# The Supply Chain Index:

## Evaluating the Industrial Value Network

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# Research Overview

The term supply chain excellence is easier to say than to measure. Over the course of the past two years, we have studied industry progress by analyzing corporate balance sheet and income statement information. We started with a deep analysis by industry. Over the course of the past two years, we have published 18 reports to analyze the progress of companies within specific industries for the period of 2000–2012. These reports were published in a *Supply Chain Metrics That Matter* series by Supply Chain Insights LLC during the period of August 2012-March 2014. These deep studies of supply chain performance within specific industries were preparatory work to build a methodology to gauge supply chain progress using financial ratios. Our goal was to give supply chain leaders a methodology to gauge supply chain improvement. We wanted it to be a methodology that could be used by all companies--large and small--within an industry peer group for a given time frame. This led to the development of the Supply Chain Index.

The Supply Chain Index is a composite metric, measuring a company's improvement on balance, strength and resiliency factors within a peer group for a given time period. In this report, we analyze progress of the industry sub-segments of automotive, automotive suppliers, consumer electronics, semiconductor and contract manufacturers for two time periods: 2006–2013 and 2009–2013.

The goal of this report is to apply the Supply Chain Index framework to help readers understand the state of supply chain in the industrial value network. For the purposes of this analysis, we define this value network as a group of trading partners focused on industrial manufacturing activities.

# Disclosure

Your trust is important to us. As such, we are open and transparent about our financial relationships and our research process. This independent research is 100% funded by Supply Chain Insights.

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# Research Methodology

The basis of this report is publicly available information from corporate annual reports from the period of 2006-2013. To complete this analysis, and understand the patterns, we partnered with a research team from the School of Computing, Informatics and Decision Systems Engineering at Arizona State University (ASU) during the spring of 2014 to develop the Supply Chain Index methodology to analyze supply chain improvement based on pattern analysis of performance. Details on the math used in this methodology are outlined in the Appendix of this report.

In the analysis of the Supply Chain Index, we use supply chain financial ratios as opposed to absolute numbers. The use of ratios allows us to compare large companies to small entities, and also to compare the progress of companies operating in different countries using differing currencies. Additionally, it allows us to track progress over time. In Table 1, we share the supply chain ratios we have been mining to understand the trends in the Metrics That Matter report series. For the Supply Chain Index, we measure the patterns and trade-offs between Year-over-Year Revenue Growth, Operating Margin, Inventory Turns and Return on Invested Capital (ROIC).

**Table 1. Financial Ratios Considered in the Determination of the Supply Chain Index**

| Financial Metrics | | | |
|---|---|---|---|
| **Growth** | **Profitability** | **Cycle** | **Complexity** |
| Common Shares | Cash | Cash-to-Cash Cycle | Altman Z |
| Employee Growth | Cash Change in Period | Days of Finished Goods | Capital Turnover |
| Employees | Cash on Hand | Days of Inventory | Current Ratio |
| Market Capitalization | Cash Ratio TTM | Days of Payables Outstanding | Quick Ratio |
| R&D Margin | Cash Ratio Quarter | Days of Raw Materials | Return on Assets |
| R&D Ratio | Cash Ratio Year | Days of Sales Outstanding | Return on Equity |
| R&D to COGS Ratio | Cost of Goods Sold | Days of Work in Progress | Return on Invested Capital |
| Revenue | EBITDA | DPO/DSO | Return on Net Assets |
| Revenue Growth | Free Cash Flow Ratio | Finished Goods Inventory | Revenue per Employee |
| Revenue Growth TTM | Gross Margin | Inventory | Working Capital Ratio |
| Revenue TTM | Gross Profit | Inventory Turns | |
| SG&A Margin | Net Profit Margin | Receivables Turns | |
| SG&A Ratio | Operating Cash Flow Ratio | Raw Materials Inventory | |
| SG&A to COGS Ratio | Operating Margin | Work in Progress Inventory | |
| | OPEX Ratio | | |
| | Pretax Margin | | |

Source: Supply Chain Insights LLC

While there are other measurements which we believe are important in the determination of supply chain excellence—like forecast accuracy, case fill rate, carbon footprint, and inventory write-offs—we cannot find a reliable and consistent source of data for these metrics that covers all industries and years studied. Instead, we find that the industry data sources are spotty and largely inaccurate due to the self-reporting of data.

The Supply Chain Index methodology was built on the belief that the supply chain is a complex system with increasing complexity. We believe it is the supply chain leader's role to build and manage supply chain performance to drive year-over-year improvements which are balanced, strong and resilient.

After two years of research in building the Metrics That Matter reports, we selected four financial ratios as the foundation of the Index—Year-over-Year Growth, Return on Invested Capital (ROIC), Operating Margin and Inventory Turns—based on interviews with supply chain leaders and the correlation to market capitalization. To understand the relationship between supply chain performance and market capitalization, we calculated the correlation of seven years of financial ratios (based on quarterly reporting) to market capitalization (the number of outstanding shares multiplied by the share price) on a quarterly basis. The results of this study on the correlation to market capitalization are presented in Table 2.

**Table 2. Correlation of Supply Chain Financial Ratios to Market Capitalization**

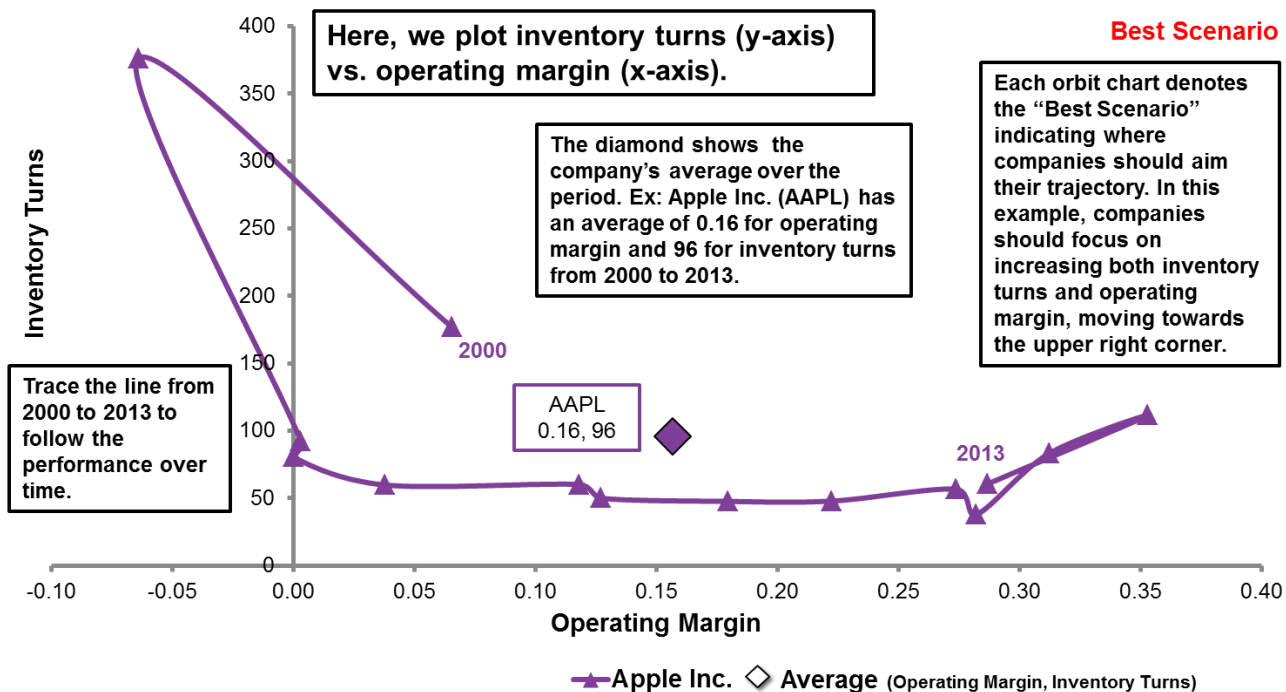| Morningstar Sector | Discount Stores | Medical Care | Drug Manufacturers - Major | Household & Personal Products | Chemical | Packaged Food | Communication Equipment | Medical Devices | Percentage of Industries Demonstrating Correlation per Metric |
|---|---|---|---|---|---|---|---|---|---|
| Number of Companies | 11 | 38 | 43 | 31 | 25 | 56 | 96 | 78 | |
| Days of Inventory (DOI) | X | X | X | X | X | X | X | | 88% |
| Days of Sales Outstanding (DSO) | X | X | | X | X | X | X | X | 88% |
| Days of Payables Outstanding (DPO) | | X | | X | X | X | X | X | 75% |
| Return on Invested Capital (ROIC) | X | | | X | X | X | X | X | 75% |
| Current Ratio (CR) | | X | X | | X | | X | X | 63% |
| Operating Margin (OM) | X | X | X | | X | X | | | 63% |
| Working Capital Ratio (WC) | X | X | | X | | | X | X | 63% |
| DPO/DSO (DPODSO) | X | | X | | | | X | X | 50% |
| Free Cash Flow Ratio (FCF) | | X | X | X | | | X | | 50% |
| SG&A to COGS Ratio (SGAC) | | X | | X | | | X | X | 50% |
| Return on Assets (ROA) | | | | | | X | X | | 25% |
| Return on Net Assets (RONA) | | | | | | X | X | | 25% |
| Year-over-Year Revenue Growth (YOY) | | | | | | | X | X | 25% |

Source: Supply Chain Insights LLC
Equations based upon data from 2006Q1 to 2011Q4
Note: The number of companies is the number listed in the Morningstar sector when the peer group was defined between March and June 2013. The number of companies included in the analysis may be smaller due to data availability issues.

The Supply Chain Index methodology also assumes that supply chain improvement takes time. In our research, we find that it takes at least three years to drive significant supply chain progress, and that the best improvements take at least five years. We also find that it is difficult for supply chain leaders to sustain progress levels that they have achieved. Most companies go through ups and downs, and we believe that the patterns matter. It is for this reason that in this report we analyze companies' progress from 2006 through 2013, and then again from 2009 through 2013, in order to contrast the patterns of the two periods. Index calculations compare one company's pattern over time, at the intersection of two financial ratios, to other peer group companies in a like industry. For the purpose of industry groupings, we use NAICS code designations.

The foundation of the Index starts with understanding the resulting pattern when two supply chain metrics (generally ratios) are plotted over time on an orbit chart. As shown in Figure 1, the orbit chart enables the visualization of performance patterns. In this case, the company is Apple, Inc. The average values for the two financial ratios of operating margin and inventory turns are shown in the box, and the annual progress is shown as points on the chart. The best scenario is notated in the upper right-hand corner. This pattern of Apple performance is very characteristic of most companies. We seldom see a company making linear improvement at the intersection of these two important metrics.

**Figure 1. Example Orbit Chart of Apple, Inc.**



Here, we plot inventory turns (y-axis) vs. operating margin (x-axis).

**Best Scenario**

Each orbit chart denotes the "Best Scenario" indicating where companies should aim their trajectory. In this example, companies should focus on increasing both inventory turns and operating margin, moving towards the upper right corner.

The diamond shows the company's average over the period. Ex: Apple Inc. (AAPL) has an average of 0.16 for operating margin and 96 for inventory turns from 2000 to 2013.

AAPL
0.16, 96

Trace the line from 2000 to 2013 to follow the performance over time.

2000

2013

Inventory Turns

Operating Margin

Apple Inc.  ◇ Average (Operating Margin, Inventory Turns)

Source: Supply Chain Insights LLC, Corporate Annual Reports 2000-2013 from One Source

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# Executive Overview

Supply chain performance matters. It can make or break corporate performance. Now 30-years old, the practice of supply chain management is still evolving. While companies speak of *best practices*, and boast about improvements in operating margin, inventory levels and asset management in conference after conference, we do not see it in our analysis of balance sheet information for any industry.

By their nature, supply chain leaders are competitive. They want to drive performance improvements and increase corporate value. Their goal is to outpace competitors. The rate of business change is intense and the personal stakes are high. Day after day, leaders must answer questions like, *"Which path should I to take? What are the best technologies to use? What is an acceptable rate of performance? How am I doing against my peer group? And, what can I learn from others that I can use to improve the performance of my own operation?"* Until the development of the Supply Chain Index by Supply Chain Insights, there was no independent and objective data-driven methodology that could answer these questions. With the development of this methodology, there now is a way to gauge improvement.

While it is easy to say the term *supply chain excellence*, it is difficult to define. Many people think that they know the definition, but there is no agreed-upon standard. The lack of a clear definition, and a methodology to measure improvement, makes progress hard to quantify and track.

The Supply Chain Index is designed to help. It is an objective measurement of supply chain improvement. It enables the comparison of companies' progress within a peer group for a given time period. The Index is based upon financial performance of companies on four metrics integral to supply chain operations: Year-over-Year Revenue Growth, Return on Invested Capital, Inventory Turns, and Operating Margin. In building the Supply Chain Index, we had three goals:

1. **Quantify Levels of Supply Chain Improvement.** The Index is a composite metric based on the calculation of balance, strength and resiliency factors for a given time period. Each factor is measuring the pattern of performance over time. In the analysis, there is an underlying assumption that the companies that can sustain the best improvement in these three areas are driving the highest rates of supply chain improvement. The input metrics of Year-over-Year Revenue Growth, Return on Invested Capital, Inventory Turns, and Operating Margin were selected in part due to their high correlation to market capitalization.

2. **Bridge the Gap between Finance and Supply Chain.** Our second goal is to bridge the gap between the supply chain organization and the financial team. While the financial team is often backwards-looking at transactions, the supply chain team is forward-looking based on flows. In the process of goal setting, or strategy definition, there is often a temptation to focus on a single financial ratio in isolation, like inventory turns, not realizing that the supply chain is a complex system with tightly interrelated relationships amongst metrics based on supply chain potential. The management of supply chain performance needs to be a system-based approach looking at a portfolio of metrics in a holistic manner. We wanted to give both groups a reference document on what is possible.

3. **Understand the Possibilities.** Each industry has a unique potential. For example, a reasonable inventory turns value for a consumer electronics company is significantly different than that of a medical device company. As a result, the targets or set points need to be different. Why? The inherent rhythms and cycles of the supply chain—product life cycle, the time to manufacture the product, demand and supply volatility, and demand shaping programs—are different. We often see well-intended and unaware executives focus on unreasonable targets for a supply chain performance metric, not understanding the differences between industries, the need to manage the supply chain as a complex system, and the market factors that are driving the change. The Supply Chain Index is designed to increase awareness in establishing the best targets for corporate performance for individual companies within an industry, grounded in real possibilities.

In this report, we apply the Index methodology to five industries comprising the industrial value chain: automotive, automotive suppliers, consumer electronics, semiconductor and contract manufacturing. These companies are not equal in their understanding of supply chain excellence. Each of the industries has struggled with low margins, shortening product life cycles, and tightening of supply.

# Improving Performance on the Effective Frontier

Without a measuring system to gauge performance improvement, supply chain excellence exists in a world of gray, not black and white. As a result, supply chain leaders are faced with the challenge of balancing competing priorities without the ability to measure improvement.

The Supply Chain Index is designed to help. It is based on the belief that a supply chain is a complex system with complex processes with increasing complexity. Improving supply chain performance

requires the management of this complex system of tightly linked and interrelated metrics. In this complex system, supply chain leaders are attempting to balance four distinct priorities: improving growth, improving profitability, reducing cycle time, and managing the ever-increasing complexity. We termed this the *Supply Chain Effective Frontier* as seen in Figure 2.

**Figure 2. The Supply Chain Effective Frontier**



In the development of the Supply Chain Index, we selected a metric from each category of the Effective Frontier model and mapped the patterns of the companies within an industry by orbit chart to understand the patterns over time. For Growth, we selected Year-over-Year Revenue Growth. For Profitability, we selected Operating Margin. For Cycle, the Index uses Inventory Turns, and for Complexity, the Supply Chain Index analyzes Return on Invested Capital (ROIC). To calculate the factors in the Supply Chain Index, we built orbit charts to analyze the pattern at the intersection of Year-over-Year Growth and ROIC and Operating Margin and Inventory Turns. It is our belief that the supply chain is both an engine of growth, and a powerful lever to control costs and inventory.

# What Is a Value Network?

To understand the patterns, we have built reports for each Industry Value Network. This report is the third report in this series. We published a summary of the Consumer Value Network in June, 2014 and a second report on the healthcare value network in July, 2014.Our goal was to understand not only industry progress, but also progress between trading partners.

A value network is a collection of industry-specific supply chains spanning across companies to deliver value to a common customer. In the delivery of goods and services, the relationships are not linear: they are complex with many links between trading partners. This report focuses on supply

chain improvement within the industrial value network including the automotive, automotive supplier, consumer electronics, semiconductor and contract manufacturing industries.

**Figure 3. A Depiction of the Industrial Value Network**
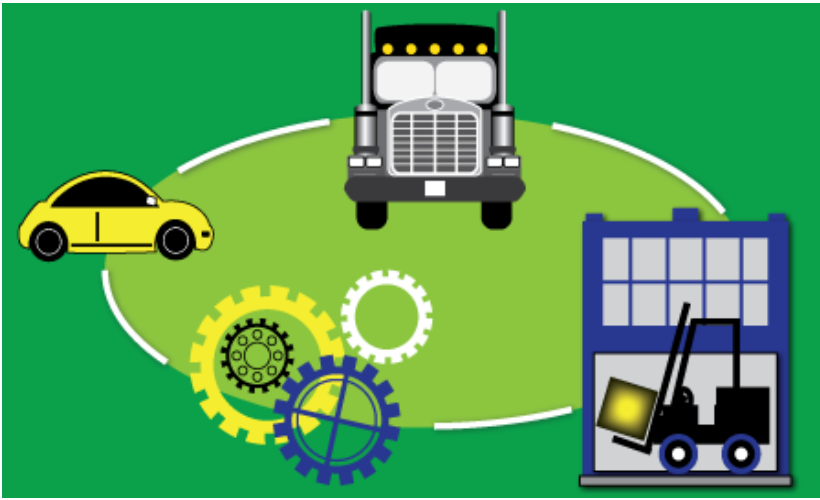


Today, the industrial value chain is more of a supply network than one aligned to improve value. It is disjointed. Contrary to the leadership demonstrated by companies in the consumer value network, few companies in the industrial supply chain have stepped forward to drive improvements across the larger value network. The exception is Taiwan Semiconductor (TSMC). As a result, there is little progress being made in aggregate across the network.

# Each Company Operates at a Unique Potential

Instead, the network is composed of individual industries each working within their own plane of performance. Figure 4 illustrates the performance of four representative companies in the industrial value network. Each company operates on its own Effective Frontier and occupies a different portion of the chart. The patterns are nonlinear and many companies are moving backwards on one or both metrics. Interestingly, **Flextronics International Ltd.** has returned to exactly the same place where it started in 2006 after struggling with low and negative margins through the Great Recession.

Note that while most supply chain leaders aspire to improve both operating margin and inventory turns, the reality is that 99% of companies across all industries are making progress in a singular metric.

**Figure 4. Industrial Value Network Orbit Chart**
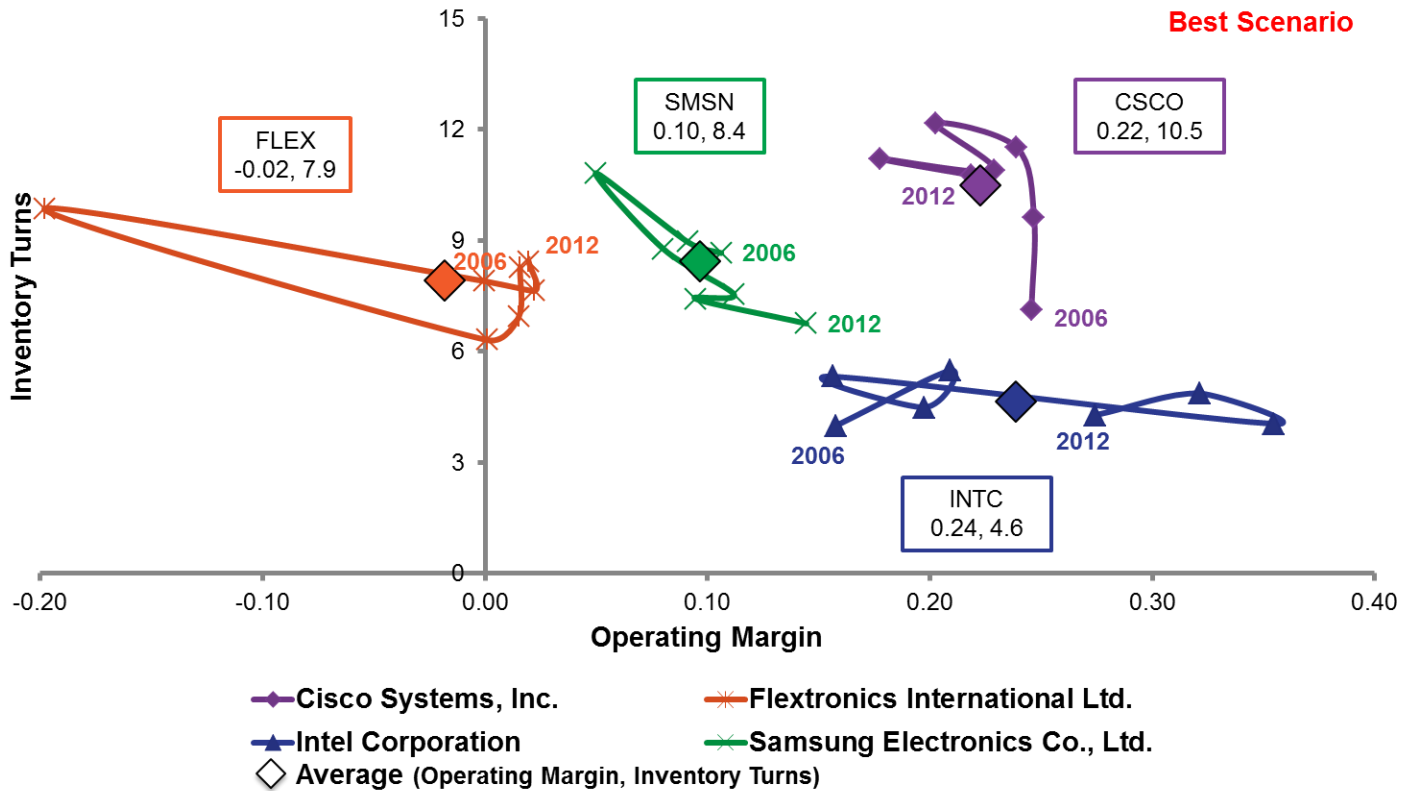


Source: Supply Chain Insights LLC, Corporate Annual Reports 2006-2012

Despite the claims of technology leaders, consulting partners and advertisements in airports, most companies are struggling to make year-over-year improvements. While each company can make improvements and drive changes in process in the short-term, in the longer-term, there are limitations to what is possible.

We find that very company operates at a different potential on the Effective Frontier. The key to driving higher levels of supply chain improvement is in improving the potential to raise the level of performance of supply chain as a system.

Each industry has its own challenges. The semiconductor manufacturer will struggle with cycle challenges unique to their industry. Consumer electronics manufacturers will deal with short inventory cycle times and rapidly shifting consumer demand. Understanding the reality of the industry, and the starting point for improvement, is a critical piece of the puzzle to determine metrics set points and the potential of each industry within a value network.

# Industry Performance within the Value Network

When we take the longer view of 2000-2012, and analyze changes in the financial ratios over that time, several clear patterns appear for the Industrial Value Network. Operating margins are low and three of the five industries within the Industrial Value Network have moved backwards in Operating Margin since 2000. In general, we find companies turning inventory faster and decreasing the Cash-to-Cash Cycle (C2C). However, many companies are improving C2C by lengthening payables terms not by reducing inventory. We capture these aggregate changes by industry within the Industrial Value Chain in Table 3.

**Table 3. Shifts in the Industrial Value Chain for the Period of 2000-2012**

| Industrial Value Chain (2000-2012) | | | | | |
|---|---|---|---|---|---|
| **Industry** | **Operating Margin** | **Inventory Turns** | **Cash-to-Cash Cycle** | **Revenue per Employee (K$)** | **SG&A Ratio** |
| **Automotive Industry** (n=39) | 0.04 ↑67% | 15 ↑5% | 44 ↓37% | 616 ↑199%* | 8% ↓30%* |
| **Automotive Supplier Industry** (n=24) | 0.05 ↑40% | 9 ↑8% | 52 ↓42% | 283 ↑118%* | 7% ↓18%* |
| **Consumer Electronics Industry** (n=12) | 0.03 ↓71% | 6 ↑34% | 57 ↓38% | 525 ↓7%*$ | 14% ↓23%* |
| **Semiconductor Industry** (n=13) | 0.04 ↓53% | 6 ↓16% | 63 ↑38% | 367 ↑57%* | 10% ↑13%* |
| **Contract Manufacturing Industry** (n=11) | 0.05 ↓60% | 8 ↑23% | 53 ↓34% | 356 ↑87%*$ | 8% ↑17%* |

Source: Supply Chain Insights LLC, Corporate Annual Reports 2000-2012
Industry Average comprised of public companies (automotive industry: NAICS 336112), (automotive supplier industry: NAICS 336312 & 336412), (consumer electronics industry: NAICS 33431% where % is any number from 0-9), (contract manufacturing industry: NAICS 33441% where % is any number from 0-2, 4-9), (semiconductor industry NAICS 334413) reporting in One Source with 2012 annual sales greater than $5 billion
*Calculated from 2002-2012 due to data availability; ^Calculated from 2003-2012 due to data availability; NC=no change; $=excluding outliers

As we see in most industries, most companies, through technology investment, have created a more efficient supply chain, reducing revenue per employee, but have struggled to improve both operating margin and inventory turns.

# Index Methodology

There are three components of the Supply Chain Index score: balance, strength, and resiliency. It is a composite metric. In this report, a company's balance, strength, and resiliency factors are calculated and then stack ranked within its industry. Each contributes equally to the final score. Here we outline the Index methodology. For a more detailed explanation of the math behind the Index, please refer to the Appendix.

## Balance

Balance in the supply chain is a constant struggle. As growth increases, there is usually an increase in demand error which can reduce the Return on Invested Capital. Reduced inventory without improving the form and function of the inventory elements can wreak havoc on customer service levels. Excess inventory can lead to high carrying cost and product obsolescence. Excessively long days of payables can translate to weakened supplier health. The examples are endless: balance in supply chain metrics is critical for supply chain health.

The two metrics comprising our balance measure are revenue growth and Return on Invested Capital. ROIC is a less well-known metric compared to Return on Assets (ROA). ROA has a narrower focus. Our research indicates that ROIC has better correlation with market capitalization and provides a broad perspective on cash flow generation and profitability based on shareholder equity.

$$Return\ on\ Invested\ Capital = \frac{Operating\ Income + Income\ Tax\ Total}{Total\ Shareholder's Equity}$$

ROIC is a measurement of the company's use of capital. The supply chain leader's goal is to drive higher returns, through the investment of capital in plant and distribution assets, at a faster rate than the market rate of the cost of capital in public markets.

To calculate the balance factor, we start with an orbit chart of year-over-year revenue growth and ROIC. The balance measure in the Supply Chain Index is a mathematical calculation of the vector trajectory of the pattern of growth and ROIC for the given period. The overall trajectory of this vector from Year 0 (2006 or 2009) to the ending year (2013) is simplified into a single value which represents the company's ability to balance growth and ROIC.

In the calculation, companies that were able to drive improvement in both Year-over-Year Growth and ROIC metrics score the best, while companies that deteriorated in both metrics do the worst. A negative number on the balance score means that the company lost ground on the metrics compared to the starting year. In this report, we calculate this factor for two time periods. Our initial analysis considers performance based upon a time period of 2006-2013. Additional analysis focuses on a narrower time period of 2009-2013. Our goal is to examine corporate performance during and after the 2007 Recession. The balance metric comprises 1/3 of the total Supply Chain Index calculation.

# Strength

A successful supply chain is strong, driving year-over-year improvements. Our research over the past two years has uncovered a rich relationship between operating margin and inventory turns. For most supply chain leaders, these are some of the most important measures of their performance. Not only are they important, they are more directly influenced by supply chain decisions than other broader corporate metrics. It is for this reason they are the two components of our strength metric.



The strength measure in the Supply Chain Index is a mathematical calculation of the vector trajectory of the pattern between inventory turns and operating margin for the period of 2006 (or 2009) to 2013. Inventory turn and operating margin performance is graphed on an annual basis from an origin point (0,0) representing performance on the two metrics at Year 0 (2006 or 2009). The overall trajectory of this vector from Year 0 (2006 or 2009) to the final year (2013) is simplified into a single value which represents strength. Improvement on both metrics simultaneously is graphically shown as movement to the upper right quadrant with increasing values for both inventory turns and operating margin over the period.

The strength metric comprises 1/3 of the total Supply Chain Index calculation. Sustained improvement on both inventory turns and operating margin indicates a strong supply chain and is reflected in a high strength score. The best performance has a high value for the strength factor.

# Resiliency

Resiliency is an adjective easily tossed around as one of the key qualities of a successful supply chain. However, the concept of resiliency is more difficult to define, and there is rarely clarity among stakeholders as to what resiliency is or should be. Here we provide a clear and concise definition.

As we plotted chart after chart, we could see that some supply chains had very tight patterns at the intersection of operating margin and inventory turns, and that other companies had wild swings. We wanted to find a way to measure this. We turned to the experts at ASU. After evaluating several methods to determine the pattern in the orbit chart, we settled upon the Euclidean mean distance between the points.

In our March 2014 report: Supply Chain Metrics That Matter: Improving Supply Chain Resiliency, we define resiliency as the tightness of the pattern at the intersection of inventory turns and operating margin. These metrics are also part of the strength factor. The tightness of the pattern (mathematically speaking, the Euclidean mean distance) indicates the ability of a supply chain to maintain a tight, consistent pattern across these two metrics as the business environment shifts and changes over an eight year period (2006-2013) or five year period (2009-2013).

The resiliency metric is similar to the cash-to-cash cycle in that companies should work to minimize the value. A lower number for resiliency is an indicator of a tighter pattern and greater reliability in results over the time period. The resiliency metric comprises 1/3 of the total Supply Chain Index calculation.

# Calculating a Score for the Supply Chain Index

In the calculation of the Supply Chain Index score of a company within the industry, the balance, strength and resiliency values for the factors are populated and stack ranked. The overall index is a weighting of the three factors. In this report, we create a table like that in Table 4 for each industry peer group for the periods of 2006-2013 and 2009-2013.

**Table 4. Supply Chain Index Ranking System**

| Supply Chain Index | | | | | | | |
|---|---|---|---|---|---|---|---|
| NAICS CODE | BALANCE | BALANCE RANKING | STRENGTH | STRENGTH RANKING | RESILIENCY | RESILIENCY RANKING | OVERALL RANKING |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

In the analysis, each industry segment, as defined by NAICS classification codes, will be considered on an individual basis. As a result, **Intel Corporation** will not be directly compared against **Ford Motor Company** or **Wal-Mart Stores, Inc.** The definition of a best-in-class supply chain varies by the complexities and realities of the operating environment and it is not a one-size-fits-all business environment. We strongly believe that you cannot compare companies with a simple spreadsheet analysis. Instead, we believe that it requires a deep analysis of the industry patterns between the metrics.

## Why the Time Period Matters

The Supply Chain Index is a measure of improvement. For this reason, the beginning year of the measurement and the period of time measured are of critical importance to the ranking. It is the basis for the entire analysis. Initially, we considered the time period of 2000-2013. However, supply chain leaders gave us feedback that 14 years was too long. The current rigors of global supply chain management are so different from what they were in 2000.

Based on this feedback, we have adapted the methodology to focus on two different time periods: 2006-2013 and 2009-2013. The earlier Index reports for the Healthcare Value Network and Consumer Value Network ended with 2012 data comparisons. However, we have added 2013 performance to analysis for this report, and we will re-publish the Index values for the Healthcare Value Network and the Consumer Value Network in a larger report in September, 2014 called *The Ten Supply Chains We Admire*.

In evaluating the data, the larger time period encompasses the recession and its aftermath, and is a good study of resiliency. The 2009-2013 time period takes a narrower focus on the recovery from the Great Recession. In some industries, the rankings change drastically based on the timeframe. We see this less in the industrial value network than we saw in the analysis of the consumer and healthcare value networks. There are fewer changes of places within the industrial value network than we see in others.

## A Closer Look at the Industrial Value Network

In this section, we start by sharing the average factors by industry peer group for manufacturers. As shown in Table 5, in the period of 2009-2013, 80% of industries experienced a sharp decline at the intersection of growth and ROIC (balance factor). Using the principles of supply chain management in

the face of a decline in overall markets, 50% of the manufacturing industry sectors were able to make improvements at the intersection of inventory turns and operating margins (strength factor).

Each industry is being driven by different market factors. While the automotive industry is currently experiencing boom times, growth and complexity are taking their toll on consumer products and pharmaceutical companies. Using the Supply Chain Index methodology, the reader can see that the worst impacts are in the consumer electronics industry. In consumer electronics, companies are battling extreme volatility while losing ground on the management of inventory turns and operating margins in a declining market. The resiliency factor is high, and they are losing considerable ground on both the strength and balance factors.

**Table 5. Supply Chain Index Industry Performance for the Period of 2009-2013**

| 2009-2013 Analysis of Manufacturing Companies Using the Supply Chain Index Methodology | | | | | |
|---|---|---|---|---|---|
| | Number of Companies | 2013 Average Revenue (B$) | Average Balance Factor | Average Strength Ranking | Average Resiliency Ranking | Net Change When Compared to 2006-2013 Factors |
| Automotive | 10 | 101 | 0.680 | 0.343 | 1.202 | Gaining Balance and Strength while Becoming More Resilient |
| Medical Device | 15 | 9 | 0.669 | -0.270 | 0.337 | Improvement in Balance, Decline in Strength and Slight Decline in Resiliency |
| Chemical | 18 | 19.5 | -0.091 | 0.254 | 0.624 | Losing Balance. Becoming Stronger and More Resilient |
| Contract Manufacturing | 6 | 31 | -0.422 | -0.078 | 1.035 | Extreme Downturn in Balance. Slight Decline in Strength and Resiliency |
| Automotive Suppliers | 8 | 34 | -0.545 | -0.219 | 0.854 | Losing Balance and Strength while Becoming More Resilient |
| Consumer Electronics | 25 | 28 | -0.560 | -0.060 | 2.689 | Extreme Downturn in Balance and Strength |
| Food | 21 | 21.9 | -0.731 | 0.014 | 0.731 | Losing Balance and Strength, Becoming Slightly More Resilient |
| Pharmaceutical | 16 | 28 | -0.941 | 0.007 | 0.100 | Extreme Downturn in Balance. Improvement in Strength and Slight Improvement in Resiliency |
| Consumer Packaged Goods | 17 | 21.6 | -1.251 | 0.017 | 0.649 | Losing Balance and Strength, Becoming Slightly More Resilient |
| Semiconductor | 10 | 11 | -1.657 | 0.414 | 0.961 | Extreme Downturn in Balance. Improvement in Strength and Resiliency |

# Companies to Admire

It is easy to get bogged down in the analysis and miss the bigger picture. The Supply Chain Index is a measurement of improvement. Companies making the biggest improvement will often have the most to lose. The secret to using the methodology is to combine the Supply Chain Index with an analysis of performance.

Supply Chain Insights™

As we develop our list of the companies that we admire, we analyze corporate progress against ROIC, operating margin and inventory turns along with supply chain improvement. To make our Companies to Admire list, companies must have posted balanced performance in inventory turns, operating margin, and ROIC, while making progress on the Supply Chain Index. As shown in Table 6, the company performing at the highest level may not rate the highest on the Index. It is just harder to drive improvement when you are already a top performer.

**Table 6. Companies to Admire in the Industrial Sector**

| 2006-2013 Analysis of Manufacturing Companies Using the Supply Chain Index Methodology | | | | |
|---|---|---|---|---|
| | Inventory Turns (Average) 2006-2013 | Operating Margin (Average) 2006-2013 | ROIC 2006-2013 | Supply Chain Index Score 2006-2013 |
| Audi | 9.5 | .09 | 8.9% | 5 |
| **Average for Automotive Companies** | **8.4** | **.04** | **3.7%** | |
| TRW Automotive Holding | 16.5 | .05 | 5.6% | 3 |
| **Average for Automotive Suppliers** | **12.2** | **.06** | **5.4%** | |
| Apple | 61.9 | .25 | 16.8% | 11 |
| Cisco Systems | 10.8 | .22 | 10.1% | 12 |
| Seagate | 11.0 | .07 | 9.3% | 6 |
| **Average for Consumer Electronics Companies** | **9.7** | **.06** | **5.4%** | |
| Intel | 4.7 | .24 | 11.6% | 1 |
| TSMC | 8.5 | .35 | 17.3% | 3 |
| **Average for Semiconductor Companies** | **5.1** | **.10** | **4.8%** | |

In the analysis of all of the companies for this report, no company in the industrial sector has performed at or above the average for these three metrics and driven supply chain improvement.

# Automotive

The automotive industry struggled and then boomed. While revenue has been strong, financial results have been more mixed. To fully use the Supply Chain Index methodology requires an understanding of a company's progress over the time period, as well as their relative location on the orbit chart

compared to their peers. The orbit chart in Figure 5 illustrates the performance of 10 automotive companies studied in this report at the intersection of inventory turns and operating margin.

**Figure 5. Automotive Orbit Chart (2009-2013)**
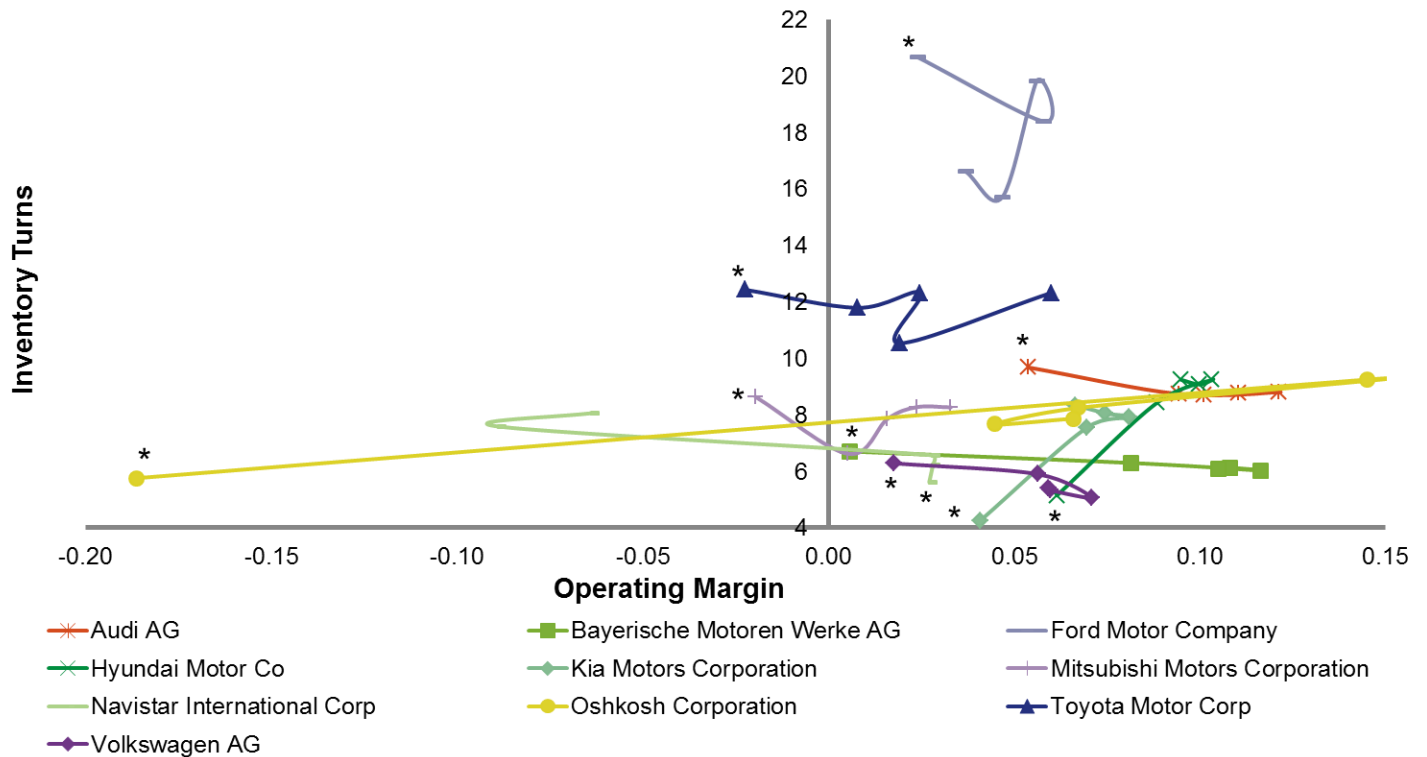


Source: Supply Chain Insights LLC, Corporate Annual Reports 2009-2013

The asterisks in the chart mark the first year (2009) of the pattern. It is clear from the chart that **Oshkosh Corporation** and **Navistar International Corp** have struggled. **Volkswagen AG** leads the Index rankings for 2006-2013 demonstrating the greatest supply chain improvement (as seen in Table 7) although they are not the leader on either inventory turns or operating margin. Audi demonstrates supply chain leadership by performing at a higher plateau on average of operating margin, inventory turns and ROIC, and showing supply chain improvement on the Supply Chain Index for both 2006-2013 and 2009-2013.

**Table 7. The Supply Chain Index: Automotive (2006-2013)**

| Company | 2013 Revenue (billions USD) | Balance | Balance Ranking | Strength | Strength Ranking | Resiliency | Resiliency Ranking | Index (0.3B + 0.3S + 0.3R) | Ranking |
|---|---|---|---|---|---|---|---|---|---|
| Volkswagen AG | 261.5 | 0.01 | 2 | 0.27 | 2 | 0.73 | 2 | 1.8 | 1 |
| Bayerische Motoren Werke AG | 101.0 | -0.12 | 5 | 0.02 | 5 | 0.62 | 1 | 3.3 | 2 |
| Toyota Motor Corp | 265.9 | 0.04 | 1 | -0.03 | 6 | 1.06 | 4 | 3.3 | 2 |
| Hyundai Motor Co | 79.7 | 0.00 | 3 | 0.47 | 1 | 2.70 | 8 | 3.6 | 4 |
| Audi AG | 66.2 | -0.08 | 4 | 0.04 | 4 | 1.25 | 5 | 3.9 | 5 |
| Oshkosh Corporation | 7.7 | -0.23 | 6 | 0.05 | 3 | 1.90 | 7 | 4.8 | 6 |
| Mitsubishi Motors Corporation | 21.9 | -0.24 | 7 | -0.25 | 8 | 1.43 | 6 | 6.3 | 7 |
| Navistar International Corp | 10.8 | -0.61 | 10 | -0.55 | 10 | 0.96 | 3 | 6.9 | 8 |
| Ford Motor Company | 146.9 | -0.51 | 8 | -0.19 | 7 | 2.89 | 10 | 7.5 | 9 |
| Kia Motors Corporation | 43.5 | -0.53 | 9 | -0.50 | 9 | 2.77 | 9 | 8.1 | 10 |

Source: Supply Chain Insights LLC, Corporate Annual Reports 2006-2013

Many are surprised by **Toyota Motor Company**'s performance on the rankings. While a leader in Lean thinking and the evolution of supply chain processes, it is clear from the analysis that Toyota has faltered, especially during the period of 2009-2013 shown in Table 8. The case of negative balance and strength scores were too much to overcome to earn a better ranking.

**Table 8. The Supply Chain Index: Automotive (2009-2013)**

| Company | 2013 Revenue (billions USD) | Balance | Balance Ranking | Strength | Strength Ranking | Resiliency | Resiliency Ranking | Index (0.3B + 0.3S + 0.3R) | Ranking |
|---|---|---|---|---|---|---|---|---|---|
| Bayerische Motoren Werke AG | 101.0 | 11.95 | 1 | 4.43 | 1 | 0.32 | 1 | 0.9 | 1 |
| Volkswagen AG | 261.5 | 0.14 | 2 | 0.56 | 2 | 0.60 | 3 | 2.1 | 2 |
| Audi AG | 66.2 | -0.05 | 3 | 0.19 | 5 | 0.41 | 2 | 3.0 | 3 |
| Kia Motors Corporation | 43.5 | -0.09 | 4 | 0.40 | 3 | 1.73 | 8 | 4.5 | 4 |
| Oshkosh Corporation | 7.7 | -0.53 | 6 | -0.25 | 7 | 1.52 | 7 | 6.0 | 5 |
| Mitsubishi Motors Corporation | 21.9 | -0.62 | 8 | -0.68 | 8 | 0.89 | 5 | 6.3 | 6 |
| Ford Motor Company | 146.9 | -0.17 | 5 | 0.09 | 6 | 2.62 | 10 | 6.3 | 6 |
| Navistar International Corp | 10.8 | -0.60 | 7 | -0.73 | 9 | 1.26 | 6 | 6.6 | 8 |
| Toyota Motor Corp | 265.9 | -1.47 | 9 | -0.92 | 10 | 0.87 | 4 | 6.9 | 9 |
| Hyundai Motor Co | 79.7 | -1.76 | 10 | 0.34 | 4 | 1.80 | 9 | 6.9 | 9 |

Source: Supply Chain Insights LLC, Corporate Annual Reports 2009-2013

# Automotive Suppliers

Automotive suppliers are a critical component of the industrial value chain. They were brutally squeezed during the depths of the Great Recession and the weakest went bankrupt. Coming out of the recession many have diversified. Figure 6 illustrates how the industry performed at the intersection of inventory turns and operating margin on the tail end of the recession from 2009-2013.

**Figure 6. Automotive Suppliers Orbit Chart (2009-2013)**
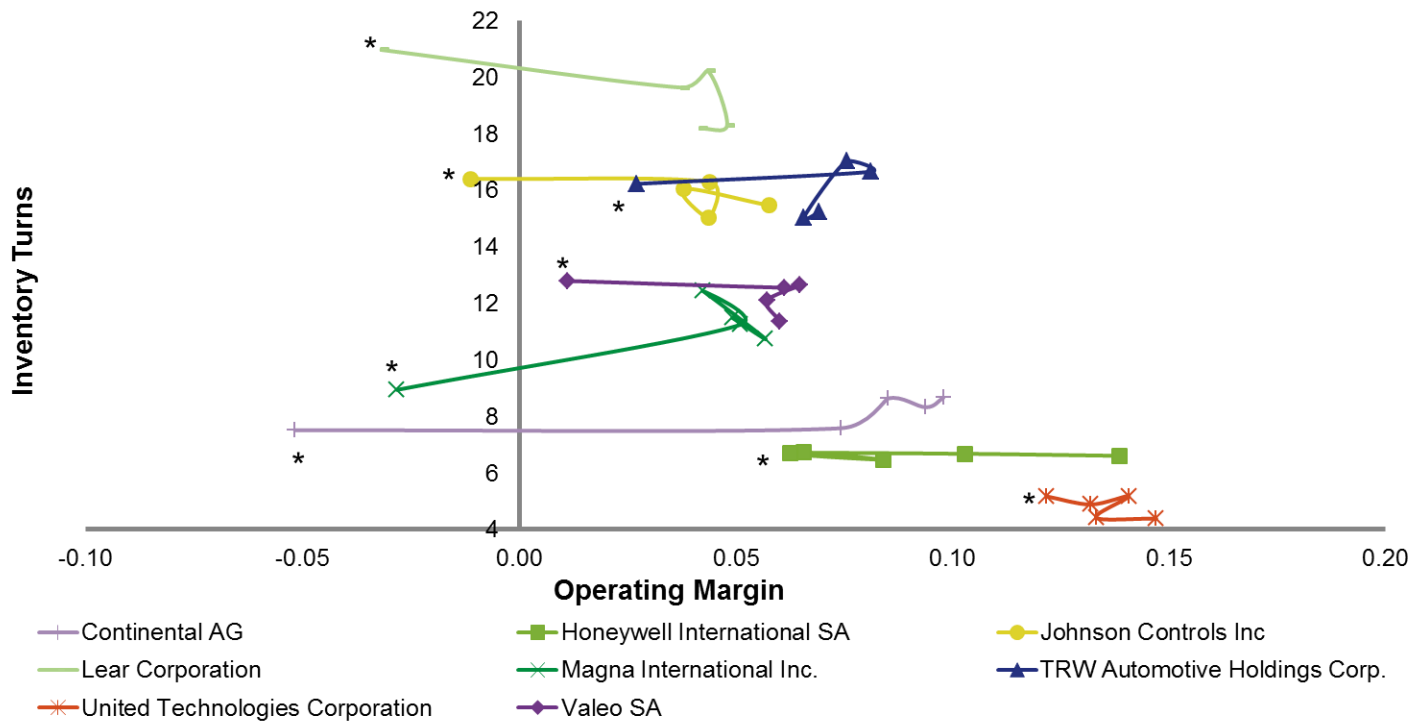


Source: Supply Chain Insights LLC, Corporate Annual Reports 2009-2013

The largest automotive suppliers have nearly universally improved operating margin since 2009 (denoted with the *). There is a significantly wide range of inventory turns values ranging from low single digits to above 20 per year. **Valeo SA** and **Honeywell International SA** which lead the rankings for both time periods have midrange performance on both inventory turns and operating margin. The best overall performance is demonstrated by **TRW Automotive Holdings Corporation**. The Supply Chain Index for automotive suppliers for 2006-2013 is presented here in table 9; while the Supply Chain Index for 2009-2013 is presented in table 10.

Balance has been difficult for these companies across both time periods. Without a more cooperative and less adversarial partnership with upstream automotive manufacturers, we see no reason to expect improvement in the future. It is in the best interest of automotive and automotive suppliers to work together to help each other improve supply chain performance. However, as with most things supply chain, this is easier said than done. The automotive manufacturers have a greater focus on procurement than end-to-end supply chain improvement, and we do not expect this to change.

**Table 9. The Supply Chain Index: Automotive Suppliers (2006-2013)**

| Company | 2013 Revenue (billions USD) | Balance | Balance Ranking | Strength | Strength Ranking | Resiliency | Resiliency Ranking | Index (0.3B + 0.3S + 0.3R) | Ranking |
|---|---|---|---|---|---|---|---|---|---|
| Valeo SA | 16.1 | 0.23 | 3 | 0.16 | 1 | 0.98 | 4 | 2.4 | 1 |
| Honeywell International SA | 39.1 | -0.06 | 6 | 0.08 | 2 | 0.47 | 2 | 3.0 | 2 |
| TRW Automotive Holdings Corp. | 17.4 | 0.28 | 2 | 0.08 | 3 | 1.72 | 6 | 3.3 | 3 |
| Magna International Inc. | 34.8 | 0.29 | 1 | 0.04 | 5 | 2.13 | 7 | 3.9 | 4 |
| United Technologies Corporation | 62.6 | -0.07 | 7 | 0.00 | 7 | 0.39 | 1 | 4.5 | 5 |
| Johnson Controls Inc | 42.7 | -0.17 | 8 | 0.06 | 4 | 0.66 | 3 | 4.5 | 5 |
| Continental AG | 44.2 | -0.05 | 5 | 0.03 | 6 | 1.46 | 5 | 4.8 | 7 |
| Lear Corporation | 16.2 | -0.04 | 4 | -0.36 | 8 | 4.34 | 8 | 6.0 | 8 |

Source: Supply Chain Insights LLC, Corporate Annual Reports 2006-2013

**Table 10. The Supply Chain Index: Automotive (2009-2013)**

| Company | 2013 Revenue (billions USD) | Balance | Balance Ranking | Strength | Strength Ranking | Resiliency | Resiliency Ranking | Index (0.3B + 0.3S + 0.3R) | Ranking |
|---|---|---|---|---|---|---|---|---|---|
| Valeo SA | 16.1 | 0.69 | 1 | 1.06 | 1 | 0.68 | 3 | 1.5 | 1 |
| Honeywell International SA | 39.1 | -0.04 | 3 | 0.27 | 3 | 0.14 | 1 | 2.1 | 2 |
| United Technologies Corporation | 62.6 | -0.46 | 4 | 0.01 | 4 | 0.47 | 2 | 3.0 | 3 |
| TRW Automotive Holdings Corp. | 17.4 | 0.22 | 2 | 0.37 | 2 | 1.09 | 6 | 3.0 | 3 |
| Lear Corporation | 16.2 | -1.18 | 6 | -0.61 | 5 | 1.50 | 7 | 5.4 | 5 |
| Magna International Inc. | 34.8 | -1.12 | 5 | -0.61 | 6 | 1.55 | 8 | 5.7 | 6 |
| Continental AG | 44.2 | -1.24 | 8 | -0.68 | 7 | 0.68 | 4 | 5.7 | 6 |
| Johnson Controls Inc | 42.7 | -1.23 | 7 | -1.56 | 8 | 0.72 | 5 | 6.0 | 8 |

Source: Supply Chain Insights LLC, Corporate Annual Reports 2009-2013

# Consumer Electronics

Several specific companies within the consumer electronics industry are often hailed as supply chain leaders. They have had no choice. The competitive nature of the industry, combined with changing demand patterns and shortening life cycles for electronics, has required high competency. The orbit chart for this industry, shown in Figure 7, has been reduced to show the patterns of nine of the most well-known companies profiled in this report.

**Figure 7. Consumer Electronics Orbit Chart (2009-2013)**
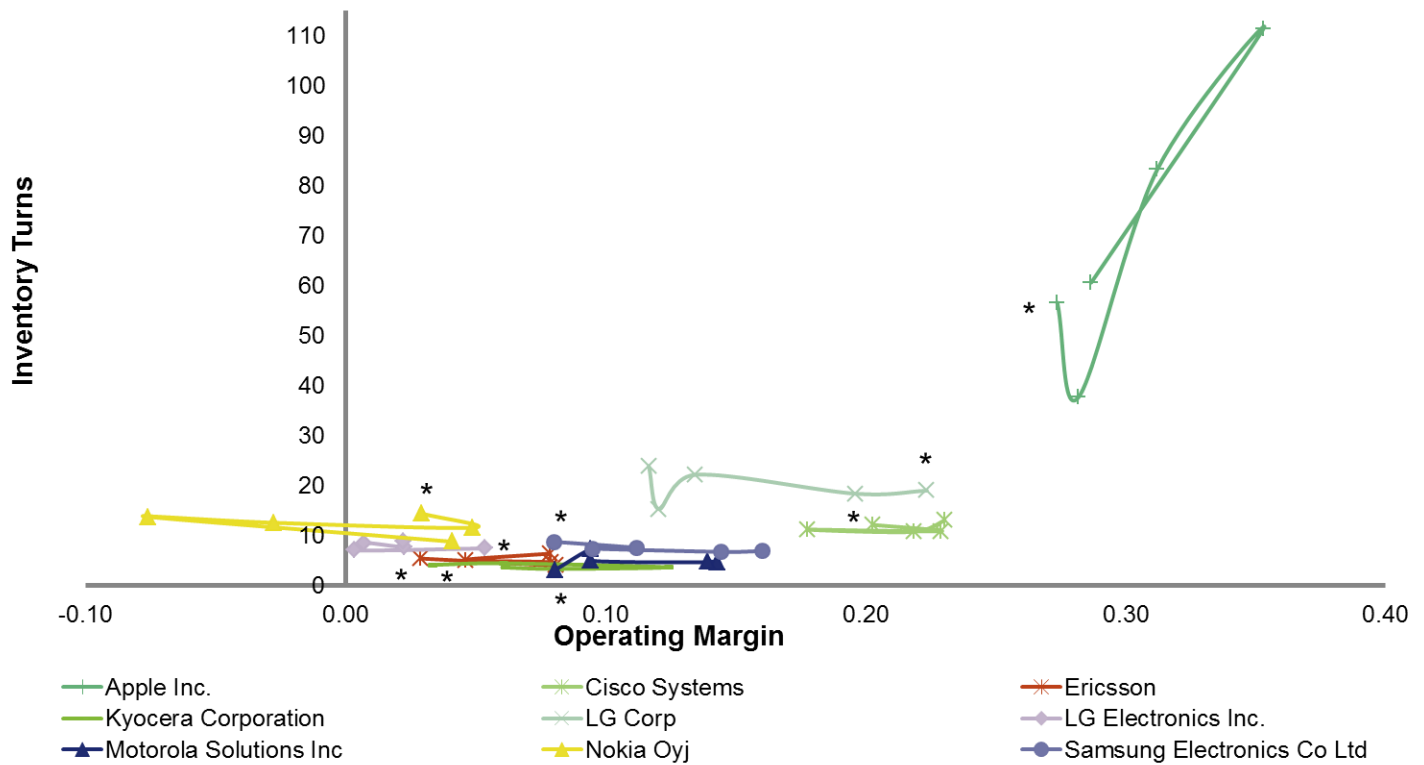


Source: Supply Chain Insights LLC, Corporate Annual Reports 2009-2012

Notice that while automotive suppliers were steadily increasing margins, in consumer electronics, most of the companies are showing a decrease in margin.

The unique business model of **Apple Inc.** enables the company to outperform its peers on both inventory turns and operating margin performance. Strong performance is also demonstrated by **Cisco Systems.**

Improvements in supply chain excellence, as measured by the Supply Chain Index, are detailed in Tables 11 and 12. Note the improvement of the significantly smaller consumer electronics companies (**Alcatel Lucent SA** and **Cabot Microelectronics Corporation**).

The most surprising result may be that large well-known consumer electronics companies, especially **Apple Inc.**, fall squarely in the middle of the rankings. From Table 11 it is clear that Apple is outpacing the industry on inventory turns and operating margin. However, their balance score is very low and their immense growth has negatively affected their resiliency ranking.

**Table 11. The Supply Chain Index: Consumer Electronics (2006-2013)**

| Company | 2013 Revenue (billions USD) | Balance | Balance Ranking | Strength | Strength Ranking | Resiliency | Resiliency Ranking | Index (0.3B + 0.3S + 0.3R) | Ranking |
|---|---|---|---|---|---|---|---|---|---|
| Alcatel Lucent SA | 19.2 | 1.21 | 3 | 0.51 | 3 | 0.69 | 7 | 3.9 | 1 |
| LG Electronics Inc. | 53.1 | 24.06 | 1 | 28.55 | 1 | 1.07 | 13 | 4.5 | 2 |
| Lexmark International Inc | 3.7 | 0.04 | 6 | 0.05 | 10 | 0.60 | 6 | 6.6 | 3 |
| EMC Corporation | 23.2 | -0.03 | 9 | 0.10 | 7 | 0.83 | 9 | 7.5 | 4 |
| Cabot Microelectronics Corporation | 0.4 | -0.08 | 11 | 0.01 | 12 | 0.57 | 4 | 8.1 | 5 |
| Seagate Technology PLC | 14.4 | 0.08 | 4 | 0.15 | 5 | 2.09 | 19 | 8.4 | 6 |
| Emerson Electric Co. | 24.7 | -0.15 | 15 | 0.06 | 9 | 0.77 | 8 | 9.6 | 7 |
| Samsung Electronics Co Ltd | 208.9 | 0.06 | 5 | 0.04 | 11 | 1.56 | 17 | 9.9 | 8 |
| LG Corp | 8.9 | 0.03 | 7 | 0.93 | 2 | 8.12 | 24 | 9.9 | 8 |
| Seiko Epson Corporation | 10.3 | 1.68 | 2 | -0.19 | 22 | 1.04 | 12 | 10.8 | 10 |
| Apple Inc. | 170.9 | 0.02 | 8 | 0.21 | 4 | 26.38 | 25 | 11.1 | 11 |
| Cisco Systems | 48.6 | -0.09 | 14 | 0.11 | 6 | 2.03 | 18 | 11.4 | 12 |
| Kyocera Corporation | 15.4 | -0.23 | 17 | -0.07 | 19 | 0.54 | 2 | 11.4 | 12 |
| Bosch Ltd | 1.5 | -0.26 | 18 | -0.04 | 18 | 0.54 | 3 | 11.7 | 14 |
| Ericsson | 34.9 | -0.21 | 16 | -0.03 | 17 | 0.92 | 10 | 12.9 | 15 |
| Vtech Holdings Ltd | 1.9 | -0.08 | 12 | -0.02 | 16 | 1.38 | 15 | 12.9 | 15 |
| Applied Micro Circuits Corporation | 0.2 | -0.51 | 21 | 0.06 | 8 | 1.55 | 16 | 13.5 | 17 |
| Bang & Olufsen A/S | 0.5 | -0.60 | 22 | -0.27 | 23 | 0.49 | 1 | 13.8 | 18 |
| LSI Corp | 2.4 | -0.39 | 19 | 0.00 | 13 | 1.09 | 14 | 13.8 | 18 |
| Logitech International SA | 2.1 | -0.50 | 20 | -0.32 | 24 | 0.59 | 5 | 14.7 | 20 |
| Motorola Solutions Inc | 8.7 | -0.09 | 13 | 0.00 | 14 | 3.27 | 22 | 14.7 | 20 |
| Western Digital Corp | 15.4 | -0.06 | 10 | -0.07 | 20 | 4.34 | 23 | 15.9 | 22 |
| Sanyo Electric Co Ltd | 17.8* | -1.12 | 24 | -0.99 | 25 | 0.95 | 11 | 18.0 | 23 |
| Canon Electronics Inc. | 1.0 | -1.31 | 25 | -0.01 | 15 | 3.13 | 21 | 18.3 | 24 |
| Nokia Oyj | 16.9 | -0.65 | 23 | -0.17 | 21 | 2.95 | 20 | 19.2 | 25 |

Source: Supply Chain Insights LLC, Corporate Annual Reports 2006-2013
*2010 revenue

**Table 12. The Supply Chain Index: Consumer Electronics (2009-2013)**

| Company | 2013 Revenue (billions USD) | Balance | Balance Ranking | Strength | Strength Ranking | Resiliency | Resiliency Ranking | Index (0.3B + 0.3S + 0.3R) | Ranking |
|---|---|---|---|---|---|---|---|---|---|
| Cabot Microelectronics Corporation | 0.4 | 0.66 | 2 | 0.54 | 1 | 0.41 | 4 | 2.1 | 1 |
| Lexmark International Inc | 3.7 | -0.04 | 7 | 0.28 | 4 | 0.64 | 7 | 5.4 | 2 |
| Motorola Solutions Inc | 8.7 | 1.20 | 1 | 0.32 | 3 | 1.72 | 18 | 6.6 | 3 |
| Bosch Ltd | 1.5 | 0.53 | 3 | -0.09 | 18 | 0.19 | 2 | 6.9 | 4 |
| Ericsson | 34.9 | 0.33 | 6 | 0.48 | 2 | 1.10 | 15 | 6.9 | 4 |
| Emerson Electric Co. | 24.7 | -0.29 | 10 | 0.07 | 9 | 0.74 | 10 | 8.7 | 6 |
| Alcatel Lucent SA | 19.2 | -0.32 | 12 | 0.00 | 14 | 0.43 | 5 | 9.3 | 7 |
| Kyocera Corporation | 15.4 | -0.90 | 21 | 0.19 | 6 | 0.54 | 6 | 9.9 | 8 |
| EMC Corporation | 23.2 | -0.38 | 15 | 0.17 | 7 | 0.85 | 11 | 9.9 | 8 |
| Canon Electronics Inc. | 1.0 | 0.38 | 4 | 0.15 | 8 | 3.70 | 22 | 10.2 | 10 |
| Bang & Olufsen A/S | 0.5 | -0.29 | 11 | -0.14 | 20 | 0.32 | 3 | 10.2 | 10 |
| Nokia Oyj | 16.9 | 0.33 | 5 | 0.00 | 13 | 2.68 | 21 | 11.7 | 12 |
| Seiko Epson Corporation | 10.3 | -0.11 | 9 | -0.31 | 22 | 0.71 | 9 | 12.0 | 13 |
| Cisco Systems | 48.6 | -0.33 | 13 | 0.05 | 11 | 1.16 | 16 | 12.0 | 13 |
| Samsung Electronics Co Ltd | 208.9 | -1.51 | 24 | 0.20 | 5 | 0.93 | 12 | 12.3 | 15 |
| Apple Inc. | 170.9 | -0.08 | 8 | 0.03 | 12 | 34.79 | 25 | 13.5 | 16 |
| Vtech Holdings Ltd | 1.9 | -0.34 | 14 | -0.06 | 16 | 1.28 | 17 | 14.1 | 17 |
| Applied Micro Circuits Corporation | 0.2 | -0.68 | 19 | 0.06 | 10 | 1.83 | 19 | 14.4 | 18 |
| LG Electronics Inc. | 53.1 | -0.60 | 18 | -0.10 | 19 | 0.96 | 13 | 15.0 | 19 |
| Sanyo Electric Co Ltd | 17.8* | -7.52 | 25 | -1.50 | 25 | 0.09 | 1 | 15.3 | 20 |
| Logitech International SA | 2.1 | -0.81 | 20 | -0.90 | 24 | 0.70 | 8 | 15.6 | 21 |
| LG Corp | 8.9 | -0.40 | 16 | -0.06 | 15 | 4.18 | 23 | 16.2 | 22 |
| LSI Corp | 2.4 | -1.02 | 22 | -0.29 | 21 | 0.98 | 14 | 17.1 | 23 |
| Seagate Technology PLC | 14.4 | -0.59 | 17 | -0.42 | 23 | 1.86 | 20 | 18.0 | 24 |
| Western Digital Corp | 15.4 | -1.05 | 23 | -0.06 | 17 | 4.43 | 24 | 19.2 | 25 |

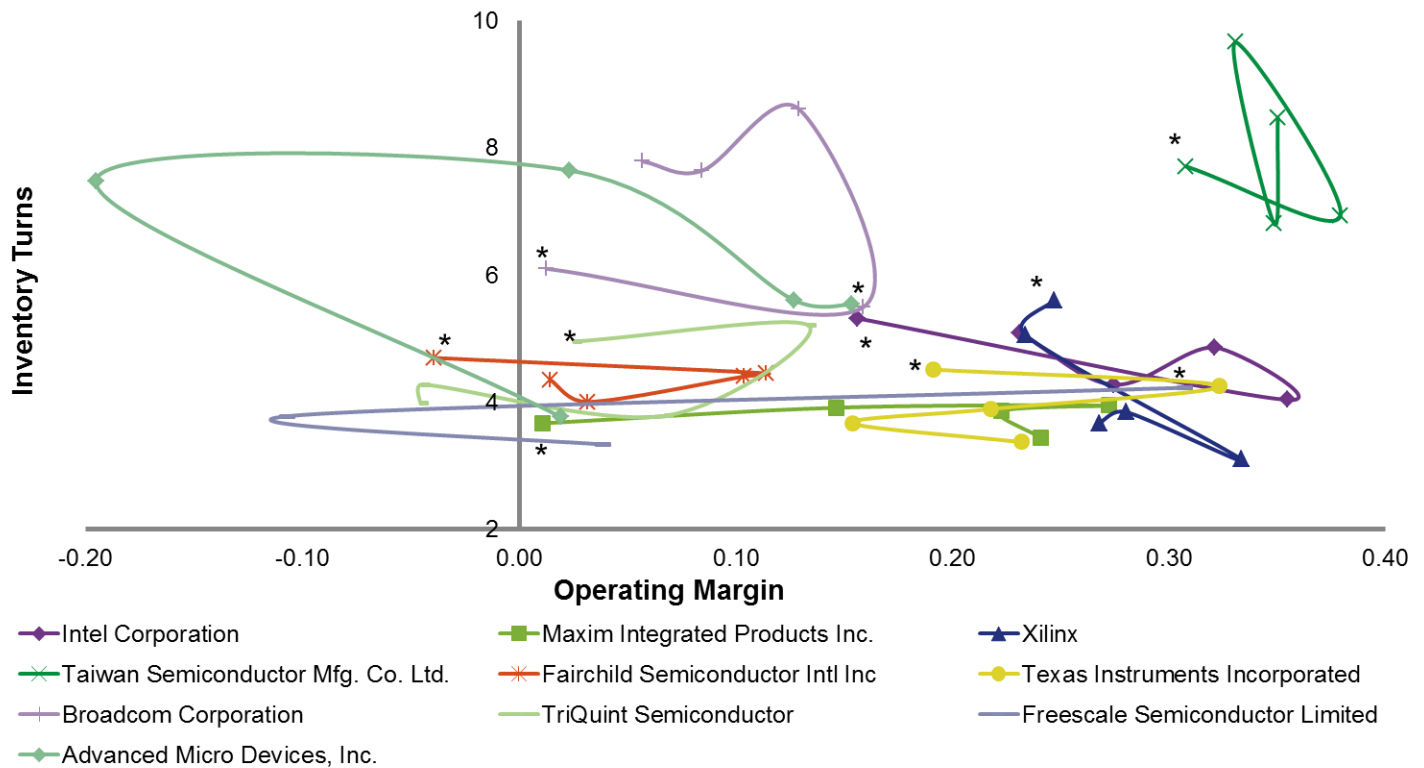Source: Supply Chain Insights LLC, Corporate Annual Reports 2009-2013
*2010 revenue

Of all of the industries studied, this peer group has weathered the most storms. Supply chain excellence is fundamental for survival.

# Semiconductor

Semiconductor manufacturers have a unique challenge in an industry that must begin developing and manufacturing products prior to any demand signals. As a result, their balance and strength scores are low and their resiliency scores are high. Figure 8 illustrates performance of the component companies at the intersection of inventory turns and operating margin from 2009-2013.

The patterns here are very nonlinear and many are in fact looping over the time period. Taiwan Semiconductor (TMSC) and Intel Corporation have done the best job of performance and improvement.

**Figure 8. Semiconductor Orbit Chart (2009-2013)**



Source: Supply Chain Insights LLC, Corporate Annual Reports 2009-2013

In Tables 13 and 14, we contrast the relative improvement of the consumer electronics leaders on delivering supply chain excellence as measured by the Supply Chain Index.

**Table 13. The Supply Chain Index: Semiconductor (2006-2013)**

| Company | 2013 Revenue (billions USD) | Balance | Balance Ranking | Strength | Strength Ranking | Resiliency | Resiliency Ranking | Index (0.3B + 0.3S + 0.3R) | Ranking |
|---|---|---|---|---|---|---|---|---|---|
| Intel Corporation | 52.7 | -0.07 | 2 | 0.11 | 1 | 0.72 | 4 | 2.1 | 1 |
| Maxim Integrated Products Inc. | 2.4 | -0.10 | 3 | 0.00 | 4 | 0.55 | 2 | 2.7 | 2 |
| Xilinx | 2.2 | -0.17 | 5 | 0.04 | 2 | 1.14 | 6 | 3.9 | 3 |
| Taiwan Semiconductor Mfg. Co. Ltd. | 20.1 | -0.04 | 1 | 0.00 | 3 | 2.25 | 10 | 4.2 | 4 |
| Fairchild Semiconductor Intl Inc | 1.4 | -0.27 | 7 | -0.13 | 7 | 0.37 | 1 | 4.5 | 5 |
| Texas Instruments Incorporated | 12.2 | -0.23 | 6 | -0.05 | 6 | 0.62 | 3 | 4.5 | 5 |
| Broadcom Corporation | 8.3 | -0.16 | 4 | -0.04 | 5 | 1.50 | 8 | 5.1 | 7 |
| TriQuint Semiconductor | 0.9 | -0.44 | 9 | -0.25 | 9 | 0.86 | 5 | 6.9 | 8 |
| Freescale Semiconductor Limited | 4.6* | -0.43 | 8 | -0.21 | 8 | 1.20 | 7 | 6.9 | 8 |
| Advanced Micro Devices, Inc. | 5.3 | -1.21 | 10 | -1.04 | 10 | 1.87 | 9 | 8.7 | 10 |

Source: Supply Chain Insights LLC, Corporate Annual Reports 2006-2013
*2011 revenue

In comparison to other industries, **Intel Corporation**'s size here seems to be providing it with an advantage. Economics of scale combined with significant work on talent development and network design lend them the edge. In parallel, TMSC's work on open design networks and collaboration with upstream consumer electronics manufacturers gives it the edge.

**Table 14. The Supply Chain Index: Semiconductor (2009-2013)**

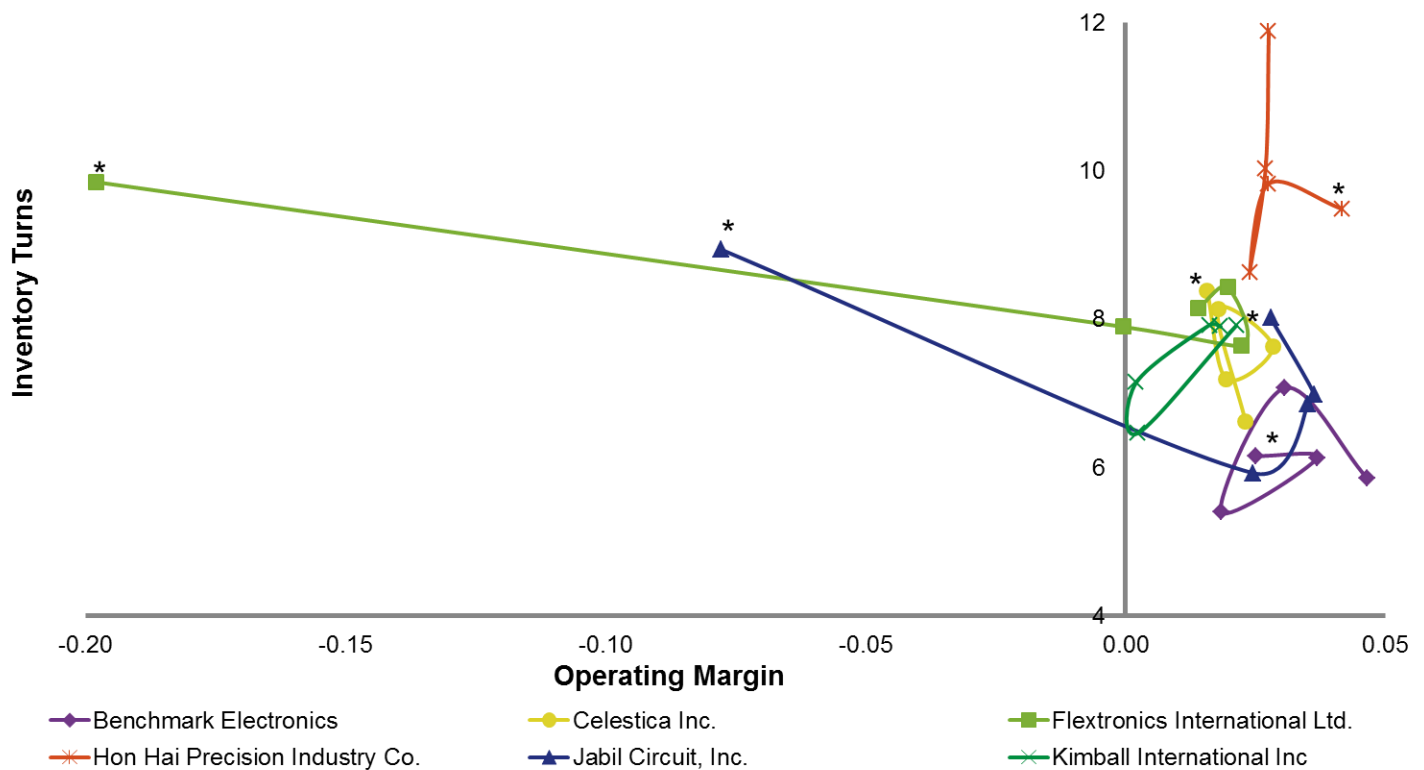| Company | 2013 Revenue (billions USD) | Balance | Balance Ranking | Strength | Strength Ranking | Resiliency | Resiliency Ranking | Index (0.3B + 0.3S + 0.3R) | Ranking |
|---|---|---|---|---|---|---|---|---|---|
| Broadcom Corporation | 8.3 | 0.26 | 2 | 0.96 | 2 | 1.59 | 2 | 1.8 | 1 |
| Xilinx | 2.2 | 0.63 | 1 | -0.06 | 6 | 1.28 | 4 | 3.3 | 2 |
| Intel Corporation | 52.7 | -0.14 | 3 | 0.11 | 3 | 0.69 | 6 | 3.6 | 3 |
| Taiwan Semiconductor Mfg. Co. Ltd. | 20.1 | -0.53 | 6 | 0.06 | 4 | 1.45 | 3 | 3.9 | 4 |
| Advanced Micro Devices, Inc. | 5.3 | -0.35 | 5 | -0.30 | 7 | 1.96 | 1 | 3.9 | 4 |
| Texas Instruments Incorporated | 12.2 | -0.18 | 4 | -0.01 | 5 | 0.58 | 8 | 5.1 | 6 |
| Maxim Integrated Products Inc. | 2.4 | -14.09 | 10 | 5.44 | 1 | 0.30 | 10 | 6.3 | 7 |
| TriQuint Semiconductor | 0.9 | -0.71 | 8 | -0.75 | 10 | 0.77 | 5 | 6.9 | 8 |
| Fairchild Semiconductor Intl Inc | 1.4 | -0.54 | 7 | -0.36 | 8 | 0.32 | 9 | 7.2 | 9 |
| Freescale Semiconductor Limited | 4.6* | -0.92 | 9 | -0.54 | 9 | 0.67 | 7 | 7.5 | 10 |

Source: Supply Chain Insights LLC, Corporate Annual Reports 2009-2013
*2011 revenue

# Contract Manufacturing

The last industry in this report is contract manufacturing. This industry is less than ten years old and is still maturing. These companies serve upstream brand owners. The industry is plagued by low margins, and a lack of performance reliability with large resiliency factors. The contract manufacturers is a critical part of the industrial value network; but based on the performance factors, we see it as a risk factor for the value chain.

In this industry, operating margins are slim and sometimes negative. The patterns in Figure 9 are chaotic with only one company having a positive balance score for the period of 2006-2013. In fact, five of the six companies studied moved backwards on performance at the intersection of ROIC and revenue growth during the period of 2006-2013. The health of the overall industry should be a stay-awake issue for brand owners contracting services.

**Figure 9. Contract Manufacturing Orbit Chart (2009-2013)**



Source: Supply Chain Insights LLC, Corporate Annual Reports 2009-2013

The performance of the contract manufacturing industry on the Supply Chain Index, is outlined in Tables 15 and 16.

**Table 15. The Supply Chain Index: Contract Manufacturing (2006-2013)**

| Company | 2013 Revenue (billions USD) | Balance | Balance Ranking | Strength | Strength Ranking | Resiliency | Resiliency Ranking | Index (0.3B + 0.3S + 0.3R) | Ranking |
|---|---|---|---|---|---|---|---|---|---|
| Benchmark Electronics | 2.5 | -0.15 | 4 | 0.00 | 2 | 0.86 | 2 | 2.4 | 1 |
| Flextronics International Ltd. | 23.6 | 0.95 | 1 | -0.02 | 3 | 1.23 | 4 | 2.4 | 1 |
| Jabil Circuit, Inc. | 18.3 | -0.03 | 2 | 0.06 | 1 | 1.23 | 5 | 2.4 | 1 |
| Kimball International Inc | 1.2 | -0.05 | 3 | -0.04 | 5 | 0.68 | 1 | 2.7 | 4 |
| Hon Hai Precision Industry Co. | 133.1 | -0.24 | 5 | -0.04 | 4 | 1.18 | 3 | 3.6 | 5 |
| Celestica Inc. | 5.8 | -1.02 | 6 | -0.55 | 6 | 1.28 | 6 | 5.4 | 6 |

Source: Supply Chain Insights LLC, Corporate Annual Reports 2006-2013

In the two time periods, **Benchmark Electronics** performed relatively well across all three factors even with a small revenue value.

**Table 16. The Supply Chain Index: Contract Manufacturing (2009-2013)**

| Company | 2013 Revenue (billions USD) | Balance | Balance Ranking | Strength | Strength Ranking | Resiliency | Resiliency Ranking | Index (0.3B + 0.3S + 0.3R) | Ranking |
|---|---|---|---|---|---|---|---|---|---|
| Benchmark Electronics | 2.5 | -0.09 | 2 | 0.20 | 1 | 0.73 | 1 | 1.2 | 1 |
| Celestica Inc. | 5.8 | 0.03 | 1 | 0.07 | 2 | 0.89 | 3 | 1.8 | 2 |
| Kimball International Inc | 1.2 | -0.35 | 3 | -0.04 | 4 | 0.74 | 2 | 2.7 | 3 |
| Hon Hai Precision Industry Co. | 133.1 | -0.44 | 4 | -0.02 | 3 | 1.41 | 5 | 3.6 | 4 |
| Flextronics International Ltd. | 23.6 | -0.91 | 6 | -0.31 | 5 | 1.00 | 4 | 4.5 | 5 |
| Jabil Circuit, Inc. | 18.3 | -0.77 | 5 | -0.37 | 6 | 1.44 | 6 | 5.1 | 6 |

Source: Supply Chain Insights LLC, Corporate Annual Reports 2009-2013

# Conclusion

The Supply Chain Index is a measurement of supply chain improvement. It is a gauge that enables supply chain leaders to see if they are making improvement on critical supply chain financial ratios. However, as seen in this report, usually a supply chain leader that's performing at a high level on the critical metrics will typically score in the upper half of the Index. To judge supply chain excellence, performance and improvement need to be accessed together.

# Appendix

Supply chain leaders want to know if they are making improvement against their peer group. The financial patterns are gnarly and it is often difficult to assess progress from a simple two-dimensional plot. To make this easier, we developed the Supply Chain Index.

In building the Index, we used financial ratios versus absolute numbers. The use of ratios allowed us to compare companies regardless of size, and to also compare companies across currencies.

The math behind the Index is defined below. This methodology was built in cooperation with a research team from the School of Computing, Informatics and Decision Systems Engineering at Arizona State University (ASU) in the spring of 2014.

# Balance

To develop the balance factor used in the Index, we evaluated a scatter plot of revenue growth and Return on Invested Capital (ROIC) for a specific company. The balance factor ($B$) is the proportional difference of points on an orbit chart for the period of 2006-2013 at the intersection of revenue growth and Return on Invested Capital. To calculate the balance factor, let $REV_i$ denote the revenue growth of the $i^{th}$ time period, $ROIC_i$ denote the return on invested capital of the $i^{th}$ time period and $n$ denote the total number of periods under consideration. Thus the balance factor is defined as:

$$B = \frac{1}{n-1}\left(\frac{REV_n - REV_1}{REV_1} + \frac{ROIC_n - ROIC_1}{ROIC_1}\right).$$

# Strength

Strength factor is a similar calculation to the balance factor, but with a focus on the intersection of operating margin and inventory turns. For this analysis, we used a scatter plot of operating margin and inventory turns on an orbit chart for a specific company. Let $OM_i$ denote the operating margin of the $i^{th}$ time period (e.g. $i^{th}$ year), $IT_i$ denote the inventory turns of the $i^{th}$ time period and $n$ denote the total number of periods under consideration.

The strength measure ($S$) is defined as:

$$S = \frac{1}{n-1}\left( \frac{OM_n - OM_1}{OM_1} + \frac{IT_n - IT_1}{IT_1} \right)$$

The denominator reflects that there are *n-1* differences between *n* time periods. Figure A depicts the intersection of operating margin and inventory turns for an example company. The difference in operating margin and inventory turns between the first and last time period is shown.

**Figure A. Inventory Turns and Operating Margin Intersection for an Example Company**
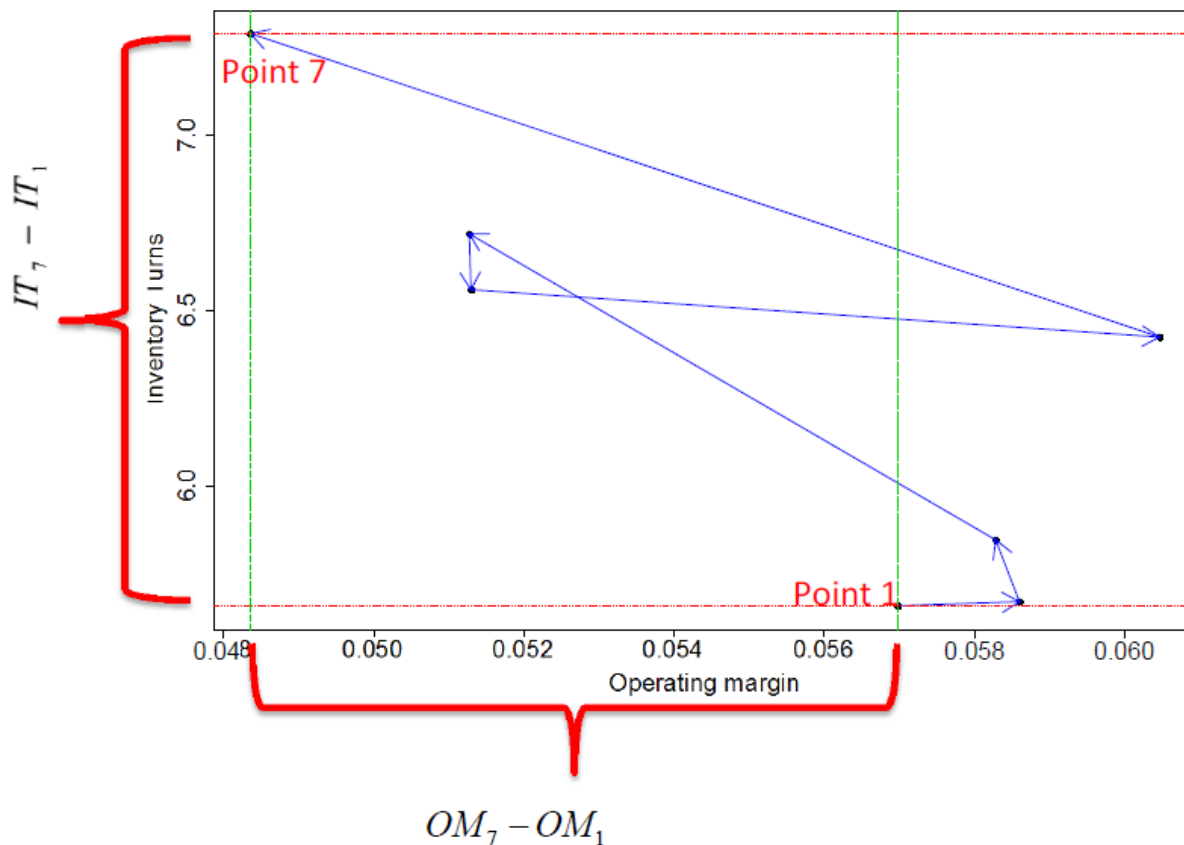


# Resiliency

The resiliency factor is a measurement of the tightness of the pattern at the intersection of operating margin and inventory turns for a given company. For companies that did well, and had a tight patter, the value will be lower than companies that lacked reliablity for the period. To develop the value, we considered a scatter plot of operating margin and inventory turns for a specific company.

Let $d_{ij}$ denote the Euclidean distance between a pair of points $i$ and $j$ and let $m$ denote the total number of pairs. The resiliency measure ($R$) is defined as the mean distance of all possible pairs of points at the intesection. That is,

$$R = \frac{1}{m}\sum_i \sum_{j>i} d_{ij}$$

Figure B shows an example of the opertaing margin and inventory turns intesection for an example company.

**Figure B. Calculation of Resiliency at the Intersection of Inventory Turns and Operating Margin for a Given Company**
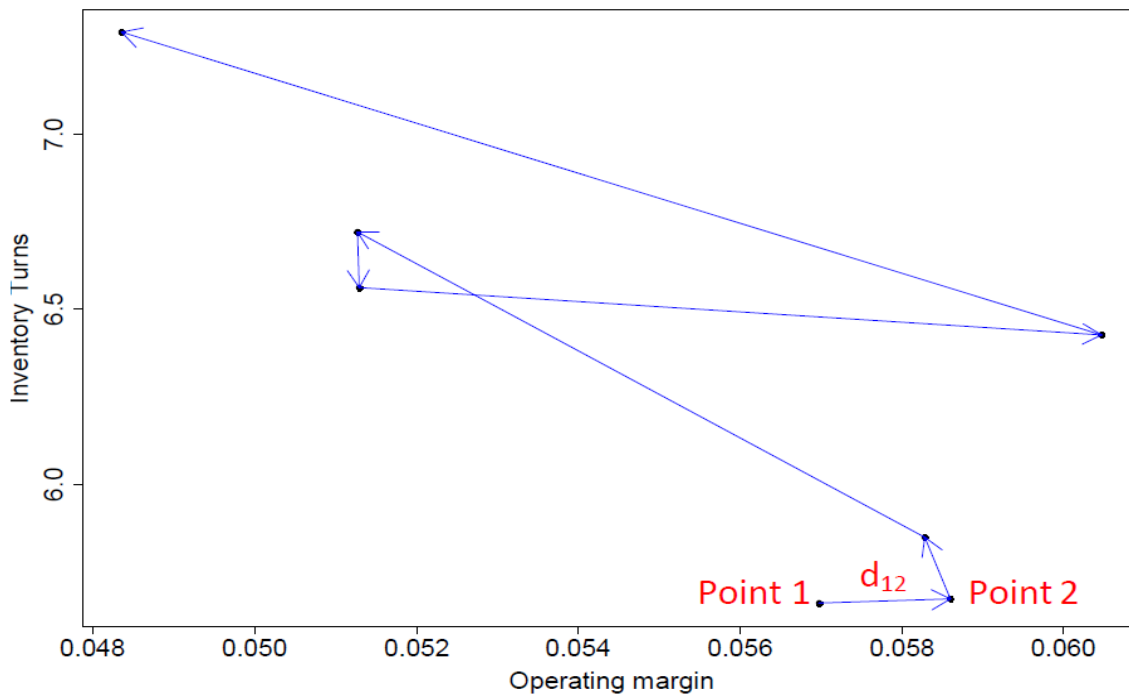


Table A shows the distances between every possible pair of points at the intersection. The resiliency is calculated from the mean of the distance values and is equal to 0.7335.

**Table A. Calculation of Euclidean Distances for an Example Company**

| | | | | | |
|---|---|---|---|---|---|
| 0.013255 | | | | | |
| 0.18865 | 0.17549 | | | | |
| 1.061544 | 1.0484 | 0.872912 | | | |
| 0.901407 | 0.888264 | 0.712778 | 0.16014 | | |
| 0.766595 | 0.753434 | 0.577946 | 0.295086 | 0.135114 | |
| 1.630622 | 1.617476 | 1.441988 | 0.569077 | 0.729216 | 0.864097 |

## Alternative Measures Considered for Resiliency

To develop the resiliency factor, we considered a number of alternative approaches. One method considered was Principal Components Analysis (PCA). It is a traditional method used to summarize multidimensional data. We considered measures commonly applied with PCA based on eigenvalues and eigenvectors. (e.g., the condition index, percentage of variance explained by the first principal component). Although these measures were reasonable they did not distinguish between orbit plots that were visually different as well as simpler approaches.

We also considered other measures based on the distances (e.g., sum, maximum, minimum and the coefficient of variation of the distances). The mean distance was finally selected to measure the compactness of a set of points. In fact, a similar measure called cohesion is frequently used in cluster analysis to measure the compactness of a set of points. Rather than taking the sum of distances (as in cohesion), we consider the mean to account for the potentially different number of points for each company.

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# About Supply Chain Insights, LLC

Founded in February, 2012 by Lora Cecere, Supply Chain Insights LLC is a research and advisory firm focused on delivering **independent, actionable, and objective advice for supply chain leaders**. If you need to know which practices and technologies make the biggest difference to corporate performance, turn to us. We help you understand supply chain trends, evolving technologies and which metrics matter.

# About Lora Cecere

Lora Cecere (twitter ID @lcecere) is the Founder of Supply Chain Insights LLC and the author of popular enterprise software blog Supply Chain Shaman currently read by 5,000 supply chain professionals. She also writes as a Linkedin Influencer and is a a contributor for Forbes. Her book, *Bricks Matter*, (co-authored with Charlie Chase) published on December 26th, 2012. She is currently working on additional books, *The Shaman's Journal* and *Metrics That Matter*, to publish in 2014.

With over ten years as a research analyst with **AMR Research, Altimeter Group, and Gartner Group** and now as a Founder of Supply Chain Insights, Lora understands supply chain. She has worked with over 600 companies on their supply chain strategy and speaks at over 50 conferences a year on the evolution of supply chain processes and technologies. Her research is designed for the early adopter seeking first mover advantage.

# About Abby Mayer

Abby Mayer (twitter ID @indexgirl), Research Associate is one of the original members of the Supply Chain Insights LLC team. She is also the author of the newly-founded blog, Supply Chain Index. Her supply chain interests include connecting financial performance and supply chain excellence, as well as talent management issues and emerging markets. Abby has a B.A. in International Politics and Economics from Middlebury College and a M.S. in International Supply Chain Management from Plymouth University in the United Kingdom. She has also completed a thru-hike of Vermont's 280 mile Long Trail, the oldest long distance hiking trail in the United States. As part of the planning and food prep process, she became interested in supply chain management when she was asked to predict hunger pangs for the entire three-week trip before departure. If that isn't advanced demand planning, what is?!?!