The Supply Chain Index

Improving Strength, Balance and Resiliency

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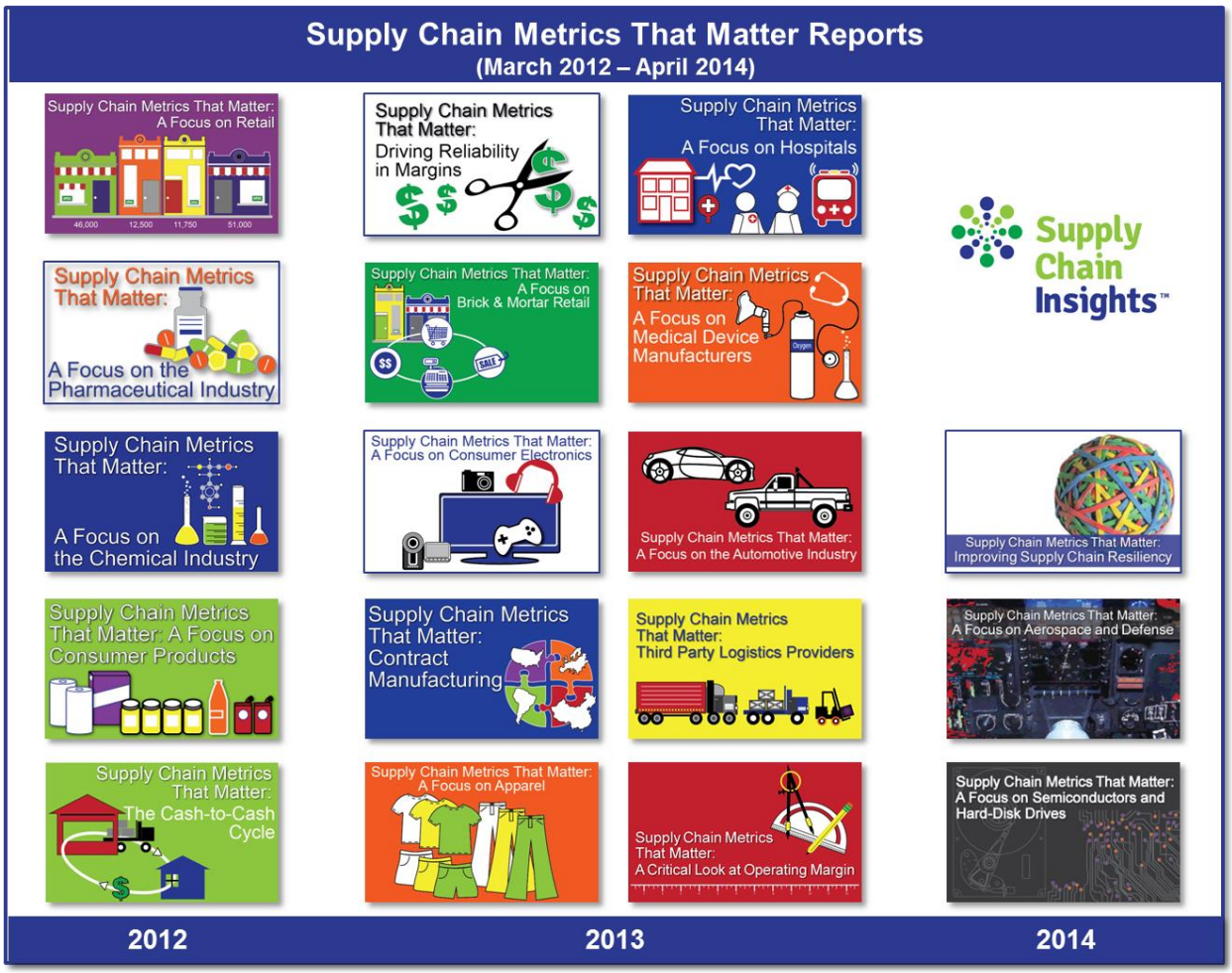
Research

Supply Chain Metrics That Matter is a series of monthly reports published by Supply Chain Insights LLC. These reports are a deep focus on a specific industry. This was preparatory work to understand the patterns of supply chain ratios for supply chain leaders.

As shown in Figure 1, the Supply Chain Insights team analyzed 15 different industries with deep dives on their progress on the cash-to-cash cycle.

Figure 1. Supply Chain Metrics That Matter Reports Published in 2012-2014



Here we take a next step, and launch the Supply Chain Index. The Supply Chain Index is a mathematical formula that a supply chain leader can use to measure their relative performance to an industry peer group. It was built in cooperation with the Operations Research team at Arizona State University (ASU).

This methodology was designed to measure the balance, strength and resiliency of a company's supply chain from an objective financial perspective. It is a measurement of supply chain improvement during the period of 2006-2012. In April 2014, we published an in-depth look at the resiliency metric: Supply Chain Metrics That Matter: Improving Supply Chain Resiliency. In this report, adding strength and balance, we examine the calculation of these three values in tandem.

The supply chain is a complex system with increasing complexity. Here we analyze how companies made trade-offs over a period of several years in balancing growth, profitability, cycles, and complexity. Many of the trade-offs were unconscious. As complexity rose, it became more difficult for companies to manage the intersection of growth and inventory turns. For leaders, as you will see in this report, the trade-offs were conscious.

Within the world of Supply Chain Management (SCM), each industry is unique. We believe that it is dangerous to list all industries in a spreadsheet and declare a supply chain leader. Instead, we believe that change needs to be measured over a number of years with a focus on an industry peer group. Here we define, and demonstrate, how the Supply Chain Index can be used to measure supply chain performance. To help the reader, we share insights on three industries—chemical, consumer packaged goods and pharmaceutical—using the methodology.

Over the course of the summer, we will be publishing additional reports in this series. This next set of reports will focus on a value chain.

- In June we will publish a report on the consumer value chain including retail, consumer electronics, consumer packaged goods, food & beverage, and chemical industries. We will analyze how companies progressed within the value chain.
- In July we will publish a report on the healthcare value chain that will include hospitals, pharmaceutical and medical device companies.
- As a follow-up, in August we will publish on industrial value chains including the automotive, industrial equipment, semiconductor, and high-tech industries.
- To wrap up the series, in September—at the end of this two-year research project—we will publish a report on the supply chains we most admire.

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.

These reports are intended for you to read, share, and use to improve your supply chain decisions. Please share this data freely within your company and across your industry. All we ask for in return is proper attribution when you use the materials in this report. We publish under the Creative Commons License Attribution-Noncommercial-Share Alike 3.0 United States and you will find our citation policy here.

Research Methodology and Overview

The basis of this report is publicly available information from corporate annual reports from the period of 2006-2012.To complete this analysis, and understand the patterns, we partnered with the operations research team at Arizona State University in January-May 2014 to develop a methodology to analyze trends. Details on this methodology are outlined in the appendix.

For this analysis, we use supply chain financial ratios as opposed to absolute numbers. These ratios allow us to compare large companies to small entities, and also compare the progress of companies operating in different countries using differing currencies. It also allows us to track progress over time. In Table 1, we share the ratios that we have been mining to understand the trends.

The Supply Chain Index methodology assumes that supply chain progress takes time. In our research we find that it takes at least three years to drive change, and that the best improvements take at least five years. It is for this reason that we analyze the progress of companies for the period of 2006-2012.

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

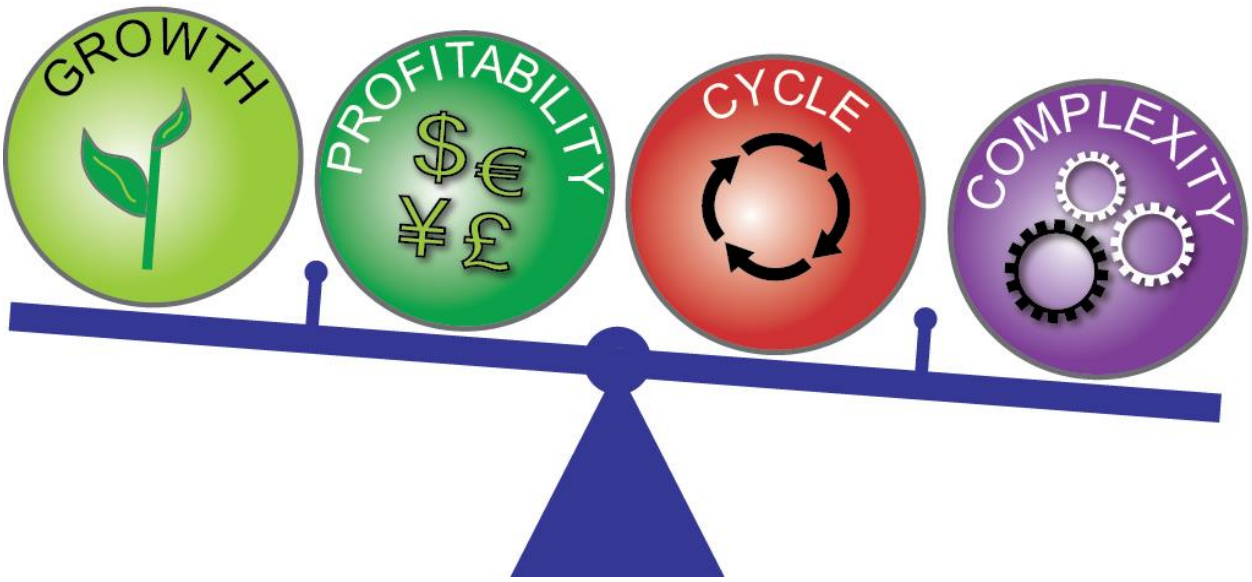
The methodology is also based on the belief that the supply chain is a complex system with increasing complexity, and that it is the role of the supply chain leader to build and manage supply chains that can drive year-over-year performance improvements that are balanced, strong and resilient.

Executive Overview

Supply chain leadership is a continuous balancing act. Companies are always faced with the task of balancing competing priorities. The best do it consciously and with purpose. The worst do it unconsciously, and are held hostage by market fluctuations.

Companies struggle to understand the supply chain as a complex system with interrelated metrics. In the process of driving operating strategy, companies balance the priorities of growth, profitability, cycle, and complexity. To design the Supply Chain Index, we studied industry performance of several financial metrics for each category of the Effective Frontier as shown in Figure 2.

Figure 2. The Effective Frontier



We find that at the beginning of the last decade, companies were able to make substantial progress. This was the dawn of business-to-business computing and the automation of supply chain processes. Recently, the story is different. Today, supply chain progress is stalled. Nine of out ten companies are stuck: unable to make progress at the intersection of inventory turns and operating margin.

To develop the Supply Chain Index, we interviewed supply chain leaders on their results, and asked over 60 leaders to tell us the metrics that they thought were the most important. We started with a list of 52 metrics, as shown in Table 1, and through these discussions narrowed the list down to four key supply chain ratios: revenue growth,

operating margin, inventory turns, and Return on Invested Capital (ROIC). We use these four supply chain ratios to calculate company progress on *balance* (the ability to balance a metrics portfolio), *strength* (year-over-year improvement), and *resiliency* (the reliability of the patterns of results.)

The Supply Chain Index is a new methodology, rigorously based in operations research, used to connect financial performance with supply chain excellence. It is an objective benchmarking tool for companies to measure supply chain performance. It is not a popularity contest.

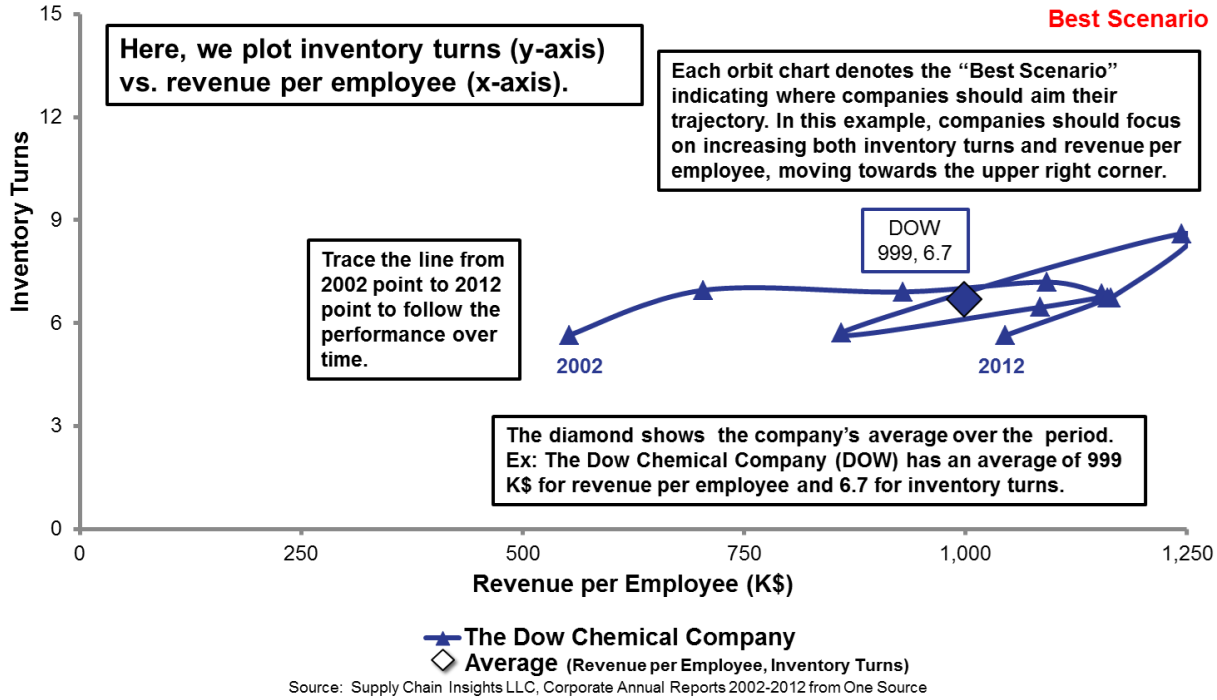
The final Index draws upon four components: strength, balance, resiliency and peer ranking. Over the course of the summer, we will be collecting peer feedback on industry analysis. Unlike other benchmarking methodologies, the peer component is a minor 10% of the calculation. (In some other assessments, the peer ranking/analyst input can be as much as 50% of the total measurement.) Each of the three financial-based metrics—balance, strength and resiliency—composes 30% of the final calculation. In this report, we take a look at the math behind the calculation of these factors. To give the reader a thorough understanding of the methodology, we then apply the it to companies operating in the chemical, consumer packaged goods, and pharmaceutical industries. This is a microcosm of the analysis that will be shared in the deeper value chain reports coming this summer.

Supply chain is moving out of the back office, but leaders struggle to speak the language of the executive team. Likewise, the finance team struggles to understand the principle of supply chain excellence. Supply chain ratios are a shared language. By basing the Supply Chain Index on well-defined supply chain financial ratios, we hope to deliver a new measuring stick to be used by corporate leaders to improve results. The Index is our way to push that progress forward.

Evolution of the Index

Our efforts at Supply Chain Insights to connect supply chain and financial performance date back to February of 2012. This research project has been more difficult than we imagined. Our work began as we mined data from online annual reports, by industry, to construct spreadsheets of common financial metrics. They quickly became cumbersome and complex. We experimented with a multitude of ways to turn a spreadsheet into a story. After much fine-tuning and experimentation, we settled on the use of orbit charts. Figure 3 is an example of an orbit chart. It plots two supply chain financial ratios, and enables the visualization of a pattern. The orbit chart in Figure 3 illustrates the performance of Dow Chemical Company on two metrics: inventory turns and revenue per employee for the time period 2002-2012. The metrics are displayed on the Y and X axes respectively and the "Best Scenario" is outlined in red in the upper right corner. The average rankings for the period are in the box below the Dow Chemical stock symbol.

Figure 3. An Example of an Orbit Chart



Source: Supply Chain Insights LLC, Corporate Annual Reports 2002-2012 from One Source

During the last two years, we built these charts for supply chain leaders for free. This allowed us to learn with them. As we plotted the metrics that they thought were important against the peer groups that they valued, we got to hear their stories and interpretation of the data.

As we shared our findings, and educated supply chain leaders about finance ratios, they helped us to better understand the data. “What caused this downswing in inventory in 2007?” we would ask. The company would then share that it was a six month laser-focus brought on by a new manager. When we asked, “What caused these cash-to-cash cycle gyrations in the period of 2002-2004?” They told us the story of a difficult merger. We found that this was a new way of looking at data; and while it took adjustment and training, it provided a new and fresh perspective at most organizations. Why? Supply chain progress happens over time; not in months or quarters, but in years. And, the interrelationships between the metrics are real. The data cannot properly be assessed in a spreadsheet.

In August of 2012, we began work on the first of many Supply Chain Metrics That Matter reports. These reports focused on a single industry ranging from automotive to consumer packaged goods and everything in between. The reports are individually listed in Figure 1. This gave us a chance to better understand the differences between the industries and cemented our belief that industries have to be evaluated individually. The patterns are just too different. It is ludicrous to compare a chemical company to an automotive one. Likewise, the supply chain of a hard disk drive manufacturer is inherently different from a supply chain focused on food products. We strongly believe that an apple-to-oranges comparison benefits no one.

In January of 2013, we felt comfortable with the data, orbit charts, and reports, and took the next step: building the Supply Chain Index. We recruited assistance from mathematical and industrial engineering students at the University of Waterloo in Ontario, and North Carolina State University, to assist in the research effort. Our work moved from subjective pattern analysis to mathematical modeling. We chose market capitalization as our dependent y-variable and included several supply chain oriented metrics (e.g., Days of Inventory (DOI), Working Capital, Return On Net Assets, etc.) as

potential independent variables. We worked through countless hiccups and came away with equations connecting market capitalization and supply chain performance. However, we found that while the data was interrelated, it was not a series of linear relationships. We then went back to the drawing board.

In January of 2014, we resumed work on the Supply Chain Index. A year wiser, we brought in assistance from Arizona State University's School of Computing, Informatics and Decision Systems Engineering. After two years of work, we believe that we now have a methodology that enables the comparison of supply chain progress in the delivery of the Supply Chain Index. To help the reader understand the Supply Chain Index, we first define the separate pieces, i.e. balance, strength and resiliency. We then define the Index as a whole and apply the methodology to chemical, consumer packaged goods, and pharmaceutical companies.

Balance

Balance in the supply chain is a constant struggle. Reduced inventory availability wreaks havoc on customer service levels. Excess inventory leads to high carrying costs and obsolescence of product. Excessively long Days of Payables lead to weakened supplier health. The examples are endless. Balance is critical.

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

shareholder equity. The formula used for ROIC is:

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

It is a measurement of the company's use of capital. The goal is to drive higher returns than the market rate of the cost of capital.

The balance measure in the Supply Chain Index is a mathematical calculation of the vector trajectory of the pattern between growth and ROIC for the period of 2006 to 2012.To understand this measurement, imagine a four quadrant grid from high school algebra with growth and ROIC on the two axes. In our calculation, the overall trajectory of this vector from Year 0 (2006) to Year 6 (2012) is simplified into a single value which represents the company's ability to balance growth and ROIC. Companies that were able to drive improvement in both metrics score the best, while companies that deteriorated in both metrics do the worst.

The balance factor comprises 30% of the total Supply Chain Index calculation. Sustained improvement on both year-over-year growth and ROIC indicates a balanced supply chain and is reflected in a high balance score.

Strength

A successful supply chain is a strong supply chain. Supply chain leaders strive to deliver 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 factor in the Supply Chain Index.

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 to 2012. Like the balance factor, imagine a four quadrant grid from high school algebra. Inventory turn and operating margin performance is graphed on an annual basis from a point originating at the origin representing performance on the two metrics at Year 0 (2006). The overall trajectory of this vector from Year 0 (2006) to Year 6 (2012) 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 factor comprises 30% 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.

Resiliency

Resiliency is an adjective easily tossed around as one of the key qualities of a successful supply chain in today's volatile world. 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.

As we plotted chart after chart, we could see that some supply chains had very tight patterns at the intersection of operating margins and inventory turns, and that other

companies had wild swings. We wanted to find a way to measure the variation. So, 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.

These results were published 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, both critical for any supply chain, are components of both the strength and resiliency metrics in our Supply Chain Index model. 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 a seven year period (2006-2012). As shown in Table 2, the resiliency of the supply chain varies considerably by industry.

Table 2. Supply Chain Resiliency by Industry

Mean Distance Analysis of Orbit Chart Performance (Inventory Turns & Operating Margin)					
Industry	**Median**	**Mean**	**Maximum**	**Minimum**	**Standard Deviation**
Medical Device Manufacturing (n=108)	0.7	**1.9**	51.9	0.2	5.5
Consumer Packaged Goods (n=133)	0.8	**2.8**	118.6	0.2	11.9
Cereal Food (n=209)	2.1	**5.3**	141.1	0.1	13.2
Pharmaceutical (n=489)	1.0	**9.7**	1556.1	0.2	75.9
Chemical (n=181)	1.2	**9.8**	644.2	0.2	59.3
Consumer Electronics (n=120)	1.6	**11.8**	697.8	0.1	68.8
Contract Manufacturing (n=1,087)	1.5	**15.1**	10253.2	0.1	313.5
Communications Equipment (n=431)	2.0	**35.7**	9915.0	0.2	484.4

Source: Supply Chain Insights LLC, Corporate Annual Reports 2000-2013 as available
Based on cooperative work between Arizona State University & Supply Chain Insights LLC
Industry Average comprised of ALL public companies (cereal food: NAICS 3112% where any % is any number from 0-9), (chemical: NAICS 325188 & 325998), (communications equipment: NAICS 3342% where % is any number from 0-9), (consumer electronics: NAICS 33431% where % is any number from 0-9), (consumer packaged goods: NAICS 3256% where % is any number from 0-9), (contract manufacturing: NAICS 33441%), (medical device manufacturing: NAICS 339112), (pharmaceutical: NAICS 325412) reporting in One Source

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 Definition of the Index: Putting It All Together

Each of the factors—balance, strength and resiliency—as defined above comprises 30% of the total score. The final 10% is a peer vote contributed by members of the Shaman's Circle. The Shaman's Circle is a group of 350 supply chain leaders that form an informal networking group within the Supply Chain Insights Community. Over the course of the summer, each of the leaders in the Shaman's Circle will be asked to rank the results by value chain. In September, we will publish the results for all industries.

The balance, resiliency, and strength values will be populated and stack-ranked prior to the vote by the Shaman's Circle. Our intention is to create a voting environment that is open to individual perspective, but also balanced with a full scorecard of objective measures to inform the voting process. The values of a table like that in Table 3 will be created for each industry peer group for the period of 2006-2012.

Table 3. Supply Chain Index Ranking System

Supply Chain Index								
NAICS Code	Balance	Balance Ranking	Strength	Strength Ranking	Resiliency	Resiliency Ranking	Peer Ranking	Overall Ranking

Source: Supply Chain Insights LLC

In the analysis, each industry segment, as defined by NAICS classification codes, will be considered on an individual basis. As a result, **Colgate-Palmolive Company** 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.

In the analysis, each company is judged by their own potential to make progress. While the average values of a company's performance may be higher, in the Supply Chain Index we are evaluating companies on their ability to drive year-over-year improvement and reliable progress on the metrics that we believe matter. It is a measurement of improvement.

Application of the Supply Chain Index Methodology

To help the reader better understand the Supply Chain Index, we now apply the methodology to three separate industry peer groups: chemical, consumer packaged goods, and pharmaceutical companies all within the NAICS Code heading 325. This is not designed to be a comprehensive ranking, but rather a discussion of the Index methodology with several of the largest and most well-known companies in those three respective industries.

To accomplish this goal, we share the rankings for ten companies within each of these sub-industries. Each analysis is accompanied by two orbit charts to help the reader understand the methodology. The first is a comparison of growth and Return on Invested Capital while the second is a comparison of Inventory Turns and Operating Margin. The Inventory Turns and Operating Margin comparison is the basis of two metrics: resiliency and strength. The third metric, balance, is based upon the comparison of Revenue Growth and ROIC.

Chemical

Sitting four to five layers back in the supply chain, the chemical industry struggled to maintain momentum through the last economic downturn. By definition, a chemical industry is dependent on assets, and the use of assets became a conundrum as costs and waste were pushed backwards in the value chain during that time.

In Table 5, we compare the results of ten industry leaders using this methodology and then contrast a strong performer with a weaker performer on a series of orbit charts to

demonstrate the difference.

Of the three sub-industries profiled here, the chemical industry struggles the most to gain balance. The results for balance are not as strong as those in consumer packaged goods or even the pharmaceutical industry.

Table 4. Chemical Peer Group Performance (2012)

Chemical Peer Group Performance								
Company	2012 Revenue (billions USD)	Revenue Growth (2006-2012)	2012 Return on Invested Capital	Return on Invested Capital Change (2006-2012)	2012 Operating Margin	Operating Margin Change (2006-2012)	2012 Inventory Turns	Inventory Turns Change (2006-2012)
Akzo Nobel N.V.	19.8	57%	-7%	-219%	-0.08	-194%	6.0	106%
BASF SE	101.2	53%	14%	75%	0.11	-11%	5.7	6%
Bayer AG	51.1	41%	7%	91%	0.10	4%	2.7	12%
E I Du Pont De Nemours And Co	35.3	22%	6%	-36%	0.09	-23%	3.5	-17%
FMC Corp	3.7	60%	15%	186%	0.18	94%	3.7	-50%
Henkel AG & Co KGaA	21.2	33%	11%	55%	0.13	31%	5.7	15%
Monsanto Company	13.5	91%	11%	67%	0.23	48%	2.3	6%
Syngenta AG	14.2	77%	10%	84%	0.16	57%	1.5	-9%
The Dow Chemical Company	56.8	16%	3%	-69%	0.04	-59%	5.6	-18%
W.R. Grace & Co.	3.2	12%	1%	18%	0.02	37%	7.1	4%

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

Table 4 illustrates the recent financial performance for the ten companies in the peer group on several critical metrics including Revenue, Revenue Growth, ROIC, Inventory Turns, and Operating Margin. We have included revenue although it is not a component of any Index calculation because we believe the size of the company can have a significant impact on the company's ability to improve supply chain performance. It is more difficult for a large company to score well on the index. Progress happens slower over time.

The companies that have performed the best in this peer group are listed in green, the average companies are listed in white, and the companies that have underperformed in the peer group are highlighted in yellow.

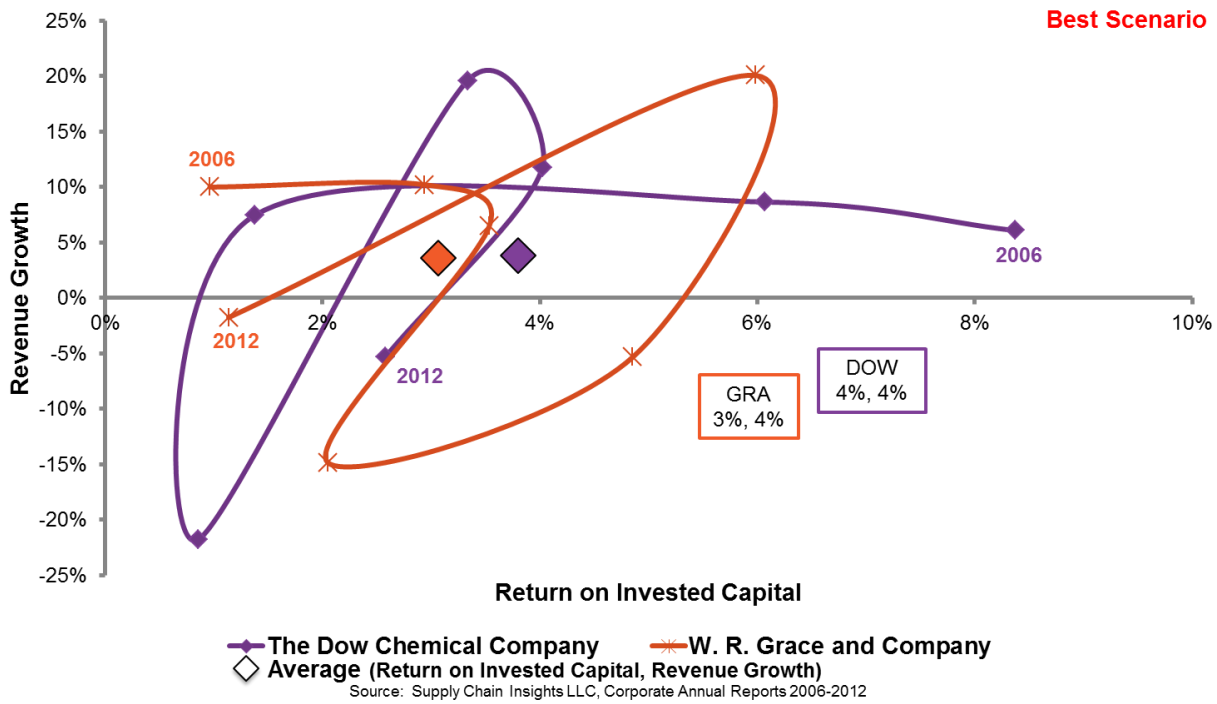
Table 5. Balance, Strength and Resiliency Rankings for Chemical Companies

Supply Chain Index (Chemical)							
Company	Balance	Balance Ranking	Strength	Strength Ranking	Resiliency	Resiliency Ranking	Overall Ranking
Monsanto Company	0.11	2	0.08	1	0.27	2	**1.5**
Bayer AG	-0.01	4	0.02	6	0.28	3	**3.9**
Henkel AG & Co KGaA	-0.13	6	0.08	2	0.46	5	**3.9**
Syngenta AG	-1.43	10	0.07	3	0.14	1	**4.2**
FMC Corp	0.29	1	0.06	4	1.47	10	**4.5**
E I Du Pont De Nemours And Co	0.02	3	-0.06	8	0.41	4	**4.5**
BASF SE	-0.04	5	-0.01	7	0.77	6	**5.4**
W.R. Grace & Co.	-0.14	7	0.06	5	0.99	7	**5.7**
The Dow Chemical Company	-0.37	8	-0.11	9	1.09	8	**7.5**
Akzo Nobel N.V.	-0.44	9	-0.13	10	1.09	9	**8.4**

Source: Supply Chain Insights LLC, Corporate Annual Reports 2006-2012
Based on cooperative work between Arizona State University & Supply Chain Insights LLC

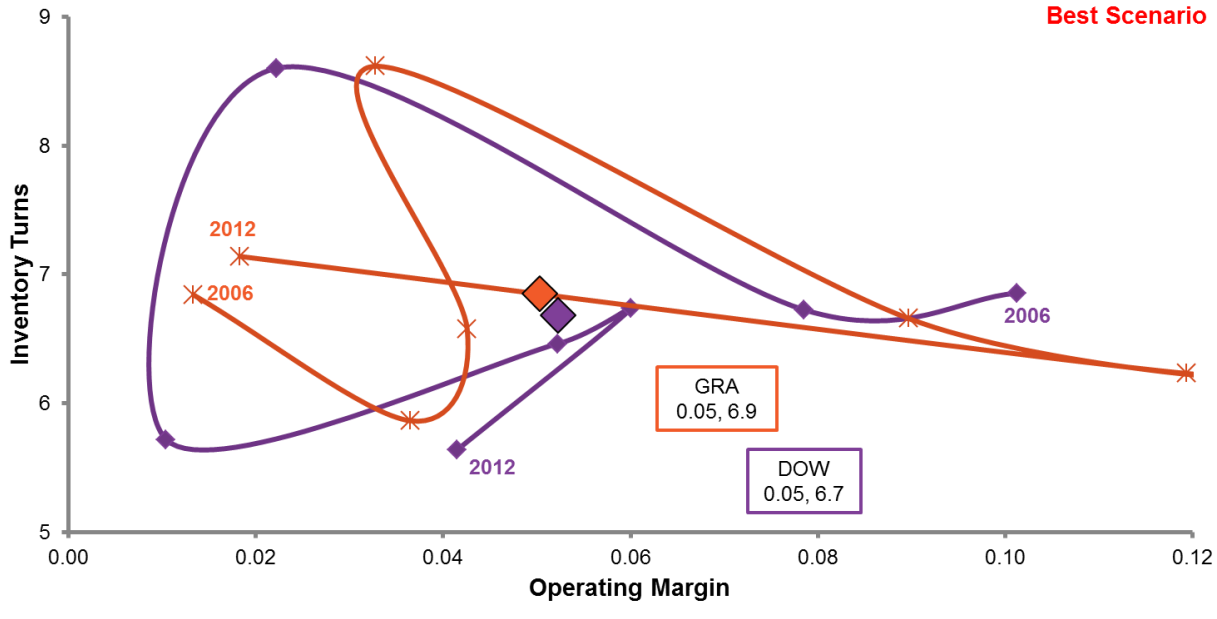
To visualize the differences in Figures 4 and 5, we plot the orbit charts of a company that performed well and a company with average performance. **The Dow Chemical Company** has struggled on the strength metric specifically compared to **W. R. Grace & Co.**

Figure 4. Revenue Growth vs. Return on Invested Capital for The Dow Chemical Company and W. R. Grace and Company (2006-2012)



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

Figure 5. Inventory Turns vs. Operating Margin for The Dow Chemical Company and W. R. Grace and Company (2006-2012)



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

Consumer Packaged Goods

In contrast to the chemical industry, the consumer packaged goods companies are higher performing on the Supply Chain Index. They have posted better values for strength and resiliency than those seen in the chemical supply chains. **Unilever N.V.** has made significant progress in the period on the strength and balance components, but severely underperforms on resiliency. **Colgate-Palmolive Company** has outperformed the industry on operating margin and demonstrates low (good) resiliency ranking. **Beiersdorf** is also a company that has made great progress.

Table 6. Consumer Packaged Goods Peer Group Performance (2012)

Consumer Packaged Goods Peer Group Performance								
Company	2012 Revenue (billions USD)	Revenue Growth (2006-2012)	2012 Return on Invested Capital	Return on Invested Capital Change (2006-2012)	2012 Operating Margin	Operating Margin Change (2006-2012)	2012 Inventory Turns	Inventory Turns Change (2006-2012)
Beiersdorf AG	7.8	21%	12%	0%	0.12	24%	2.9	0%
Colgate-Palmolive Company	17.1	40%	29%	23%	0.23	29%	5.2	-1%
Estee Lauder Companies Inc	9.7	50%	14%	45%	0.14	41%	2.0	-8%
Kao Corporation	12.7	20%	7%	-24%	0.10	3%	5.2	15%
Nature`s Sunshine Prod.	0.4	3%	12%	-536%	0.09	314%	2.2	21%
Reckitt Benckiser Group Plc	15.2	67%	16%	36%	0.26	38%	5.4	-14%
Sensient Technologies Corporation	1.5	33%	8%	13%	0.13	11%	2.2	-2%
The Clorox Co	5.5	18%	12%	2%	0.14	3%	8.2	-10%
The Procter & Gamble Company	83.7	30%	7%	-20%	0.16	-18%	6.3	25%
Unilever N.V.	65.9	33%	15%	35%	0.14	0%	6.7	34%

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

Similar to Table 4, Table 6 illustrates recent performance for the ten companies on several critical financial metrics.

While many think of **The Procter & Gamble Company** (P&G) as the top performing company in consumer packaged goods, its progress in supply chain performance has slipped over the last five years. The company just could not sustain the progress of the period of 2000-2005.

Table 7. Balance, Strength and Resiliency Rankings for Consumer Packaged Goods Companies

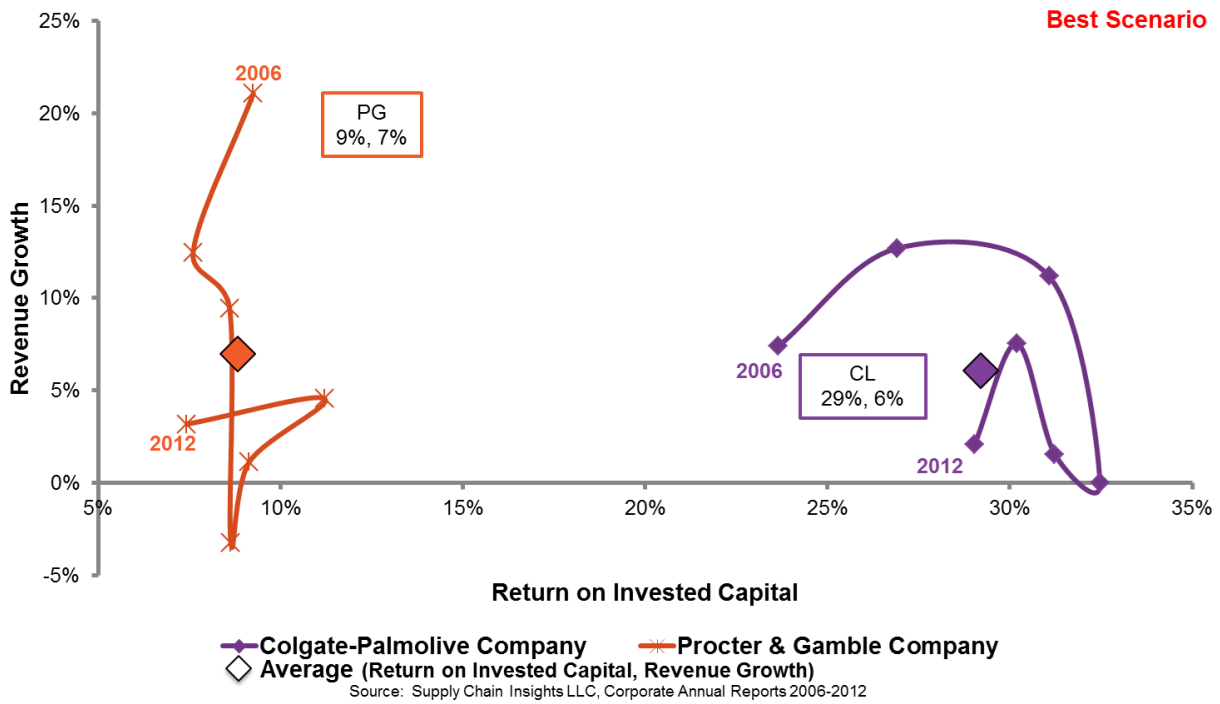
Supply Chain Index (Consumer Packaged Goods)							
Company	Balance	Balance Ranking	Strength	Strength Ranking	Resiliency	Resiliency Ranking	Overall Ranking
Nature`s Sunshine Prod.	0.48	1	0.33	1	-0.92	1	**0.9**
Sensient Technologies Corporation	0.01	3	0.09	2	-0.09	2	**2.1**
Estee Lauder Companies Inc	0.42	2	0.05	4	0.18	3	**2.7**
Colgate-Palmolive Company	-0.07	6	0.04	5	0.19	4	**4.5**
Unilever N.V.	-0.02	4	0.05	3	0.89	10	**5.1**
Beiersdorf AG	-0.08	7	0.03	7	0.20	5	**5.7**
Reckitt Benckiser Group Plc	-0.11	8	0.03	6	0.54	7	**6.3**
The Clorox Co	-0.03	5	-0.01	10	0.65	8	**6.9**
Kao Corporation	-0.29	10	0.02	8	0.44	6	**7.2**
The Procter & Gamble Company	-0.15	9	0.01	9	0.65	9	**8.1**

Source: Supply Chain Insights LLC, Corporate Annual Reports 2006-2012
Based on cooperative work between Arizona State University & Supply Chain Insights LLC

Over the past five years, growth has slowed for P&G. In addition, the leadership of P&G has thrown the supply chain out of balance with a focus on inventory with a detrimental impact in costs as compared to others in the peer group. This has a negative impact on the ratings. One of the issues that P&G, like many others, is fighting is the rise in complexity in the product portfolio over the course of the last period.

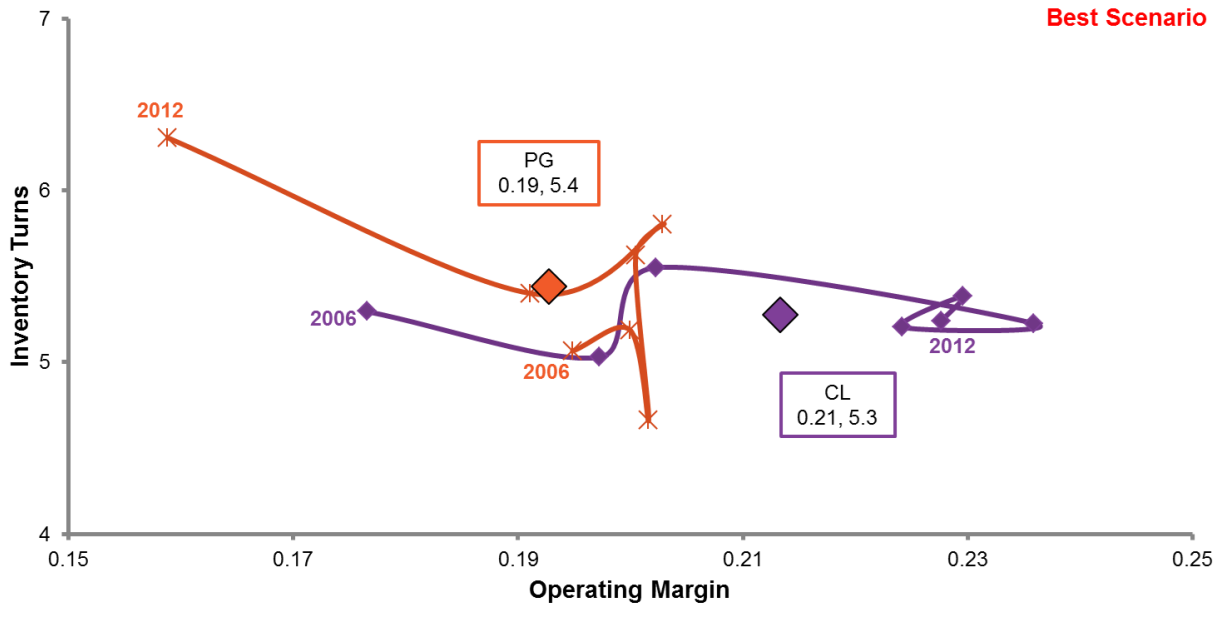
In figures 6 and 7, we contrast the performance of **Colgate-Palmolive Company** to **The Procter & Gamble Company**.

Figure 6. Revenue Growth vs. Return on Invested Capital for Colgate-Palmolive Company and The Procter & Gamble Company (2006-2012)



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

Figure 7. Inventory Turns vs. Operating Margin for Colgate-Palmolive Company and The Procter & Gamble Company (2006-2012)



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

Pharmaceutical

Overall, the pharmaceutical supply chain has performed better at the intersection of Growth and ROIC than Operating Margin and Inventory Turns. As a result, the industry scores better on balance, and worse on strength and resiliency, than the other two industries in this report.

The pharmaceutical industry carries three times the level of inventory than the prior two industries, and they have been slow to adopt more advanced supply chain practices. We often see that companies with high margins have less drive to get serious about supply chain management. Their progress in supply chain management lags consumer products.

Table 8. Pharmaceutical Peer Group Performance (2012)

Pharmaceutical Peer Group Performance								
Company	2012 Revenue (billions USD)	Revenue Growth (2006-2012)	2012 Return on Invested Capital	Return on Invested Capital Change (2006-2012)	2012 Operating Margin	Operating Margin Change (2006-2012)	2012 Inventory Turns	Inventory Turns Change (2006-2012)
Abbott Laboratories	39.9	77%	10%	144%	0.17	86%	4.0	13%
AstraZeneca plc	28.0	6%	15%	-21%	0.29	-6%	2.6	3%
Bristol-Myers Squibb Co	17.6	9%	7%	70%	0.13	3%	2.8	7%
Eli Lilly & Co.	22.6	44%	10%	-13%	0.24	10%	1.8	16%
GlaxoSmithKline plc	41.9	-2%	17%	-14%	0.28	-17%	1.8	-5%
Johnson & Johnson	67.2	26%	9%	-45%	0.20	-25%	2.9	-6%
Novartis AG	57.6	64%	8%	-18%	0.20	-8%	2.8	33%
Novo Nordisk A/S	13.5	107%	44%	221%	0.38	14%	1.4	27%
Pfizer Inc.	59.0	22%	5%	-46%	0.20	-24%	1.6	25%
Shire PLC	4.7	161%	13%	331%	0.20	42%	1.5	-25%

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

Table 8 illustrates the peer group performance of several chemical companies. As noted above, the high Operating Margin present within the industry has enabled pharmaceutical companies to prosper with less mature supply chain practices. However, recent changes in the business environment, and slowing growth, creates a different environment. We see more and more pharmaceutical companies getting more serious about supply chain excellence.

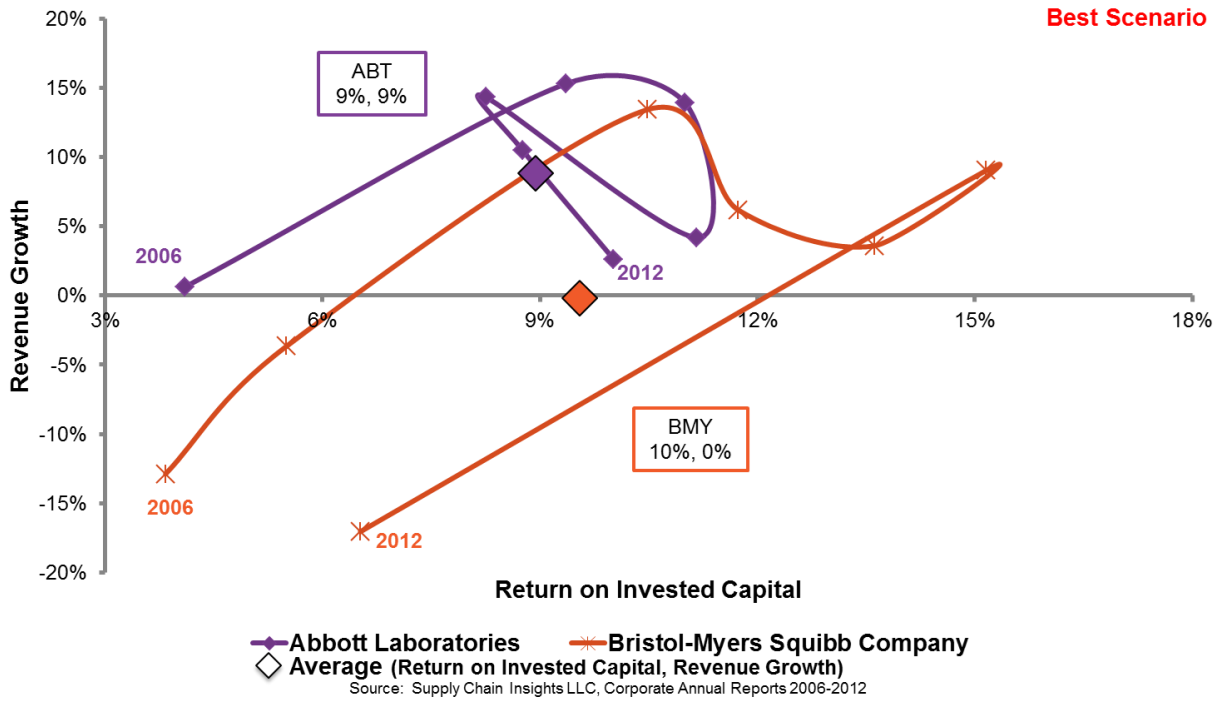
Table 9. Balance, Strength and Resiliency Rankings for Pharmaceutical Companies

Supply Chain Index (Pharmaceutical)							
Company	Balance	Balance Ranking	Strength	Strength Ranking	Resiliency	Resiliency Ranking	Overall Ranking
Novo Nordisk A/S	0.25	3	0.12	2	0.21	2	**2.1**
Abbott Laboratories	0.67	1	0.14	1	0.55	6	**2.4**
Eli Lilly & Co.	-0.30	8	0.04	3	0.32	3	**4.2**
Novartis AG	-0.21	6	0.04	4	0.52	5	**4.5**
Shire PLC	0.44	2	0.02	5	0.58	8	**4.5**
GlaxoSmithKline plc	-0.28	7	-0.03	9	0.19	1	**5.1**
Johnson & Johnson	-0.12	5	-0.04	10	0.34	4	**5.7**
Bristol-Myers Squibb Co	0.15	4	0.01	6	0.97	10	**6**
Pfizer Inc.	-0.88	10	0.00	7	0.58	7	**7.2**
AstraZeneca plc	-0.40	9	0.00	8	0.64	9	**7.8**

Source: Supply Chain Insights LLC, Corporate Annual Reports 2006-2012
Based on cooperative work between Arizona State University & Supply Chain Insights LLC

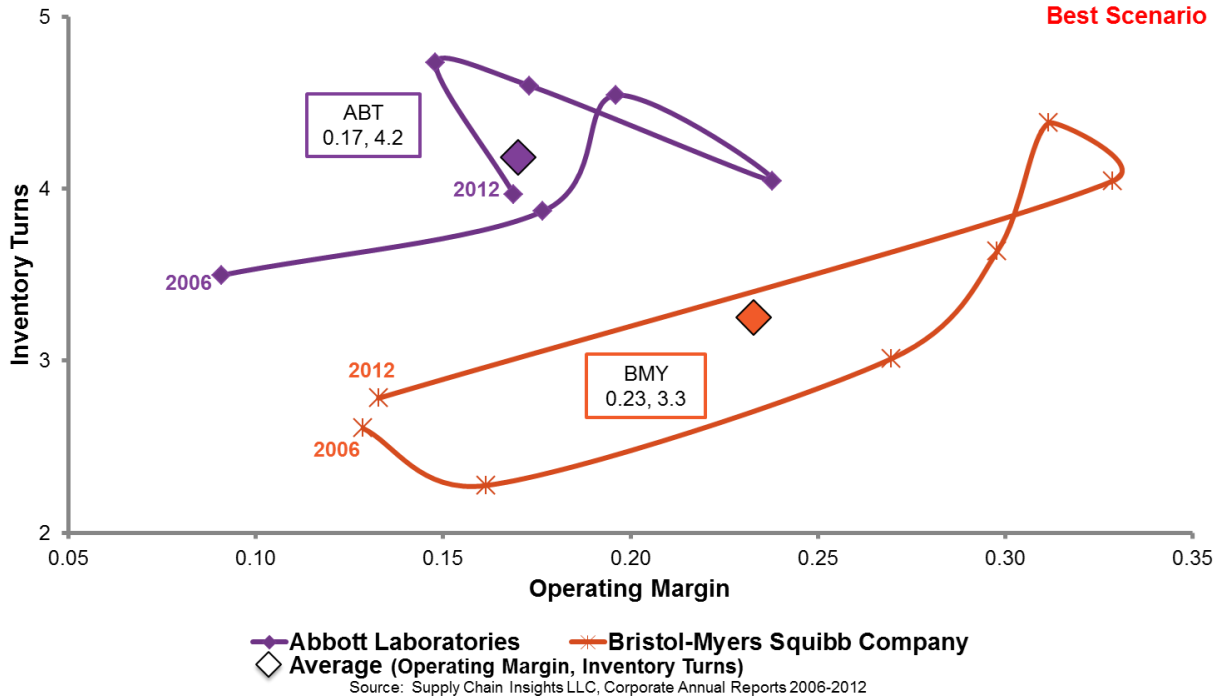
Here we compare the performance of **Abbott Laboratories** and the **Bristol-Myers Squibb Company** across the two orbit charts. **Abbott Laboratories** leads the peer group in both balance and strength rankings.

Figure 8. Revenue Growth vs. Return on Invested Capital for Abbott Laboratories and Bristol-Myers Squibb Company (2006-2012)



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

Figure 9. Inventory Turns vs. Operating Margin for Abbott Laboratories and Bristol-Myers Squibb Company (2006-2012)



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

Conclusion

The supply chain is a complex system with interrelated metrics. We believe that it should be the goal of supply chain leaders to improve the capability of the supply chain to perform at higher levels. Each company has a different potential. This is driven by product categories, labor inputs, market share, commodity markets and geographic reach. While the supply chain leader cannot change many of these factors, they can improve the ability of the organization to drive year-over-year improvements. The goal of this report is to share a methodology that makes this possible.

We want organizations to use the methodology to drive a deeper conversation at the board room table on why supply chain excellence matters. Metrics comparisons are complex and should never be viewed solely in a spreadsheet. Yet, time after time, we are called in to help a company that has been badly advised on inventory or cost target reductions. These metrics cannot be assessed in isolation. Instead, they should be considered as a composite of supply chain ratios that represent the trade-offs of the Supply Chain Effective Frontier. In the process of evaluating industry progress, a company needs to be evaluated within a peer group. Within this evaluation, the questions should be:

- Is my company performance balanced?
- As a supply chain leader, am I driving year-over-year progress on a balanced portfolio?
- Is there strength against my peer group?
- Is this progress reliable with predictable results?

When you do this type of analysis and improve the potential of the supply chain, we want to help you celebrate your supply chain success. Driving supply chain improvement is tough work. We want to give the supply chain leader a measuring stick.

This is the goal of the Supply Chain Index.

Company Profiles

Company	Stock Exchange: Ticker Symbol	2012 Revenue (billions USD)	2012 Global Employees (thousands)	Country Where Based
The Dow Chemical Company	NYSE: DOW	56.8	54.4	USA (Michigan)
W. R. Grace and Company	NYSE: GRA	3.2	6.5	USA (Maryland)

Source: Supply Chain Insights LLC, Corporate Annual Reports 2012

Company	Stock Exchange: Ticker Symbol	2012 Revenue (billions USD)	2012 Global Employees (thousands)	Country Where Based
Colgate-Palmolive Company	NYSE: CL	17.1	37.7	USA (New York)
Procter & Gamble Company	NYSE: PG	83.7	126.0	USA (Ohio)

Source: Supply Chain Insights LLC, Corporate Annual Reports 2012

Company	Stock Exchange: Ticker Symbol	2012 Revenue (billions USD)	2012 Global Employees (thousands)	Country Where Based
Abbott Laboratories	NYSE: ABT	39.9	70.0	USA (Illinois)
Bristol-Myers Squibb Company	NYSE: BMY	17.6	28.0	USA (New York)

Source: Supply Chain Insights LLC, Corporate Annual Reports 2012

Appendix

Detailing the Mathematical Calculations

The specific methodology and development of the three metrics is diagrammed below with the assistance of Dr. George Runger and Bahareh Azarnoush of Arizona State University.

Balance

Consider a scatter plot of revenue growth and return on invested capital for a specific company. The balance measure (*B*) is defined similar to the strength measure but now at the intersection of revenue growth and return on invested capital. 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 balance is defined as

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

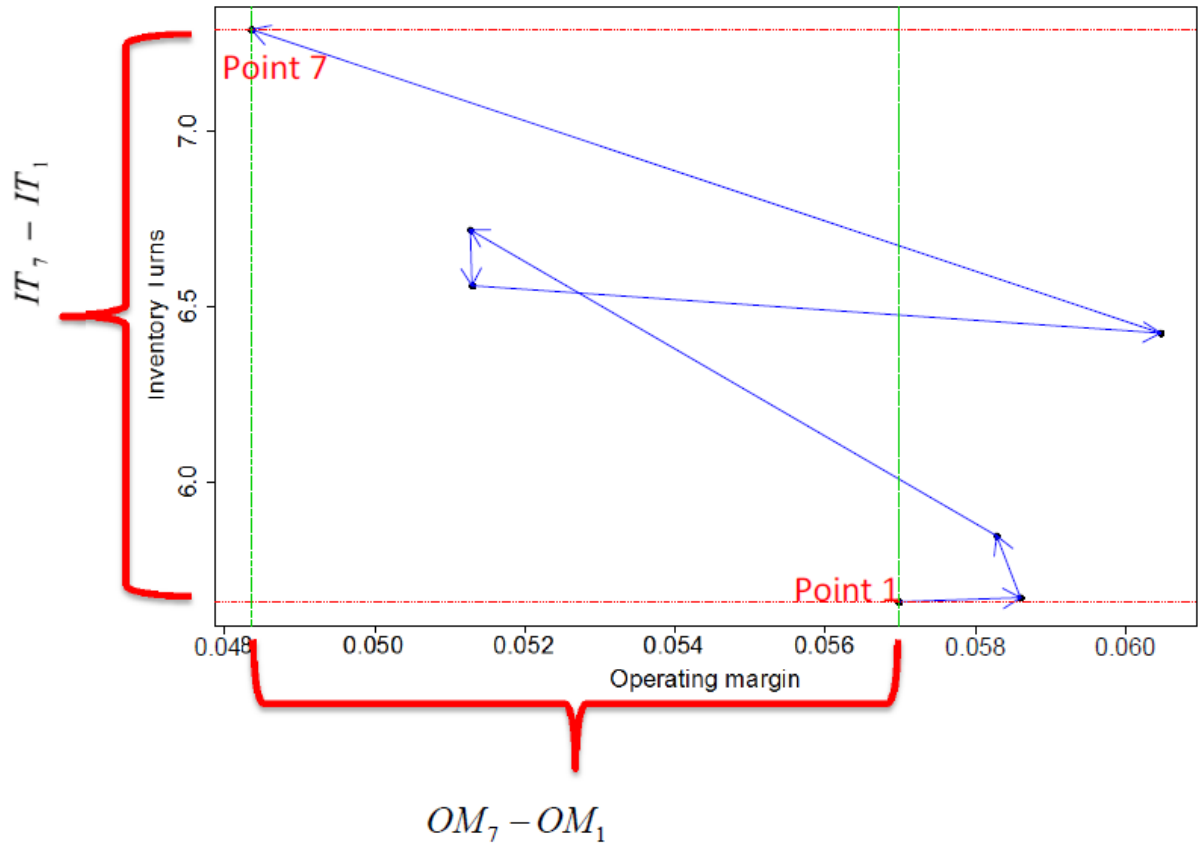
Strength

Consider a scatter plot of operating margin and inventory turns 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

Consider 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. Table 10 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.

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

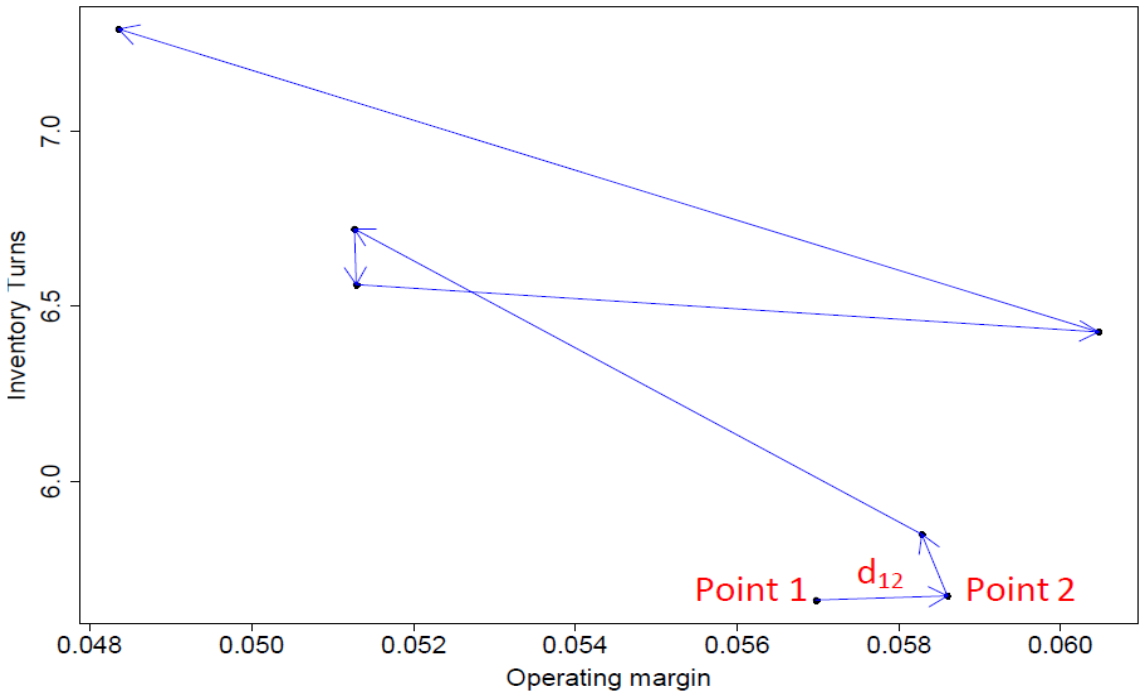


Table A. Euclidean Distances for an Example Company.

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

Principal Components Analysis (PCA) is a traditional method to summarize multi-dimensional 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.

Other Reports about the Index

Supply Chain Metrics That Matter: Improving Supply Chain Resiliency

Published by Supply Chain Insights in March 2014

About Supply Chain Insights, LLC

Founded in February, 2012 by Lora Cecere, Supply Chain Insights LLC is 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 are a company dedicated to this research. 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 a second book, *Metrics That Matter*, to publish in 2014.

With over nine 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?!?!