A Bloomberg Professional Services Offering

Content & Data Solutions

Quant

Supply chain customer momentum.

Bloomberg Quant Research

Bloomberg

Supply Chain Customer Momentum

A Study of Global Regions

June 5, 2019

ABSTRACT

The Bloomberg supply chain dataset has a comprehensive coverage of global business relationships. In this whitepaper, we examine the efficacy of revenue-weighted customer momentum as an equity factor for the supplier companies. The factor backtesting is performed for a variety of global markets over the period 2013-2018.

1 Introduction

Investors are looking to systematically integrate supply chain information into their decision process as the data becomes increasingly available, more comprehensive in coverage of global relationships and historical periods for robust purposes. At the same time, researchers are focusing on a quantitative examination of complex interactions between suppliers and customers through the historical data underlying the relationships.

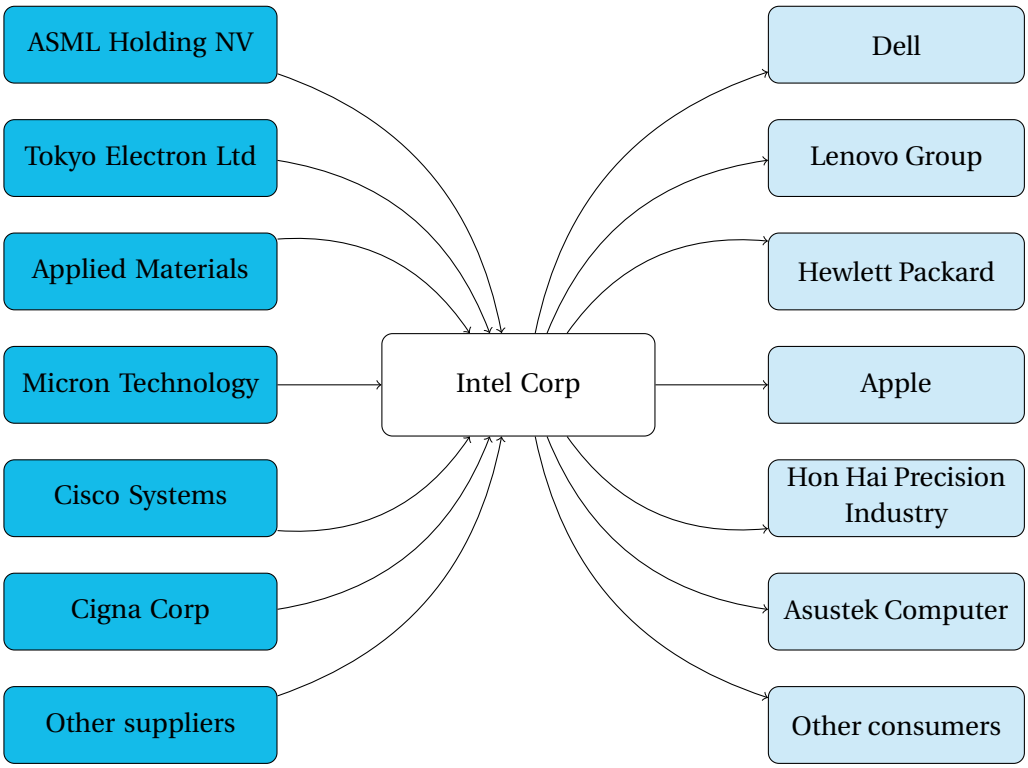

Figure 1.1: A typical set of Intel Corp's suppliers and customers.

The complexity of global supply chain dataset makes it a rich minefield for quantitative analysis. Firm shocks transmit through suppliers and customers. Evans and Outlaw (2018) measure the ripple effects of an unusual event on a company to the connected entities. The supply chain relationships are also an important predictor of the holdings of institutional investors. Alldredge and Puckett (2016) find that an institution that owns a customer company is five times more likely than other institutions to also have an ownership stake in the company's supplier. Paatela, Noschis and Hameri (2017) note that stock price and operational data of customer companies provide an indication of supplier companies' future operations and business performance. The delays and time lags between supply chain operations may represent an opportunity to forecast company performance even before the company publishes its own financial reports. Some studies focus on a part of the supply chain network associated with certain sectors. For example, Wang, Li and Anupindi (2017) study the prevalence of overlapping sub-tier suppliers and their impact on financial performance for firms in the high-tech sector.

The traditional top-down approach of screening stocks and selecting a few names to invest in is highly prone to idiosyncratic risk. Alternatively, passive factor investing is gaining popularity recently as investors look for systematic factors that drive returns and risks of a large universe of underlying stocks to help construct diversified portfolio strategies. The factor portfolios take positions in a large number of names, leading to exposures mainly in the systematic factors only. In this study, we build and evaluate a selected set of factors based on the global supply chain data. For the initial set of factors we have proposed, the factor scores of a firm are based on immediate connections of that firm within the supply chain network.

2 Supply Chain Data

Bloomberg supply chain data covers a broad spectrum of global business relationships:

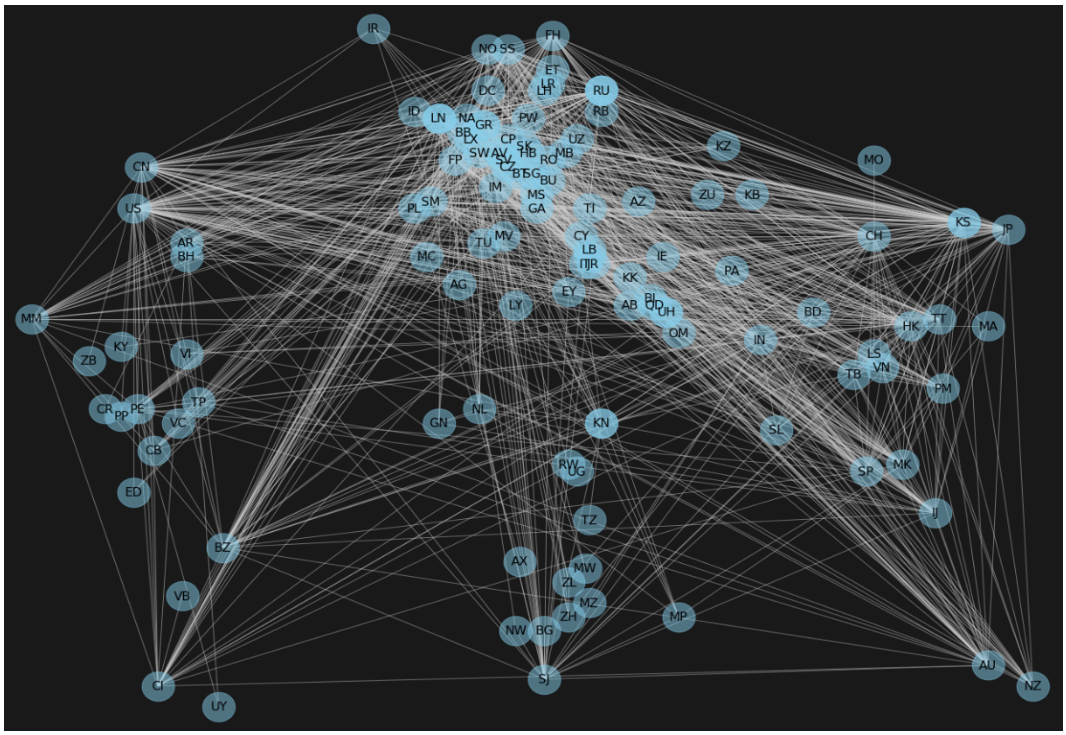

Figure 2.1: A graph of global supply chain network. Each node represents a country or a region.

- 23,000+ public companies
- 100,000+ private companies
- 800,000+ supplier-customer relationships
- ~200,000 relationships with quantified values (e.g., dollar values)
- Total history from 2006, estimated relationship history from 2011

Geographically, the majority of Bloomberg supply chain relations are reported in APAC, North America, and EMEA. In Table 2.1, we report the top 10 supplier or customer regions in terms of the aggregate relationship values quantified as of the end of 2017. With the understanding that

bias exists because of unquantified relationships, we make the observation that (1) United States, China, and Japan are the top three countries as supplier; (2) United States, United Kingdom, and China are the top three countries as customer. United Kingdom and Germany ranked higher as a customer than as a supplier.

Top 10 Supplier Regions	Value (10^9 \$)	Top 10 Customer Regions	Value (10^9 \$)
United States	1,363	United States	1,364
China + Hong Kong	1,157	United Kingdom	746
Japan	523	China + Hong Kong	542
South Korea	235	Japan	464
India	186	South Korea	253
Taiwan	108	India	185
France	93	Germany	105
United Kingdom	83	France	80
Germany	67	Taiwan	71
Canada	56	Italy	56

Table 2.1: Top 10 supplier or customer regions in terms of quantified relationship values, as of the end of 2017.

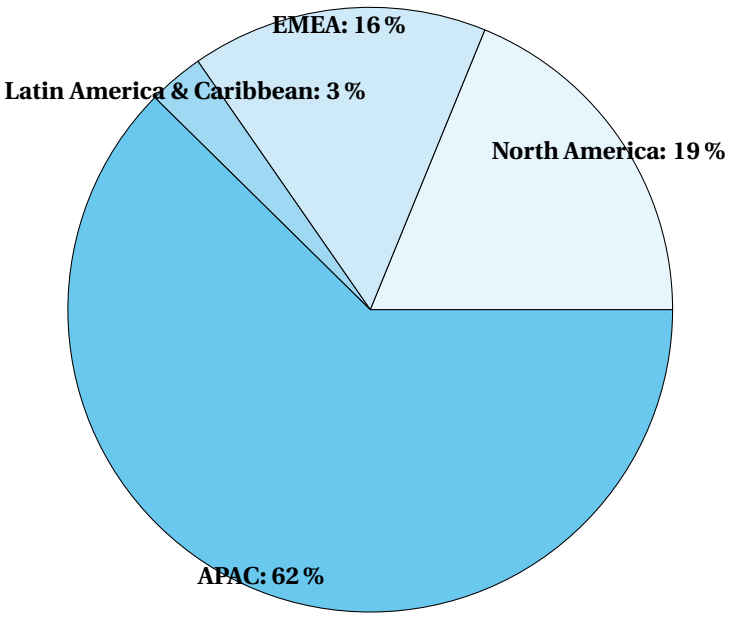

Figure 2.2: Geographical distribution of Bloomberg supply chain data coverage.

3 Company Relationships and Customer Momentum

Each relationship is characterized by a supplier company and a customer company, quantified by a value associated with a cost account (COGS, CAPEX, SGA, or RND) from the customer's perspective. In some cases, a value percentage weight is a useful concept. Depending on the context, a value percentage weight means (1) from a customer's perspective, the cost incurred by a supplier as a percentage of the customer's total cost; (2) from a supplier's perspective, the revenue generated from a customer as a percentage of the supplier's total revenue.

Deriving company-specific metrics from supply chain data is a process of aggregating edge-wise information in a network and transforming it to node-wise information. A variety of quantitative metrics can be formed from supply chain network to characterize the participating firms. In this section, we describe the general idea behind the construction of supply chain customer momentum. An important application of company metrics is factor investing.

The important link between suppliers and customers should be taken into account when forming expectations about the supplier's future cash flows. Cohen and Frazzini (2007) pioneered the study of return predictability across economically linked firms. The predictable returns resulting from buying or selling the supplier company following a positive or negative shock, respectively, to its customers could result from investors' limited attention to supplier-customer relationships or the supply chain's inefficient transmittal of information through the network.

For a supplier company i, denote the set of its customers by $\mathbb{C}_i$ and the quantified revenue percentage by w_{ij} for $j \in \mathbb{C}_i$. The revenue-weighted customer price momentum for supplier i at time t is defined as

$$\text{Revenue-Weighted Customer Momentum}_i(t', t) \triangleq \frac{\sum_{j\in\mathbb{C}_i} w_{ij}\,\text{Customer Momentum}_j(t', t)}{\sum_{j\in\mathbb{C}_i} w_{ij}}$$

where the $\text{Momentum}_j(t', t)$ for customer j is calculated in terms of the percentage total return over a period of time $[t, t']$: [1]

$$\text{Customer Momentum}_j(t', t) \triangleq \frac{P_j(t)}{P_j(t')} - 1, \quad \forall\, j \in \mathbb{C}_i.$$

In the context of factor construction, we choose the ending time t to be the time when a factor snapshot is taken. In this document, we consider the following time horizons for momentum calculation: $t - t' \in \{1\text{D}, 2\text{W}, 1\text{M}, 2\text{M}, 3\text{M}, 12\text{M}$, where D stands for day, W for week and M for month.

[1] For a real trading strategy, both ends of the momentum calculation are often smoothed to avoid trading around noise. Exponential moving average momentum is such a choice.

4 Factor Backtesting in Global Regions

The goal of this study is to evaluate the efficacy of revenue-weighted customer momentum as a supplier company's factor. Focus is placed on the factor efficacy with respect to:

- horizon of momentum calculation
- global region of supplier companies

Time Period. A time period 2012-2018 is chosen for backtesting.

Security Universe. We examine the efficacy of revenue-weighted customer momentum in several global regions.

- United States: S&P 500, Russell 3000
- Europe: STOXX 600
- Japan: TPX

Long/Short Portfolio and Rebalancing Frequency: A common way to evaluate the efficacy of a factor is to form quintile portfolios by sorting on that factor score, for example, going long Q1 and short Q5, or forming butterfly positions going long the belly and going short the wings. These naïve quintile portfolios are intuitive and easy to construct, but they do not represent pure exposures to the factor under consideration. In this test, we resample the customer momentum factors and rebalance the resulting portfolio monthly.

Calendar Convention. Although an investor is often interested in forming scores for stocks in a given market to help trading decisions, the supply chain network is global by nature. U.S. supplier companies typically have customers globally and the calculation of scores inevitably involves international relationships. For example, the customers of S&P 500 companies in U.S. and across the world (~ 6000) have different trading calendars. At a given time t, we adopt the convention of picking the closest trading day no later than t with a look-back period of eight calendar days. Because our factor portfolio is rebalanced monthly, it is critical to properly account for international trading calendars to avoid missing data on non-trading days.

Adjustments. Several adjustments are performed to examine the overlap with Fama-French and supplier momentum factors:

- Fama-French: the factor portfolios of Fama-French 3-factors and momentum from Kenneth R. French's Data Library.
- Subject company momentum: the simple factor portfolio of the subject companies' (suppliers) momentum calculated over the same period of time as the customers'.
- Fama-French + Supplier momentum: the factor portfolios of Fama-French 3-factors from Kenneth R. French's Data Library, plus the simple factor portfolio of supplier momentum calcualted over the same period of time as the customer momentum.

The adjustment is done through a time series regression on the portfolio PnL with respect to Fama-French-Carhart portfolios' daily returns. The residuals are interpreted as alpha.

$$\mathrm{PnL}_t \sim \beta_M \times \mathrm{MKT\text{-}RF}_t + \beta_s \times \mathrm{SMB}_t + \beta_v \times \mathrm{HML}_t + \beta_m \times \mathrm{MOM}_t + \alpha_t,$$

where at any time t, MKT-RF$_t$ is the market factor less the risk-free rate, SMB$_t$ is the size factor, HML$_t$ is the value factor, MOM$_t$ is the Carhart momentum factor. We are interested in observing α_t as a trading signal not spanned by the Fama-French factors.

In the following sections, the cumulative return time series of the supply chain customer momentum factors for suppliers in various markets will be graphed: United States S&P 500 in Section 4.1, Russell 3000 in Section 4.2, Europe STOXX 600 in Section 4.3, and Tokyo TPX in Section 4.4. For each market, a group of eight graphs will be organized in a 3×2 matrix:

1D	2W
1M	2M
3M	12M

Within each graph, five time series of cumulative factor returns are plotted for: **black** for the revenue-weighted customer momentum (without any adjustment), **gray** for the subject companies' (suppliers') momentum calculated over the same horizon as the customer momentum (**black** lines), **blue** for the revenue-weighted customer momentum α_t controlled by Fama-French factors:

$$\text{PnL}_t \sim \beta_M \times \text{MKT-RF}_t + \beta_s \times \text{SMB}_t + \beta_v \times \text{HML}_t + \alpha_t,$$

cyan for the revenue-weighted customer momentum α_t controlled by the subject company's momentum factors (**gray** lines), **orange** for the revenue-weighted customer momentum α_t controlled by Fama-French factors plus the subject company's momentum factors (**blue** lines adjusted by **gray** lines):

$$\text{PnL}_t \sim \beta_M \times \text{MKT-RF}_t + \beta_s \times \text{SMB}_t + \beta_v \times \text{HML}_t + \beta_m \times \text{MOM}_t + \alpha_t.$$

To summarize the relationship between the various lines in the following:

- **black**: raw factor returns of the revenue-weighted customer momentum
- **gray**: raw factor returns of the subject companies' (suppliers') momentum
- **blue** ~ **black** $\ominus$ Fama-French
- **orange** ~ **black** $\ominus$ Fama-French $\ominus$ **gray** ~ **blue** $\ominus$ **gray**

where the symbol $\ominus$ means *adjusted for*. In each plot, the realized Sharpe ratios of the return series are reported in the legend.

For brevity, we use *customer momentum* to stand for supply chain revenue-weighted customer momentum in the following sections.

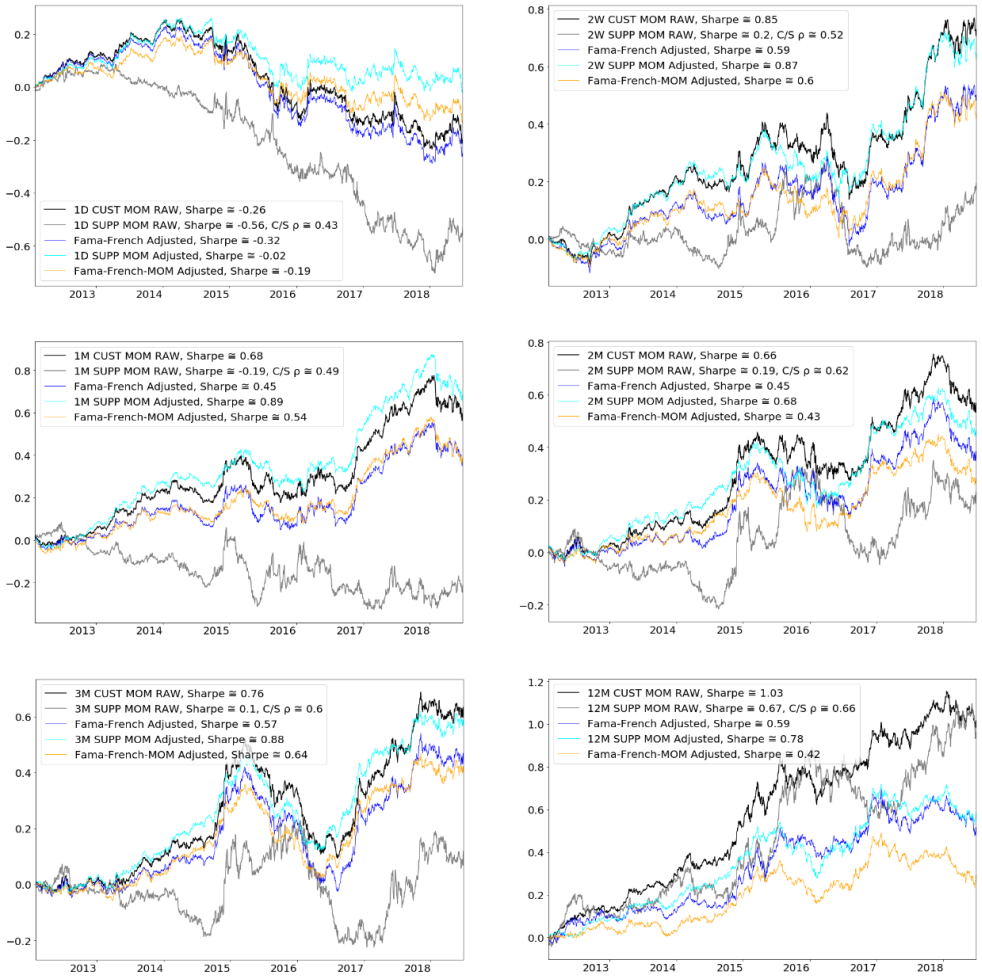

Figure 4.1: S&P 500 suppliers. Long/short q1-q5 quintiles of revenue-weighted customer momentum calculated over horizons of 1D, 2W, 1M, 2M, 3M and 12M.

Customer momentum calculated over a short horizon (e.g., 1-day) does not predict supplier returns. The resulting factor returns are essentially orthogonal to Fama-French-Carhart adjustments. See the top-left plots in Figures 4.1, 4.2, 4.3 and 4.4, where the **blue** lines and the **black** lines almost coincide. Customer momentum calculated over a long horizon (e.g., 12-month) does drive the supplier returns. However, the corresponding factor returns are heavily correlated with Fama-French factors and the subject company's own momentum factors, resulting in reduced factor efficacy after adjustments. As a result, significant deviations of **blue**/**cyan**/**orange** lines from the **black** line can be observed in the bottom rows of Figures 4.1, 4.2 and 4.4.

Customer momentum calculated over a medium horizon (e.g., 1 to 3 months) exhibit the most

interesting behavior. They predict supplier returns and, at the same time, are relatively weakly correlated with regular Fama-French factors and the subject company's own momentum factors. See the middle rows in Figure 4.1, 4.2, 4.3 and 4.4.

4.2 United States Russel 3000 (January 2012 - June 2018)

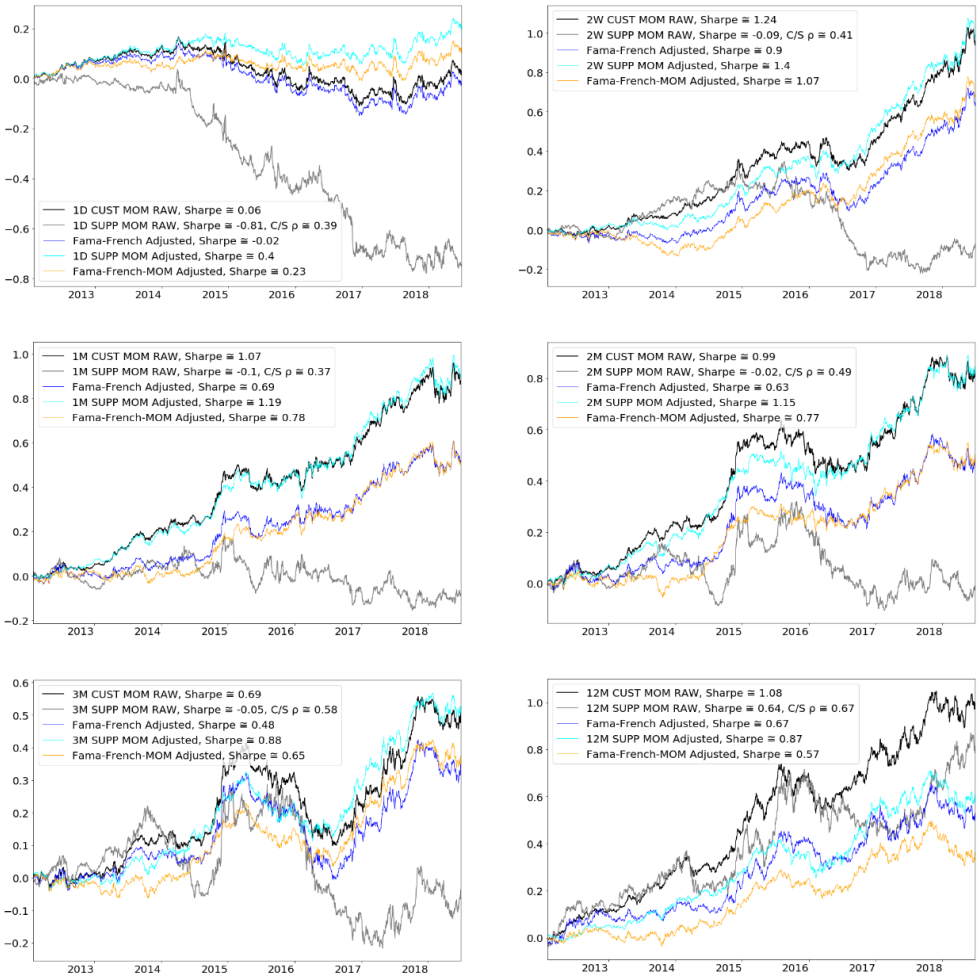

Figure 4.2: Russel 3000 suppliers. Long/short q1-q5 quintiles of revenue-weighted customer momentum calculated over horizons of 1D, 2W, 4W, 1M, 2M, 3M and 12M.

Generally speaking, calculated over the same horizon, the customer momentum factor returns are positively correlated with those of the subject company's momentum factors. However, we emphasize that the customer momentum behaves differently from the conventional momentum as a predictor of the supplier's returns. The customer momentum factor returns do become increasingly similar to the supplier momentum as the horizon gets larger, which reflects an assimilation of the customer information into the supplier company's returns.

4.3 Europe STOXX 600 (January 2012 - June 2018)

As shown in Figure 4.3, the customer momentum calculated over a 2-month horizon shows a strong performance for STOXX 600 market, which might be interpreted as a typical period of time for customer momentum information to transmit through the supply chain network. Compared with the STOXX 600 and TPX markets, the performance of the customer momentum in S&P 500 and Russell 3000 markets suggests that the supply chain of U.S. companies is more efficient at transmitting the customer momentum information through the network.

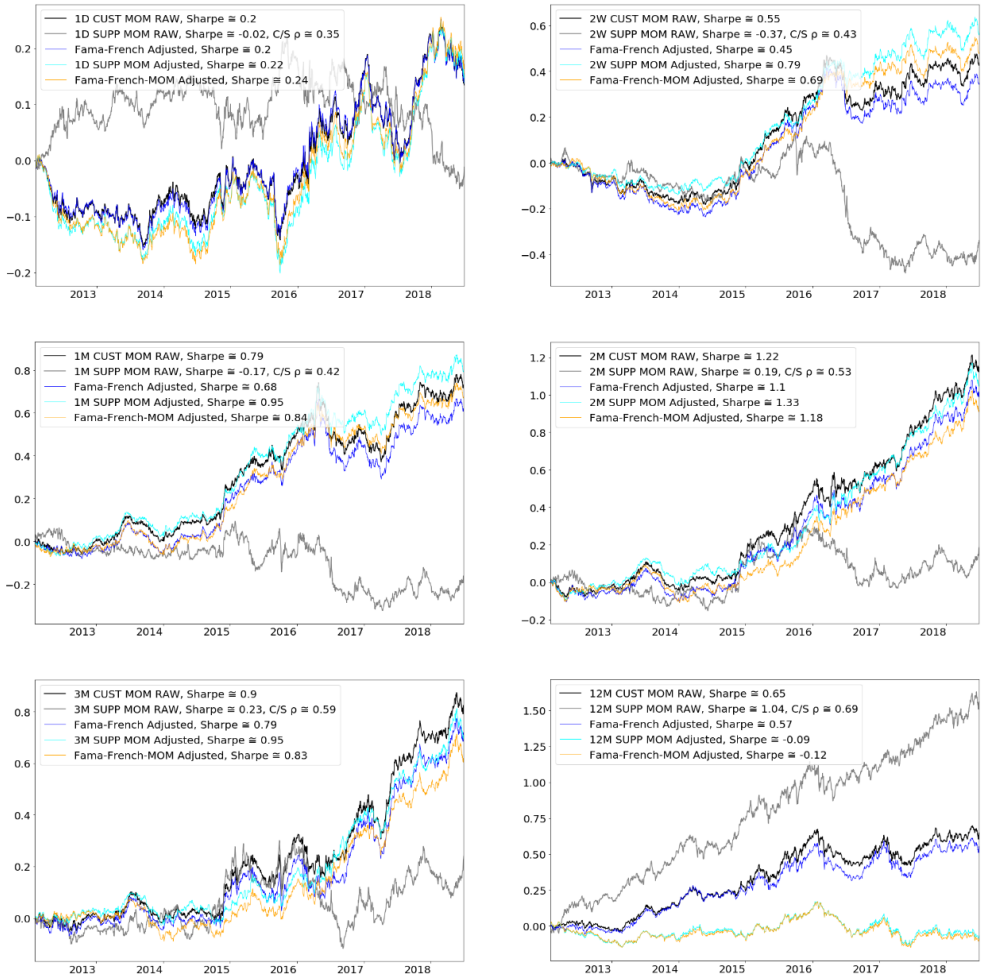

Figure 4.3: STOXX 600 suppliers. Long/short q1-q5 quintiles of revenue-weighted customer momentum calculated over horizons of 1D, 2W, 4W, 1M, 2M, 3M, 12M, and 12M-1M. Recalculate factors and rebalance portfolio monthly.

4.4 Tokyo Stock Exchange (January 2012 - June 2018)

The customer momentum for TPX index exhibits the strongest performance, shown in Figure 4.4. This is partly explained by the fact that Japan is a global supplier heavily dependent on export.

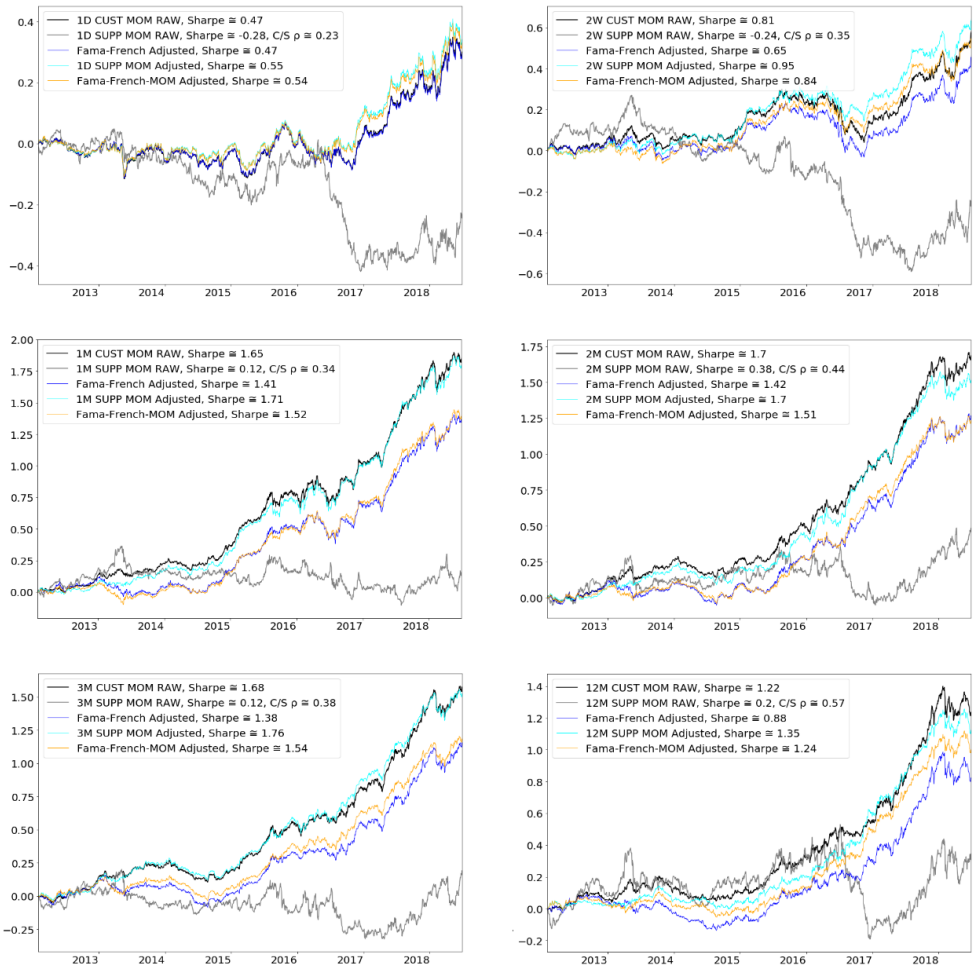

Figure 4.4: TOPIX suppliers. Long/short q1-q5 quintiles of revenue-weighted customer momentum calculated over horizons of 1D, 2W, 4W, 1M, 2M, 3M, 12M, and 12M-1M. Recalculate factors and rebalance portfolio monthly.

5 Conclusions

In this report, we have scratched the surface of the deep wealth of Bloomberg supply chain data. Descriptive statistics are provided to characterize the global business relationships with respect to geographical regions. To demonstrate the added value to investment decisions, we built a use case of equity factors based on supply chain customer momentum. The results from backtesting show that the supply chain customer momentum is a significant driver of supplier returns and, at the same time, behaves differently from the conventional Fama-French and momentum factors. This research opens up a path to incorporating supply chain information in factor investing and significantly expands the institutional investors' arsenals.

References

Dallin Alldredge and Andy Puckett, *The Performance of Institutional Investor Trades Across the Supply Chain*, April 2016. https://ssrn.com/abstract=2757735 or http://dx.doi.org/10.2139/ssrn.2757735

Lauren Cohen and Andrea Frazzini, *Economic Links and Predictable Returns*, SSRN: https://ssrn.com/abstract=2758776, May 2007.

Jocelyn D. Evans and Dominique G. Outlaw, *The Information Content of Short Selling Around Close Supply Chain Relationships*, *The Financial Review*, Volume 53, No. 3, August 2018. https://doi.org/10.1111/fire.12163

Antti Paatela, Elias Noschis and Ari-Pekka Hameri, *Abnormal Stock Returns using Supply Chain Momentum and Operational Financials*, *The Journal of Portfolio Management* 43 (2) 50-60, Winter 2017.

Yixin Wang, Jun Li and Ravi Anupindi, *Risky Suppliers or Risky Supply Chains? An Empirical Analysis of Sub-Tier Supply Network Structure on Firm Performance in the High-Tech Sector*, Ross School of Business Paper No.1297, June 2017.

Jing Wu and John R. Birge, *Supply Chain Network Structure and Firm Returns*, https://ssrn.com/abstract=2385217, November 2015.

Take the next step.

For additional information, press the <HELP> key twice on the Bloomberg Terminal®.

Beijing
+86 10 6649 7500

Dubai
+971 4 364 1000

Frankfurt
+49 69 9204 1210

Hong Kong
+852 2977 6000

London
+44 20 7330 7500

Mumbai
+91 22 6120 3600

New York
+1 212 318 2000

San Francisco
+1 415 912 2960

São Paulo
+55 11 2395 9000

Singapore
+65 6212 1000

Sydney
+61 2 9777 8600

Tokyo
+81 3 3201 8900

bloomberg.com/professional