

INVESTING IN AN INTERCONNECTED WORLD

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Globalization of Stock Markets

Markets have become increasingly complex and interconnected. The globalization of trade has spurred this rise in interconnectedness, linking trading partners and supply chains around the world. Improved accessibility to financial markets means investment managers are evaluating stocks through a global lens, considering a much broader opportunity set rather than numerous local opportunities.

Arguably, the growth of ESG has contributed to a better understanding of linkages between companies. For example, evaluating scope 3 carbon emissions, which are the result of activities from assets not controlled by an organization but that indirectly impact its value chain, has created deeper linkages between companies. Likewise, a greater focus on human rights issues has impacted global supply chains. The evolving nature of financial markets and their extensive linkages create exciting new opportunities for quantitative investors.

Direct and Indirect Information

Quantitative investment processes tend to focus predominantly on direct information. Think of sell-side analyst forecasts for a given company. Quant investors typically use this direct information to analyze only the individual company in focus. However, direct information for company A could be indirect information for companies B, C, and D due to linkages and information diffusion dynamics.

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All investments involve risk, including the possible loss of capital.

Linkages and the diffusion of information exist across a number of industries, often stemming from supply chain effects. For example, an information shock for a manufacturer can diffuse or ripple through the supply chain and across several industries. Another example of linkages exists within the same industry. This is a leader-laggard effect where an industry shock becomes reflected in the price of leaders first due to their greater visibility, but diffuses through to industry laggards.

Linkages and information diffusion effects can also arise across countries or geographies (for example, from developed to emerging markets) as well as amid market capitalization ranges (from large-cap to small-cap stocks). Other more novel linkages can result due to common technologies (such as similarities in patent portfolios).

Clearly understanding linkages and information diffusion dynamics creates more alpha opportunities for investment managers who can reap the benefits of exploiting information asymmetry, first from a direct shock, and secondarily via the indirect ripple effect. An appealing aspect of exploiting indirect information is that even without direct information about a company, such as analyst coverage and conference calls, various linkages lead to indirect information that can yield insights about future performance prospects.

Identifying Market Linkages

We first illustrate the investment opportunities stemming from market linkages by examining linkages between firms within the same industry (intra-industry information diffusion). The starting point is to identify a cohort of stocks among which we can reasonably expect there to be the diffusion of common information. To do this, we are cognizant of the fact that the success of exploiting the lead-lag effect is influenced by factors such as the complexity of an information shock or another structural market feature that limits an investor’s ability to respond to information in a timely manner.

As such, this leads us to identify a global peer group. Thinking globally means we place more focus on a global ‘common’ information shock, which is more challenging to evaluate than a ‘local’ information shock. This should slow down the diffusion of information and increase the possibility of exploiting this ‘ripple’.

With a global collection of companies, we group stocks into common industries. As a starting point we use GICS classifications to aggregate stocks. We conduct extensive correlation analysis of stock returns to confirm whether there is a high degree of similarity among stocks within these industry groups. It should be noted that groupings can be improved by using methods beyond GICS, such as revenue-based groupings or groupings based on Natural Language Processing (NLP). These can be more detailed and more dynamic than GICS-based groupings.

When classifying stocks, there can be a tendency to focus on very granular industry groupings. However, investors must balance such detailed classification against the necessity for adequate industry breadth, as lack of breadth can constrain the implementation of a lead-lag strategy.

Among each common grouping we strive to identify how information will diffuse. A reasonable position is that a common information shock to an industry will diffuse from the ‘leaders’ to the ‘laggards.’ Leaders are expected to be the largest firms in each industry group. However, we assess beyond the relatively naïve measure of market capitalization to identify those leaders. While traditional indexes position the largest market capitalization firms as the ‘largest’ in their industry, these companies are not always the industry’s leaders. There can be valuation elements contributing to an elevated market capitalization. Therefore, using fundamental measures such as sales or assets can produce a more stable identification of industry leaders and the identified companies should not change significantly from month to month.

To identify leaders using fundamental data, a common approach is to use a market share percentage as a cutoff. For example, the group of companies that capture X% of market share within an industry are identified as being the leaders. This seems sensible but can be problematic to implement. Table 1 illustrates that a 30% market share cutoff across GICS industry groups would result in several industries with a single company representing 30% market share.

Table 1: Market Share as a Measure of Industry Leadership	
Company	Industry Group & Industry Name
Wuchan Zhongda Group Co., Ltd. Class A	Retailing - Distributors
Amazon.com, Inc.	Retailing - Internet & Direct Marketing Retail
Procter & Gamble Company	Household & Personal Products - Household Products
Berkshire Hathaway Inc. Class B	Diversified Financials - Diversified Financial Services
Microsoft Corporation	Software & Services - Software

Source: Factset, MSCI, Worldscope, Refinitiv.

Clearly, attempting such a result leads to identifying more idiosyncratic information than a common industry information shock. Hence, it is necessary to augment such ‘cutoff’ rules with other requirements to ensure a sensible collection of leaders in each industry.

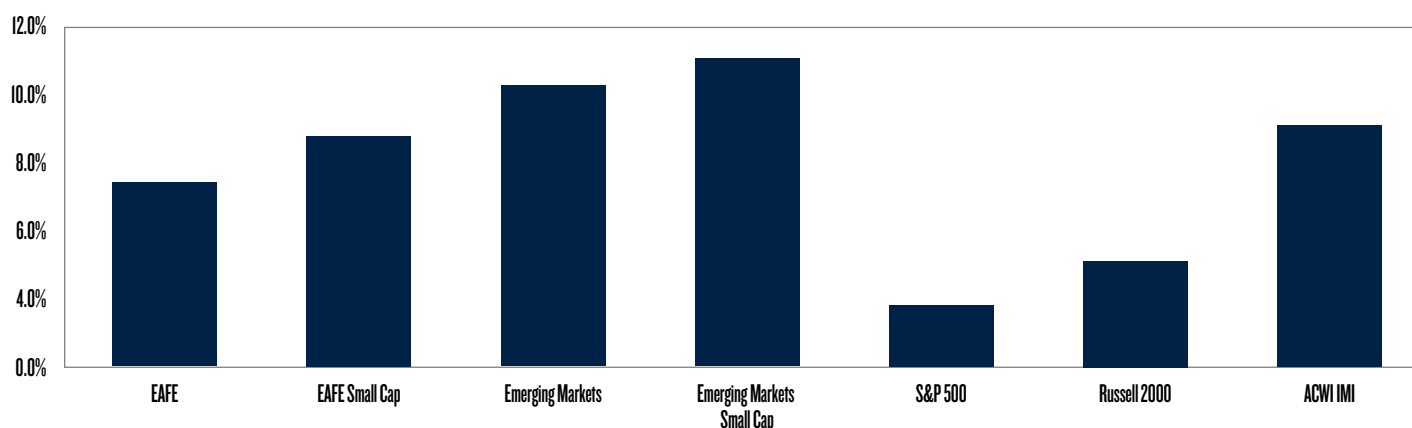
The last challenge is identifying the information shock. At PGIM Quantitative Solutions we focus primarily on fundamental insights. As such, we are naturally drawn to information revealed by analyst estimate revisions (analysts’ revised earnings forecasts in response to new information). However, analysts themselves are not always timely in processing information. Instead, we focus on a market-based proxy for an information shock, which yields a timelier signal. We look at the market reaction of our identified leaders. To cleanly discern a common information shock, we have to remove much of the confounding noise. For instance, because we evaluate global industry groups, the market reaction of leaders could be in response to country-specific information, rather than industry information. Country information is not expected to ripple across our common industry group. Therefore, we strip out country-related effects that would have no bearing on the broader global industry. This provides us with a cleaner information shock that is revealed first among leaders, and is then expected to ripple to laggards.

A Diversifying Return Driver

To create a testable investment strategy, we form a long portfolio of laggards with the strongest ‘leader market reactions’ and form a short portfolio of laggards with the weakest ‘leader market reactions.’ We test this across a broad global universe using the MSCI ACWI Investable Market Index (IMI), but also evaluate on several sub-universes (MSCI EAFE Index, MSCI EAFE Small Cap Index, MSCI Emerging Markets Index, MSCI Emerging Markets Small Cap Index, S&P500 Index, and Russell 2000 Index).

The chart below shows the annualized spread returns for this strategy across the aforementioned universes. We see several intuitive results. Strategy returns are strongest in Emerging Markets stocks relative to US equities (information ripples from developed to emerging markets). Likewise, returns are strongest in small-cap relative to large-cap stocks (information ripples from large to small).

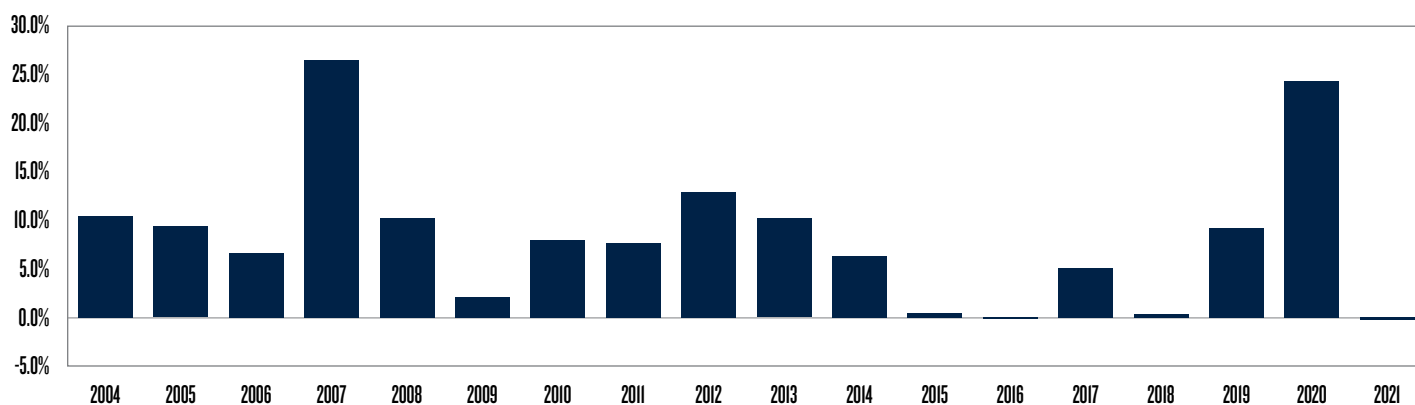
Annualized Spread Returns by Universe



Source: Factset, MSCI, Worldscope, Refinitiv. Data as of February 28, 2021.

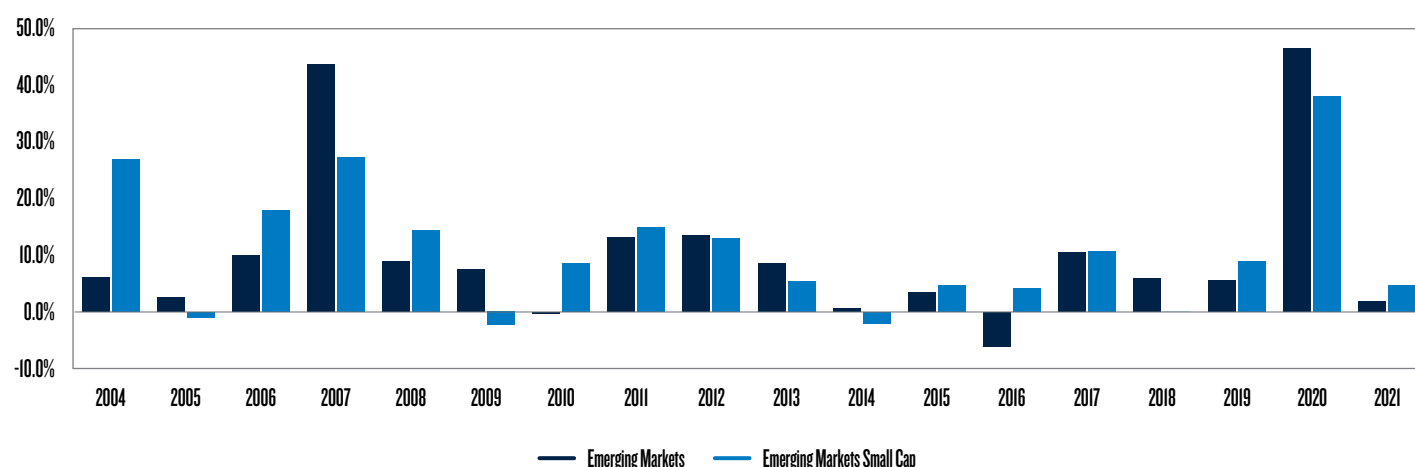
Digging deeper, the annual performance profile reveals that this industry lead-lag strategy presents interesting diversification possibilities. The charts below show the annual returns for the MSCI ACWI IMI universe and also the MSCI Emerging Markets and Emerging Markets Small Cap universes. The diversification benefit is best illustrated by the performance in 2021. Performance challenges of other fundamental factors during 2021 have been well documented. However, this intra-industry lead-lag strategy has had very strong performance during much of 2021, which showcases how exploiting information diffusion can lead to positive performance effects. 2021 has been characterized by extreme uncertainty around the COVID-19 crisis. As clarity improves, industry leaders react first, with ripples flowing to the laggards. Given the magnitude of market movements, this ripple effect has been extremely pronounced.

Annualized Calendar Spread Returns for ACWI IMI



Source: Factset, MSCI, Worldscope, Refinitiv. Data as of February 28, 2021.

Annualized Calendar Spread Returns for Emerging Markets & Emerging Markets Small Cap



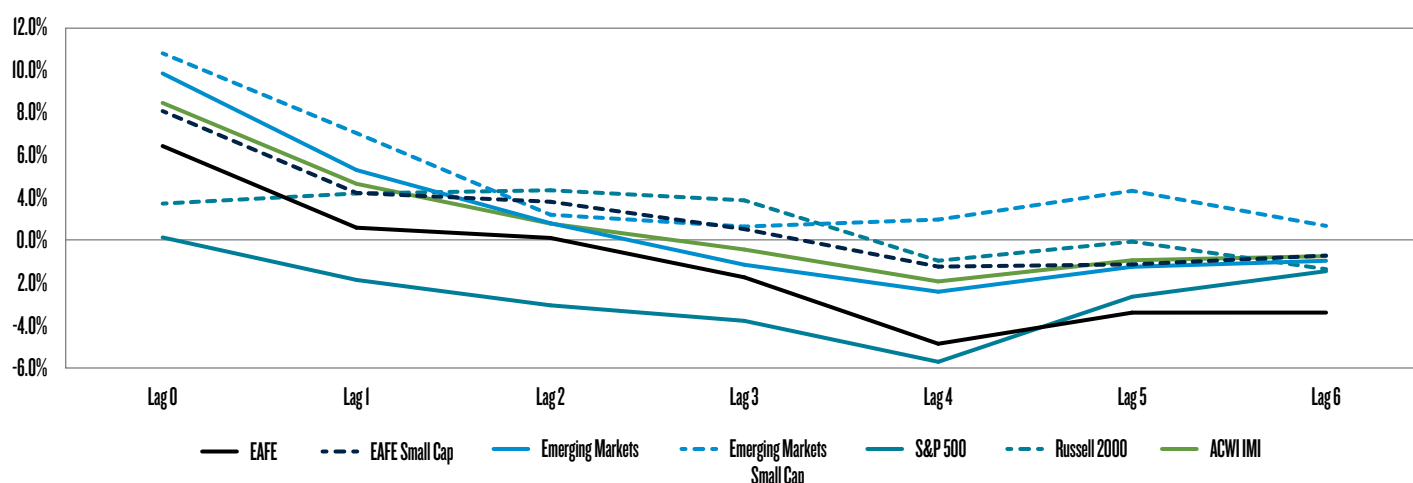
Source: Factset, MSCI, Worldscope, Refinitiv. Data as of February 28, 2021.

Ripple Size

While these returns are compelling, they may nevertheless be impossible to exploit. If the information revealed by industry leaders is fully reflected in the stock prices of industry laggards within a month, it becomes challenging for investment managers to reposition their portfolios in such a short time frame (and certainly without outsized market impact).

Accordingly, we examine how long it takes for leader information to fully diffuse into the prices of laggards. We use the signals for laggards today to predict portfolio returns at different times: today (forming a portfolio using the latest signal), in one month (using the signal from one month ago), and then in six months (using the signal to determine how predictive portfolio returns are with a six-month lag). Plotting the realized strategy returns using signals lagged over different intervals, we find that after a modest positive strategy return with the S&P500 Index, lagging the signal one month eliminates any positive return. To no surprise, the S&P500 Index shows a rapid decay in processing and responding to new information given the inherent efficiency of developed markets. We see the decay slow for the MSCI EAFE Index, and become most compelling for the MSCI Emerging Markets Index and the three small-cap universes, as expected, given the slower diffusion of information in those markets.

Performance Decay Profile by Universe

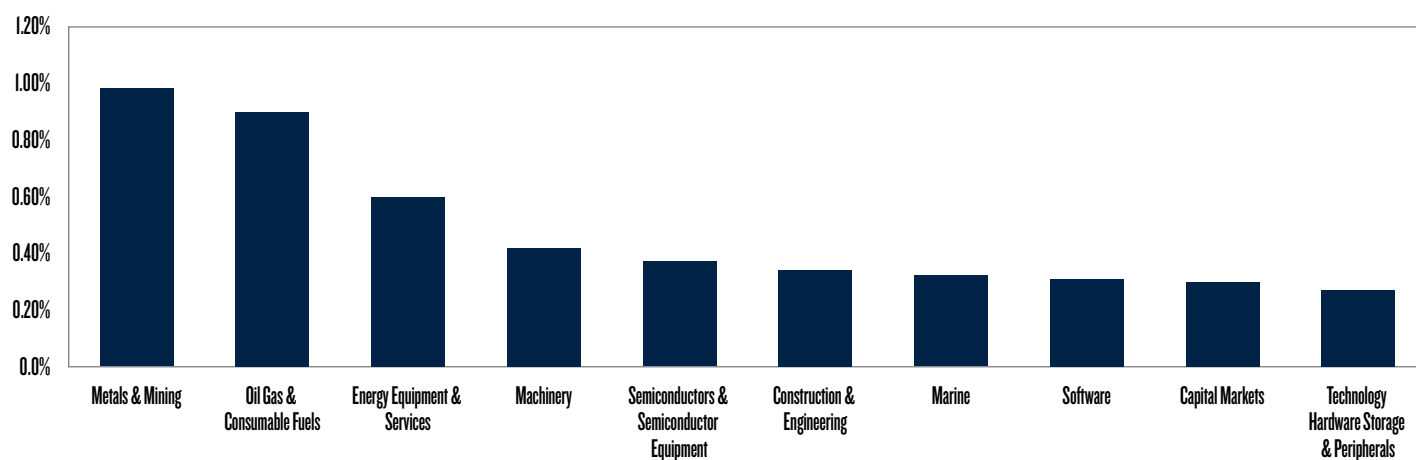


Source: Factset, MSCI, Worldscope, Refinitiv. Data as of February 28, 2021.

Information Diffusion by Industry

How can we further exploit the diffusion of information within an industry? Certain industries exhibit a higher degree of commonality. In industries with common characteristics, we expect the lead-lag relationship to be most effective (i.e. we can more cleanly identify a common information shock). To illustrate this point, we demonstrate the performance generated for the overall intra-industry lead-lag strategy from each industry. In the chart below, we show the ten industries with the highest return contribution. Common industry shocks from commodities (Metals & Mining; Oil, Gas & Consumable Fuels), the economy (Machinery; Construction & Engineering), and financial markets (Capital Markets) are evident and contribute to improved performance of the strategy.

Annualized Return Contribution by Industry



Source: Factset, MSCI, Worldscope, Refinitiv. Data as of February 28, 2021.

Not Just Industry Momentum

The performance discussed previously has been based on univariate testing. Given the nature of the intra-industry lead-lag strategy, it is reasonable to question whether the produced performance is something ‘new’ or just a repackaging of other known factors, such as industry or stock momentum. Below, we examine the score correlations across universes for several common factors. The intra-industry lead-lag factor is most strongly correlated with industry momentum. A more modest positive correlation exists with stock-level price momentum and with stock-level growth (i.e. estimate revisions). We subsequently conduct Fama-French style regressions controlling for these factors to determine any excess strategy performance. We find that these factors do not fully explain the performance of the intra-industry lead-lag strategy. For instance, across the MSCI ACWI IMI universe, the strategy still delivers a significant annualized excess spread return of approximately 3%.

Table 2: Factor Score Correlations					
Factor	EAFE	EAFE Small Cap	Emerging Markets	Emerging Markets Small Cap	ACWI IMI
Industry Momentum	49.8%	48.6%	48.2%	46.7%	49.0%
Value	-2.1%	-1.1%	-1.5%	-0.5%	-0.8%
Growth	4.5%	1.5%	2.2%	0.6%	2.5%
Quality	0.8%	0.1%	0.8%	0.8%	0.5%
Momentum	10.7%	4.7%	6.4%	3.4%	6.7%

Source: Factset, MSCI, Worldscope, Refinitiv. Data as of February 28, 2021.

Putting It All Together

The intra-industry lead-lag strategy offers compelling performance prospects. Our additional analysis further distinguishes between laggards to better identify those most strongly linked to industry leaders. Overall, we find that our more in-depth research is additive to our existing investment processes.

Such approaches are rich with opportunities. The diffusion of information within industries is but one area of financial markets in which information diffuses with delay. In the current arms race to source the latest alternative data, different modeling techniques can also help users gain more insight from available information and identify new approaches in constructing existing factors to produce profitable investment opportunities for quantitative investors.

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