

December 2004

Benchmarking Financial Chain Efficiency - the Role of Economies of Scale for Financial Processes

Stefan Blumenberg
Frankfurt University

Follow this and additional works at: <http://aisel.aisnet.org/pacis2004>

Recommended Citation

Blumenberg, Stefan, "Benchmarking Financial Chain Efficiency - the Role of Economies of Scale for Financial Processes" (2004).
PACIS 2004 Proceedings. 77.
<http://aisel.aisnet.org/pacis2004/77>

This material is brought to you by the Pacific Asia Conference on Information Systems (PACIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in PACIS 2004 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

Benchmarking Financial Chain Efficiency – the Role of Economies of Scale for Financial Processes

Stefan Blumenberg
Frankfurt University,
E-Finance Lab, Germany
blumenberg@wiwi.uni-frankfurt.de

Abstract

While many firms have used advancements in information and communication technology to optimize their supply chain and primary processes, there is still a substantial efficiency potential associated with financial processes. A main hypothesis is that an industrialization of the financial chain by standardizing as well as internal and external systems integration can offer great efficiency potentials due to economies of scale.

In this paper, based on an empirical survey with Fortune 1,000 CFOs, a benchmark of the invoicing process in these firms reveals to what extent economies of scale can explain the substantial efficiency discrepancies.

Keywords: Efficiency Measurement, Financial Chain, Data Envelopment Analysis, Economies of Scale

1. Preface

Many firms have used advancements in information and communication technology to automate their primary processes, to integrate internal systems and to tighten the network of partners transcending the firms' borders and thereby rearranging the entire value chain. But in contrast to e.g. successful supply chain management for primary processes, many secondary processes supporting a firm's main value chain have long been neglected as an autonomous source of optimization. Since especially financial processes are characterized by the possibility of a fully electronic workflow, an industrialization of the financial chain focusing especially on realizing economies of scale could be a means to establish a competitive advantage. But are economies of scale despite their strong IT support really that important? This paper answers this question using an empirical survey with the CFOs of Germany's Fortune 1,000 firms. Using a DEA analysis it is shown how efficient firms can be identified and to what extent economies of scale are the reason for differences in financial chain efficiency.

1.1 Outsourcing Financial Chain Processes

The main advantage associated with outsourcing IT infrastructure and processes are cost savings due to economies of scale resulting from bundling similar processes of different business units or firms [Cachon, G., and Harker, P. 2002; Schott, E. 1997]. In contrast, especially for high volume processes such as securities processing or payment there is an increasing number of managers arguing that they have already reached the maximum level of scale economies within their firm [Lacity, M. et al. 1996, p. 17; Earl, M. J 1996, S. 27]. Also, some processes, especially in the financial chain, might be repetitive to such a high extent that real fixed costs might be of quite small importance. If the cost function is linear and the transaction volume high, the average costs approximate marginal costs. In this context, only 17.6% of the responding managers deem further savings in their financial chain due to economies of scale possible.

Thus, in order to analyze if economies of scale are important in financial chain processes and can therefore offer substantial efficiency improvements, this paper examines the efficiency of the invoicing process which is the single most important subprocess of the financial chain regarding optimization potential, according to our survey. Using DEA analysis, it turns out that even for Fortune 1,000 firms economies of scale are important. As a consequence, an industrialization of the financial chain by sourcing these processes to a process factory could help to establish a lasting competitive advantage in an area that has long been neglected.

1.2 Financial Chain Management

A supply chain can be described as the interaction among different organizational units within a legal body like a company and the interactions between legally separated organizational units such as different companies [Ballou, R. H. 2004, p. 5)].

A supply chain can be roughly differentiated into two different flows [Ballou, R. H. (2004), p. 6]:

- 1. Products or services
- 2. Information

The physical part of the supply chain is determined by the transformation of goods and services and their flow through different companies or organizational units within a company. This part has been optimized very thoroughly during the last years, especially automotive industry achieved a high level of knowledge in this area [Mentzer, J. T. et al. (2001)]. In contrast, the flow of information and especially the incorporated financial processes have been rarely analyzed and optimized [Pfaff, D., Skiera, B., and Weitzel, T. (2003), p. 2].

The E-Finance Lab, the Institute of Information Systems and the Chair of Electronic Commerce, Frankfurt University, conducted a study of the financial processes within the supply chain (the so-called “financial chain”) of the top 1,000 companies in Germany, excluding financial service institutions and insurance companies. Unlike financial service providers, the financial chain of the participating companies has only a supporting character to their core competencies.

These companies were ignored because the financial chain study only focuses on companies where the financial chain represents a supporting function.

We identified a “generic financial chain” that consists of seven subprocesses. This financial chain forms the basis of the study.

Figure 1 shows the generic financial chain divided into two main parts: financial trade enablement with the subprocesses qualify, finance, price and assure and financial trade settlement with the three subprocesses invoice, dispute and pay. Financial trade settlement covers the financial after sales actions within the financial chain. Financial trade enablement and financial trade settlement envelop the fulfillment where goods and services are interchanged. Information about these subprocesses are collected and analyzed to improve performance. For further information about the financial chain see Pfaff, D., Skiera, B., and Weiss, J. (2004).

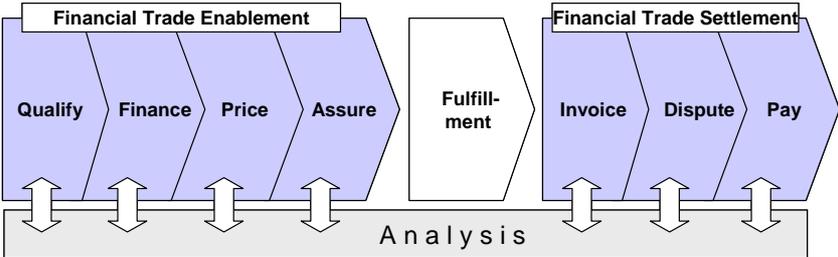


Figure 1: Generic model of the financial chain

As this part of the supply chain has not been the focus of last years' research every single subprocess and the cooperation between these can be improved.

85% - 99% of the companies stated that these seven subprocesses exist within their organization [Skiera, B. et al. (2003)]. Two of three companies quoted to be dissatisfied with their financial processes and half of them also have identified possibilities for improvement.

They were asked if they could imagine to integrate subprocesses in a shared service organization that executes the specific subprocess companywide or to outsource a complete subprocess.

51.5% of the companies are confident that several subprocesses can be integrated in a shared services organization or even be outsourced to reduce costs [Skiera, B. et al. (2003)]. The subprocess invoice seems to be one of the most interesting subprocess concerning the integration in a shared service organization: nearly 70% of the companies stated that they already integrated it, are planning to integrate it or at least believe this subprocess to be integrable [Skiera, B. et al. (2003)]. As the construction of a shared service organization requires the processes to be well-structured and documented, shared service organizations can be seen as a pre-stage to outsourcing.

Outsourcing is only an interesting option if there is a big opportunity for improvement. But an outsourcing decision requires these companies to take a closer look on their invoice subprocess and to compare their invoice process to these of other organizations.

2. Benchmarking Invoice Efficiency

2.1 A Brief Overview of Benchmarking Research in Literature

In literature the comparison of different processes is referred to as "benchmarking". The superior aim of benchmarking is the performance enhancement of an organization [Ulrich, P. (1998), pp. 15-16]. As far as the invoice subprocess is concerned, organizations try to compare their invoice process performance to other companies. Identifying inefficiencies could be an indicator to improve processes or think of a consolidation in a shared services organization or ultimately to outsource the whole process.

In general, the process of benchmarking can be divided into five steps: [Homburg, C. (2000), p. 583; Töpfer, A. (1997)]

1. Choosing an object of investigation.
2. Choosing benchmarking partners: the process of benchmarking is often differentiated into internal and external benchmarking. An internal benchmarking analyzes objects of investigation within a company whereas external benchmarking focuses on legally independent companies [Legner, C. (1999), p. 7].
3. Analysis: measuring the performance differences via the identification of operating figures.
4. Identification of improvement possibilities.
5. Execution of the identified improvement possibilities: beneath an execution the results have to be monitored and their improvement potential has to be identified via a profitability analysis.

The comparison of different units is not an invention of the last years' research [Church, A. H. (1909), p. 188]. In German literature it is known as intercompany comparison which is similar to benchmarking [Wöhe, G. (1984), p. 1254].

2.2 Choosing Methodology

The financial chain study focuses on inputs and outputs that characterize the invoice subprocess and queries two inputs and two outputs that are used for benchmarking.

As a result, a single efficiency measure using this data is required to compare these companies against each other. Due to the fact that invoices are not traded on a market and therefore there is no common market price for this output, no single or weighted efficiency relation measure like [number of cars produced multiplied with the car market price / number of people producing cars multiplied with the loan] can be estimated [Scheel, H. (2000), p.60].

Concerning these input and output data the application of the “Data Envelopment Analysis” is suitable. Data Envelopment Analysis (DEA) uses input and output factors to identify a single relative efficiency measure to compare a company to the best performing organizations [Schmid, F. A. (1994), p. 228]. This method does not require monetary inputs and outputs. Further, it uses combinations of efficient units to compare inefficient units against these linear combinations (virtual units) and identifies their relative efficiency scores [Charnes, A. et al. (1994), p. 6].

2.3 Data Envelopment Analysis

2.3.1 Basic Principles of the Data Envelopment Analysis

In the DEA context, different units that are compared against each other (f.e. companies, branches or even processes) are called “Decision Making Units” (DMU) because they are able to identify and vary their inputs and outputs [Bala, K., and Cook, W. D. (2003), p. 440]. Data Envelopment Analysis is a non-parametric approach that compares a population of observations against the “best practice” observation [Parsons L. J. (1992), p. 186]. Unlike parametric approaches such as regression analysis it optimizes on each individual observation and does not require a single function that suits best to all observations [Charnes A. et al. (1994), p. 5; Scheel, H. (2000), p. 62; Cooper et al. (2003), p. 13].

Figure 2 describes this implication. The population of DMUs is characterized by utilizing a certain amount of one input (described at the axis of abscissae) producing a certain amount of one output (described at the axis of ordinates). If DMU 13 and DMU 4 are compared, it is clear that DMU 4 produces more output at the same rate of input compared to DMU 13. Therefore DMU 4 dominates DMU 13. DMUs 2, 4, 7, 8 and 11 are also efficient because combinations of them dominate the other DMUs. These efficient DMUs build a piecewise linear frontier derived from DEA that is described by the solid line in fig. 2. Every DMU beneath this efficient frontier is inefficient.

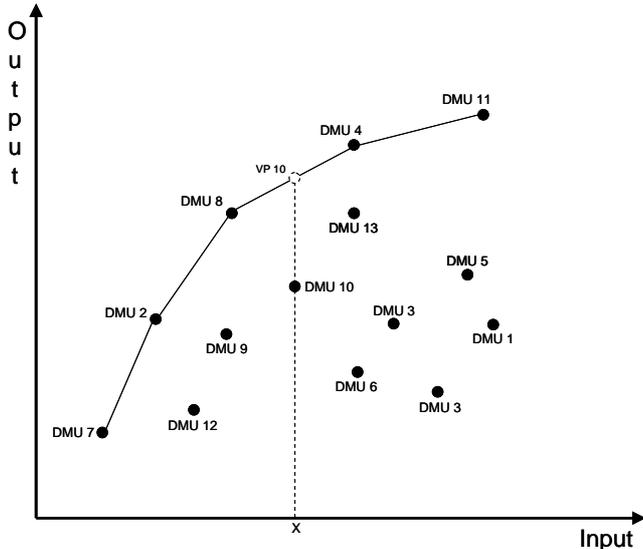


Figure 2: Basic DEA model

The usage of combinations of efficient DMUs is the heart of the DEA: these combinations are called virtual producers. For example, DMU 10 is inefficient because it lies beneath the efficient frontier. Its virtual producer lies on the piecewise linear frontier between DMU 8 and 4 described by VP 10. This virtual producer is a combination of approximately 50% of DMU 8 and 50% of DMU 4 and produces more output than DMU 10 with the same amount of input X.

The DEA efficiency measure θ is scaled between 0 and 1: efficient DMUs (i.e. in fig. 2 DMUs 2, 4, 7, 8, and 11) have an efficiency measure of $\theta = 1$, inefficient ones beneath the efficient frontier a measure $\theta \leq 1$. Subsequent the efficiency measure of DMU 10 in this simple drawing can be calculated by the fraction of the distances between X/DMU 10, X/VP 10 and DMU10/ VP 10:

$$\theta = \frac{X/DMU\ 10}{X/DMU\ 10 + DMU\ 10/VP\ 10}$$

Equ. 1: Calculation of DEA efficiency in a simple graphical one input/ one output example

In the current example the distances have the following values:

$$\begin{aligned} X/DMU\ 10 &= 6,2 \\ DMU\ 10/VP\ 10 &= 2,8 \end{aligned}$$

Resulting, DMU 10 has an efficiency measure of $\theta = 0,689 = 68,9\%$ compared to the virtual producer VP 10. This means that the input of DMU 10 has to be decreased by 31,1 % to become efficient.

It has to be pointed out that this comparison is only a relative one. All DMUs are compared to the best performing DMUs and therefore their efficiency measure is calculated in relation to all other DMUs. This implicates that a comparison in a weak market sector and its organizations could result in a differentiation described above with DEA efficient companies which may have a negative operating profit but compared to their competitors perform better (but still not profitable). Therefore, the sample of analyzed companies has to be chosen thoroughly.

2.3.2 Benefits and Limitations of the Data Envelopment Analysis

As already described in 2.3.1, DEA offers some benefits to other approaches but also has some limitations that have to be kept in mind while using DEA.

Advantages [Charnes A. et al. (1994), p. 8; Schmid, F. A. (1994), p. 228]:

- DEA is able to handle multiple inputs and outputs
- DEA does not require a functional form that relates inputs and outputs
- DEA optimizes on each individual observation and compares them against the “best practice” observations
- DEA can handle inputs and outputs without knowing a price or knowing the weights
- DEA produces a single measure for every DMU that can be easily compared with other DMUs

Limitations [Homburg, C. (2000), p. 583; Charnes A. et al. (1994), p. 5; Anderson, T. (1996)]:

- DEA only calculates relative efficiency measures
- As a nonparametric technique statistical hypothesis test are quite difficult

2.3.3 Basic DEA Models and Extensions

Data envelopment analysis is not just one single method. This analysis is a collection of different methods which serve diverse needs depending on scale effects, measurement of the distance to the envelopment surface or the functional form of the envelopment analysis [Charnes A. et al. (1994), p. 23]. In literature usually four characteristics of the DEA are differentiated

(CCR model, BCC model, Additive model and Multiplicative model). The basic CCR- and BCC model (this model will be used for benchmarking later) will be briefly introduced:

1. CCR model (Charnes, Cooper and Rhodes, 1978):

The CCR model bases the evaluation on a production technology that has constant returns to scale (CRS) and radial distance measure to the efficient frontier [Cantner, U., and Hanusch, H (1998), p. 231], i.e. that the inefficiency of a DMU compared to the corresponding efficient units lying on the efficient border is measured via a radius vector [Schefczyk, M. (1996), p. 171]. Furthermore, the efficient frontier is piecewise linear [Charnes A. et al. (1994), p. 45]. The CCR model is differentiated into input or output orientation, depending upon the reduction of inputs with constant outputs or enhancement of output with constant input [Charnes A. et al. (1994), p. 31].

As a result, the CCR model reveals an objective description of overall efficiency and identifies the sources of inefficiencies [Charnes A. et al. (1994), p. 23], i.e. how much output has to be increased for an inefficient unit to become an efficient one.

2. BCC model (Banker, Charnes and Cooper, 1984):

In contrast to the CCR model the BCC model offers a differentiation between technical efficiency and scale-efficiency [Golany, B., and Roll, Y. (1989), p. 249] because it evaluates solutions for nonincreasing returns to scale (NIRS), nondecreasing returns to scale (NDRS) or variable returns to scale (VRS) [Bowlin, W. F. (1998), p. 9]. With a combination of the CCR model inefficient CCR DMUs do not have to be technical inefficient [Cantner, U., and Hanusch, H (1998), p. 234]. Potentially a part of this inefficiency can be mitigated by increasing or decreasing the production volume resulting in a removal of scale inefficiencies. As well as the CCR model the BCC model also implies a radial distance measure and a piecewise linear frontier [Charnes A. et al. (1994), p. 45].

Like the CCR model the BCC model also differentiates into an input or output orientation [Schefczyk, M. (1996), p. 171].

These DEA models build a profound basis for an efficiency analysis with different returns to scale, different envelopment surfaces and different ways to project inefficient units to the efficient frontier [Charnes A. et al. (1994), p. 49]. During the last years', a lot of extensions to these four models have been developed which allow further fine-tuning to the basic models. One of these extensions should be briefly described because it is used for benchmarking the invoice efficiency later:

The basic DEA models always assume that inputs and outputs can be altered by the DMUs. In a realistic situation there are often variables that are exogenous and can not be altered. For example, the distribution of competitors may influence efficiency scores without being alterable by the DMUs [Banker, R. D., and Morcy, R. C. (1986a), p. 513]. These variables are called nondiscretionary.

For a close discussion of the differences between the four basic DEA models and for more information about extensions to the basic DEA models see "Data Envelopment Analysis: Theory, Methodology, and Application" [Charnes, A. et al (1994)].

2.3.4 CCR Model Algorithm

After the basic information about DEA and its different models the algorithm of the CCR model will be explained.

Basis for the efficiency measurement is usually the productivity θ [Holling, H., Lammers, F., and Pritchard R. D. (1999); Wöhe, G. (1996), p. 49] that can be described as:

$$\theta = \frac{\text{Output}}{\text{Input}}$$

Equ. 2: Efficiency measure in the one input/ one output case

This case assumes a single input and output. If some organizations are compared this way a bigger (smaller) θ means a better (worse) performance because less (more) input is used for a constant amount of output. The meaning of θ is only available through a comparison to other organizations, for this reason the efficiency measure θ is always a relative one [Scheel, H. (2000), p. 3].

Typically, organizations have multiple inputs and outputs that have to be weighted. These weights have to be defined by the researcher before a calculation. This *a priori* definition results in an inaccurate efficiency measure because it is not clear if this measures depend on the real performance or on the (randomly) chosen weights. In contrast, DEA chooses the optimal individual weights for every DMU derived from the data [Charnes A. et al. (1994), p. 5; Scheel, H. (2000), p. 62] described by the objective function in equation 3. It is important that every other DMU_l has $\theta \leq 1$ with the chosen weights of DMU_k because the DEA efficiency measure should be scaled between 0 and 1. This coherency is described by side condition 1, equation 3. Furthermore, we have the nonnegative constraints for the weights u_j and v_i .

$$\begin{aligned} \max \theta_k &= \frac{\sum_{j=1}^s u_j y_{jk}}{\sum_{i=1}^m v_i x_{ik}} \\ \frac{\sum_{j=1}^s u_j y_{jl}}{\sum_{i=1}^m v_i x_{il}} &\leq 1, (l = 1, \dots, n) \\ u_j &\geq 0 \\ v_i &\geq 0 \end{aligned}$$

Equ. 3: Basic formulation for the CCR model

This formulation shows one disadvantage: it cannot be solved by linear programming because of its nonlinear character.

$$\begin{aligned}
 & (LP_k) \\
 & \max = \sum_{j=1}^s u_j y_{jk} \\
 & \sum_{i=1}^m v_i x_{ik} = 1 \\
 & \sum_{j=1}^s u_j y_{jl} \leq \sum_{i=1}^m v_i x_{il}, (l = 1, \dots, n) \\
 & u_j \geq 0 \\
 & v_i \geq 0
 \end{aligned}$$

Equ. 4: Linear CCR algorithm

Equation 4 describes the linearized system of equations that can be solved via linear programming tools.

2.4 Empirical Data Usage to Benchmark Invoice Efficiency

2.4.1 Demography

The rate of return of the financial chain study was 10.3 % of the 1,000 surveyed companies, of which 31 companies returned a sufficient answer to benchmark their invoice processes. Sufficient means that these companies answered the four questions concerning the described inputs and outputs completely that are required for the usage of Data Envelopment Analysis. It is quite obvious that two of these 31 companies misunderstood the three input and output questions within the questionnaire because their answers diverge heavily from the other results. For example one company quotes that their annual IT costs for the production of 1,000 invoices are 11,905,000 Euro at an average of 12,658 Euro (calculated without the two outliers). These two outliers are not considered in the subsequent computations.

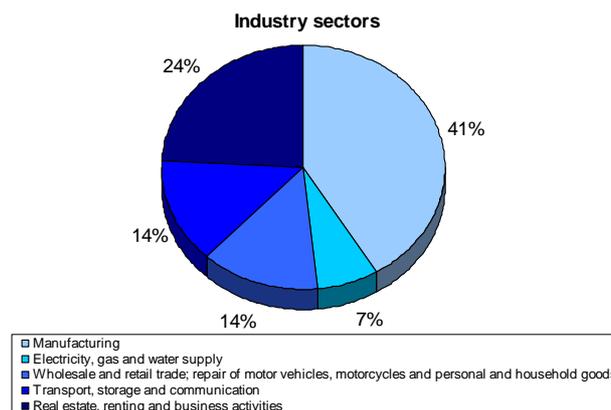


Figure 3: Industry sectors of the benchmarked companies

As a result figure 3 shows the differentiation of the 29 benchmarked companies into different industry sectors. This differentiation is based on the NACE codes that are used by the European Union to designate the various statistical classifications of economic activities. 41% of these companies are part of the manufacturing sector, followed by 24% of real estate, renting and business activities sector, 14% wholesale and retail trade, repair of motor vehicles, motorcycles and personal household sector, another 14% transport, storage and communication sector and finally 7% belong to the electricity, gas and water supply sector.

2.4.2 Classification of the Research Data into the DEA Framework

Concerning the five steps required to benchmark a unit described in 2.1 DEA just covers one step [Homburg, C. (2000), p. 583]: analysis (step 3). DEA mainly results in the single efficiency measure that allows the simple comparison of different DMUs and therefore its core competency lies in the identification of operating figures.

Besides this single efficiency measure DEA addresses a part of step No. 4 of the benchmarking process with slacks. Slacks, which are a result of a DEA, are the amount of inputs (outputs) that a DMU has to reduce (increase) in order to reach the efficient frontier and become efficient. But these figures are not as strong as required by the five step model. The identification of improvement possibilities can be fulfilled by a detailed examination of the DMUs that build the virtual producer or by a case study.

In this case the desired object of investigation (step 1) is the invoice process. This subprocess of the financial chain is focused because of its importance concerning a consolidation within an organization (i.e. a shared service organization) or even an outsourcing.

2.4.3 Calculation and Interpretation of the Efficiency Measures

As a result of the financial chain study we received 4 inputs and outputs characterizing the invoice process:

1. Input data:
 - a. IT costs per month for the invoice infrastructure and maintenance (this could be an IT infrastructure or a paper based infrastructure)
 - b. Number of people working within the invoice process and perform the operations
2. Output data:
 - a. Number of invoices produces per month
 - b. Invoice complexity measure

During the design of the financial chain questionnaire and the subsequent pretests it was obvious that none of the pretested companies was able to specify their invoice complexity with invoice line items as an optimal complexity measure. Thus, the complexity is calculated via an approximate value: total revenue per year divided by amount of invoices per year.

The benchmarking partners are the 1,000 biggest German companies without financial service providers.

The questioned companies have an amount of invoices per year that ranges from 1,000 to 60,000,000. About 70% believe the subprocess invoice to be suitable to be integrated in a shared service organization [Skiera, B. et al. (2003), p. 47]. As a result of this integration a cost reduction by exploiting economies of scope is expected.

Consequential the efficiency measures have been calculated using the BCC model algorithm which is described in 2.3.2 with the software Efficiency Measurement System (EMS) [Scheel, H. (2000), p.152] which is based on the interior point solver BPMPD [Mészáros, C. (1997)].

The EMS software was used with an input oriented adjustment because of the input oriented aim to minimize the inputs without a reduction of the output. Concerning the BCC algorithm nondecreasing returns to scale have been chosen as described above. Contrary to the other inputs and outputs the complexity measure of invoices can not be controlled by the DMUs because only customers can influence this value by their orders. Therefore the average unit's complexity must be treated as a nondiscretionary variable (as described in 2.3.2) that cannot be altered by the DMUs.

The results are described in table 1. Six DMUs (DMU 1, DMU 2, DMU 4, DMU 5, DMU 6 and DMU 8) have an efficiency score of 100% and therefore these DMUs build the efficient

frontier. Apart from the efficient DMUs it is astonishing that 7 DMUs have an efficiency score less than 1%. This result requires an examination of possible correlation to other factors.

DMU	Efficiency with NDRS
1	100,00%
2	100,00%
3	50,70%
4	100,00%
5	100,00%
6	100,00%
7	70,74%
8	100,00%
9	90,98%
10	28,79%
11	5,30%
12	8,81%
13	10,26%
14	10,27%
15	2,00%
16	1,21%
17	1,87%
18	0,37%
19	0,75%
20	0,16%
21	1,11%
22	26,56%
23	0,76%
24	9,96%
25	4,99%
26	0,59%
27	0,07%
28	0,27%
29	4,98%

Table 1: Efficiency measures (BCC-model) of the 29 benchmarked companies with nondecreasing returns to scale

As described in the physical supply chain management one thesis is that the automotive industry sector has an advantage in managing its financial chain and its subprocesses in comparison to the other industry sectors. In this case, the comparison of the invoice subprocess does not reveal a conclusion. Two of the efficient units belong to the industry sector of manufacturing while the other units are all from different sectors. Figure 4 shows the industry sector differentiation of the inefficient DMUs which are quite similar to the industry sector differentiation of all benchmarked companies described in figure 3.

Another thesis concerning the efficiency is the influence of economies of scale. The correlation between the efficiency scores and the amount of invoices per year reveals a coherency. DMU 5 and 6 have the third and second highest amount of invoices per year (20,544,000 and 50,400,000) followed by a big gap to the next company with 4 million invoices. It seems that companies with a high yearly amount of invoices tend to be efficient (Pearson's correlation coefficient of 0,439 with a significance of 0,05).

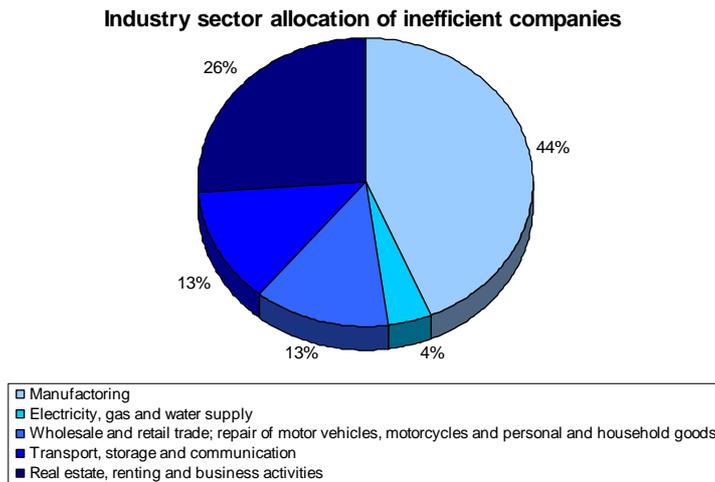


Figure 4: Industry sectors of the inefficient companies

This conclusion supports the questionnaire's outcome that the financial chain invoice sub-process contains economies of scale that are important for a consolidation of the invoice sub-process within a shared service organization or even an outsourcing of the whole subprocess. Aside from economies of scale analysis the usage of electronic bill presentment could influence the efficiency scores. A correlation analysis of the received efficiency scores with the amount of electronically shipped invoices reveals a negative correlation (Pearson's correlation coefficient of -0,345 with a significance of 0,10). This finding may sound astounding but a closer look at these companies shows that it supports the economies of scale outcome. Twelve companies answer to ship their bills partial electronically but only 5 of them ship more than 30% of their bills electronically. These 5 companies have an amount of invoices that lies far below the average of 5 million shipped bills (average amount of shipped bills of these 5 companies: 154,000). This supports the finding, that economies of scale concerning the invoice process influence the efficiency in a very strong way.

Besides the amount of invoices another correlation is significant. The financial chain study reveals that about two-thirds of the participating companies are dissatisfied or indifferent concerning their financial chain. Only 6 % of the questioned companies state to be content with their financial chain. Compared to the efficiency it shows that the inefficient companies tend to be dissatisfied with their financial chain (Pearson's correlation coefficient of 0,340 with a significance of 0,10).

3. Conclusion

The financial processes as a part of the supply chain has been rarely analyzed and optimized during the last years. Data Envelopment Analysis is used to benchmark the invoice process of the German Fortune 1,000 companies. Benchmarking is an important step to measure and compare its own efficiency with competitors that could serve as possible outsourcing providers. First research in this area reveals that there are big differences in the efficiency measures: 7 of 29 analyzed companies have an efficiency measure beneath 1% that cannot be explained by an industry sector differentiation as could be expected in comparison to the supply chain management literature [Mentzer, J. T. et al. (2001)].

But the influence of economies of scale regarding the efficiency scores is intense. Companies with a high amount of invoices tend to be efficient which is also supported by the dominance of economies of scale over the usage of electronic bill presentment.

Due to the fact that the financial chain is rarely designed and optimized to provide a competitive advantage the exploitation of economies of scale is a managerial issue. Bundling the invoice processes internally in a shared service organization or externally by using a specialized provider (business process outsourcing, BPO) a company can utilize the scale of operations of others and thereby exploit substantial economies of scale. According to the Fortune 1,000 survey, 51.5 % of the CFOs consider outsourcing of parts of the financial chain possible. Concerning the status quo of invoice subprocess sourcing, we found BPO rates of 27 %.

4. Further research

Further research in this area can be splitted into two main parts.

First of all, Data Envelopment Analysis will be extended by the integration of managerial skills as an input that quantifies the already existing input. Following the resource-based theory a further data collection will be conducted to receive information about four different managerial skills (generic, related industry, industry-specific, firm-specific) [Castanias, R. P., and Helfat, C. E , p. 664] concerning the financial chain management within the 29 benchmarked companies. Furthermore the heterogeneity of IT infrastructure within the invoice process will be analyzed in detail to identify the amounts of used IT systems and resulting gaps between them. This value will also be used as further input for DEA. Besides the input-extension a closer look at the ratios of the inputs of the efficient companies should reveal information about the optimal input composition that specify efficient companies.

Second, the usage of Data Envelopment Analysis will be compared to other statistical approaches like regression analysis and finally these two methods will be combined.

Acknowledgments

This work was developed as part of the sourcing framework of the E-Finance Lab. I am indebted to the participating universities and industry partners.

Bibliography

- Anderson, T. "A Data Envelopment Analysis (DEA) Home Page, Portland State University", <http://www.emp.pdx.edu/dea/homedea.html>, [2004/02/02].
- Bala, K., and Cook, W. D. "Performance measurement with classification information: an enhanced additive DEA model" *Omega - The International Journal of Management Science* (31:6), 2003, pp. 439-450.
- Ballou, R. H. (2004): *Business Logistics/Supply Chain Management*, 5th ed, Prentice Hall, New Jersey, 2004.
- Banker, R. D., and Morey, R. C. "The Use of Categorical Variables in Data Envelopment Analysis" *Management Science* (32:12), 1986b, pp. 1613-1627.
- Bowlin, W. F. *Measuring Performance: An Introduction to Data Envelopment Analysis (DEA)*, <http://lanes.panam.edu/edul8305/papers/introtodea.pdf>, 1998, [2004/01/04].
- Cantner, U., and Hanusch, H. „Effizienzanalyse mit Hilfe der Data-Envelopment-Analysis“ *Wirtschaftswissenschaftliches Studium* (27:5), 1998, pp. 228-237.
- Charnes, A., Cooper, W. W., Lewin, A. Y., and Seiford, L. M. *Data Envelopment Analysis: Theory, Methodology, and Application*, Kluwer Academic Publishers, Boston, 1994.
- Cachon, G., and Harker, P. "Competition and outsourcing with scale economies" *Management Science* (48:10), 2002, pp. 1314-1333.
- Castanias, R. P., and Helfat, C. E. "The managerial rents model: Theory and empirical analysis" *Journal of Management* (27:6), 2001, pp. 661-678.
- Church, A. H. "Organisation by production factors" *The engineering magazine* (38), 1909, pp. 184-194.
- Cooper, W. W., Seiford, L. M., and Tone, K. *Data Envelopment Analysis – A Comprehensive Text with Models, Applications, References and DEA-Solver Software*, Kluwer Academic Publishers, Boston, 2003.
- Earl, M. J. "The Risks of Outsourcing IT" *Sloan Management Review* (37:3), 1996, pp. 26-32.
- Golany, B., and Roll, Y. "An Application Procedure for DEA" *Omega International Journal of Management Science* (17:3), 1989, pp. 237-250.
- Holling, H., Lammers, F., and Pritchard R. D. *Effektivität durch Partizipatives Produktivitätsmanagement - Überblick, neue theoretische Entwicklungen und europäische Fallbeispiele*, http://www.hogrefe.de/aktuell/3-8017-0842-X_lese.html, 1999, [2004/03/01].
- Homburg, C. „Benchmarking durch Data Envelopment Analysis“ *Wirtschaftswissenschaftliches Studium* (29), 2000, pp. 583-587.

Lacity, M., Willcocks, L., and Feeny, D. "The Value of Selective IT Sourcing" *Sloan Management Review* (37:3), 1996, pp. 13-25.

Legner, C. *Benchmarking informationssystemgestützter Geschäftsprozesse*, Dissertation, St. Gallen, PhD thesis, [http://verdi.unisg.ch/org/iwi/iwi_pub.nsf/wwwPublAuthorEng/87C790B3BDD2D05CC1256BD700347F72/\\$file/Diss990724_druck.pdf](http://verdi.unisg.ch/org/iwi/iwi_pub.nsf/wwwPublAuthorEng/87C790B3BDD2D05CC1256BD700347F72/$file/Diss990724_druck.pdf), 1999, [2004/01/26].

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., and Zacharia, Z. G. "Defining Supply Chain Management" *Journal of Business Logistics* (22:2), 2001, pp. 1-26.

Mészáros, C. "BPMPD Home Page", <http://www.sztaki.hu/~meszaros/bpmpd/>, 1997, [2003/12/28].

Parsons L. J. "Productivity Versus Relative Efficiency In Marketing: Past And Future?" in *Research Traditions In Marketing (Recent Economic Thought)*, Lilien G., Laurent G., and Pras B. (eds.), Kluwer Academic Publishers, Amsterdam, 1992, pp. 169-196.

Pfaff, D., Skiera, B., and Weiss, J. *Financial Supply Chain Management*, Galileo Press, Bonn, 2004.

Pfaff, D., Skiera, B., and Weitzel, T. „Financial-Chain-Management – Empirische Fundierung und Ansätze zur Verbesserung“ forthcoming in *WIRTSCHAFTSINFORMATIK*, 2004.

Scheel, H. *Effizienzmaße der Data Envelopment Analysis*, PhD thesis, Deutscher Universitäts-Verlag, Wiesbaden, 2003.

Schefczyk, M. „Data Envelopment Analysis“ *Die Betriebswirtschaft* (56:2), 1996, pp.167-183.

Schmid, F. A. „Messung technischer Effizienz durch DEA - Ein Kommentar zu Sheldon“ *ifo Studie: Zeitschrift für empirische Wirtschaftsforschung* (40), 1994, pp. 227-36.

Schott, E. *Markt und Geschäftsbeziehung beim Outsourcing: eine marketingorientierte Analyse für die Informationsverarbeitung*, PhD thesis, Deutscher Universitätsverlag, Frankfurt, 1997.

Skiera, B., König, W., Gensler, S, Weitzel, T., Beimborn, D., Blumenberg, S., Franke, J., and Pfaff, D. *Financial-Chain-Management – Prozessanalyse, Effizienzpotenziale und Outsourcing – Eine empirische Untersuchung mit den 1.000 größten deutschen Unternehmen*, Research report, Frankfurt, <http://www.efinancelab.com/pubs/pubs2003/fcm.pdf>, 2003, [2003/10/02].

Ulrich, P. *Organisationales Lernen durch Benchmarking*, Deutscher Universitäts-Verlag, Wiesbaden, 1998.

Wöhe, G. *Einführung in die Allgemeine Betriebswirtschaftslehre*, 15th ed., Vahlen, München, 1984.