

INVESTING IN AN INTERCONNECTED WORLD: CROSS-INDUSTRY LINKAGES

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SOPHIA (JINGYAN) ZHANG
Senior Quantitative Researcher

GAVIN SMITH
Head of Equity Research and Sustainable Investing

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THE LABYRINTH OF LINKAGES

The world is interconnected. Companies operate within an ecosystem, intricately connected to one another through a multitude of relationships such as customer-supplier relationships, partnerships, collaborations, and as competitors. We believe capturing these global interconnections in the course of the investment process can help identify new investment opportunities and limit portfolio risks. Given an increasing awareness of environmental, social, and governance (ESG) issues globally, cross-industry linkages are also helpful in scrutinizing all of a company's connections up and down the supply chain and with business partners.

Exploiting the linkages between companies can yield insights about future performance prospects. Utilizing linkages and information asymmetry, by evaluating information diffusion effects and examining information diffusion delays among companies within a single industry or business segment, can provide investment insights and be used to help generate alpha. Quantitative investment processes typically focus on direct information, such as sell-side analyst forecasts, but the returns of stocks can also be affected by indirect company information, which can often be captured by identifying and assessing the linkages between companies. In our first piece on company linkages, [Investing in an Interconnected World](#), we explored this topic within the same industry/business segment. In this paper, we explore how utilizing linkages among firms in different industries/business segments can add value to the existing factors we use to help identify more profitable investment opportunities for quantitative investors.

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CROSS-INDUSTRY LINKAGES: UNCOVERING HIDDEN POTENTIAL AND RISKS

Identifying the nature of business relationships is critical for understanding and predicting a company's business opportunities, risk exposure, and ultimately its performance potential. But that's no easy task given these relationships are often complicated. The following examples illustrate how cross-industry linkages allow us to explore the interconnections between firms that can help determine their growth prospects.

1. **Customer-Supplier Connections:** Smaller supplier firms benefit from relationships with large customer firms in many ways, such as knowledge sharing, operational efficiency, insulation from competition, and reputation in capital markets. Company linkages that arise from technological expertise and operating strategy can translate to expansion of knowledge and innovation. Nevertheless, customer bargaining power, an undiversified customer base, and innovation strategy can all expose suppliers to disruption.
2. **Information Diffusion:** The manner in which information and ideas spread along relationship networks, such as supply chains, drives the return predictability of cross-industry linkages. This adds up because the economic fundamentals of related companies are correlated. On one hand, the co-attention that related companies receive from market participants (investors, financial analysts, etc.) leads to return predictability; on the other hand, limited coverage by market participants of related companies belonging to different industries leads to orthogonal alpha opportunities – new alpha factors that have low correlation with existing factors.
3. **Global Supply Chain Restructuring:** The interrelationships between customer companies and supplier companies is among the most important of economic linkages. Events like the China-US trade war, the COVID-19 pandemic, and the Russia-Ukraine war have fully exposed the risks associated with the concentration of international supply chains as a result of globalization. Capturing the relationship of global supply chains, which have been restructured in the aftermath of these (and other) disruptions helps us to optimally react to such events.

MEASURING CROSS-INDUSTRY INFORMATION FLOW

The linkages we use as proxies for the relationships we expect firms to have across industries are dynamic and not solely based on information revealed by a company. Once we have identified these linkages our next challenge is measuring the relevant information that could 'ripple' from one industry to another. At PGIM Quant we focus primarily on fundamental insights, so to best capture what we believe to be meaningful fundamental information that will diffuse from one industry to another we remove much of the confounding noise (e.g., country-specific information). The result is a cleaner information shock that is revealed first in a stock within one industry and is then expected to ripple to firms in a related industry.

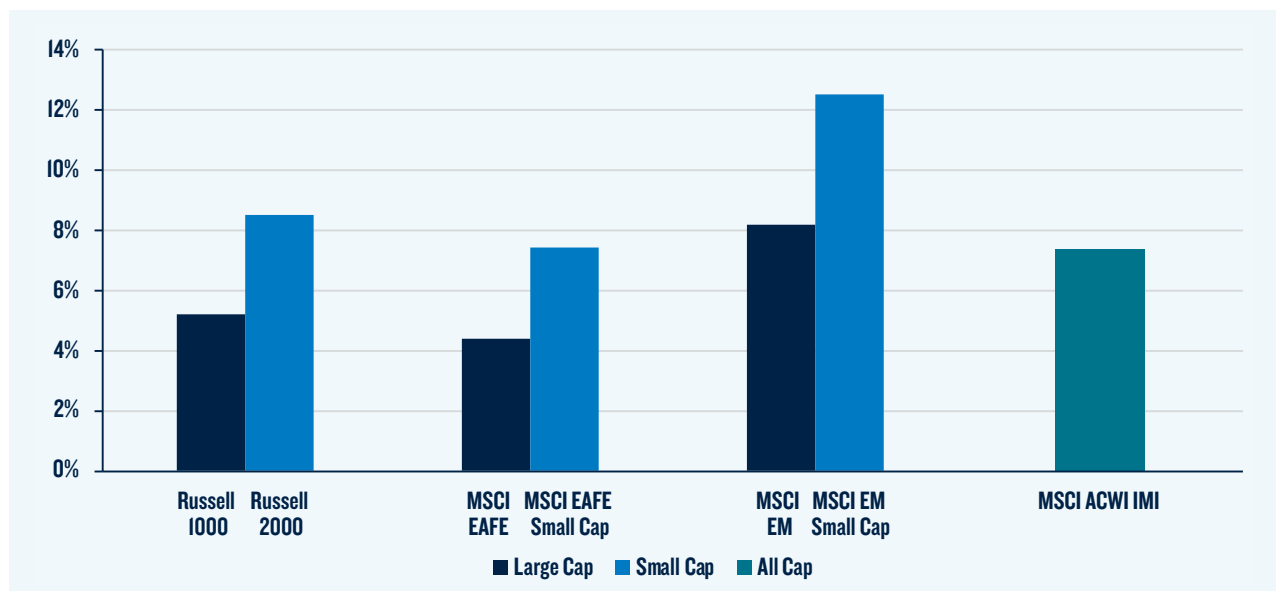


The manner in which information and ideas spread along relationship networks, such as supply chains, drives the return predictability of cross-industry linkages.

RETURN ANALYSIS BY MARKET

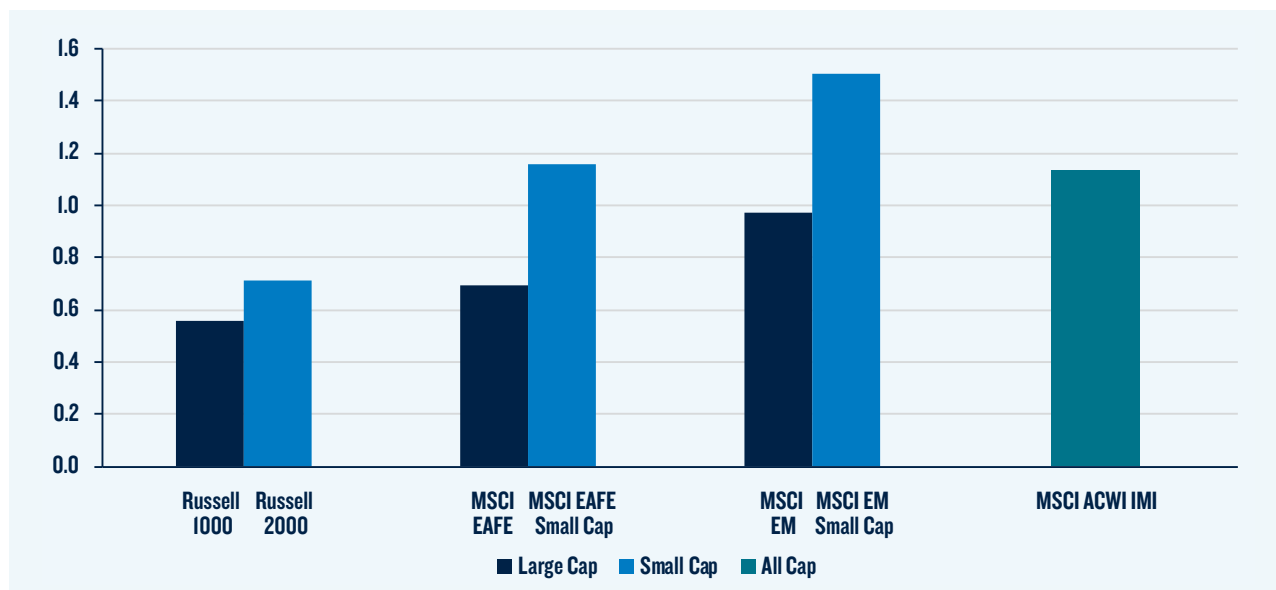
The cross-industry linkage factor delivers compelling performance in both domestic and international markets. The annualized quintile return spread of the linkage factor for the US, EAFE, and Emerging Markets is consistent across different markets. The return spread and information ratio are intuitively higher in small-cap universes than in large-cap universes, reflecting increased inefficiencies related to the diffusion of price-relevant information.

Figure 1: Annualized Quintile Returns



Source: FactSet, Datastream, MSCI, S&P, Refinitiv, Russell, Worldscope, IBES, PGIM Quant Solutions.
Data from 12/31/2013-9/30/2023

Figure 2: Information Ratio

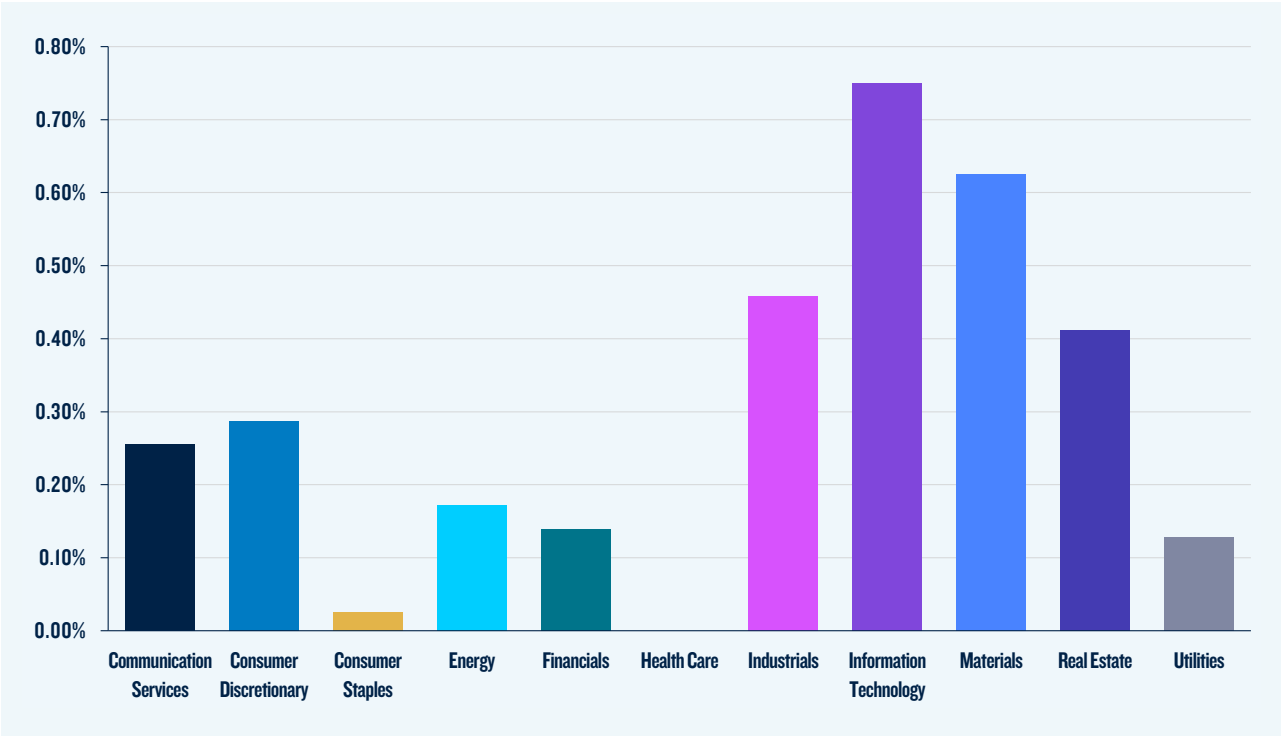


Source: FactSet, Datastream, MSCI, S&P, Refinitiv, Russell, Worldscope, IBES, PGIM Quant Solutions.
Data from 12/31/2013-9/30/2023

RETURN ANALYSIS BY SECTOR

While the linkage factor is also predictive by sector, it shows the most compelling performance in Information Technology, Materials, and Industrials, where supply/demand dynamics are more impactful to company performance.

Figure 3: Average Monthly Return Spread by Sector – MSCI ACWI IMI



Source: FactSet, Datastream, MSCI, S&P, Refinitiv, Russell, Worldscope, IBES, PGIM Quant Solutions.
Data from 12/31/2013-9/30/2023

CORRELATIONS WITH EXISTING FACTORS

The linkage factor’s low correlations with the value, growth, and quality insights of our factor suite reflect information not contained in those factors, which helps to offer diversification benefits:

Cross-Industry Linkage



Source: FactSet, Datastream, MSCI, S&P, Refinitiv, Russell, Worldscope, IBES, PGIM Quant Solutions.
Data from 12/31/2013-9/30/2023

PERFORMANCE DURING EXTREME MARKET EVENTS

Diversification is particularly critical during extreme market events. To underscore the benefits of diversification in periods of heightened market volatility, we examined the linkage factor's performance during the height of the COVID-19 pandemic. Figure 4 illustrates the factor's compelling performance in a period when many other traditional quant factors were less effective.

Reinforcing this diversification benefit, the linkage factor performed well during the height of COVID. This is compelling as many other traditional quant factors were less effective in that environment.

Figure 4: Cumulative Return Spread – MSCI ACWI IMI



Source: FactSet, Datastream, MSCI, S&P, Refinitiv, Russell, Worldscope, IBES, PGIM Quant Solutions.
Data from 12/31/2013-9/30/2023

THE BOTTOM LINE

The cross-industry linkage factor was built to uncover interdependent business relationships between firms in different industries and the impact of those interconnections on a company's future performance. The factor's consistent long-term performance across markets and sectors and its low correlation with our existing factors can help lead to greater portfolio diversification and potentially more compelling returns. Our continuous research to uncover alternative data and implement different modeling techniques leads us to gain more insight from hard-to-capture indirect information and identify new approaches in constructing our alpha factors to help produce profitable investment opportunities for quantitative investors. Reinforcing this diversification benefit, the linkage factor performed well during the height of COVID. This is compelling as many other traditional quant factors were less effective in that environment.

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