfolio weights.

Bloomberg R&D Leaders Mid & Small Cap Strategy Industry Active Exposures



Source: Bloomberg MAC3 Risk model. Note: attributed active exposures are the factor exposures of the Bloomberg R&D Leaders Mid & Small Cap Strategy less the factor exposures of the benchmark Bloomberg United States Mid & Small Cap Total Return Index multiplied by active portfolio weights.

Table 5: Bloomberg R&D Leaders Mid-Small Select Index Holdings

Name	Ticker	Primary Exchange	Weights	Sector
Top 10 Holdings				
Super Micro Computer Inc	SMCI	Nasdaq	3.90%	Technology
DoorDash Inc	DASH	Nasdaq	3.67%	Communications
AMETEK Inc	AME	New York	3.62%	Industrials
Trade Desk Inc/The	TTD	Nasdaq	3.33%	Communications
CoStar Group Inc	CSGP	Nasdaq	3.18%	Real Estate
GE HealthCare Technologies Inc	GEHC	Nasdaq	3.07%	Health Care
Spotify Technology SA	SPOT	New York	2.79%	Communications
Datadog Inc	DDOG	Nasdaq	2.78%	Technology
Xylem Inc/NY	XYL	New York	2.67%	Industrials
Monolithic Power Systems Inc	MPWR	Nasdaq	2.53%	Technology
Bottom 10 Holdings				
Enphase Energy Inc	ENPH	Nasdaq	1.38%	Energy
Trimble Inc	TRMB	Nasdaq	1.37%	Industrials
Graco Inc	GGG	New York	1.34%	Industrials
Okta Inc	OKTA	Nasdaq	1.32%	Technology
Akamai Technologies Inc	AKAM	Nasdaq	1.31%	Technology
Pure Storage Inc	PSTG	New York	1.25%	Technology
Zoom Video Communications Inc	ZM	Nasdaq	1.25%	Technology
Manhattan Associates Inc	MANH	Nasdaq	1.24%	Technology
Nutanix Inc	NTNX	Nasdaq	1.21%	Technology
SS&C Technologies Holdings Inc	SSNC	Nasdaq	1.13%	Technology

Note: US Mid-Small Cap R&D Leaders top holdings and bottom holdings as of 2024-04-12 semi-annual rebalance.

The R&D Leaders Mid-Small Select Index comes with significantly greater diversification than its US Large and Mid-Cap counterpart, both in the distribution of index weights and sector composition. For instance, during the most recent rebalancing, the weight capping constraint of "8%-4%-40%" is not restrictive. This index autonomously selects a broad spectrum of innovative companies from multiple industries, showcasing its extensive reach.

The top five holdings in this index, which collectively make up just under 18% of the total weight, illustrate the index's sector diversity. Here, we see:

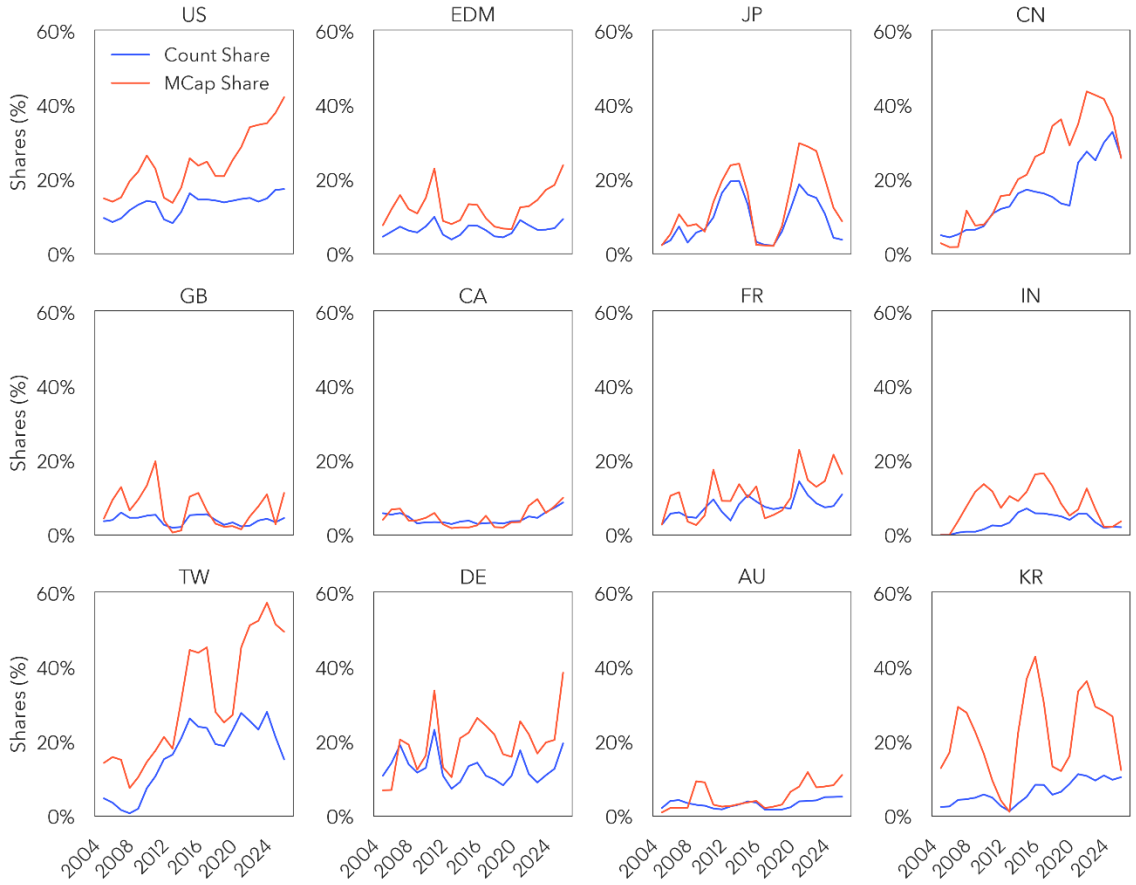
- Super Micro, a pioneer in AI hardware, specializing in liquid cooling solutions for data centers.
- DoorDash, dominating the consumer food delivery space.
- AMETEK, known for designing and manufacturing global electronic instruments.
- The Trade Desk, which excels as a platform for intelligent digital advertising aimed at media buyers.
- CoStar Group, providing critical news and analytics for real estate transactions.

Despite the post-COVID market trends where large cap stocks significantly outperformed smaller ones, the R&D Leaders US Mid-Small Select Index offers a compelling alternative for exposure to innovation. This index focuses on companies that might not be as familiar to the average investor but are at the forefront of innovation. If the trend of size ("big-minus-small") factor dominance reverses, it would be noteworthy to observe if these mid-small cap innovative stocks could once again outpace their large and mid-cap counterparts.

Innovation Is Globally Pervasive

So far, we have shown that the innovation factor has been richly rewarded in the US across sectors and market cap segments over the past twenty years. But the triumph of innovation is not a uniquely US phenomenon, but in fact a globally pervasive one. In Figure 11, we plot the shares of R&D persistent companies across major global markets in both absolute percentages and the percentages of country index weights. What emerges from this picture is that innovation companies have seen their market caps rise as a share of their respective national stock market in almost all markets. Moreover, the market cap shares rose more than their absolute count shares in most markets, which reflects the higher valuation the market assigns to innovative companies. What sets the US apart seems to be less the level of innovation spending but the degree of consistency!

Figure 12: Percentages of R&D Persistent Companies Across Global Markets.



Source: Bloomberg. A company is R&D persistent if its R&D expenditures growth is posistive in the past three years consecutively. Count Share is the percentage of companies in a given market that are R&D persistent. MCap Share is the R&D persistent companies total market cap as a percentage of the country total market cap. EDM stands for Europe Developed Markets. Other codes are standard.

The countries with the most R&D persistent companies are the US and China, followed by other advanced East Asian economies like Japan, Korea, and Taiwan. European economies and the Europe Developed Markets are a distinct laggard in terms of average percentages of consistent R&D spenders. The rise of innovation in China over the last twenty years is truly extraordinary and matches the media and academic narrative of China as a rising innovative

superpower[17]. The roller-coaster like performance of the Chinese stock market over the last twenty years notwithstanding, innovative R&D persistence stocks still significantly outperformed the benchmark. [See Appendix]

Now, Europe. The underperformance of the rest of the developed world relative to the US over the last twenty (especially ten years) has been much talked about. For the sake of space, the international investigation of innovation will focus on Europe Developed Markets (EDM). It is commonly known that to a large extent the difference between US and European stock market index performances is in fact attributable to industry composition and style factor differences. Compared to the US the Europe Developed Market tends to consist of older and less technology industries that tilt more towards value and away from growth.

Looking at R&D spending patterns gives us another angle to examine the origins of the divergences between the US and Europe over the past twenty years. Comparing Table 1 and Table 6, the US and Europe have high R&D spending in similar industries (technology and health care) at similar levels of R&D intensity at the start of the new millennium. However, as the next twenty years unfolded, the differences between the US and European innovation efforts grew steadily larger[18], such that by 2023 the median US tech and healthcare companies are spending twice as much on R&D as their EDM median counterparts. Perhaps what is even more important than the differences in R&D intensity, it is the differences in the percentage of R&D persistent companies. Whereas at least half the US tech companies have persistent R&D expenditures since 2013, the same number for EDM tech companies is only 17%, which has decreased from 27% ten years ago. Similar yawning differences exist for other innovative sectors like health care, communications and even consumer discretionary[19].

Table 6: Europe Developed Markets Corporate R&D Intensity and Persistence

	R&D Intensity Median			R&D Persistence Percentage		
DATE	2003	2013	2023	2003	2013	2023
All	1%	0%	0%	4%	8%	7%
Communications	0%	0%	0%	1%	3%	1%
Consumer Discretionary	0%	0%	0%	2%	9%	4%
Consumer Staples	0%	0%	0%	2%	7%	5%
Energy	0%	0%	0%	3%	4%	4%
Financials	0%	0%	0%	0%	0%	2%
Health Care	11%	11%	8%	20%	24%	26%
Industrials	2%	0%	0%	4%	11%	8%
Materials	1%	0%	1%	5%	9%	9%
Real Estate	0%	0%	0%	0%	0%	0%
Technology	12%	11%	8%	14%	27%	17%
Utilities	0%	0%	0%	0%	2%	3%

Note: The table displays 3 snapshots of the R&D spending patterns across Bloomberg Industry Classification Standards (BICS) sectors. R&D Intensity median is the sector median of R&D Intensity. R&D Persistence percentage is the percentage of companies in a sector that have 3 years of consecutive R&D spending growth. The companies are members of the Bloomberg EDM Large, Mid and Small Cap index (EDMLST).

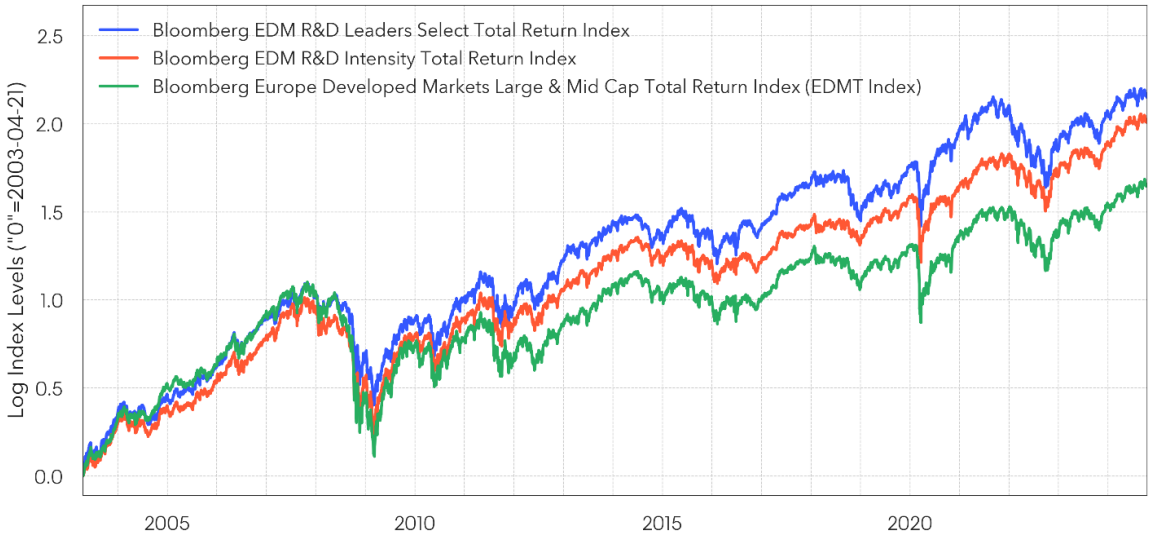
[17] Atkinson, *China is rapidly becoming a leading innovator in advanced industries*. 2024.

[18] Because only companies spending at least 1% of sales are historically required to disclose R&D, the sector median values likely understate the differences between US and European R&D spendings.

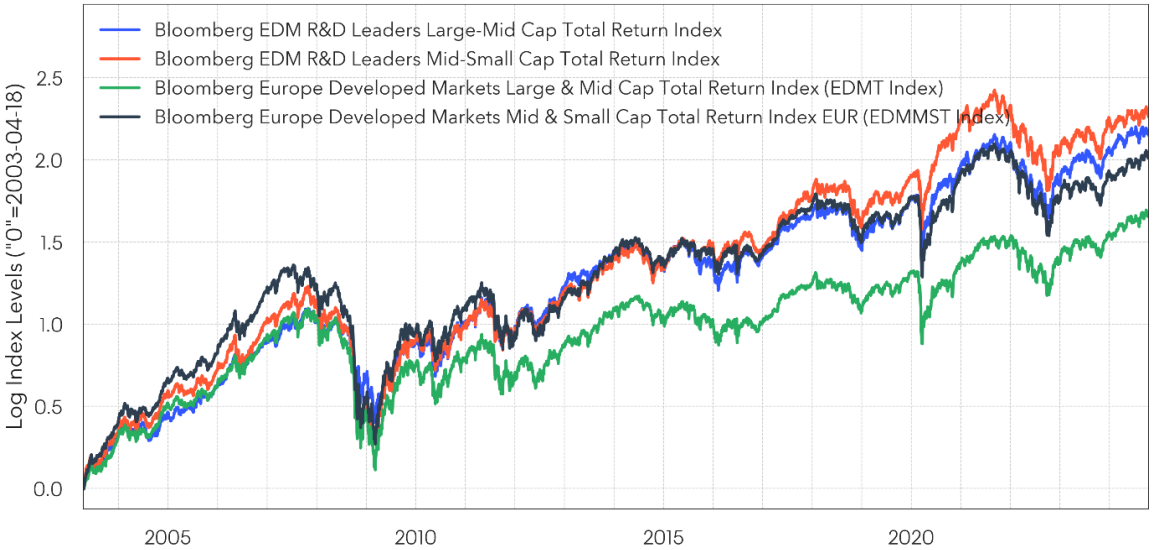
[19] One interesting exception may be consumer discretionary especially in Germany, whose auto industry spends a significant amount on R&D every year. This is also somewhat visible from Fig. 12. The lackluster performance of German stocks may suggest that Germany spent on the wrong types of R&D. Instead of disruptive new categories of innovation, German R&D may have been spent mostly on refining existing technologies.

Does the fact that European R&D has lagged the US imply that the innovation factor ((similarly defined as in the BINVENT index in the US) has not been richly rewarded in Europe? No. In fact, we find that in Europe Developed Markets R&D Leaders has experienced very similar success over its respective market benchmarks: 1) R&D persistence is better than R&D intensity; and 2) R&D persistence in the small-mid cap is better than R&D persistence in the large-mid cap.

Figure 10: R&D Leaders Index Performance in Europe Developed Markets



Note: Bloomberg EDM R&D Leaders Select Total Return Index selects from the benchmark EDMT Index securities with three consecutive years of R&D spending growth, top 90th percentile R&D intensity, and top 50 by market cap. Bloomberg EDM R&D Intensity Total Return Index selects the benchmark EDMT Index securities in the top 50th percentile of R&D intensity and top 50 by market cap. Additional liquidity screens and security & sector weight caps applied. USD returns. Both indices are research backtests and for indicative purposes only. See whitepaper for details.

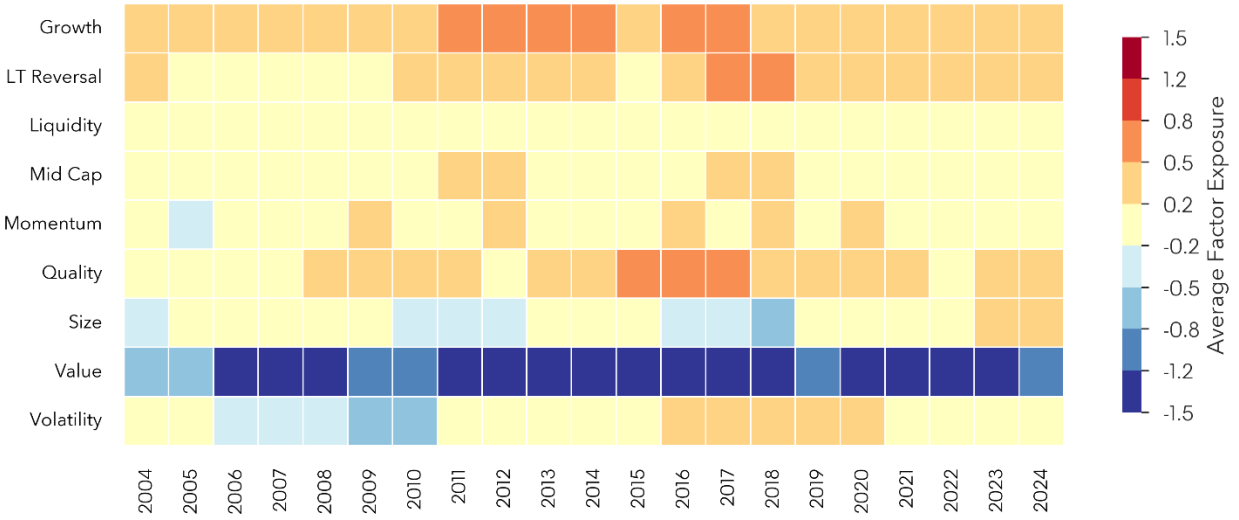


Note: Bloomberg EDM R&D Leaders Large-Mid Cap Total Return Index (Bloomberg EDM R&D Leaders Mid-Small Cap Total Return Index) selects from the benchmark EDMT Index (EDMMST Index) companies with three consecutive years of R&D spending growth, top 90th percentile R&D intensity, and top 50 by market cap. Additional liquidity screens and security & sector weight caps applied. All returns are in USD. Both indices are research backtests and for indicative purposes only. See whitepaper for details.

Consistent with its counterpart in the US, the EDM R&D Leaders Index Large & Mid-Cap Index has strong positive active exposures to the growth, quality and long-term reversal factors and a deeply negative exposure to the value factor. In terms of industry exposures, most of the positive active exposures are in the European technology and health care industries. Unlike the US, European R&D Leaders do not seem to have a strong exposure to either the communications or the consumer discretionary sectors. Instead, the European R&D Leaders tend to feature more health care (pharmaceutical) innovators than in the US.

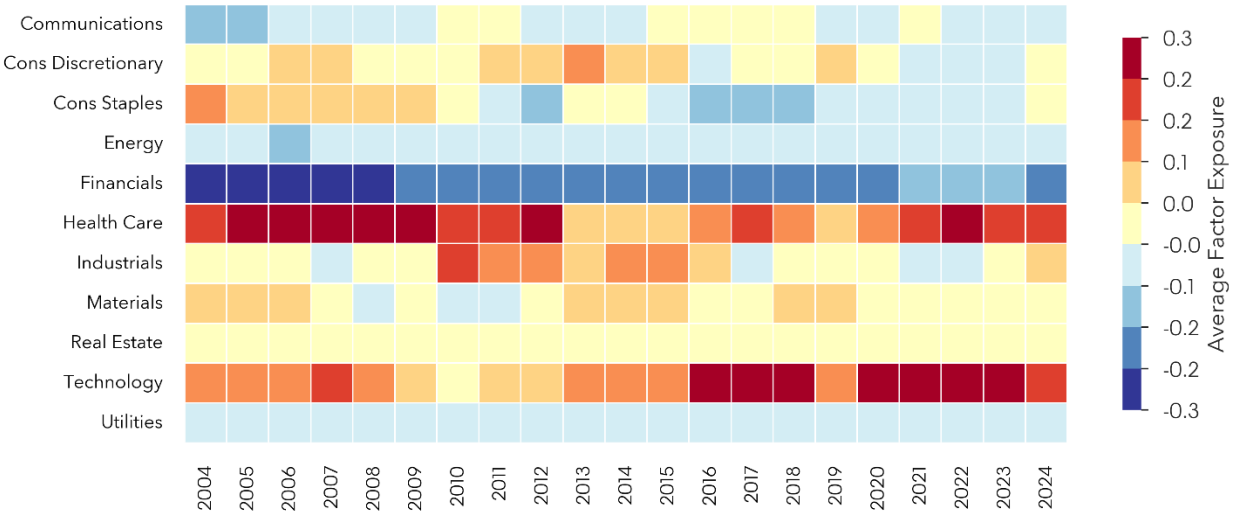
Figure 11: EDM Large Mid-Cap R&D Leaders Active Factor Exposures: Style and Industry.

Bloomberg R&D Leaders Europe Developed Large & Mid Cap Strategy Style Active Exposures



Source: Bloomberg MAC3 Risk model. Note: attributed active exposures are the factor exposures of the Bloomberg R&D Leaders Europe Developed Large & Mid Cap Strategy less the factor exposures of the benchmark Bloomberg Europe Developed Markets Large, Mid & Small Cap Total Return Index multiplied by active portfolio weights.

Bloomberg R&D Leaders Europe Developed Large & Mid Cap Strategy Industry Active Exposures

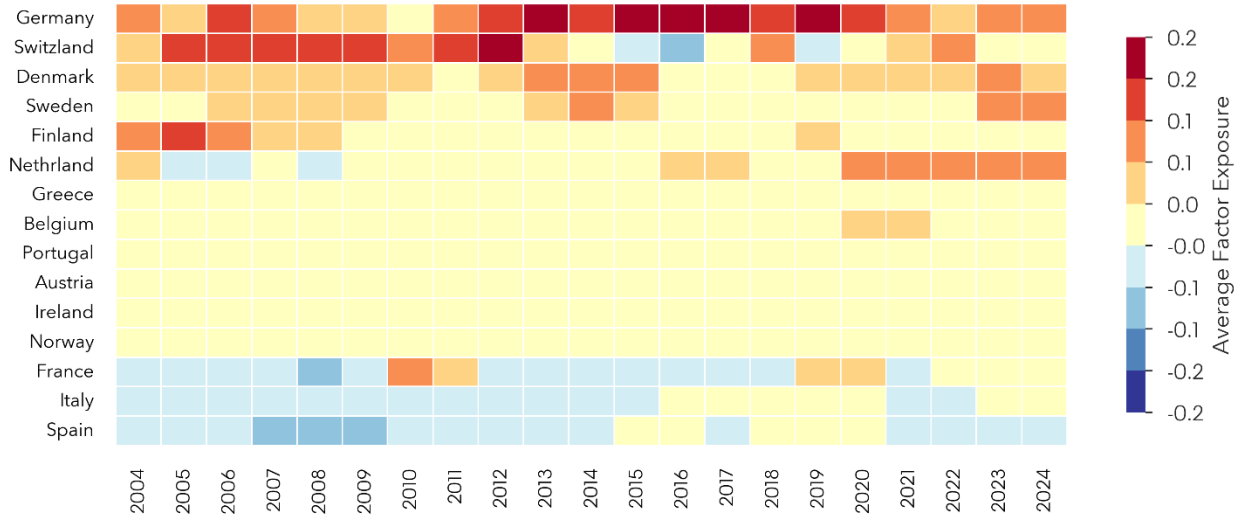


Source: Bloomberg MAC3 Risk model. Note: attributed active exposures are the factor exposures of the Bloomberg R&D Leaders Europe Developed Large & Mid Cap Strategy less the factor exposures of the benchmark Bloomberg Europe Developed Markets Large, Mid & Small Cap Total Return Index multiplied by active portfolio weights.

The factor-based attributions of Europe Developed Markets R&D Leaders index give us an additional dimension: geography. Country factor attribution can be interpreted as a "map" of innovation. In addition to *how* innovation has manifested in Europe, we are able to see *where* innovation has taken place over time. From Fig. 12, we can see that European innovation has historically tended to take place in Germany, Switzerland, and Scandinavian countries and there has been some significant and interesting migration over the last twenty years.

Figure 12: EDM Large Mid-Cap R&D Leaders Active Factor Exposures: Country.

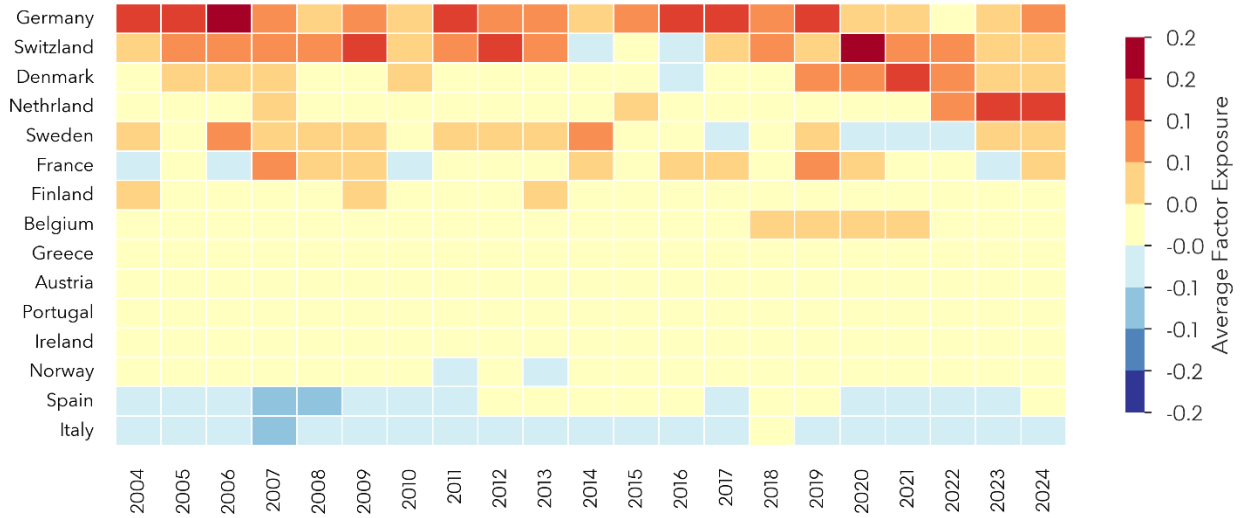
Bloomberg R&D Leaders Europe Developed Large & Mid Cap Strategy Country Active Exposures



Source: Bloomberg MAC3 Risk model. Note: attributed active exposures are the factor exposures of the Bloomberg R&D Leaders Europe Developed Large & Mid Cap Strategy less the factor exposures of the benchmark Bloomberg Europe Developed Markets Large, Mid & Small Cap Total Return Index multiplied by active portfolio weights.

Figure 13: EDM Mid Small-Cap R&D Leaders Active Factor Exposures: Country.

Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy Country Active Exposures



Source: Bloomberg MAC3 Risk model. Note: attributed active exposures are the factor exposures of the Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy less the factor exposures of the benchmark Bloomberg Europe Developed Markets Mid & Small Cap Total Return Index EUR multiplied by active portfolio weights.

Between 2003 and 2019, Germany (engineering) or Switzerland (pharmaceutical) have taken turns to be leaders in European innovation with a modest degree of overweight in the Scandinavian countries. Since 2020 (or the onset of COVID pandemic), we seem to have entered a new regime. EDM active country exposures have become distinctly more spread out between Germany, Scandinavia, and the Netherlands. The significant increase in country overweight in the latter two sets of countries is likely attributable to the consistent inclusions of the tech giant ASML (Netherlands) and the pharma giant Novo Nordisk, which reflect the ascendant power of AI (microchips) and the GLP-1 ("Ozempic") innovations.

There seems to have been a northward "migration" of innovative companies in EDM Large-Mid-Cap universe from Germany and Switzerland towards the Scandinavian countries and Netherlands. What is even more interesting is that there is a similar migration in the Small-Mid-Cap segment too. A plausible explanation of this "co-migration" phenomenon is the existence of supply chain linkages or an agglomeration effect, where companies in the same or related industries tend to be closely relocated to each other. This could happen because they tend to draw from the same talent or resource pools, being close to major university research hubs or simply share the same languages. In the academic international trade literature, there is well documented evidence for knowledge spillover between related companies whether they are direct competitors or customer-suppliers[20]. Knowledge can also diffuse across companies from a variety of channels such as trade conferences or cross-hiring.

Table 7: Europe Developed Markets R&D Leaders Indices Top Holdings

Name	Ticker	Primary Exchange	Weights	Sector
EDM Large-Mid Cap Top 10 Holdings				
Novo Nordisk A/S	NOVOB	Copenhagen	8.00%	Health Care
ASML Holding NV	ASML	EN Amsterdam	8.00%	Technology
SAP SE	SAP	Xetra	8.00%	Technology
AstraZeneca PLC	AZN	London	8.00%	Health Care
Novartis AG	NOVN	SIX Swiss Ex	8.00%	Health Care
Siemens AG	SIE	Xetra	4.00%	Industrials
Schneider Electric SE	SU	EN Paris	4.00%	Industrials
Sanofi SA	SAN	EN Paris	4.00%	Health Care
Atlas Copco AB	ATCOA	Stockholm	3.46%	Industrials
Stellantis NV	STLAM	Borsa Italiana	3.07%	Consumer Discretionary
EDM Mid-Small Cap Top 10 Holdings				
Cie de Saint-Gobain SA	SGO	EN Paris	8.00%	Materials
ASM International NV	ASM	EN Amsterdam	8.00%	Technology
Genmab A/S	GMAB	Copenhagen	5.72%	Health Care
Symrise AG	SY1	Xetra	4.66%	Materials
Kingspan Group PLC	KSP	EN Dublin	4.12%	Materials
BE Semiconductor Industries NV	BESI	EN Amsterdam	3.30%	Technology
Alfa Laval AB	ALFA	Stockholm	3.17%	Industrials
Spirax Group PLC	SPX	London	2.73%	Industrials
Wartsila OYJ Abp	WRT1V	Helsinki	2.45%	Industrials
Nibe Industrier AB	NIBEB	Stockholm	2.30%	Industrials

Note: Europe Developed Markets Large-Mid Cap and Mid-Small Cap R&D Leaders top holdings as of 2024-04-12 semi-annual rebalance.

[20] Customer-supplier innovation linkages is an area of research we are actively pursuing through the use of the Bloomberg supply chain data (SPLC <GO>).

Table 7 displays the top 10 holdings of the R&D Leaders Index in Large-Mid Cap and Mid-Small Cap Indices in Europe Developed Markets. A comparison of the top holdings in EDM and in the US (Table 5) provides a more concrete glimpse at the various dimensions of differences between the American and European innovations that we have alluded above. US innovation tends to comprise more new technology companies, including those initially founded in Europe by European founders, such as Spotify, whereas European innovation tends to comprise older industrial and health care companies. The common running theme is a persistent dedication to R&D.

Conclusion

This study advances our understanding of corporate innovation and its implications for investment strategy. While innovation has emerged as a crucial driver of corporate value creation globally, its identification and measurement have remained elusive for investors. We address this gap by developing a systematic framework for identifying innovative companies through their R&D expenditure patterns. Specifically, we introduce R&D persistence as a novel and more effective signal for predicting innovation success.

Our empirical analysis reveals that companies exhibiting persistent R&D investment—which we term R&D Leaders—demonstrate superior subsequent operating performance across multiple metrics, suggesting successful accumulation of valuable intangible capital. This operational excellence translates into significant stock outperformance. Importantly, the returns to innovation persist across different market capitalizations and geographical regions, with systematic risk factors providing a rational explanation for the observed premium.

The study's findings have significant implications for investment practice. By introducing a systematic approach to identifying innovative companies through R&D persistence, we provide investors with a practical tool for capturing quality growth opportunities globally. This framework not only enhances our theoretical understanding of innovation's role in value creation but also offers a concrete methodology for incorporating innovation exposure into investment portfolios.

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Appendix

A. R&D Disclosure Rates

Table A1: Disclosure Rates by Country

	Disclosure by Count			Disclosure by Market Cap		
	2003	2013	2023	2003	2013	2023
United States	40%	65%	65%	50%	73%	79%
Europe Developed Markets	34%	62%	66%	48%	67%	74%
Asian Developed Markets	62%	75%	84%	55%	77%	86%
Other Developed Markets	36%	73%	71%	24%	53%	54%
China	44%	80%	86%	44%	65%	83%
India	25%	75%	45%	42%	62%	42%
Middle East	72%	75%	68%	57%	54%	59%
Latin America	17%	74%	66%	31%	72%	57%
Miscellaneous	16%	51%	56%	30%	54%	57%
ASEAN	16%	79%	69%	10%	56%	60%

* We deviate slightly from how Bloomberg indices typically defines regional indices. "Asian Developed Markets" in this article include Japan, Korea, and Taiwan. "Other Developed Markets" include Australia, Canada, and New Zealand. "China" includes mainland China and Hong Kong.

Table A2: Disclosure Rates by Sector

	Disclosure by Count			Disclosure by Market Cap		
DATE	2003	2013	2023	2003	2013	2023
Technology	73%	86%	88%	91%	95%	97%
Financials	3%	13%	20%	2%	8%	20%
Health Care	72%	86%	92%	87%	97%	97%
Industrials	53%	81%	80%	67%	85%	87%
Consumer Discretionary	41%	79%	80%	42%	84%	85%
Communications	35%	77%	75%	27%	73%	85%
Consumer Staples	45%	77%	77%	46%	82%	79%
Materials	56%	82%	81%	63%	81%	86%
Energy	41%	82%	79%	71%	89%	84%
Real Estate	19%	44%	36%	20%	32%	22%
Utilities	30%	81%	84%	32%	87%	87%

B. Global Markets R&D Spending

Table B1: Europe Developed Markets* R&D Spending Intensity and Persistence

	R&D Intensity Median			R&D Persistence Percentage		
	2003	2013	2023	2003	2013	2023
Communications	0%	0%	0%	1%	3%	1%
Consumer Discretionary	0%	0%	0%	2%	9%	4%
Consumer Staples	0%	0%	0%	2%	7%	5%
Energy	0%	0%	0%	3%	4%	4%
Financials	0%	0%	0%	0%	0%	2%
Health Care	11%	11%	8%	20%	24%	26%
Industrials	2%	0%	0%	4%	11%	8%
Materials	1%	0%	1%	5%	9%	9%
Real Estate	0%	0%	0%	0%	0%	0%
Technology	12%	11%	8%	14%	27%	17%
Utilities	0%	0%	0%	0%	2%	3%

* Bloomberg Europe Developed Markets Large, Mid, and Small Cap Index constituents.

Table B2: Asian Developed Markets R&D Spending Intensity and Persistence

	R&D Intensity Median			R&D Persistence Percentage		
	2003	2013	2023	2003	2013	2023
Communications	0%	0%	1%	2%	9%	16%
Consumer Discretionary	1%	0%	0%	3%	15%	8%
Consumer Staples	0%	0%	0%	4%	12%	5%
Energy	0%	0%	0%	3%	8%	14%
Financials	1%	0%	0%	0%	0%	0%
Health Care	6%	7%	9%	6%	14%	16%
Industrials	1%	1%	1%	2%	16%	10%
Materials	1%	1%	1%	2%	15%	7%
Real Estate	0%	0%	0%	0%	0%	1%
Technology	3%	3%	4%	7%	29%	23%
Utilities	0%	0%	0%	0%	6%	2%

* Asian Developed Markets include Bloomberg Japan, Korea and Taiwan, Large, Mid and Small Cap Index constituents.

Table B3: China R&D Spending Intensity and Persistence

	R&D Intensity Median			R&D Persistence Percentage		
	2003	2013	2023	2003	2013	2023
Communications	0%	7%	7%	0%	38%	25%
Consumer Discretionary	0%	0%	3%	6%	8%	29%
Consumer Staples	0%	0%	1%	3%	8%	29%
Energy	1%	1%	3%	0%	22%	42%
Financials	0%	0%	1%	0%	1%	3%
Health Care	2%	4%	9%	17%	37%	48%
Industrials	0%	0%	4%	1%	17%	34%
Materials	0%	0%	3%	5%	7%	35%
Real Estate	0%	0%	0%	0%	0%	5%
Technology	1%	4%	10%	29%	38%	51%
Utilities	0%	0%	0%	0%	2%	22%

* China includes Chinese Mainland and Hong Kong from Bloomberg China and Hong Kong, Large, Mid and Small Cap Index constituents.

C. Intra Sector R&D Persistent vs R&D Non-Persistent Backtests

Table C1: US R&D Persistent vs R&D Non-Persistent Sector Backtests – Equal-Weighted

	Technology	Health Care	Communications	Materials	Industrials	Consumer Discretionary
Sector Backtests: 2003 - 2024						
Persistent Mean	16.3%	13.3%	17.2%	13.1%	12.7%	11.6%
Non-Persistent Mean	14.0%	13.1%	12.8%	14.6%	15.6%	12.2%
Mean Difference	2.3%	0.2%	4.5%	-1.9%	-2.9%	-0.6%
Persistent SD	26.4%	23.9%	28.3%	25.5%	24.7%	28.5%
Non-Persistent SD	25.6%	23.9%	26.9%	24.2%	23.2%	28.3%
t statistic	19.92	1.82	16.61	-11.72	-21.96	-2.47
Sector Backtests: 2014 - 2024						
Persistent Mean	17.9%	11.5%	16.8%	10.5%	13.2%	9.1%
Non-Persistent Mean	15.2%	10.1%	10.4%	12.5%	12.7%	8.0%
Mean Difference	2.7%	1.4%	6.5%	-2.3%	0.5%	1.0%
Persistent SD	26.2%	27.3%	27.6%	24.9%	23.2%	28.7%
Non-Persistent SD	23.6%	25.4%	26.1%	22.0%	22.6%	26.0%
t statistic	13.93	8.55	20.60	-10.25	2.43	3.05

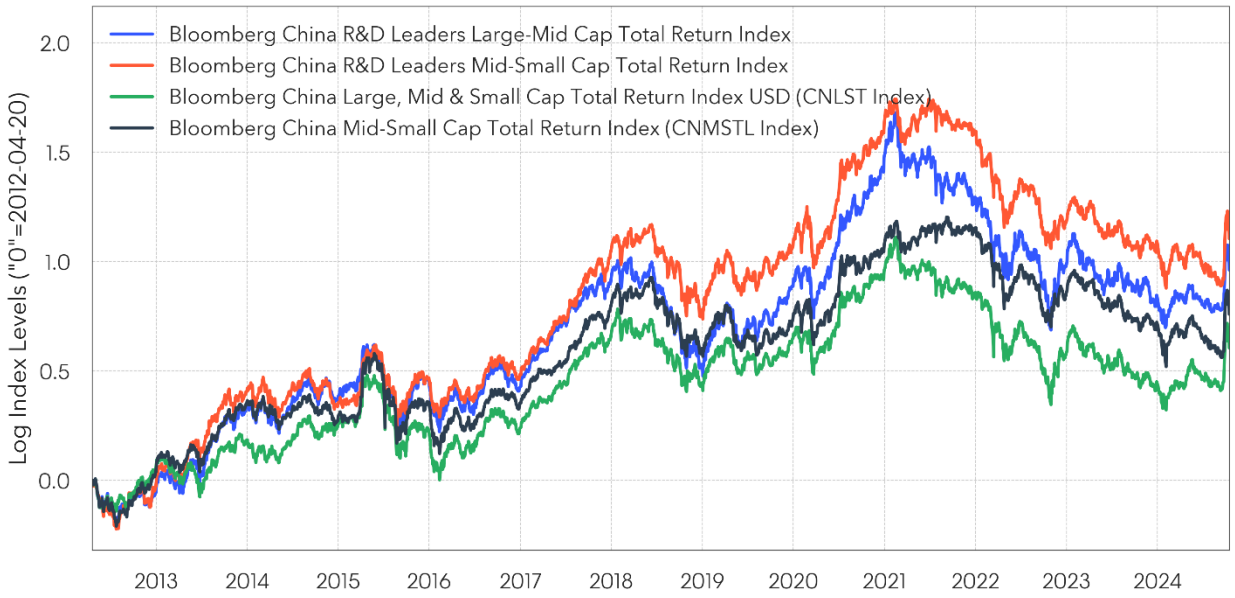
Table C2: EDM R&D Persistent vs R&D Non-Persistent Sector Backtests – Value-Weighted

	Technology	Health Care	Industrials	Consumer Discretionary
Sector Backtests: 2003 - 2024				
Persistent Mean	13.7%	11.8%	11.2%	14.3%
Non-Persistent Mean	12.7%	11.2%	16.5%	13.4%
Mean Difference	1.0%	0.5%	-5.3%	1.0%
Persistent SD	27.6%	18.6%	25.7%	40.5%
Non-Persistent SD	27.7%	18.5%	25.6%	28.2%
t statistic	3.51	2.82	-31.62	1.95
Sector Backtests: 2014 - 2024				
Persistent Mean	25.2%	12.7%	15.2%	24.0%
Non-Persistent Mean	17.6%	11.1%	12.8%	16.6%
Mean Difference	7.6%	1.7%	2.4%	7.4%
Persistent SD	25.8%	18.8%	21.6%	29.9%
Non-Persistent SD	23.4%	16.0%	21.7%	35.0%
t statistic	31.67	9.18	10.38	11.69

Table C3: EDM R&D Persistent vs R&D Non-Persistent Sector Backtests – Equal-Weighted

	Technology	**Health Care**	**Industrials**	**Consumer Discretionary**
Sector Backtests: 2003 - 2024				
Persistent Mean	16.6%	13.5%	13.1%	11.8%
Non-Persistent Mean	14.4%	13.3%	15.9%	12.4%
Mean Difference	2.2%	0.2%	-2.8%	-0.6%
Persistent SD	26.4%	23.9%	24.7%	28.5%
Non-Persistent SD	25.6%	23.9%	23.2%	28.2%
t statistic	18.89	1.95	-21.79	-2.61
Sector Backtests: 2014 - 2024				
Persistent Mean	18.6%	11.9%	13.9%	9.5%
Non-Persistent Mean	16.1%	10.5%	13.4%	8.5%
Mean Difference	2.5%	1.4%	0.5%	1.0%
Persistent SD	26.2%	27.3%	23.3%	28.7%
Non-Persistent SD	23.7%	25.4%	22.7%	26.0%
t statistic	12.87	8.74	2.72	2.86

D. Additional Global Market Performances



Note: Bloomberg China R&D Leaders Large-Mid Cap Total Return Index (Bloomberg China R&D Leaders Mid-Small Cap Total Return Index) selects from the benchmark CNLST Index (CNMSTL Index) companies with three consecutive years of R&D spending growth, top 90th percentile R&D intensity, and top 50 by market cap. Additional liquidity screens and security & sector weight caps applied. All returns are in USD. Both indices are research backtests and for indicative purposes only. See whitepaper for details.

Table D: China R&D Leaders Indices Top Holdings

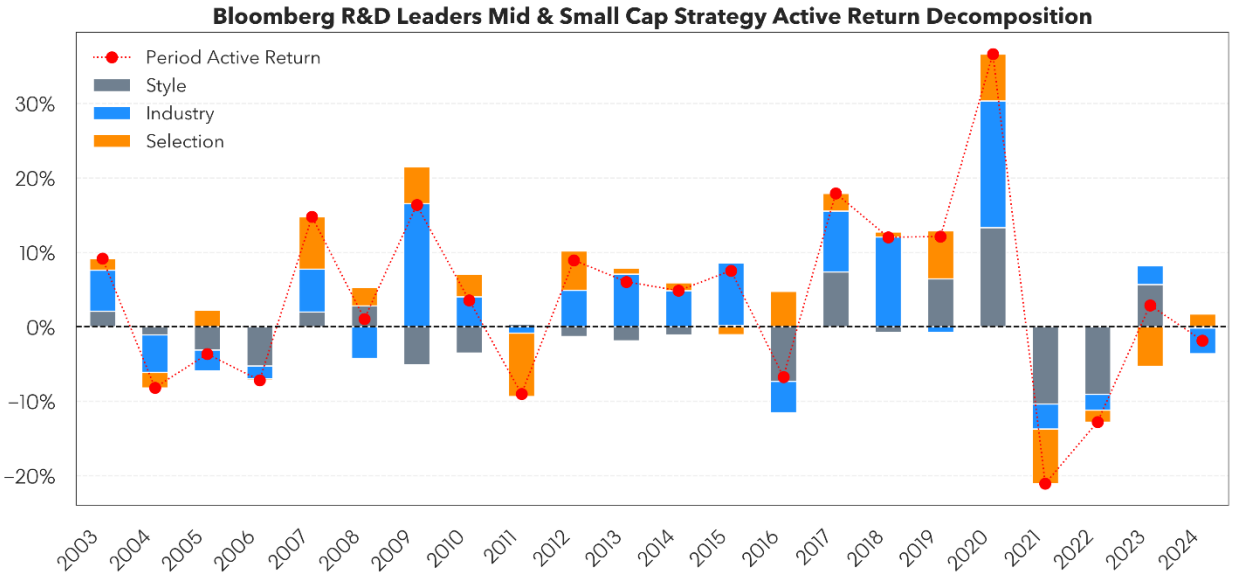
Name	Ticker	Primary Exchange	Weights	Sector
China Large-Mid Cap Top 10 Holdings				
NetEase Inc	9999	Hong Kong	8.00%	Communications
BYD Co Ltd	2594	Nth SZ-SEHK	8.00%	Consumer Discretionary
Contemporary Amperex Technology	300750	Nth SZ-SEHK	6.95%	Consumer Discretionary
Xiaomi Corp	1810	Hong Kong	6.22%	Technology
PetroChina Co Ltd	601857	Nth SSE-SEHK	5.83%	Energy
China Yangtze Power Co Ltd	600900	Nth SSE-SEHK	4.00%	Utilities
Li Auto Inc	2015	Hong Kong	3.88%	Consumer Discretionary
Techtronic Industries Co Ltd	669	Hong Kong	3.88%	Industrials
ANTA Sports Products Ltd	2020	Hong Kong	3.08%	Consumer Discretionary
Shenzhen Mindray Bio-Medical Electronics Co., Ltd	300760	Nth SZ-SEHK	2.84%	Health Care

Note: Greater China Large-Mid Cap and Mid-Small Cap R&D Leaders top holdings as of 2024-04-12 semi-annual rebalance.

Commentary: Interestingly, China R&D Leaders Index autonomously picks up among its largest holdings companies that sit at China's technological frontiers: gaming (Netease), electric vehicles (BYD, Li Auto), battery storage (Contemporary Amperex Technology), as well as power tools (Techtronic), over which China holds significant technological edge.

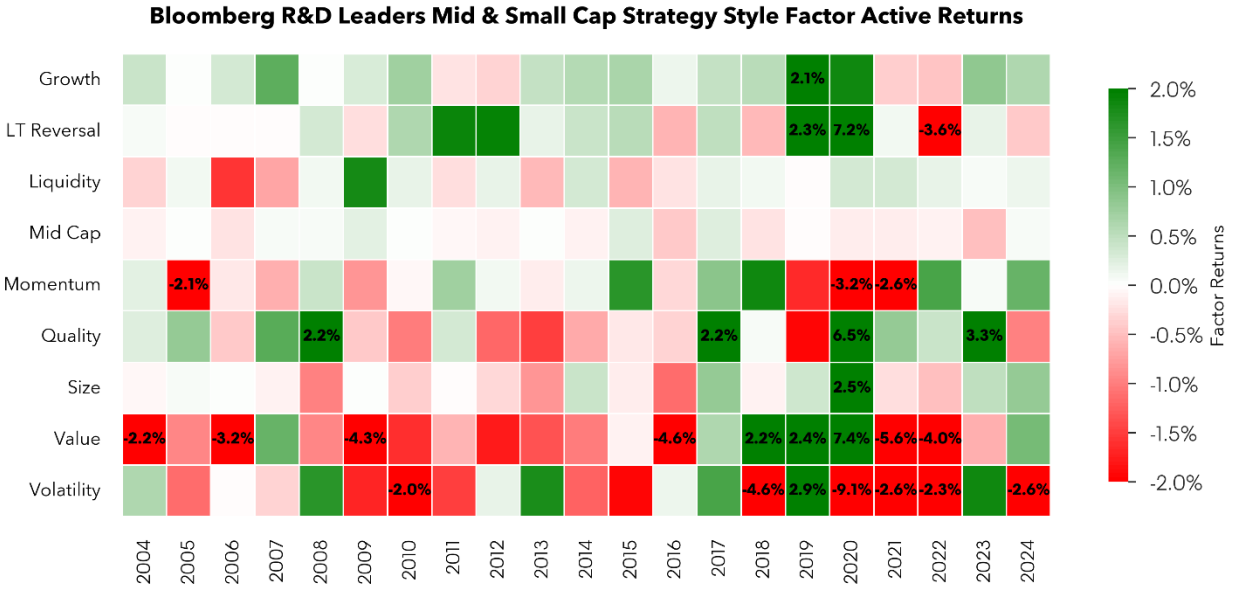
E. Factor-Based Attribution Results

US Mid-Small Cap Return Attribution.



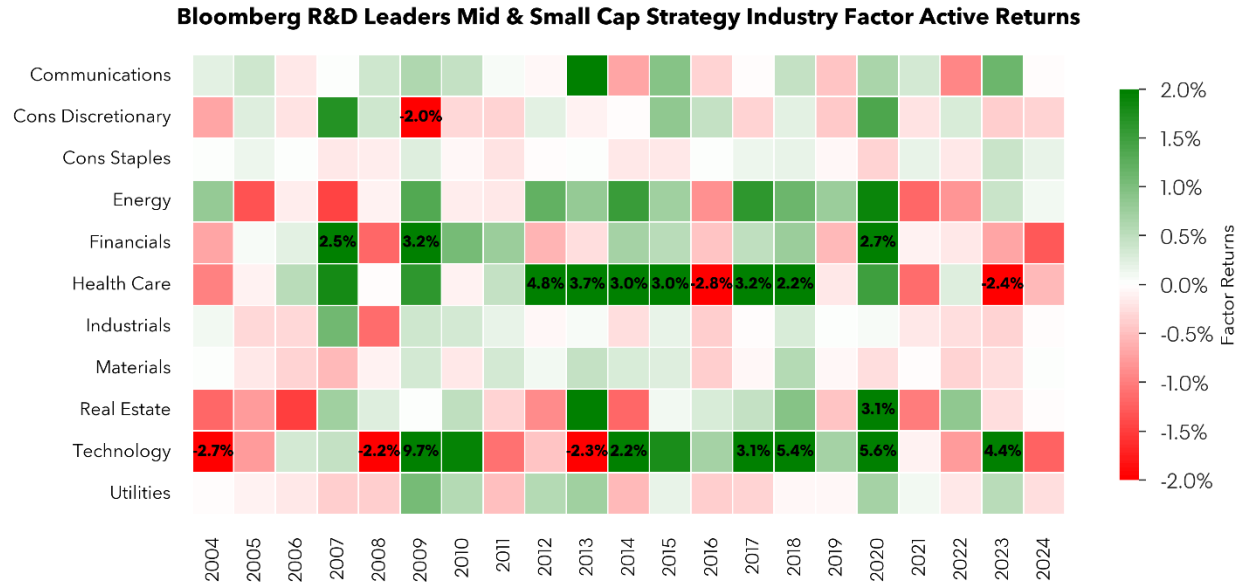
Source: Bloomberg MAC3 Risk model. Note: active return is the total return of the backtested Bloomberg R&D Leaders Mid & Small Cap Strategy less the total return of the benchmark Bloomberg United States Mid & Small Cap Total Return Index. Attributed factor returns are obtained from the MAC3 risk model. All returns are USD returns.

US Mid-Small Cap Style Factor Return Attribution.



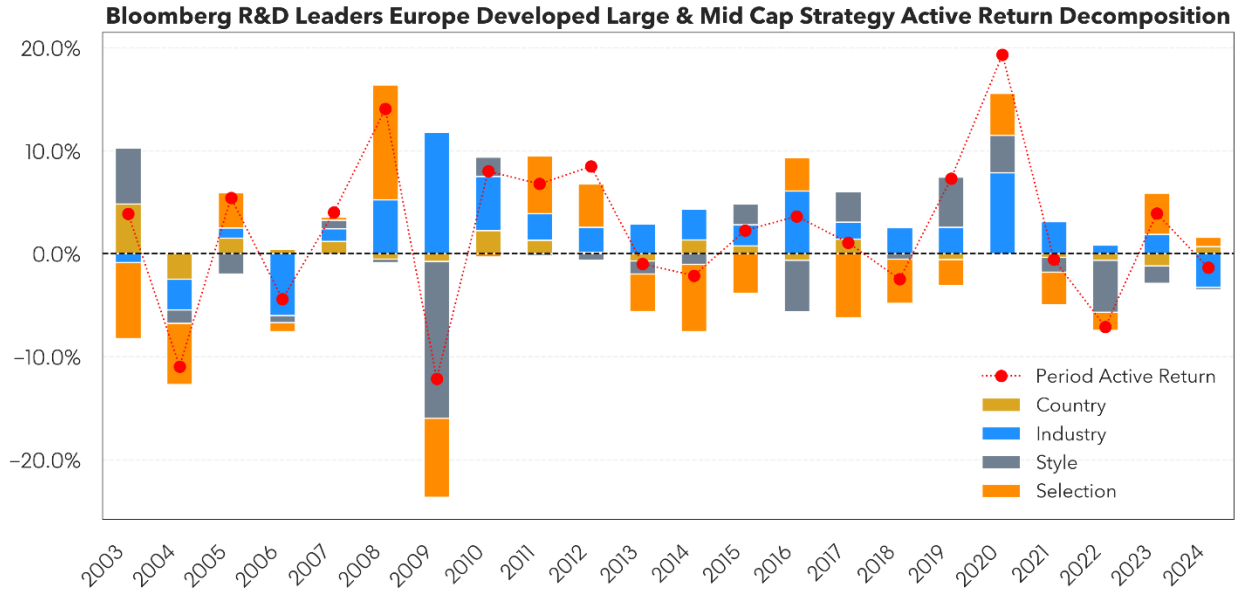
Source: Bloomberg MAC3 Risk model. Note: Attributed active factor returns are the products of active weights of the Bloomberg R&D Leaders Mid & Small Cap Strategy relative to the benchmark Bloomberg United States Mid & Small Cap Total Return Index with the style factor exposures and factor returns. All returns are USD returns.

US Mid-Small Cap Industry Factor Return Attribution.



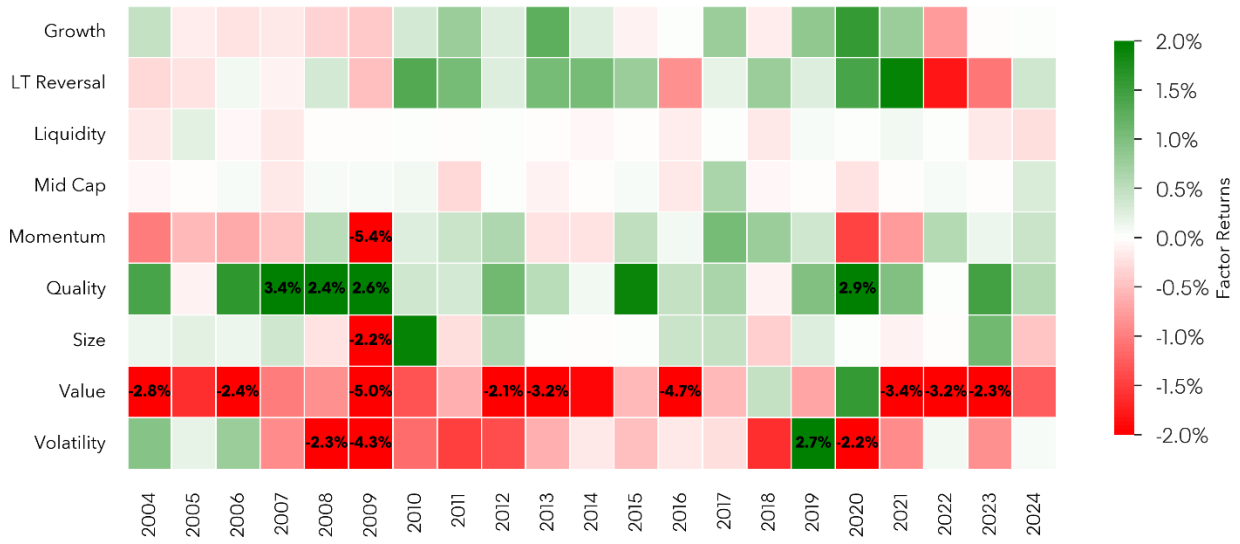
Source: Bloomberg MAC3 Risk model. Note: Attributed active factor returns are the products of active weights of the Bloomberg R&D Leaders Mid & Small Cap Strategy relative to the benchmark Bloomberg United States Mid & Small Cap Total Return Index with the industry factor exposures and factor returns. All returns are USD returns.

EDM Large-Mid Cap Factor Return Attribution.



Source: Bloomberg MAC3 Risk model. Note: active return is the total return of the backtested Bloomberg R&D Leaders Europe Developed Large & Mid Cap Strategy less the total return of the benchmark Bloomberg Europe Developed Markets Large, Mid & Small Cap Total Return Index. Attributed factor returns are obtained from the MAC3 risk model. All returns are USD returns.

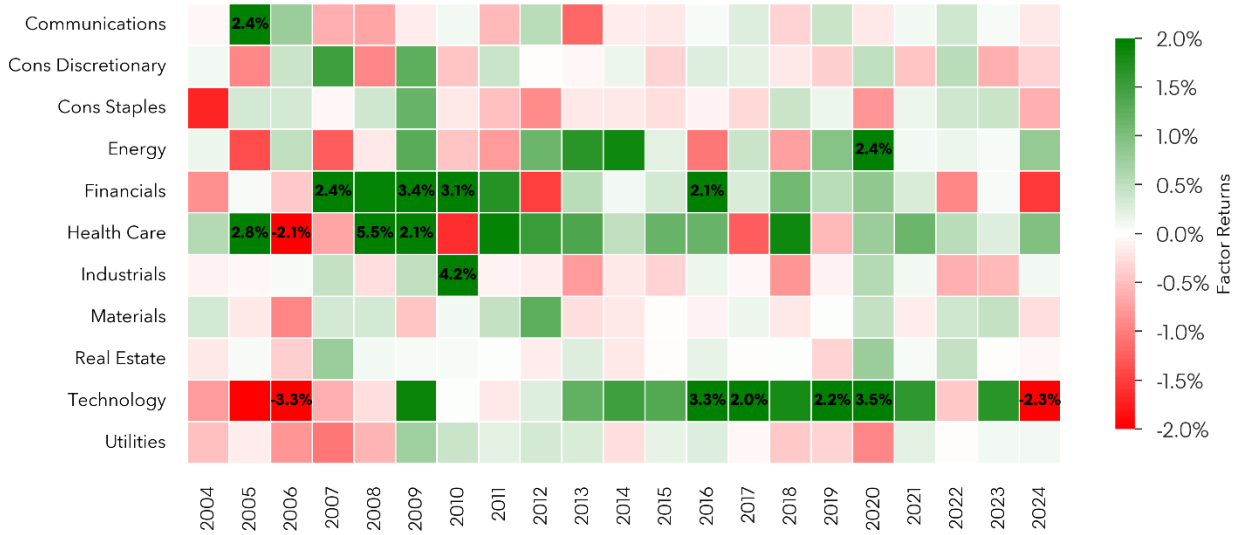
Bloomberg R&D Leaders Europe Developed Large & Mid Cap Strategy Index Style Factor Returns



Source: Bloomberg MAC3 Risk model. Note: Attributed factor returns are the products of active weights of the Bloomberg R&D Leaders Europe Developed Large & Mid Cap Strategy relative to the benchmark Bloomberg Europe Developed Markets Large, Mid & Small Cap Total Return Index with the style factor exposures and factor returns. All returns are USD returns.

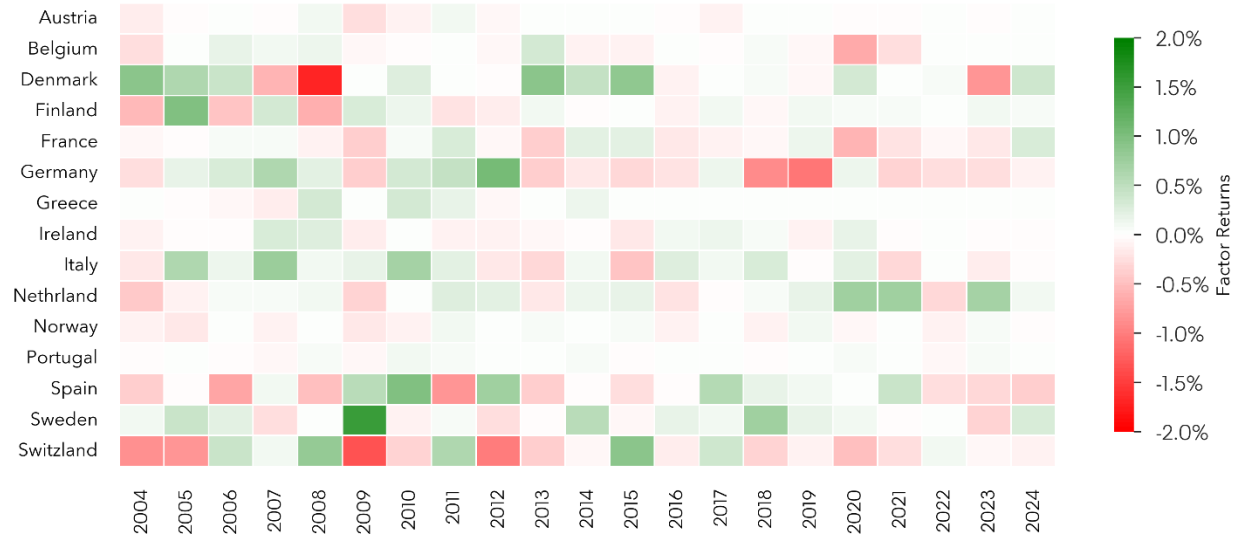
EDM Large-Mid Cap Industry Factor Return Attribution.

Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy Index Industry Factor Returns



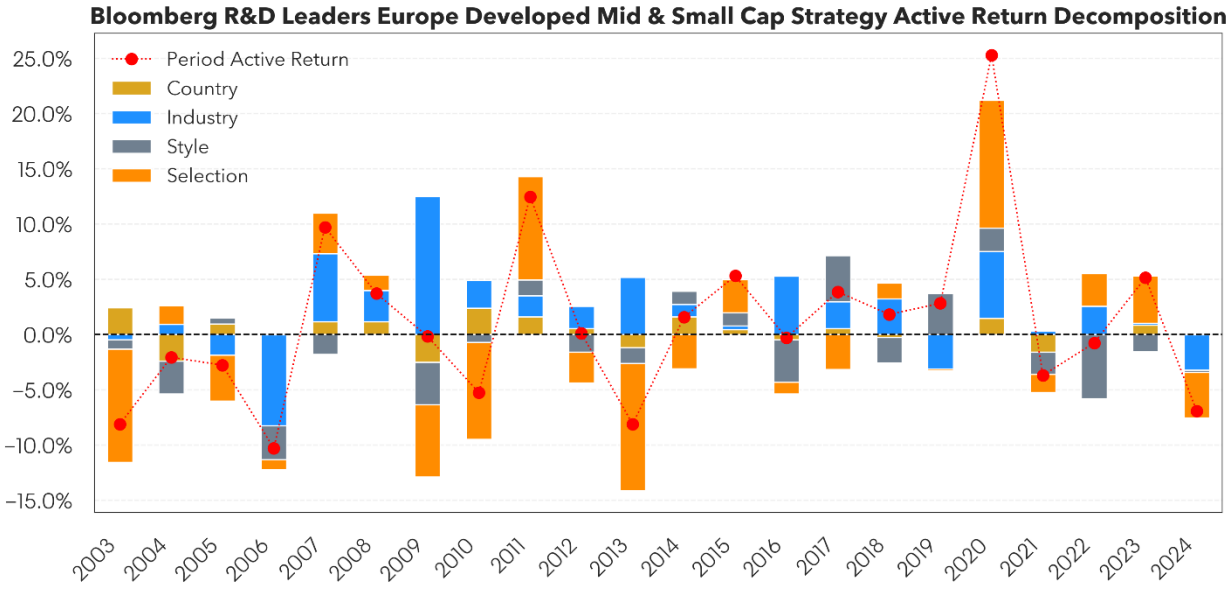
Source: Bloomberg MAC3 Risk model. Note: Attributed factor returns are the products of active weights of the Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy relative to the benchmark Bloomberg Europe Developed Markets Mid & Small Cap Total Return Index EUR with the industry factor exposures and factor returns. All returns are USD returns.

Bloomberg R&D Leaders Europe Developed Large & Mid Cap Strategy Country Factor Active Returns



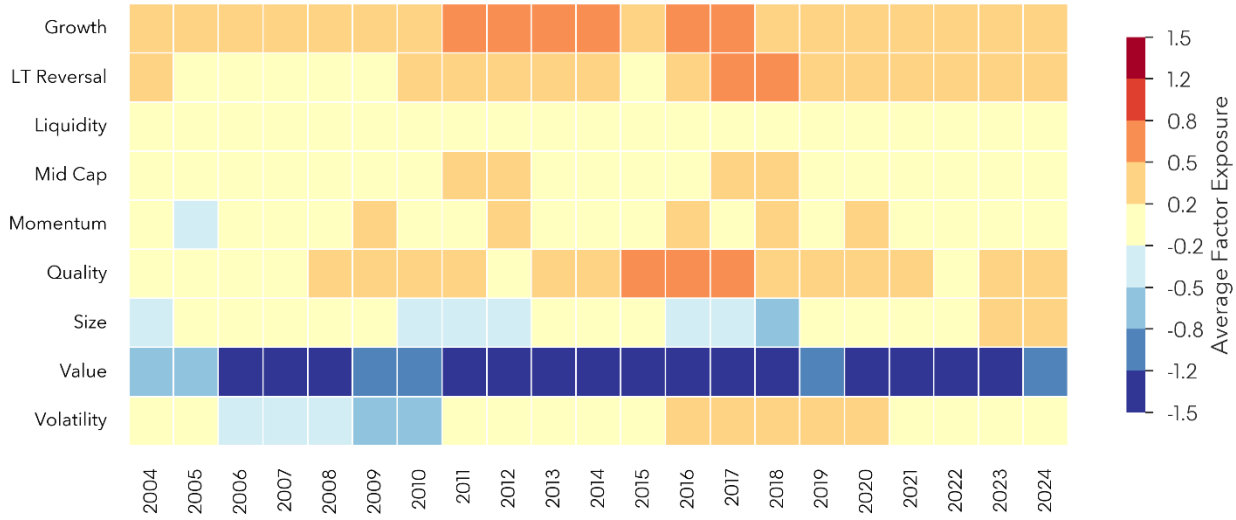
Source: Bloomberg MAC3 Risk model. Note: Attributed active factor returns are the products of active weights of the Bloomberg R&D Leaders Europe Developed Large & Mid Cap Strategy relative to the benchmark Bloomberg Europe Developed Markets Large & Mid Cap Price Return Index with the country factor exposures and factor returns. All returns are USD returns.

EDM Mid-Small Cap Industry Factor Return Attribution.



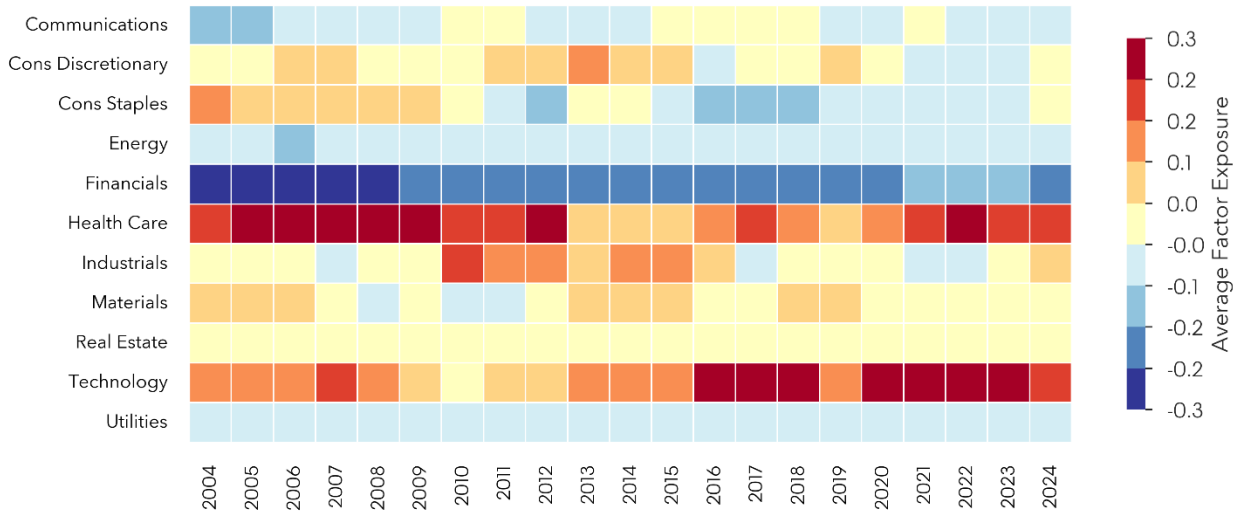
Note: Active Return is the total return of the backtested Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy less the total return of the benchmark Bloomberg Europe Developed Markets Mid & Small Cap Total Return Index EUR. Factor return attribution is based on the the Bloomberg MAC3 Equity Factor Risk model.

Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy Style Active Exposures



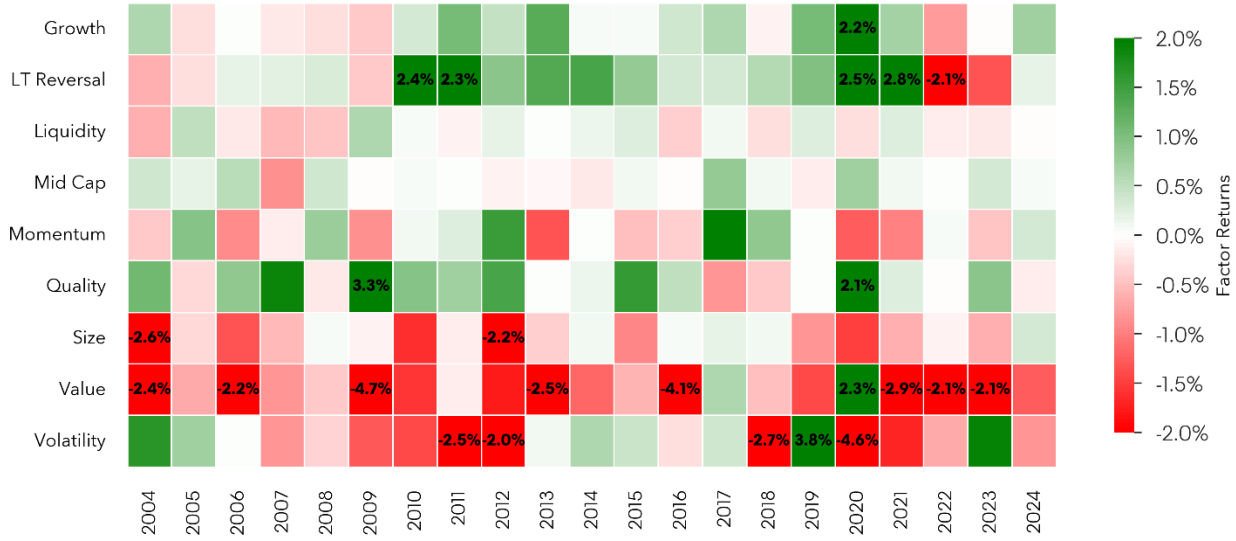
Source: Bloomberg MAC3 Risk model. Note: attributed active exposures are the factor exposures of the Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy less the factor exposures of the benchmark Bloomberg Europe Developed Markets Mid & Small Cap Total Return Index EUR multiplied by active portfolio weights.

Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy Industry Active Exposures



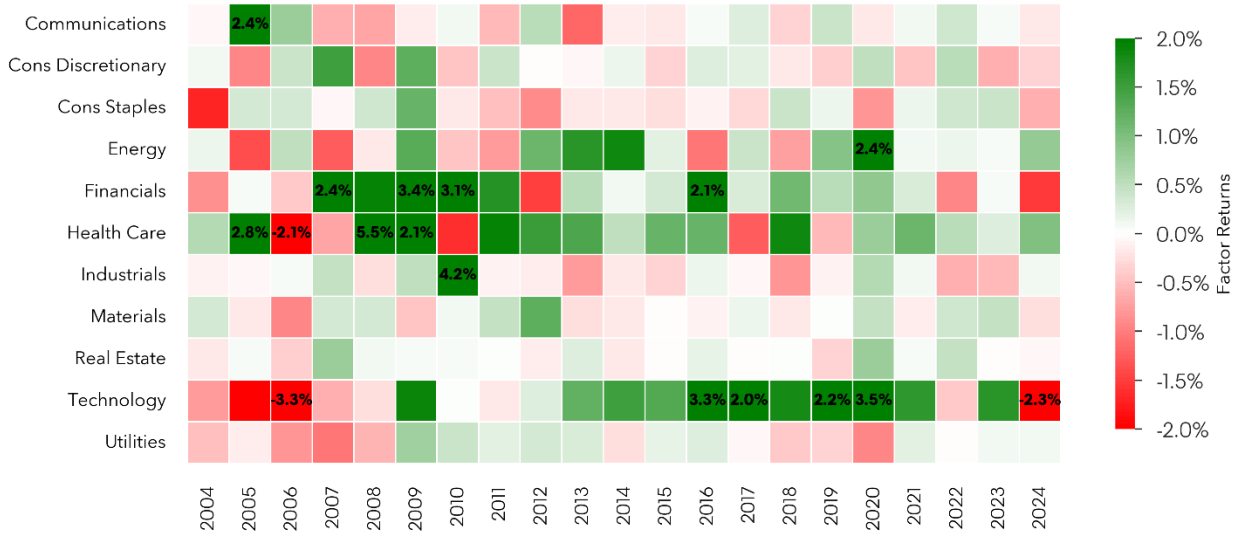
Source: Bloomberg MAC3 Risk model. Note: attributed active exposures are the factor exposures of the Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy less the factor exposures of the benchmark Bloomberg Europe Developed Markets Mid & Small Cap Total Return Index EUR multiplied by active portfolio weights.

Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy Style Factor Active Returns



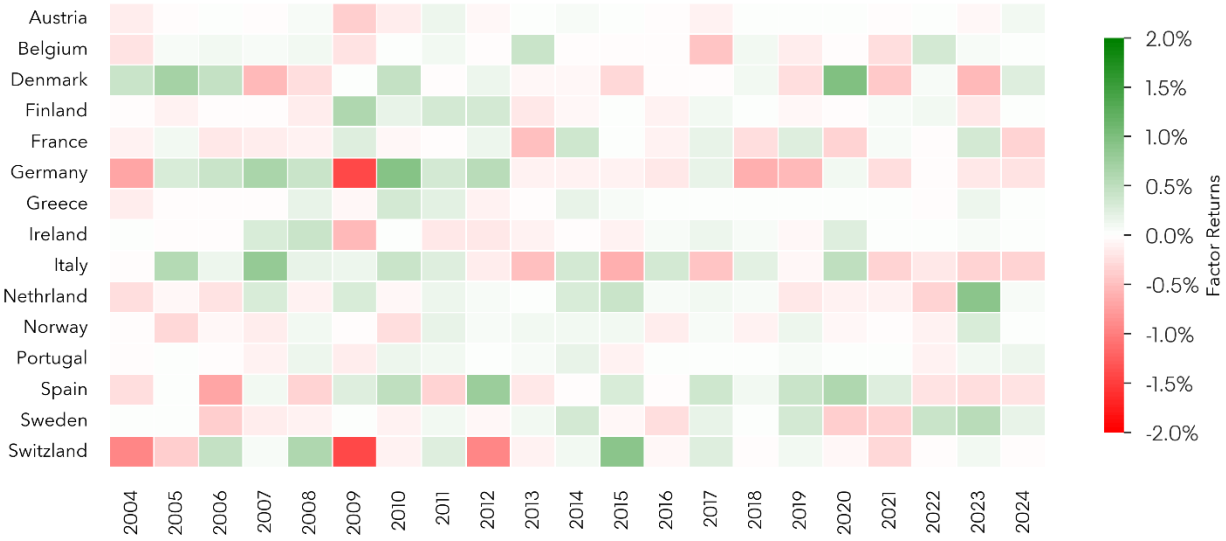
Source: Bloomberg MAC3 Risk model. Note: Attributed active factor returns are the products of active weights of the Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy relative to the benchmark Bloomberg Europe Developed Markets Mid & Small Cap Total Return Index EUR with the style factor exposures and factor returns. All returns are USD returns.

Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy Index Industry Factor Returns



Source: Bloomberg MAC3 Risk model. Note: Attributed factor returns are the products of active weights of the Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy relative to the benchmark Bloomberg Europe Developed Markets Mid & Small Cap Total Return Index EUR with the industry factor exposures and factor returns. All returns are USD returns.

Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy Country Factor Active Returns



Source: Bloomberg MAC3 Risk model. Note: Attributed active factor returns are the products of active weights of the Bloomberg R&D Leaders Europe Developed Mid & Small Cap Strategy relative to the benchmark Bloomberg Europe Developed Markets Mid & Small Cap Total Return Index EUR with the country factor exposures and factor returns. All returns are USD returns.

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