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INFLUENCE OF SUPPLY CHAIN MANAGEMENT INITIATIVES ON THE BASIC DRIVERS OF THE EUROPEAN MANUFACTURERS PROFITABILITY

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INFLUENCE OF SUPPLY CHAIN MANAGEMENT INITIATIVES ON THE BASIC DRIVERS OF THE EUROPEAN MANUFACTURERS PROFITABILITY

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Obtaining substantial financial benefits from supply chain management initiatives is of central importance to senior management. In this study we empirically investigate the impact of the basic drivers of profitability that are influenced by supply chain initiatives (i.e., revenues, costs, fixed assets and working capital) on the profitability of more than 20,000 large and mid-size European manufacturers. The existence of correlations among the basic drivers of profitability indicates that supply chain initiatives can have multiple (sometimes unintended) consequences, and points to the importance of managing and controlling all basic drivers simultaneously. In particular, our analysis reveals that despite the growing importance of supply chain management, the surveyed companies were not able to improve their operating profit margin and cash-to-cash cycle time simultaneously, resulting in their inability to increase profitability as fast as their revenues. This suggests that top-line initiatives cannot improve profitability, without effective supply chain initiatives to manage costs and assets.

Keywords: Supply chain management; firm performance; operational and financial performance measures

INTRODUCTION

In today's global economy companies are expected to pursue profitable growth and generate shareholder value by providing competitive returns. Profitability is generally considered to be the key driver of shareholder value. To improve profitability many firms have sought to view supply chain management as a tool that goes beyond just lowering costs. In fact, Losbichler *et al.* (2008) linked the impact of supply chain management initiatives to shareholder value by mapping profitability to its four basic drivers: revenues, costs, fixed assets and working capital. For example, operational benefits commonly noted as a direct result of supply chain initiatives not only include cost savings, but superior delivery performance, improved quality of goods and services and higher customer satisfaction (e.g., Das & Narasimhan, 2000).

Supply chain management competency has also been cited as playing a critical role in improving profitability and creating shareholder value by directly impacting revenue growth, operating costs, working capital and customer satisfaction (Camerinelli, 2009; Green *et al.* 2006). In addition, numerous studies have examined the supply chain management competency as a means of creating competitive advantage (e.g., Cook *et al.* 2011; Christopher, 2011).

Thus, supply chain managers need to understand the leverage of the four drivers of profitability and be able to influence them effectively. This is challenging since supply chain management encompasses many corporate functions and supply chain initiatives can have multiple (sometimes unintended) consequences affecting more than one driver of profitability, involving trade-offs. In the traditional view of supply chain management, the leverages and the knowledge about multiple consequences (or trade-offs) were not critical, as supply chain managers primarily focused on lowering costs. However, in today's environment both leverages and the knowledge about multiple consequences are critical.

Existing research has not focused on these multiple consequence and trade-offs. Thus, many companies whose objective is profitable growth remain uncertain about how and where to direct their supply chain initiatives to maximize their profitability. Although there is empirical evidence on the leverage that the basic drivers (i.e., revenues, costs, fixed assets and working capital) have on profitability, it is critical to determine how likely it is to successfully influence a driver. Thus, we empirically investigate the correlation among the four drivers and determine the impact of each driver on profitability.

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This study is based on the widely accepted principle that economic value is only created if the profitability of a company exceeds its cost of capital. Thus, profitability and its basic drivers are key to value creation. We empirically investigate the leverage that each basic driver has on profitability (as measured by Return on Capital Employed- ROCE) of large and mid-size European manufacturing companies in the period from 2003 to 2011. Furthermore, we examine the correlations among the four basic drivers of profitability. Thus, linking the ROCE metric to its four basic drivers. This is useful as the basic drivers are directly controlled by managers across the supply chain and provide them the opportunity to highlight the importance of their supply chain initiatives to top executives. Furthermore, it allows the analysis of various trade-offs in the supply chain.

In the next section we review the literature and provide further motivation for this study. This is followed by a description of shareholder value creation framework and research questions. We then demonstrate the influence of supply chain strategies on the basic drivers of profitability. Next we present our study's data collection and the methodology utilized. We then provide analysis of the data and discuss our study's results. Finally, we present the conclusions of our study and provide suggestions for future research.

LITERATURE REVIEW

A few studies have shown that superior supply chain management practices can lead to increased firm financial performance (e.g., Craighead *et al.* 2009). This has been primarily attributed to lower cost and increased efficiency in supply chain processes. For example, studies have shown that companies that have invested in IT-based supply chain management systems became more capital efficient and improved their logistics performance (e.g., Dehning *et al.* 2007; Joong-Kun Cho *et al.* 2008). However, the results have been mixed and the empirical evidence of a financial value contribution is fragmented. This may be attributed to the fact that studies often define firm performance in their own way. For example, firm performance has been defined as cost reduction, increase in revenue, higher prices, return on assets, profitability, productivity and growth, gross margin, inventory turnover, market share, and reduction in sales and administrative expenses (Greer & Theuri, 2012).

Greer and Theuri (2012) investigated the linkages between firm supply chain leadership, as determined by Gartner's (formerly known as AMR) supply chain Top-25 list, and overall financial performance. The goal of this study was to determine the overall financial health of supply chain leader firms and whether they demonstrated more financial health compared with firms not chosen as supply chain leaders in the same industry sector. Their results indicated that firms identified as supply chain leaders consistently outperformed their non-supply chain leader peers in accounting-based costs, activity and liquidity ratios. They concluded that, the decisions that supply chain managers make have an impact on the financial health of the firm.

Ellinger *et al.* (2012) examined the influence of supply chain management competency on customer satisfaction and shareholder value (as measured by Economic Value Added). Utilizing data from Gartner Supply Chain Group's 2007-2010 Top-25 supply chain ranking, they assessed the supply chain management competency. The results indicated that firms recognized by peers and experts for superior supply chain management competency exhibited higher levels of customer satisfaction and shareholder value than their respective industry averages. However, further evidence is required to prove causality does exist between the variables studied. Another limitation associated with this study was that the use of secondary data restricted the number of top performing firms available for analysis.

Hartmann *et al.* (2012) utilized a performance measurement model to empirically validate whether purchasing and supply management contributes to the company's financial success, and whether the financial value contribution is mediated by benefits of cost, quality and innovation performance. Their survey results indicated that a comprehensive implementation of purchasing and supply management activities contributed to an improvement in purchasing and supply management outcomes, which in turn mediated company success. The primary limitation of the study is relying on the perceptions of key informants (rather than more objective metrics) to measure operational performance and relying on single top management key informants.

Green *et al.* (2011) proposed a comprehensive green supply chain management practices model and empirically investigated the impact of such practices on the performance of manufacturing companies by utilizing a structural equation modeling methodology. The results indicated that the adoption of green supply chain management

practices leads to improved environmental performance and economic performance, which in turn positively impact operational performance.

On the other hand, Golicic and Smith (2013) note that studies linking environmental sustainable supply chain practices to firm performance have found mixed associations, leaving practitioners puzzled as to what actions to pursue. Thus, they examined over two decades of research on environmental supply chain practices by utilizing a meta-analysis to determine the overall effect of such practices on firm performance. Their results show that the link between environmental supply chain practices and market, operational and accounting-based forms of firm performance is positive and significant.

Thornton *et al.* (2013) conducted a multinational study to investigate the extent to which socially responsible supplier selection is associated with customer firm's financial performance in China, the United Arab Emirates and the United States. This exploratory empirical analysis indicated that there are differential outcomes by region: while the positive impact of socially responsible supplier selection on firm's performance is realized in China and the United Arab Emirates, it is not realized in the United States. They suggest more research is needed to explore the concept of socially responsible supplier selection and its impact on firm performance in different national settings beyond their selected regions.

Lueschner *et al.* (2013b) noted that while general support exists in the literature regarding the positive impact of supply chain integration on firm performance, there are some mixed findings. So, they conducted a meta-analysis to determine the impact of supply chain integration on firm performance. Their results indicated that there is a positive and significant correlation between supply chain integration and firm performance.

While several studies have found a significant positive association between logistics customer service and firm performance, other studies have shown that the effect between logistics customer service and firm performance is not significant (Davis-Sramek *et al.* 2008). It is not clear why the magnitude of this association varies considerably across studies. Leuschner *et al.* (2013a) conducted a meta-analysis to provide a quantitative examination of 37 sample studies and an assessment of the overall population effects. The results provide evidence that logistics customer service has a significant positive relationship with firm performance. However, due to the detection of significant heterogeneity, additional research is needed to obtain generalizable evidence. The authors particularly recommend further research that combines logistics customer service measures with objective financial performance.

Finally, a variety of studies have demonstrated the impact of certain management practices on financial performance and value creation. In particular, the studies that focus on supply chain and operations management and logistics management have provided frameworks to quantify the impact on financial ratios (e.g., Jodlbauer & Altendorfer, 2011). Also, a few studies have proposed general frameworks for improving profitability or creating shareholder value (e.g., Copeland *et al.* 1994; Timme & Williams-Timme, 2000).

In summary, although a variety of studies have demonstrated a generally positive impact of supply chain management initiatives on different operational and financial performance metrics, the evidence is somewhat fragmented (Hartmann *et al.* 2012). Furthermore, the narrow scopes of the studies limit the generalizability of the reported results (Ellram *et al.* 2002). Finally, although there is empirical evidence on the leverage that the basic drivers of profitability (i.e., revenues, costs, fixed assets and working capital) have on the firms' overall profitability, the relationship among the drivers and the impact of each driver on profitability is not well understood.

SHAREHOLDER VALUE CREATION FRAMEWORK AND RESEARCH QUESTIONS

While shareholder value can be measured by utilizing a variety of metrics, the key point in creating shareholder value is that the ROCE has to exceed the interest rate a company pays for capital to lenders and shareholders. In other words, ROCE has to exceed the company's cost of capital (Losbichler & Mahmoodi, 2010). Losbichler *et al.* (2008) proposed a framework that links the impact of supply chain management initiatives to shareholder value by mapping ROCE to its basic drivers: revenues, costs and capital employed (assets), as illustrated in Figure 1.
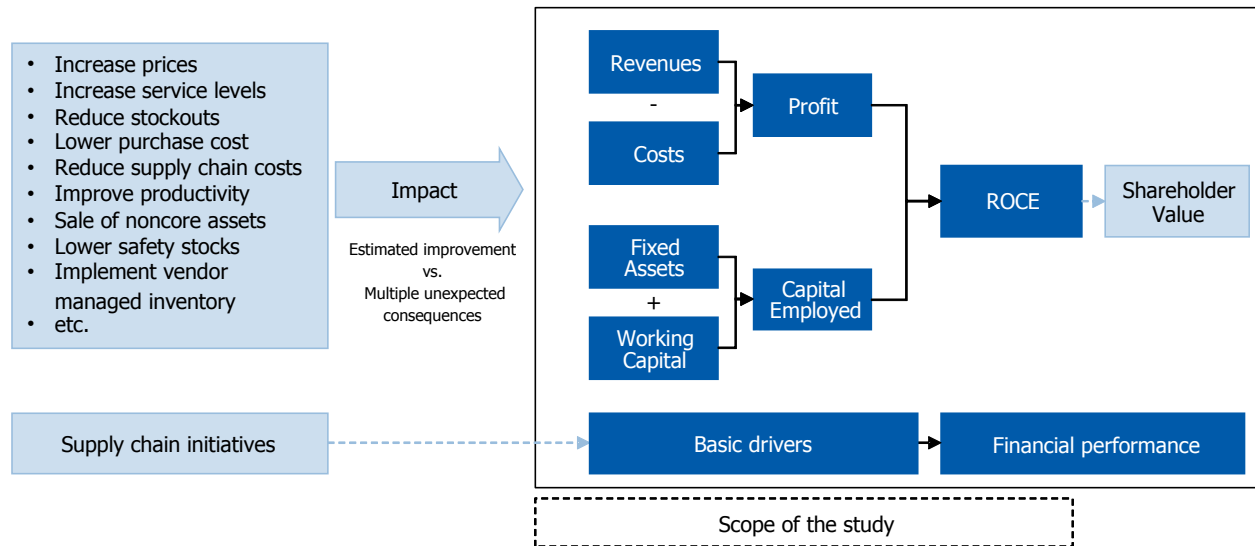
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Figure 1. The shareholder value creation framework

Note that it is better to break down capital employed into fixed assets and working capital to allow the analysis of the trade-offs between lower inventory and higher equipment efficiency. As a result, ROCE has four basic drivers, all of which can be impacted by supply chain management initiatives (Losbichler & Mahmoodi, 2010):

- Higher revenues measured by revenue growth;
- Lower costs measured by operating profit margin;
- Lower fixed assets measured by fixed asset turnover; and
- Lower working capital measured by cash-to-cash (C2C) cycle time.

The C2C cycle time is a metric expressing the average days required to turn a dollar invested in raw material into a dollar collected from customers. The C2C cycle time is equal to days sales in inventory (DSI), plus days sales outstanding (DSO), minus days payable outstanding (DPO).

Note that to increase profitability, management has to identify the supply chain initiatives that provide a considerable leverage on profitability. This is challenging as in today's far-flung supply chains, management activities have multiple consequences (many of them unintended). For example, lower unit costs as a result of offshoring can be offset by longer lead times and higher inventory carrying costs to maintain the desired service levels. It may be the case that the source with the lowest unit cost does not have the highest impact on profitability (Ferreira & Prokopets, 2009). On the other hand, reducing costs by decreasing product variety will not only lower the operating costs but also the inventory and working capital. Thus, supply chain decisions often simultaneously affect more than one value driver, and involves trade-offs between revenues, costs, fixed assets and working capital. Utilizing profitability ratios can help managers extract greater value and the integrated empirical analysis of all value drivers can unveil important findings to improve profitability.

In this study we empirically investigate the impact of the basic drivers of profitability which are influenced by supply chain initiatives (i.e., revenues, costs, fixed assets and working capital) on the profitability of more than 20,000 large and mid-size European manufacturers from 2003 to 2011. Specifically, we analyze the manufacturers' efforts to grow and improve ROCE by utilizing the basic drivers effectively, the relationship among the basic drivers and the impact of the basic drivers on profitability. Therefore, we examine five research questions during the specified observation period:

1. Were European manufacturing companies successful in managing profitable growth as measured by ROCE?
2. Which basic drivers of profitability did the European manufacturing companies use effectively?
3. Were there significant correlations among the four basic drivers of profitability (i.e., revenues, costs, fixed assets and working capital)?

4. Were European manufacturing companies able to influence the components of C2C cycle time independently or were there correlations among the components (i.e., DPO, DSO and DSI)?
5. Which basic drivers of profitability displayed the greatest leverage on the ROCE of the European manufacturing companies?

In the next section, we discuss the supply chain strategies and practices of two global companies as examples to demonstrate the influence of supply chain strategies on the basic drivers of profitability (i.e., revenues, costs, fixed assets and working capital).

THE INFLUENCE OF SUPPLY CHAIN MANAGEMENT STRATEGIES ON THE BASIC DRIVERS OF PROFITABILITY- TWO EXAMPLES

The unique supply chain management practices of Spanish retailer and manufacturer, Zara has enabled it to gain competitive advantage over other global fashion retailers (Loeb, 2013). Inditex, Zara's Parent company, has been opening an average of more than a store a day for the past few years, leveraging its centralized distribution infrastructure. Zara utilizes a responsive supply chain to bring more than 12,000 fashionable designs a year in a limited quantity to the market quickly, at relatively a reasonable price. Zara's vertically integrated, agile supply chain enables it to place the latest designs in all of its stores across the globe in two to three weeks. Small and frequent shipments has kept inventories fresh and limited, encouraging customers to visit the stores frequently in search of new designs and to buy right away, because it may be gone tomorrow (Anderson & Lovejoy, 2007).

Their quick turn around on merchandise helps the cash flow, eliminating the need for significant debt. Potential bottlenecks are avoided because Zara is vertically integrated. For short lead times, 60% of the manufacturing processes are outsourced in countries close to the Zara headquarters (as opposed to further away, lower cost locations) and the postponement strategy is utilized effectively. Finally, Zara maintains a strong relationship with its suppliers, viewing them as part of the company (Anderson & Lovejoy, 2007). In summary, Zara's supply chain strategies have had the following impacts on the four drivers of profitability:

1. Increased revenues (due to bringing a variety of latest designs to market quickly, customers frequent visits and their tendency to buy at full price, avoiding the typical fire sales).
2. Increased costs (due to less outsourcing than competitors, particularly in low cost countries, as well as higher transportation costs).
3. Increased fixed assets (due to more vertical integration and less outsourcing).
4. Reduced working capital (primarily due to higher inventory velocity and carrying less inventory).

Walmart, the largest retailer in the world, is believed to be one of the best supply chain operators of all times. Many analysts attribute Walmart's leadership status in the retail industry and its phenomenal growth to its pursuit of a hybrid supply chain management strategy that focuses on both efficiency and responsiveness (Gilmore, 2012). The company has been able to offer a large variety of products at very low cost. Two major factors have contributed to this success: efficient and responsive distribution and transportation systems (resulting in reduced logistics costs and short lead times), and its computerized inventory system, which has shortened replenishment cycles, speeded up the checkout times, as well as minimizing inventory carrying and stockout costs.

In addition, Walmart has been able to reduce its procurement costs by purchasing directly from manufacturers, bypassing intermediaries, as well as utilizing its enormous purchasing power to obtain more favorable terms from its suppliers. Finally, Walmart has utilized sophisticated technology and information systems to track sales and merchandize in its facilities, and to communicate effectively internally as well as with its suppliers across the globe. In summary, Walmart's supply chain strategies have had the following impacts on the four drivers of profitability:

1. Increased revenues (due to offering everyday low prices, fewer stock outs, as well as better customer service).
2. Lower costs (due to lower distribution / logistics costs, use of technology to effectively manage inventories, reduced safety stocks and lower procurement costs).
3. Increased fixed assets (due to owning its own distribution facilities and transportation fleet).

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4. Reduced working capital (primarily due to higher inventory turnover and negotiating better payment terms with the suppliers by utilizing their enormous purchasing power).

As demonstrated in the above examples, there are clear trade-offs between possessing a responsive and efficient supply chains. While agile supply chains generally create shareholder value by increasing revenue growth and reducing working capital, efficient supply chains commonly create shareholder value by reducing costs and fixed asset utilization.

DATA COLLECTION AND METHODOLOGY

We used a common operating definition of ROCE to avoid distortions due to interest and taxes. In the numerator we used the operating profit before interest and taxes (EBIT). Thus, the capital employed only represents the interest bearing capital employed. In general, capital employed can be determined from both sides of the balance sheet, as illustrated in Figure 2.
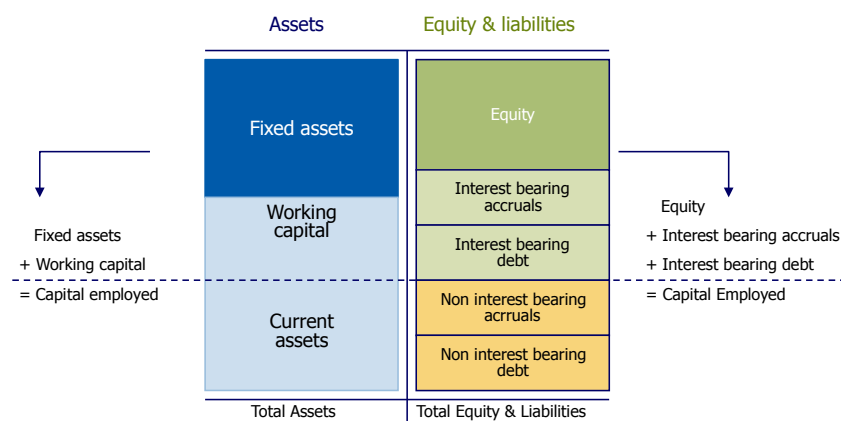

Figure 2. Determining capital employed from two different perspectives

Determining capital employed from the "capital"-perspective or the right side of the balance sheet helps keep calculations simple. Equity and interest bearing liabilities, such as long-term debt were added together. The nature of pension and payroll related liabilities are considered differently in the literature (Weissenberger, 2009). However, this approach has three major shortcomings. First, it is difficult for non-financial experts to understand. More importantly, it is almost impossible to break down capital employed into its useful value drivers. The amount of assets that is required for doing business induces the amount of equity and liabilities and not vice versa. Capital employed can only be managed effectively if assets are controlled and monitored. Third, this approach makes it difficult to determine the net amount that is really tied up in the operating business. For example, it would be possible to deduct financial investments (that is not tied up in the operating business) from the total of equity and interest bearing liabilities. However, one may find it difficult to determine if these financial assets were financed with interest bearing and non-interest bearing capital.

We determined capital employed from the perspective of assets. First, we selected the assets that are tied up in the operating business. For example, financial investments, marketable securities, financing receivables and deferred taxes were excluded. Second, non-interest bearing capital that is related to the operational business, such as accounts payable was deducted, resulting in the net amount of assets that affects the cost of capital. This approach disaggregates capital employed into its basic drivers and appeals to managers at the core of their business. Note that the accuracy of determining capital employed as the amount that is tied up in a company's operational business that has to be financed with interest bearing capital is limited by the available published data.

We utilized the AMADEUS database that covers approximately 520,000 private and public companies in Europe from 2003 to 2011. Since the main focus of our research is on the manufacturing sector, companies in industries such as wholesale and retail trade, transportation, agriculture, education, insurance, finance or non-profit-organizations were excluded. Variables considered include SIC code, revenues, cost of goods sold, fixed assets,

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inventory, accounts payable and accounts receivable. Note that the companies that use the total expenditures format for their income statements do not report their cost of goods sold and thus were not considered in this study. The classification of sectors is achieved by the SIC code. This code not only allows us to compare different European sectors, but classifies the resulting data for further comparisons with U.S.-based companies and sectors.

We only included large and mid-size manufacturing companies whose datasets were complete in the observation period. Therefore, in the period from 2003 to 2011, data for 20,322 companies with complete variables was extracted. We used descriptive statistics to analyze the significance of the basic value drivers on the ROCE metric. Selected companies were clustered by firm size and European region for further investigations. Additionally, we utilized correlation analysis by Pearson to determine the relationship among the value drivers and the components of C2C cycle time. Subsequently, we performed multiple linear regression analysis to investigate the leverage of the basic drivers on the ROCE metric. For more details regarding the AMADEUS database and the calculation of various profitability metrics, revenue growth, operating profit margin, fixed asset turnover and C2C cycle time, please refer to the Appendix.

DISCUSSION OF RESULTS AND IMPLICATIONS

Our first research question focuses on the relationship between revenue growth and performance metric ROCE. We used descriptive statistics for the selected large and mid-size European manufacturing companies during the chosen observation period (2003-2011). As indicated in Figure 3, the companies show a fairly sustained revenue growth on the median level during the observed periods (annual growth rate of 6.3% from 2003 to 2011). Considering the European average inflation rate of 2.5%, the annual revenue growth rate was 3.8% after inflation. After the financial crisis in 2008/2009, European manufacturing companies' revenues recovered with yearly increases of 17.8% in 2010 and 17% in 2011. However, the companies were unable to manage an increase in ROCE simultaneously. The median ROCE decreased from 10.0% in 2003 to 9.7 % in 2011. ROCE decreased during the financial crisis from 12.3% to 7.9%. The economic recovery was only accompanied by an increase in ROCE in 2010, remaining nearly unchanged in 2011.
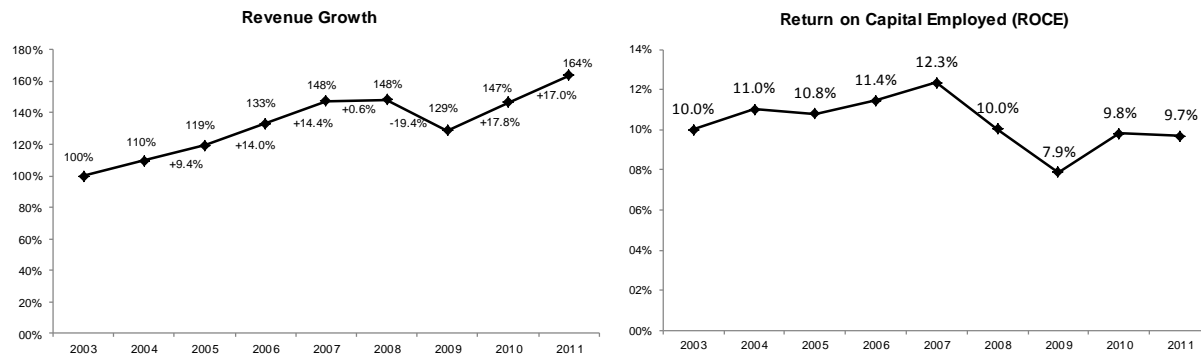

Figure 3. Revenue growth and ROCE (2003-2011)

Further descriptive statistics is presented by clustering the European manufacturing companies by firm size and region. The companies were classified into large (i.e., Revenues > 50 Million €, N=7,632), and mid-size companies (i.e., 10 Million € < Revenues < 50 Million €, N=12,690), as well as classified by different regions as shown in Table 1.

Category	Countries
Southern Europe	Italy, Spain, Portugal, Croatia, Serbia, Bosnia and Herzegovina, Greece, Malta, Montenegro
Western Europe	United Kingdom, Ireland, France, Netherlands, Belgium, Iceland
Central Europe	Germany, Switzerland, Austria, Poland, Hungary, Slovakia, Czech Republik, Liechtenstein
Northern Europe	Norway, Sweden, Finland, Estonia, Latvia, Lithuania
Eastern Europe	Russian Federation, Bulgaria, Ukraine, Moldavia

Table 1. Categories of regions

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Figure 4 shows the ROCE metric on median level for different firm sizes. Investigating ROCE with respect to firm size reveals returns on capital employed of about 10%-13%, and 9-12% for large and mid-size companies, respectively. This range excludes the periods of the financial crises, where ROCE declined to 8.5 and 7.5%. The performance gap between large and mid-size companies widened, increasing from a range of 1-2% before the financial crisis to 3.5% after the crisis. This indicates that large companies were able to recover more profitability in comparison to mid-size companies (small companies were excluded in our analysis due to limited sample size). Figure 5 illustrates the ROCE metric for various regions. The comparison of the different regions reveals significant trends during the observation period. Despite the crises, the annual median performance of Northern European companies increased by 0.15, followed by average yearly performance increases in Eastern, Western and Central Europe (approximately 0.1%). However, the median performance of Southern European companies decreased by 0.20%. Since the companies located in Southern Europe were highly represented in our sample (40%), the median performance decline of the entire sample is mainly due to their poor performance.
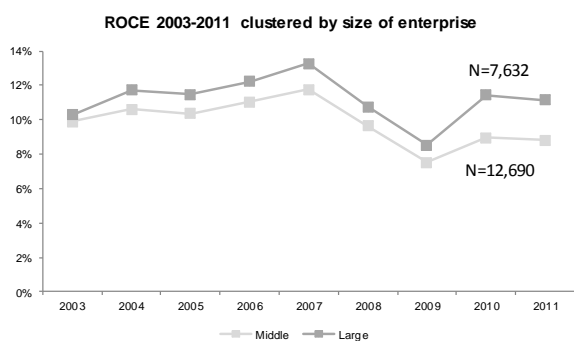
Figure 4. ROCE clustered by firm size.   **Figure 5. ROCE clustered by region.**
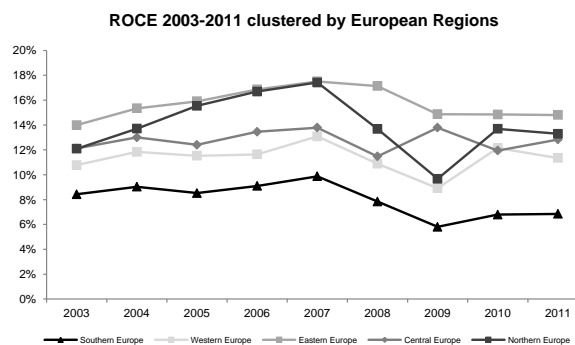
Figure 6 illustrates differences in profitability by industry of the selected manufacturing companies. The overview of median ROCE-spread in 2011 of these subsectors also compares the 25% and 75%-quartiles. The observed ROCE ranges from the lumber and wood products sector (6.0%) on the left hand of the performance-interval to the metal mining sector on the right hand (17%). The tobacco industry represents an outlier based on the 75%-quartile of ROCE metric (i.e., 57.1%). Thus, the tobacco industry was not considered in the subsequent correlation and linear regression analysis.

Figure 6. ROCE of manufacturing industries (2011)

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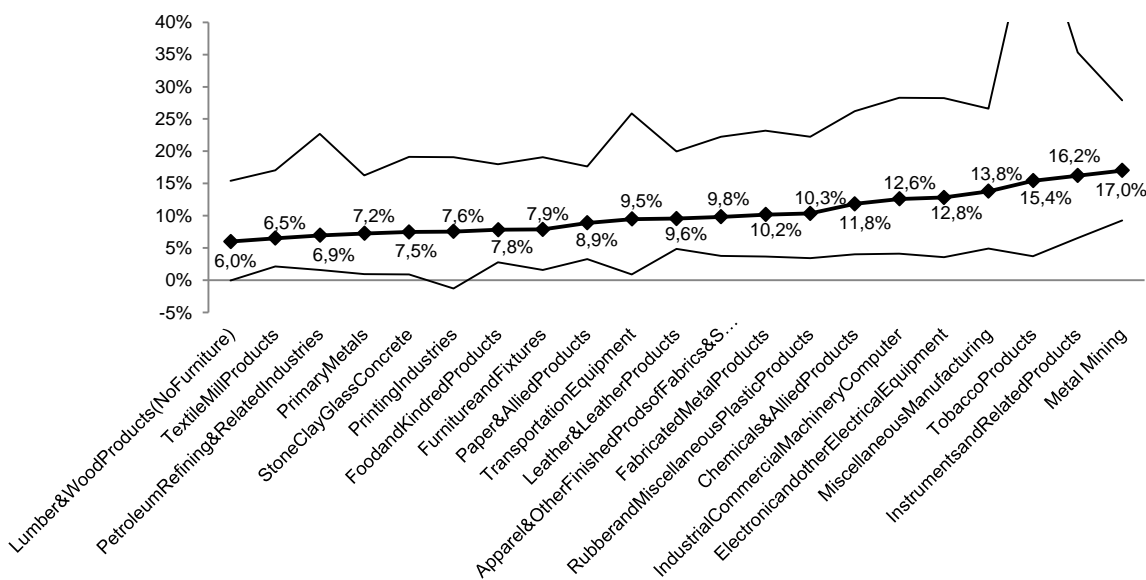We now address our second research question: Which basic drivers of profitability did the European manufacturing companies use effectively? Figure 7 provides an overview of the four basic drivers for large and mid-size European manufacturing companies from 2003 to 2011.
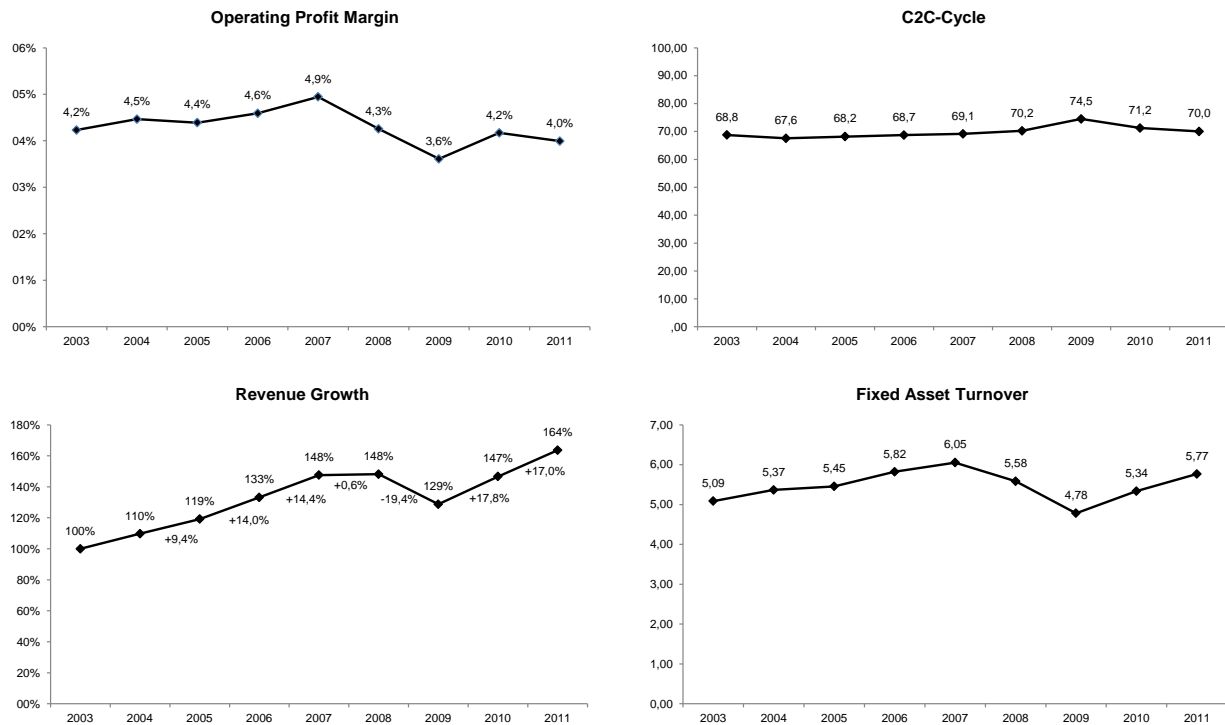

Figure 7. Operating profit margin, revenue growth, C2C cycle time and fixed asset turnover from 2003 to 2011

The European manufacturing companies showed a steady revenue growth on the median level during the observed period, characterized by an annual growth rate of 6.3% from 2003 to 2011. Despite this growth, the companies were unable to increase operating profit margin or decrease their C2C cycle times. The median operating profit margin showed no significant trend, decreasing from 4.2% in 2003 to 4.0% in 2011.

Fixed asset turnover of the European manufacturing companies showed an increase from 5.09 in 2003 to 5.77 in 2011. In 2008 fixed asset turnover decreased parallel to unchanged revenues on median level, indicating that despite the slowdown of the economy capital expenditures increased. Only in 2009 fixed assets remained stable compared to the previous year, continuing to be unchanged in 2010 and slightly increasing in 2011.

The C2C cycle time increased over the entire observation period by 2%. From the level of 2003, C2C cycle time performance of the European manufacturing companies further increased, dropping by 1.2 days. Despite the volatile European economy, the positive trend of 2010 (-3.3 days) continued in 2011.

We now address our third research question: Were there significant correlations among the four basic drivers of profitability (i.e., revenues, costs, fixed assets and working capital)? Note that after the computation of firm-specific time-series means for each value driver, the components of C2C cycle time and ROCE, these means were aggregated by region and industry. Based on 103 time-series means per basic driver, we utilized Pearson's correlation coefficient to address our third research question.

Table 2 illustrates the calculated Pearson's correlation coefficients (two-tailed probabilities) and the significance of the correlations. This analysis reveals significant positive correlations between revenue growth and C2C cycle time, revenue growth and operating profit margin and C2C cycle time and operating profit margin. The highly significant correlation of -0.329 between revenue growth and C2C cycle time shows that the European manufacturing companies were able to improve their working capital in parallel with revenue growth, however not to

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the same extend. The Pearson correlation coefficient of 0.215 between revenue growth and operating profit margin reveals a similar trend: the companies were not able to increase their profit margins at the same rate as their revenues.

		Revenue_Growth_Mean_ 2003_11_median	OPM_Mean_2003 _11_median	FA_TO_Mean_2003 11_median	C2C_Mean_2003 _11_median
Revenue_Growth_Mean _2003_11_median	Correlation by Pearson	1	.215*	.107	-.329**
	Level of Significance (2-tailed)		.029	.283	.001
	N	103	103	103	103
OPM_Mean_2003_11_ median	Correlation by Pearson		1	-.114	.389**
	Level of Significance (2-tailed)			.252	.000
	N		103	103	103
FA_TO_Mean_2003_11 _median	Correlation by Pearson			1	-.055
	Level of Significance (2-tailed)				.582
	N			103	103
C2C_Mean_2003_11_ median	Correlation by Pearson				1
	Level of Significance (2-tailed)				
	N				103

** Correlation is significant on a level of 1%   * Correlation is significant on a level of 5%

Table 2. **Correlation of aggregated average growth for basic drivers on median level**

We now address our fourth research question: Were European manufacturing companies able to influence the components of C2C cycle time (i.e., DPO, DSO and DSI) independently or were there correlations among its components? Figure 8 illustrates the breakdown of the C2C cycle time into three components. The DSI shows steady increases in the 2003 to 2010-period, while remaining nearly unchanged in 2011. DSO declined by 4.2 days over the observation period, showing slight increases until 2006, while decreasing during the financial crisis and recovering after a moderate rise in 2009-2010 to 64.5 days in 2011. Finally, DPO showed similar trends, declining during the crisis after moderate increases in the previous years. After an increase in 2009 and 2010, DPO decreased slightly to a median level of 44.3 days.
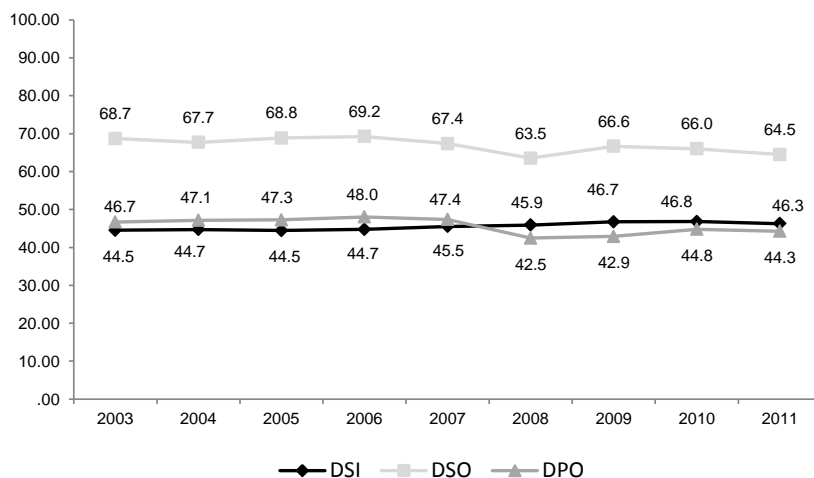
Figure 8. The components of the C2C cycle time: DSI, DSO and DPO from 2003 to 2011

We then conducted a second correlation analysis, computing the Pearson's correlation coefficients among DPO, DSO and DSI, as shown in Table 3. The calculated Pearson's coefficients show a highly significant correlation of 0.839 between DSO and DPO, indicating that as the European manufacturer's customers paid them later, the manufacturers in turn paid their suppliers later. On the other hand, no significant relationships between DSO and DSI, and DPO and DSI were observed. This implies that DSI has been controlled independently from DSO and DPO by the European manufacturing companies.

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		DSI_Mean_2003_11_median	DSO_Mean_2003_11_median	DPO_Mean_2003_11_median
DSI_Mean_2003_11_median	Correlation by Pearson	1	.145	-.009
	Level of Significance (2-tailed)		.145	.926
	N	103	103	103
DSO_Mean_2003_11_median	Correlation by Pearson		1	**.839****
	Level of Significance (2-tailed)			**.000**
	N		103	**103**
DPO_Mean_2003_11_median	Correlation by Pearson			1
	Level of Significance (2-tailed)			
	N			103

** Correlation is significant on a level of 1%   * Correlation is significant on a level of 5%

Table 3. **Correlation of C2C cycle time components: DSO, DPO and DSI on median level**

We now address our fifth research question: Which basic drivers of profitability displayed the greatest leverage on the ROCE of the European manufacturing companies? We conducted multiple linear regression analysis to address this research question. The regression model was defined by the dependent variable ROCE, whereby our basic drivers: operating profit margin, C2C cycle time, fixed asset turnover and revenue growth represent the independent variables. Once again, we utilized the median of aggregated time-series means by region and industry. The regression equation for dependent variable ROCE for each of the 103 time-series is illustrated by equation (1):

$$(1)\ ROCE_j\ =\ B_0 + \sum_{i=1}^{4} B_i * V_{ij} + e_j \qquad j = 1,2,\dots,103$$

V_{ij}: Value driver i of dataset j B_o: Absolute term
B_i: Regression coefficient i e_j: Error term of dataset j

The requirements for the multiple linear regression models were fulfilled, as all variables are quantitative and the distribution of our dependent variable is normal (Kolmogorov-Smirnov-Test). A stepwise selection method was chosen (5% entry significance level, 10% removal value), which resulted in the regression coefficients, as well as the model fit shown in Table 4. Significant links between the chosen basic drivers and the ROCE metric were derived, as shown in equation (2):

$$(2)\ ROCE =\ 6.174 + 1.687 * OPM - 0.064\ C2C + 0.379 * \text{Fixed Asset Turnover} + 0.013 * \text{Revenue Growth}$$

	Non standardized Coefficients		Standardized Coefficients					
Significant Factor	Regression Coefficient B	Standard Error	Beta	T	Significance	R²	Adjusted R²	VIF
Absolute Term	6.174	1.043		5.921	.000	.682	.669	
OPM_Mean_2003_11_median	1.687	.153	.749	11.000	.000			1.357
C2C_Mean_2003_11_median	-.064	.011	-.391	-5.611	.000			1.428
FA_TO_Mean_2003_11_median	.379	.061	.360	6.206	.000			1.035
Revenue_Growth_Mean_2003_11_median	.013	.006	.141	2.130	.036			1.497

Table 4. Coefficients and model fit for multiple regression analysis of ROCE

The quality of our multiple regression line is specified by the coefficient of determination (R²) of 0.682, and adjusted R² of 0.669, indicating that nearly 70% of the variance in ROCE can be predicted by operating profit margin, C2C cycle time, fixed asset turnover and revenue growth. All Variance Inflation Factors (VIF) are less than 3.0, indicating no evidence of multi-collinearity.

All value drivers, except for C2C cycle time, are positively correlated with ROCE. As expected, the standardized coefficients (Beta) reveals that the operating profit margin showed the strongest leverage on the ROCE

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metric (i.e., 0.749). The impacts of fixed asset turnover and C2C cycle time were comparatively weaker. Finally, revenue growth showed the least leverage on the ROCE metric.

CONCLUSIONS AND FUTURE RESEARCH

Supply chain management competency plays a critical role in creating shareholder value by directly impacting the four basic drivers of profitability: revenues, costs, fixed assets and working capital. It is critical for supply chain managers to understand the leverage of the four drivers of profitability and be able to influence them effectively. This is challenging since supply chain initiatives can have multiple consequences affecting more than one driver of profitability, involving several trade-offs. Previous research has not focused on these multiple consequence and trade-offs. Thus, most companies remain uncertain about what supply chain initiatives to pursue to maximize their profitability.

We empirically investigate the correlation among the four drivers and determine the impact of each driver on the profitability of more than 20,000 large and mid-size European manufacturing companies in the period from 2003 to 2011, by utilizing the AMADEUS database. This allows managers to analyze various trade-offs in the supply chain, as well as the opportunity to highlight the importance of their supply chain initiatives to top executives.

The results of this study demonstrate the complex nature of supply chain management. Our empirical analysis reveals that profitability is significantly influenced by all four basic drivers. Despite the growing importance of supply chain management, the surveyed companies were not able to improve their operating profit margin and C2C cycle time simultaneously. Thus, the European manufacturing companies were not able to increase their profitability as fast as their revenues. This suggests that growth strategies, without effective supply chain initiatives to manage costs and assets will not result in improved profitability. Finally, the existence of correlations among the value driver's points to the importance of managing all four basic drivers simultaneously. Specifically, the key results of our analysis include:

1. During the post financial crisis recovery, the large and mid-size European manufacturers' ROCE did not increase as fast as their revenues. Thus, revenues grew at the expense of profitability, increasing the pressure on supply chain managers to further reduce costs and assets.

2. The large European manufacturing companies were able to recover more profitably compared to the mid-size companies, resulting in a widening gap.

3. The large and mid-size manufacturing companies in Southern Europe were less profitable than those in the other regions.

4. The European manufacturers showed a 6.3% annual revenue growth rate from 2003 to 2011. Considering that the average annual inflation rate was 2.5%, the annual revenue growth rate was 3.8% after inflation. However, the European manufacturers were unable to increase operating profit margin and C2C cycle time simultaneously. In fact, the median operating profit margin showed no significant trend, decreasing from 4.2% in 2003 to 4.0% in 2011. The C2C cycle times of the European manufacturers showed no sustainable improvements, remaining largely unchanged from 2003 to 2011. The fixed asset turnover of the European manufacturing companies increased from 5.09 in 2003 to 5.77 in 2011. In 2008, their fixed asset turnover decreased at the same rate as the median revenue growth, indicating that despite the economic slowdown, capital expenditures increased. Only in 2009 fixed assets remained stable compared to the previous year, remaining unchanged in 2010 while increasing slightly in 2011.

5. There were significant positive correlations between revenue growth and C2C cycle time, revenue growth and operating profit margin, and C2C cycle time and operating profit margin. The highly significant correlation of -0.329 between revenue growth and C2C cycle time shows that companies were able to improve their working capital in parallel with revenue growth, however not to the same extend. The Pearson correlation coefficient of 0.215 between revenue growth and operating profit margin revealed a similar trend: manufacturing companies were not able to increase their profit margins at the same rate as their revenues.

6. There was significant correlation between DSO and DPO, indicating that as the European manufacturer's customers paid them later, the manufacturers in turn paid their suppliers later. On the other hand, no significant relationships between DSO and DSI, and DPO and DSI were observed, suggesting that DSI has been controlled independently from DSO and DPO by the European manufacturing companies.

7. While all four basic drivers positively influence ROCE, operating profit margin showed the strongest leverage on the ROCE metric, followed by C2C cycle time and fixed asset turnover. Revenue growth showed the least leverage on the ROCE metric.

The results derived from this empirical study are exploratory in nature, as the data utilized is limited. First, companies often whitewash the figures that they report at the end of the accounting periods. For example, companies can focus on inventory reduction at the end of a specific accounting period. Second, the accounting standards and the disclosure requirements differ in European countries. For example, in Austria only publicly limited companies and large limited liability companies are obligated to fully publish their annual reports. In order to present the records in the database in a common format, they had to be adjusted. Thus, some variables could differ from what was reported in the original annual reports. Third, the results of the study depend on the available records in the database.

The results of this study lead to several additional research questions. For example, a detailed analysis of the interdependencies among the basic financial drivers, supply chain management leverages and operational metrics would be very interesting. In addition, further clustering of manufacturing companies into high, moderate and low performer or into different countries would be recommended. Finally, comparison of our results with the performance of the manufacturing companies in other regions of the world, such as North America and Asia, would be very worthwhile.

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APPENDIX

We relied on the level of disaggregation of the AMADEUS database. The AMADEUS database publishes balance sheet items; an example in shown in Table 5.

INCOME STATEMENT

Operating revenue (Turnover)	**75,505**
Sales	73,497
Costs of goods sold	53,986
Gross profit	21,519
Other operating expenses	12,933
Operating P/L [=EBIT]	**8,586**
Financial P/L	384
P/L before tax	8,970
Taxation	2,367
P/L after tax	6,603
Extr. and other revenue	n.a.
Extr. and other expenses	n.a.
Extr. and other P/L	n.a.
P/L for period [=Net income]	6,603

BALANCE SHEET

Assets		Liabilities & Equity	
Fixed assets	32,585	Shareholders funds	25,385
- Intangible fixed assets	**11,919**	- Capital	1,176
- Tangible fixed assets	**17,966**	- Other shareholders funds	24,209
- Other fixed assets	2,700		
		Non-current liabilities	27,460
Current assets	28,590	- Long term debt	14,060
- Stock	**10,059**	- Other non-current liabilities	13,400
- Debtors	**10,886**	* Provisions	13,400
- Other current assets	7,645		
* Cash & cash equivalent	2,048	Current liabilities	8,330
		- Loans	0
		- Creditors	**5,121**
		- Other current liabilities	3,209
TOTAL ASSETS	61,175	TOTAL SHAREH. FUNDS & LIAB.	61,175

Table 5. AMADEUS database for BASF group report 2011 in million €

Based on the available data, we determined capital employed as follows (data used for calculation of ROCE and its drivers is in bold letters in the income statement and balance sheet in Table 5):

$$ROCE = \frac{EBIT}{Capital\ Employed} = \frac{8,586}{45,709} = 18.8\%$$

Capital Employed = Net fixed assets + Working Capital = 29,885+ 15,824 = 45,709
Net fixed assets = Tangible fixed assets + Intangible fixed assets = 11,919 + 17,966 = 29,885
Working Capital = Stock + Debtors – Creditors = 10,059 + 10,886 – 5,121 = 15,824

We measured the operating profitability that may vary from other studies or reported figures. Table 6 illustrates different approaches:

Ratio	Formula	Profit	Capital	Profitability
ROCE (our study) =	$\dfrac{EBIT}{Capital\ Employed}$	8,586	45,709	18.8%
ROCE (REL study) =	$\dfrac{EBIT}{Total\ Assets\ -\ Creditors}$	8,586	56,054	15.3%
ROA =	$\dfrac{P/L\ after\ tax}{Total\ Assets}$	6,603	61,175	10.8%

Table 6. Calculation of BASF's profitability based on different ratios or formulas

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Revenue growth is the year-over-year increase of a company's revenues, expressed as a percentage. Revenue growth can be accomplished by an increase in selling volume or increased prices or a combination of both.

$$\text{Revenue Growth} = \frac{\text{Revenues}_{2011}}{\text{Revenues}_{2003}} = \frac{75,505}{33,922} = 222.59\%$$

The operating profit margin measures the profit from sales after deducting all operating expenses. It is calculated by dividing operating profit by revenues. The operating profit margin is an indicator of a company's ability to control costs relative to revenues. It measures the operating core business, excluding effects of investments, financing and taxes.

$$\text{Operating profit margin} = \frac{\text{Operating profit}}{\text{Revenues}} = \frac{8,586}{75,505} = 11.37\ \%$$

The fixed asset turnover measures the relationship between a firm's revenues and fixed assets needed to sustain this level of operation. It primarily analyzes how effectively a firm uses its plants and equipment to generate sales. The fixed asset turnover can also be used to forecast the required investments for a projected sales level. The fixed asset turnover is affected by a company's financing policy (e.g., leases), its vertical integration and the nature of its industry.

$$\text{Fixed asset turnover} = \frac{\text{Revenues}}{\text{Net fixed assets}} = \frac{75,505}{29,885} = 2.53$$

The C2C cycle time is a composite metric describing the average days required to turn a Euro invested in raw material into a Euro collected from a customer. It measures how effectively working capital is managed and how long capital is tied up by a company's operating business. The C2C cycle time is equal to Days Sales in Inventory (DSI), plus Days Sales Outstanding (DSO), minus Days Payables Outstanding (DPO), as illustrated in Figure 9.
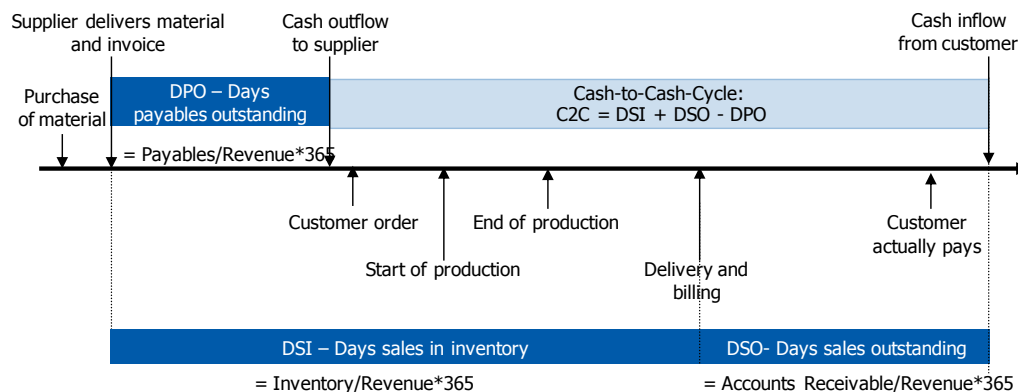

Figure 9. Cash-to-Cash cycle time calculation

C2C cycle time = DSI + DSO - DPO = 48.6 + 52.6 - 24.8 = 76.4

$$\text{DSI} = \frac{\text{Stock}*365}{\text{Revenues}} = \frac{10,059*365}{75,505} = 48.6 \qquad \text{DSO} = \frac{\text{Debtors}*365}{\text{Revenues}} = \frac{10,886*365}{75,505} = 52.6$$

$$\text{DPO} = \frac{\text{Creditors}*365}{\text{Revenues}} = \frac{5,121*365}{75,505} = 24.8$$

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