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understanding reality — facing challenges — creating future

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Inhalt

THE ABSORPTION OF NEW TECHNOLOGIES

For several years the adoption of general purpose technologies like internet and its effects are intensively discussed by scientific scholars and practitioners. These technologies are seen a driving force to use firm's internal and external resources efficiently and to increase firm's competitiveness. It is questionable whether firms in traditional industries are able to pick up new technologies quickly.

The present edition mainly addresses the role of product characteristics and firm's embeddedness in particular value chains to explain the propensity to adopt new technologies like E-Business solutions. E-Business solutions allow to overcome limitations in the size of markets at firm location. The Baltic Sea region is a natural example for the geographical limitation of markets at firm location. Therefore, E-Business solutions are of particular relevance for firms in this region. Given this, it would be appropriate to analyze empirically the determinants of the adoption of new technologies and their economic effects in adopting firms.

The first article in this issue provides empirical evidence for firms in the textile sector to address the role of product characteristics for adopting new technologies. The second one asks for the relevance of firm's embeddedness in value chains to explain the adoption of E-Business solutions. In the second part of this edition we shed light on two relevant management tools in practice, namely balancing scorecard and models to forecast the evolution of stock prices.

We hope that you will enjoy to read this issue of the Baltic Management Review and that you will benefit from these articles.

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THE CONDEMNED LIVE LONGER:
THE INNOVATION-DRIVEN RECOVERY OF THE GERMAN TEXTILE INDUSTRY

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FIRM PERFORMANCE AND SIZE; TEXTILE INDUSTRY

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THE CONDEMNED LIVE LONGER:
THE INNOVATION-DRIVEN RECOVERY OF THE GERMAN TEXTILE INDUSTRY

ABSTRACT

This article discusses how a midtech industry of a highly industrialized country is able to improve its competitiveness and to ensure its survival in a globalized economy. The SME dominated and crisisridden textile industry of Germany was chosen as an example. Our analyses of the underlying industry specific innovation systems revealed three success factors which ensured the recovery of parts of the textile industry namely: (i) collective research, (ii) the coverage of new markets and (iii) a long lasting professional and spatial proximity between companies and research institutes. With data from a firm survey and an econometric model we try to reveal the positive effects of these forces on firm growth.

JEL: L25, L67, O31, O38

1. The German textile industry: A story of long decline and recent recovery?

Since at least two decades certain countries in Asia, South America and North Africa realized a tremendous growth in production, export and employment due to low labour costs and the tendency of international firms to shift production capacities from highly industrialized countries to the East and South (Grömling and Matthes 2003). In contrast many Old Economy sectors in highly industrialized countries face a remarkable downturn with declining production, employment and firm size. The textile industry is an outstanding example for such a development. The heavy losses in the textile production of industrialized countries on the one hand and the remarkable growth rates of some emerging countries on the other are shown by table 1. In Japan and United Kingdom the production has almost completely collapsed, whereas in China, the GDP from manufacture of textiles has doubled in the last five years. Many other industrialized countries are long way from their former levels. The decline of the (West) German textile industry already started in the early 1960s. The number of employees decreased from 600,000 to 90,000 in 2007. For many decades the majority of labourers were employed by large firms. But since 1995 around two third of the workforce is employed in SMEs with up to 250 labourers. However, with a view to table 1, there is some indication that the downturn of the SME dominated textile industry in Germany is seriously attenuated since 2005.

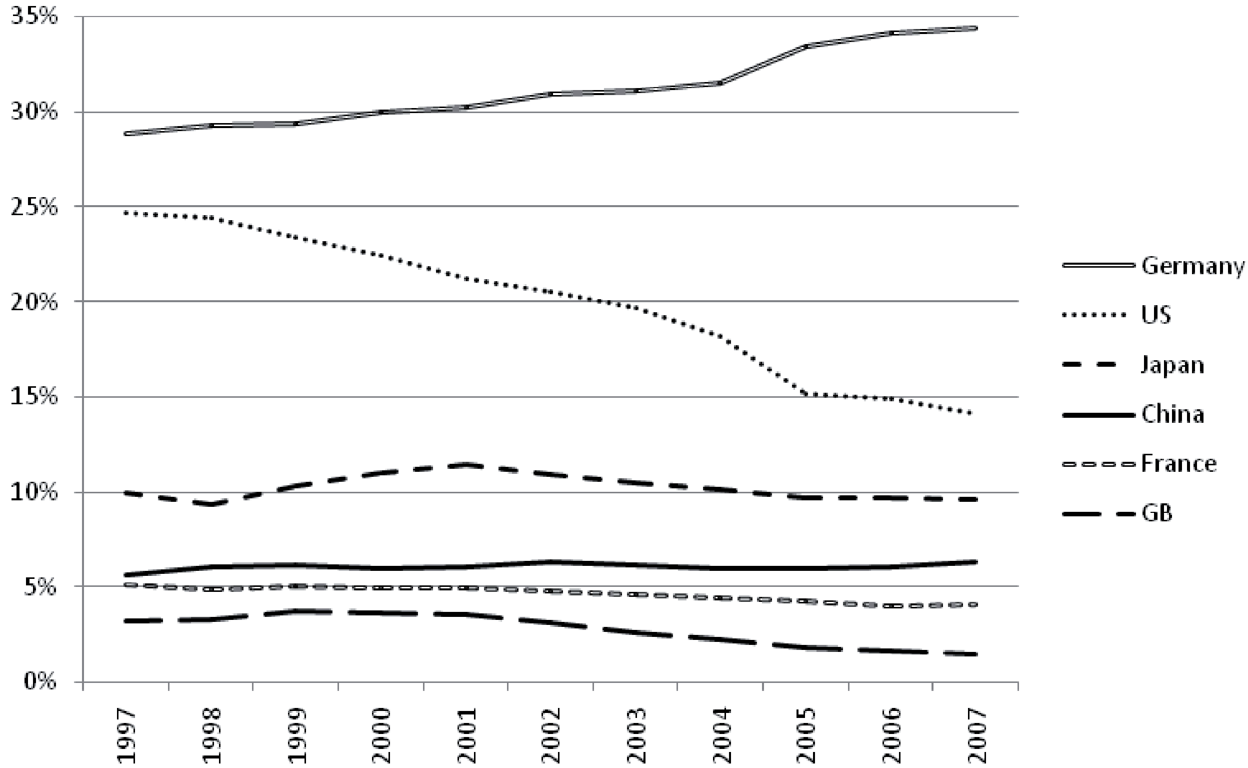
TABLE 1: GDP of textile industry in industrialized countries

Country	GDP from Manufacture of Textiles and Textile Products						
	US$ mn	Index 1997 =100					
	1997	1997	1999	2001	2003	2005	2007
Germany	12,644	100.0	96.3	93.4	85.3	80.9	82.5
France	11,935	100.0	96.4	91.9	87.6	75.9	71.1
USA	24,960	100.0	99.0	85.8	87.1	78.7	70.6
Australia	3,860	100.0	105.3	94.5	80.9	66.8	64.9
Japan	38,623	100.0	80.6	61.7	51.1	42.5	38.1
United Kingdom	11,351	100.0	83.7	71.9	57.2	48.8	37.0
China	39,375	100.0	104.0	122.3	142.7	190.9	258.0
India	6,388	100.0	111.3	126.5	142.3	169.7	204.1
Brazil	7,912	100.0	105.5	111.2	122.5	155.5	182.2
Tunesia	972	100.0	114.3	141.5	145.8	143.1	153.9

Source: Own calculations based on Euromonitor International (2010).

And there is a second striking feature of the German textile industry. Figure 1 shows the development of textile patent applications. Certain high industrialized countries like Japan or France hold shares of the patent application below 10% out of a total of 2,915 EPO-applications in the year 2007. The USA had a share of 24% in 1997 but just of 14% in the year 2007. In contrast, Germany's share grew in the same period from 28% up to 34%. These figures are very noticeable because of two relevant facts: Firstly, the German industries together hold an average share of patent applications of only 18% in 2007 and secondly, the German textile industry is stongly dominated by small and medium sized firms (SME) that usually have a reduced tendency innovate and to protect their innovations by patents (Arundel and Kabla 1998, INPI 2004, Macdonald 2004).

Figure 1: Share of Textile Patent Applications at European Patent Office (EPO)



Source: Own calculations based on PATSTAT Database. Number of patent applications 1981 = 939 and 2007 = 2,915.

Taken these facts together, one may ask (i) whether strong efforts in R&D might be a reason for a potential recovery of parts of the German textile industry and (ii) what about the ability to conduct R&D by the SMEs of this crisisridden industry.

At this point our paper joins the discussion and aims to show due to what modes and means the German textile industry tries to keep pace successfully with the globalized competition due to steady collective R&D activities, which are an important precondition in order to capture new markets with innovative products.

Our paper is divided in five parts. This introduction is followed by a brief discussion of conceptual anchor points, the research questions and the design of our study (part 2). The third part describes the structures and development of the German Textile Innovation System. In part 4 we present findings on success factors of the German textile industry, involving some descriptive statistics of our firm survey and an econometric model. We end with some conclusions (part 5).

2. Conceptual consideration, research questions and study design

2.1 Conceptual anchor points

Since around two decades a growing number of studies analyses the role of SMEs in a globalized economy (Audretsch 2003, Ratten et al. 2007). Many contributions focus on the emergence and the positioning of firms in globalized production systems of hightech industries and the knowledge intensive service sector (Jones 1999, Aspelund and Moen 2004). Oftentimes this literature is concerned with the linkages between innovation and its finance, foreign direct investment, export activities and the growth perspectives for SMEs (Acs et al. 1999, Gilroy et al. 2008). These studies on internationalization concentrate on the outward orientation of SMEs either in highly industrialized countries (Volery 2008), newlyindustrializing countries (Aw et al. 2001) or in Eastern European economies (Moskowitz 2008). Oftentimes such studies are restricted to the firm perspective (Hollenstein 2005).

Another line of research deals with firm clusters or rather spatially bound innovation networks as a precondition to enhance SMEs competitiveness in particular – mainly upcoming - industries (Yamawaki 2002, Sturgeon 2003). Related to it, other authors discuss the decline of SME-dominated traditional industries in particular regions of highly industrialized nations (Schamp 2005). Oftentimes the discourse is centred on the modes of buffering the effects of restructured globalized value chains due to some kind of public intervention which aims at networking of local firms. The focus is on the survival of a rather limited number of highly specialised firms within their small ancestral spatial domain.

However, we see further scope to enrich the discussion about competitiveness of SMEs in globalised economies by widening the perspective on an important mid tech industry with respect to the number of firms and employers at the national level. We take the challenge to study success factors of the recovery of at least a part of the German textile industry as an example for a larger SME dominated industry. In this context it will be purposeful to take up an allembracing view on industries and the development path of its related sectoral and regional innovation systems.

A first important conceptual approach is related to the problem of the easy and worldwide access to technical knowledge in the era of the World Wide Web (Maskell 1999). But many studies could show that interorganisational activities can initiate a systematic information exchange and joint knowledge creation in relation to the development of favourable conditions for R&D and innovation activities in a particular region without losing valuable information. Such activities further stimulate learning processes aimed at generating region specific tacit knowledge, thus creating competitive advantages in supra-regional, i.e. international competition (Gertler 2003).The successful organisation of such region- and industrybound interorganisational activities of firms, intermediary and public organisations as well as associated teaching and research institutes requires a well structured institutional setting. Hence, appropriate policy strategies, public promotion schemes and joint strategic efforts of firms and their associations together form socalled Regional Innovation Systems over a longer time (Lundvall and Maskell 2000, Cooke 2003). Firms which are embedded in such an innovative milieu have some means in hand to shift into new value chains with high quality products and address new markets (Humphrey and Schmitz 2002).

An aligned theoretical anchor point is the concept of different types of proximity (Gertler 1995, Gertler and Wolfe 2006). It helps to understand that spatial proximity alone is not at all a sufficient precondition to develop the necessary linkages between firms, organisations and persons in order to form a robust innovation system. The professional proximity – i.e. the relation between (former) colleagues, fellow students and alike through which socalled communities of practice are formed - is a very important requisite for stable and trustful relations for the exchange of sensitive R&D-related tacit knowledge within a region and/or an industry (Benner 2003). Professional proximity requires on the one hand temporary spatial proximity but also allows to keep relations over longer geographical distance. Thus, different RIS - which focus on a particular industry such as textiles - can be linked with each other and probably form a superimposing sectoral innovation system at the national scale. This would help to prevent regional 'lock-ins' (Grabher 1993), as interregional links foster the influx of external knowledge and thereby promotes again collective R&D activities and the following individual innovation activities at the firm level in a particular region.

2.2. Research questions and study design

Against the empirical findings and the described conceptual anchors this paper aims to analyse potential success factors of the recovery process of the German textile industry. Thus, our study is focussed on three central questions related to the Textile Innovation System (TIS):

How can R&D be conducted in a crisis-ridden SME dominated industry and what role play collective approaches to innovation?

1. Which topics and new markets are in the focus?
2. What role different types of proximity between firms and their R&D-partners play?

By answering these questions we aim to provide an inside into the intra industry mechanisms which help to regain competitiveness of SMEs in "old industries" in the era of globalization. Further, we scrutinize the role of spatial proximity of actors as either an indispensible precondition, a remarkable barrier or a neglectable factor for the development of a powerful sectoral innovation system.

The paper is based on the evaluation of the largest SME related public promotion scheme on industrial R&D in Germany, which is named ICR – Industrial Collective Research (cf. part 4.1). The evaluation takes place since 2005 and will end in the year 2010. It contains a serial of studies on the programs effect on particular segments of the economy.

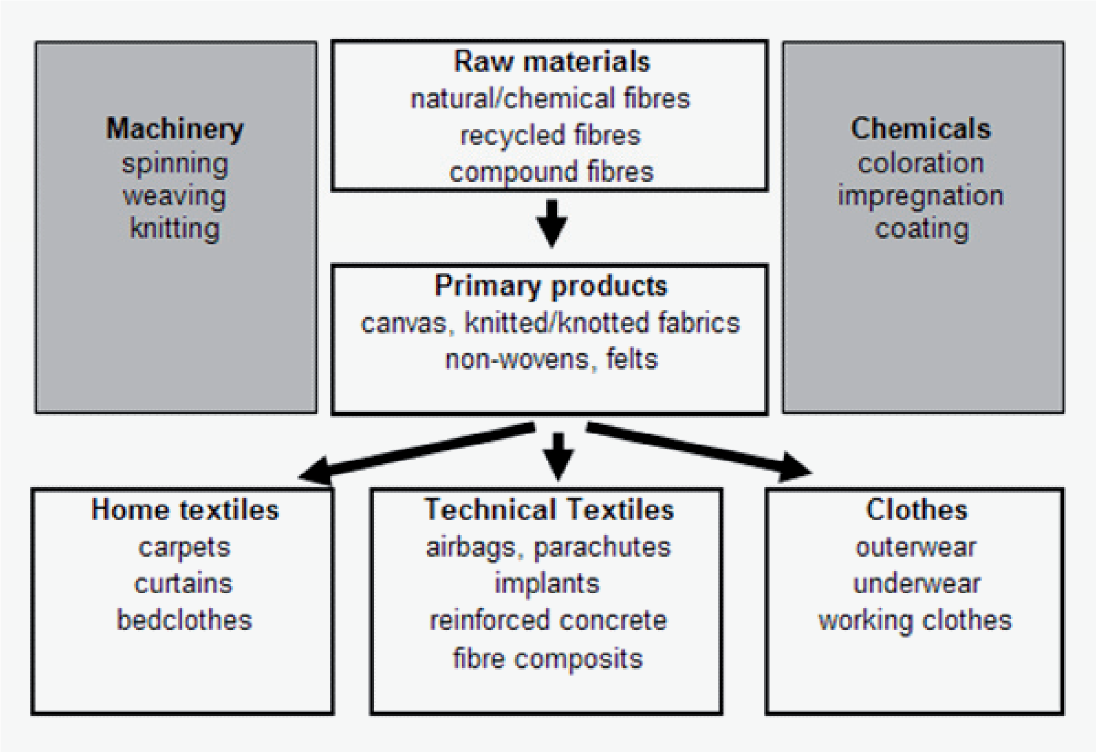
This paper discusses main results of a special study on effects of the ICR programme on German textile industry. It was conducted between May 2008 and July 2009. The study design contains one the one hand 20 personal interviews with representatives of research institutes, intertrade organisations, chambers of commerce, (semi-)public development agencies, universities and firms and on the other a standardised questionnaire in the textile industry. Our sample consists of 335 firms, most of them (85%) are performing R&D and three out of four firms belong to the group of SME. For classification we have used the SME-definition accord-ing to the EU (<250 employees and <= 50 Mio. annual sales). We evaluate some descriptive statistics and - to explore the elaborated pattern more rigorously - the empirical methodology proceeds by specifying a probit model describing the probability of firm's success.

Further, we analysed the database of the national programme for SME oriented collective research, certain official statistics and relevant literature on the development of the textile industry and related fields of industrial R&D. In addition we used data from OECD, UNO and the European Patent Office (EPO) to analyse the general macroeconomic framework the German textile industry is currently faced with.

3. The German textile innovation system

The structure of the technology field Textiles is presented in figure 2 and reflects the interrelation between different production chains at different stages which again provide the link to R&D-activities. At first we find the stage of primary products like fibres, canvas, knitted & knotted fabrics, nonwovens and felts. Linked to it is R&D which focuses on textile machinery and chemicals, which are used for coloration, impregnation and coating. Other research streams are oriented towards home textiles and garments. But the most promising field of research at present is the quite heterogeneous segment of technical textiles. They find buyers in the automotive and aircraft industry, in the medical engineering, the construction sector, agriculture and the field of environmental protection.

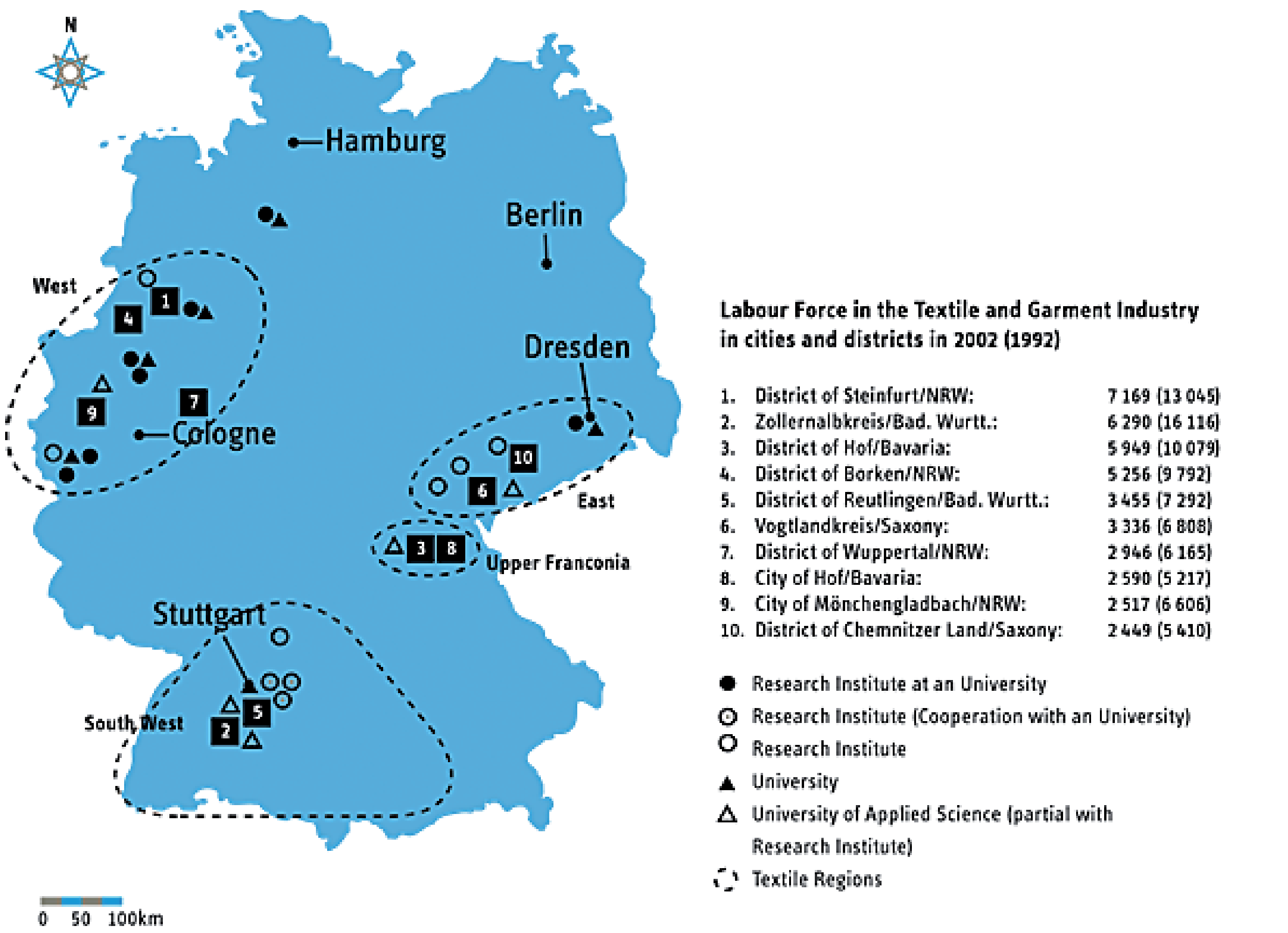
Figure 2: Technology field Textiles



Source: Own depiction.

The Textile Innovation System (TIS) in Germany is quite multi-faceted structured and therefore able to cover all the mentioned segments of the technology field Textiles quite satisfactory. The spatial orientation of the system is linked to the geographical distribution of production centers (figure 3). Despite of its decline in the 1990s the textile industry shows a high persistence of its spatial pattern. At present we find four regional production centers, namely the Rhineland – Munsterland region ("West", mainly in the federal state of North Rhine - Westpha-lia), the Alb - Schwaben region ("South West", mainly in the federal state of Baden-Wurttemberg), Upper Franconia (the northern part of Bavaria) and the "East" (parts of Saxony and Thuringia). The last two mentioned clusters were separated by the inner-German borderline until the unification in the year 1990.

Figure 3: The German Textile Innovation System with its three regional innovation systems and main production centres



Source: Own depiction and calculations based on Federal Employment Agency, Region West.

The historical roots of the TIS go back to the 19th century. Due to the joint effort of firms and local politicians an institution was founded in 1855 in the South Western part of Germany (figure 5). It was a combination of school for textile engineers, a public research institute and a laboratory which could be used against fees by textile firms of the region. This was the seed of what is now the largest cluster of textile research in Europe. The Southwest region contains 1 university and 2 universities of applied science with related faculties. Further 4 out of 17 textile R&D institutes in Germany are located in this area, were around 250 out of altogether 1.000 German textile scientists are working. The institutes are personally linked with the university through the leading scientists (figure 5).

A similar situation we find in the textile regions West and East, were universities and free R&D institutes together form a strong “critical mass”. Only the traditional textile region Upper Franconia does not own considerable research capacities. Nevertheless, a university of applied science ensures the education of textile engineers.

Our study revealed the existence of a comprehensive set of personal relations between the R&D institutes and the firms (see part 4.3). One indicator is the large share of firm represen-ta-tives in the scientific boards of the research institutes (table 2). This is of particular importance, since the scientific boards decide over research strategies, the execution of particular projects, different forms of cooperation with interested firms as well as the modes and means to inform them regularly about the R&D activities of the institute.

TABLE 2: Composition of Curatorships and Scientific Boards in Textile Research Institutes

Commitee	Member*	Share of firms (%)	Share of regional members (in %)
Hohensteiner Institute, Bönningheim (Baden-Württemberg)			
Curatorship	12	58,3	58,3
Scientific board	39	56,4	30,8
DITF Denkendorf (Baden-Württemberg)			
Curatorship	32	68,8	65,6
Scientific board	34	67,2	42,3
DWI Aachen (North Rhine-Westphalia)			
Regular members	102	55,9	43,1
STFI Chemnitz (Saxony, Thuringia)			
Curatorship	16	25,0	81,3
Scientific board	22	63,6	40,9
TITV Greiz (Thuringia, Saxony)			
Curatorship	13	46,2	84,6
Scientific board	18	61,1	38,9

Source: Annual statistics 2007/2008; * individuals, firms, research institutes, organisations.

In the Southwest the share of firms is about 60 to 70% and in the Eastern region between 50 and 60%. Further, in the Southwest (East) about 40 to 60% (40 to 80%) of all the members of the scientific boards are from the same region. However, this result indicates not only a strong connection between science and firms but also between the research institutes and the region. These findings also show, that there are many linkages of the R&D institutes to other partners than enterprises, i.e. firm associations, representatives of the political administration and agencies of business promotion. Moreover, the regional systems are open systems, since a remarkable number of board members are from outside the particular regions.

All the textile research institutes, the different branch associations as well as firm representatives do form a national textile research association (FKT - Forschungskuratorium Textil). One of its tasks is to develop jointly a research strategy for the technology field Textile over a period of 5 to 7 years. Further, the FKT organizes together with the R&D institutes the application for public project funds, as in the case of the ICR program (see part 4.1). Thus, the FKT and the R&D institutes constantly adjust their research strategies and annual programs with each other. In this way they also consider the various focus of research of the institutes, i.e. the manifold strengths of the actors in the TIS. As a result, the different aspects with regard to research content, national and regional activities are abridged within the German TIS.

Within the regional centers of textile production the research institutes also interact with the political actors and region based firm associations in order to adjust collective R&D activities on particular regional conditions. For example in East Germany, the federal government and the state governments launched certain promotion schemes for SMEs (e.g. the InnoRegio Program) in order to boost the clustering of innovative firms – including those from the textile industry – following the tremendous structural changes in East Germany after the political unification in 1990. Hence, a large array of schemes is available since the end of the 1990th to East German textile firms and R&D institutes. Their joint usage is organized in the federal state of Saxony by a socalled "Textile Industry Coordinator" who manages research alliances between R&D institutes, textile firms, regional firm associations and consultants under particular research schemes. In this way collective R&D is "tailor made" for the textile Industry in East Germany.

Another example is the state of Baden-Wurttemberg (figure 5: "Southwest") were the state government launched a cluster oriented program in 2009. It aims to enter new markets for the regional textile industry, in particular for the producers of technical textiles. Here the R&D institutes play also an important role in arranging meetings between decision makers of textile firms and those from other industries were technical textiles have good prospects as substitute materials.

A last important feature of the German TIS is the large array of knowledge transfer activities as well as of consultancy offers to firms which are organized by each R&D institutes or groups of them. Examples include regular conferences to inform the companies about the latest R&D results, brainstorming workshops with particular groups of firms on specific topics, individual workshops within textile firms on their demand, newsletters or the exchange of researchers and trainees / students between the R&D institutes, firms and the universities in the region. Our study revealed, that all 17 R&D institutes try to keep a balance in their knowledge transfer activities in the sense that they address equally the firms of their region as well as firms in other parts of Germany, which are interested in the research focus of the particular institute. Again, in this way the national, regional and sectoral parts of the German TIS are interlinked with each other and form a very complex, stable but overall flexible innovation system.

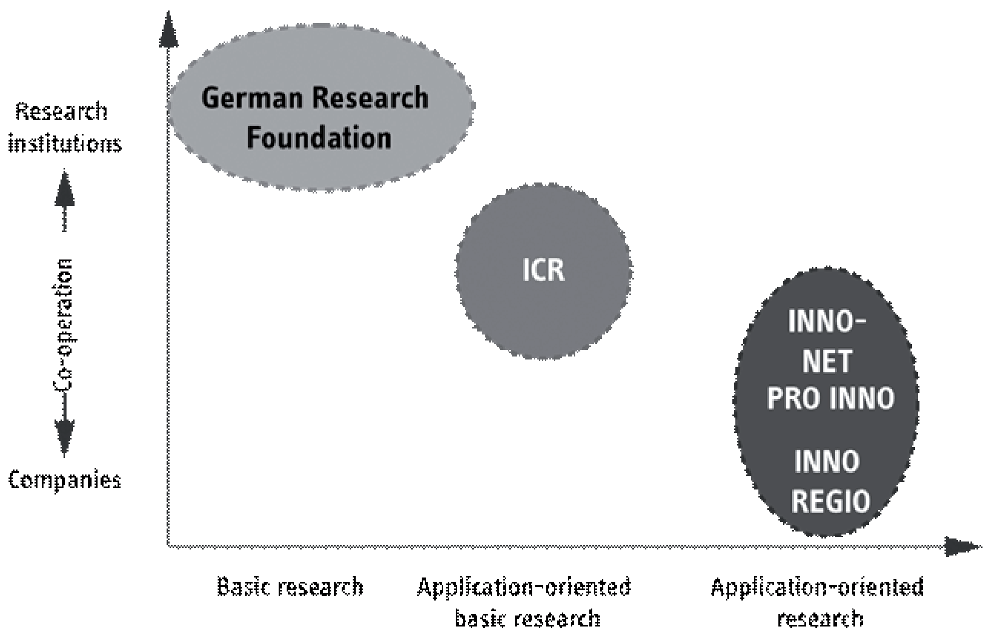
4. Success factors

4.1 Collective Research

The ICR programme is an outstanding example of a network-oriented technology programme which has developed in Germany for half a century: It has been launched originally by the Federal Ministry of Economic Affairs (BMWi) in 1954. Its target has been from the beginning to strengthen the innovation capacity of SMEs and foster their competitiveness by financing precompetitive industrial collective research. Today, SMEs are regarded as essential source of industrial inventions and major actor involved in product and process innovations. Financing industrial R&D for SMEs is seen as a mean of triggering external benefits which would – via spillovers – by far exceed the expenses originally incurred. Thus, ICR is viewed as an instrument of compensating for 'underinvestment' in R&D by SMEs which results from market failure, e.g. informational asymmetries in financial markets in financing innovation.

Financing research networks has always been the core of ICR activities, i.e. many years before "networking" became an outstanding subject in innovation economics. In this sense ICR introduced a component into German technology policy which predates scientific reflection on innovation processes by many years. The focus of the programme lies on application oriented basic research. Thus, it serves as an interlinkage between basic research programmes such as projects promoted by the German Research Foundation (DFG - Deutsche Forschungsgemeinschaft) and other more application or diffusion oriented programmes (e.g. INNO NET, PRO INNO or INNO REGIO) that are more readily usable (figure 4). In contrast to the programmes focussing on basic research (main addressee: research institutes) and applied research (main addressee: firms) the ICR programme contains a strong enforcement for a cooperation between research institutes and business firms. Thus, the research interest of the textile firms should be considered and that is decisive for the later application of the research results at the firm level. In this context the research institutes are constantly competing with each other in order to gain public funds for industrial collective R&D.

Figure 4: Innovation programs of Federal Government of Germany



Own depiction.

The whole ICR-program is founded with about 100 Mio. € per year. During the last decade textile projects administrated by the national textile research association (FKT) were subsidised with 15% to 20% of this amount. This emphasises the both the important role the textile industry plays in the system of ICR and the important role the ICR plays for the R&D of this branch. Due to this continuous funding the actors of the textile innovation system were able to build a research infrastructure that is considered exemplary for other innovation fields.
According to the programme rules which are presently in force each ICR project is guided by a project Project Advisory Board. The board members are representatives of firms which are interested in the research project. The regulation that at least 50% of the firms represented should be SMEs. Firms mainly participate to obtain ideas or even concrete solutions for technical problems which have to be solved in the own firm. Other motives include the interest in communication on technical questions with the research institutes involved.

Table 3 shows the importance of ICR in the German textile industry. Around 40% of polled firms have already attended an ICR project. Enterprises producing textile machinery reach the highest share with 65%, whereas only 22% of home textile and clothing firms are taking part in ICR activities. More than one third of all textile firms have already used results of ICR-projects. The shares of participation and utilisation for SME's are below average but nevertheless remarkable.

TABLE 3: Importance of Industrial Collective Research in Textile Industry in Germany

	n = …	Participating in ICR-projects	Using ICR-results	Performing R&D
Textile production	90	43%	36%	94%
Technical textiles	55	36%	33%	93%
Home textiles and clothing	77	22%	18%	65%
Textile machinery	31	65%	55%	100%
Textile Services	39	56%	67%	69%
Other	43	44%	28%	93%
Large firms	81	59%	52%	96%
SME	254	35%	30%	81%
Total	335	41%	36%	85%

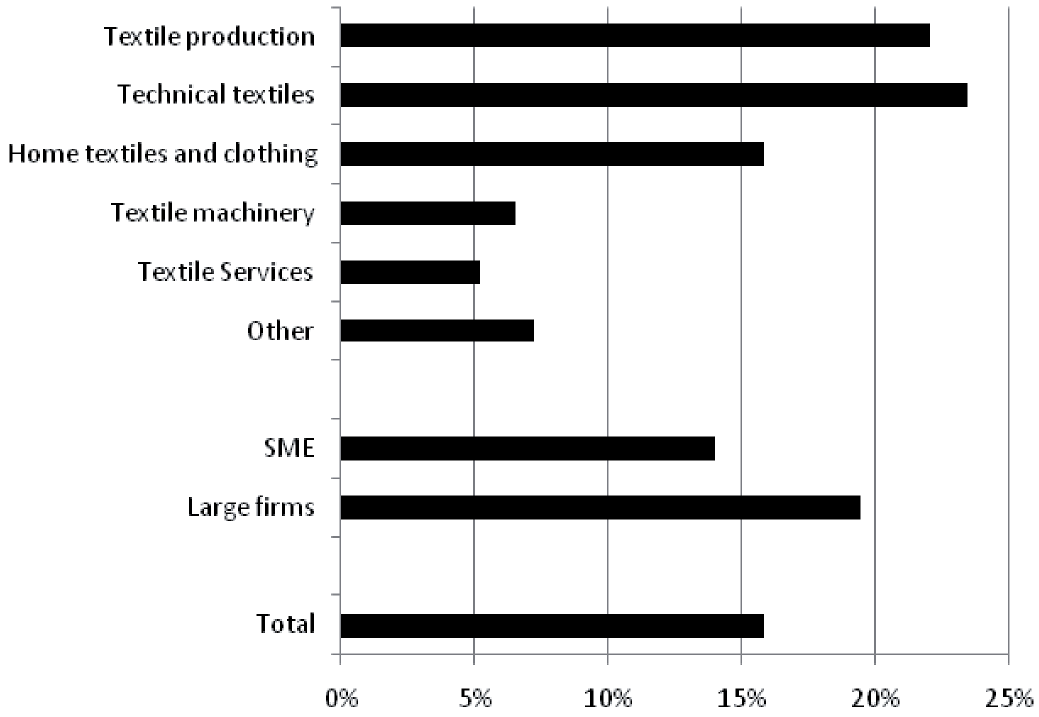
Source: Own survey, 2008/09.

4.2 New markets

The tremendous downturn of the textile industry in highly industrialized countries is mainly related to the shrinking demand for simple preliminary products for the garment production, which is nowadays largely located in the countries with low labour cost in Asia, North Africa and partly Eastern Europe. In order to survive the producers of textiles were in search for new markets, i.e. for high quality textiles latest since the middle of the 1990s. Major buyers are the big producers in the automotive, rail and aircraft industry, the firms from medical engineering, mechanical engineering, the logistic and transport sector, the environmental as well as the construction sector. Our study revealed, that altogether 16% of the sample firms extended their product range since the year 1995 and focussed at least partly on the production of technical textiles (figure 5). In this way the group of firms grew, which are solely going for technical textiles (TT). But also firms which remain in other segments of the textile industry show a remarkable tendency to enter this heterogeneous new market. This is in particular true for the producers of textiles as a preliminary product for subsequent treatment.

Further, we found that from the 54 firms of our sample (n = 335) which are actual TT-producers 75% are SMEs. And around two third of the TT-firms recorded an employment growth of at least 10%, and one third of at least 30% during the period 1995 to 2007. Many SMEs were amongst them. Hence, this seems to be an indicator for the fact that the occupation of new markets is a factor of success for SMEs in the German textile industry.

Figure 5: Extension of product range between 1995 and 2007 - technical textiles



The actors of the TIS reacted accordingly. In the year 1998 just 24% of all research projects conducted by actors of the described German TIS were focusing on TT. Considering the subgroup of ICR-projects the share was just 20% (table 4). In contrast the share of TT projects on all ICR-projects was 47% in the year 2008. In the group of projects financed by other donors the share of TT related projects reached even 67%.

TABLE 4: Importance of technical textiles in research projects of the German TIS

	ICR-projects		Other research projects	
	1998	2008	1998	2008
Overall research projects	113	90	96	94
Research projects focusing on technical textiles	23	42	27	60
Share of projects focusing on technical textiles	20%	47%	28%	64%

Source: Own calculations based on FKT and AiF project database.

These figures show a remarkable shift in the research strategy which is based on joint decisions made by firms, scientists and public organizations dealing with SME and R&D promotion. Our studies also revealed, that between the years 2003 and 2007 altogether 135 ICR projects were conducted in the technology field Textiles. In 60% of these projects the Project Advisory Board was not only staffed with representatives of textile firms but with decision makers from other industries which are mainly interested in using technical textiles. Thus, one can state that the ICR program not only helps to gain knowledge with respect to new products and markets but it also helps to establish the necessary relations between the textile firms and other industries, i.e. customers.

Finally, there are signs that the focus on research in TT helped to strengthen the global competitiveness of the innovative part of the German textile industry. Table 5 shows that in comparison to other highly industrialized countries Germany still realize a remarkable sale of textiles in total. But the remarkable point is the high share of TT products with 12% of 13.4 Bio € in the year 2004. Traditional producers like UK and France do not even scratch the 5% line.

TABLE 5: Share of technical textiles sales in different countries

	Sales volume 2004 [Mio. €]		
Country	Technical Textiles (TT)	Textiles (total)	Share of TT
France	541	12,800	4.2%
Germany	1,585	13,400	11.8%
Italy	796	37,000	2.2%
Spain	278	9,200	3.0%
UK	430	9,200	4.7%

Quelle: Own calculations based on: UN Statistics Division (2009), OECD (2009)

4.3 Proximity between firms and R&D partners

Our description of the German TIS structure has already suggested that the spatial proximity of firms and organizations as well as the professional proximity of its staff members play equally an important role in its foundation, preservation and future development. There are more hard facts which confirm this finding.

We analyzed the regional constitution of the Project Advisory Boards of the 135 textile ICR projects between the years 2003 and 2007. It was found that only in 5% of the cases all firms representatives belonged to the same textile region (West, East, Southwest) like the R&D institute which was responsible for the particular project. But in 42% a large share of firms were located in the same region. For the other 53% of the cases we could note a high spatial dispersion of the board member firms and the R&D institutes. Thus, in nearly half of the analysed projects we could identify a high spatial proximity. But there is a good reason to believe, that the other project groups were also working with success. According to all interview partner professional proximity is glue and lubricant for a successful project work.

When we asked the textile firms in our questionnaire for the location of their external R&D partners we found that spatial proximity to the nearby R&D institutes plays a very important role for the East German firms (table 6). Here, the firms are comparatively new in the market and very small. Hence, R&D is of a particular risk. On the other hand, the leading scientists of the East German R&D institutes and the leaders of the regional textile business association are well known to many firm owners due to former joint professional activities in the old textile state holding companies which existed before the unification in 1990. According to our interview partners this is the base for a very trustful interaction in the region. Thus, simultaneously to spatial proximity – i.e. short distances – the professional and even cultural proximity plays an important role for the existence of the TIS in East German textile cluster.

TABLE 6: External R&D-Partners of textile firms (multiple answers, share in %)

Firm location	No. of firms with external R&D-Partners	Research institute location			University	Enterprises
		East	Southwest	West		
East	66	50.0	4.5	0	6.1	34.8
Southwest	50	8.0	40.0	8.0	14.0	50.0
West	55	20.0	25.5	32.7	16.4	54.5
Other regions	46	21.7	26.1	26.1	15.2	45.7
Total	217	26.7	22.6	15.7	12.4	45.6

Source: Own survey, 2008 / 09.

Table 6 also shows, that firms in the Southwest also prefer to cooperate with R&D institutions of the region (40%) but also and to a larger extend with other firms (50%). In contrast the respondents from the Western region tend to cooperate with many R&D institutes in all the 3 regional TIS and to the largest extend with other companies (55%). This indicates that professional proximity permits to cooperate by crossing regional boundaries.

This thought is supported by the results presented in table 7. We asked whether the firms discuss with other companies in the region the results of ICR projects. In total 28% of the firms discuss ICR results with neighbour firms. The highest shares are found for the Eastern region with 38%. The questionnaire also revealed that 54% of the firms discuss the ICR results with other companies. That means, just a minority of the surveyed firms lead intraregional discussions on results of collective R&D while in general a small majority prefers to discuss R&D results with other colleagues of the industry. But many of them are not located in the same region. Thus, again professional proximity seems to fulfile an important function in the case of knowledge flow within the interlinked national and region bound TIS.

TABLE 7: Discussion of ICR-project results with regional firms

Firm location (textile region)	Firms discussing with other firms of the region	Total	Share
East	23	60	38%
Southwest	13	53	25%
West	19	55	35%
Other regions	6	51	12%
Total	61	219	28%

Source: Own survey 2008/09.

4.4 Econometric model of success factors

Regarding the elaborated results we search for empirical significance of the three identified success factors with the help of an econometric model describing the probability of business success:

$$y_i^* = \beta' x_i + \varepsilon_i$$

where x is a vector of explanatory variables, ε is an error term, ß is a vector of estimated coefficients, and the subscript i denotes the observation. The variable yi* measures the success of an business firm and is therefore unobservable. We do, however, observe the associated outcome, which can be denoted by the dichotomous variable yi:

$y_i = 1$ if $y_i^* > 0$ and 0 otherwise

In the present analysis, yi equals one for firms who have increased employment by more than 10% since 1995 and zero for those who have not. Even though there might be many different reasons for an increase of employment, this indicator could be used as a first approach to define corporate success. Referring to equation (1), if the error term is assumed to have a normal distribution, then the parameters ß can be estimated using the maximum likelihood method with the probit link function:

$$P(y_i = 1) = \Phi(\beta' x)$$

where Φ is the standard normal distribution function. In interpreting the estimates from the probit model, interest generally focuses on the effects of changes in one of the independent variables on the probability of a zero or one outcome. For the standard probit, this marginal effect is given by:

$$\frac{\partial P(y_i = 1)}{\partial x_k} = \phi(\beta' x) x_k$$

where is the standard normal density function.

For the estimation model we chose a set of explanatory variables describing some important characteristics of textile firms Variable definitions and descriptive statistics are presented in table 8. As some of these variables could either positively or negatively affect the probability of firm's success, it is not always possible to state a priori which effects are expected to prevail, e.g. firm size (variable SME). However, positive signs could be ascribed to all other variables.

TABLE 8: Variable definitions and descriptive statistics

Variable	N	Mean	SD	Definition
SME	335	0.76	0.43	1 if firm is an SME
R&D	335	0.85	0.36	1 if firm performs R&D
TECHTEX	335	0.16	0.37	1 if firm focuses on technical textiles
REGION	335	0.79	0.40	1 if firm is located in one of the 3 main textile regions
FOREIGN	335	0.26	0.44	1 if firm has an additional domicile abroad
ICR-RESULTS	335	0.35	0.48	1 if firm uses ICR research results
ICR-PARTICIPATION	335	0.41	0.49	1 if firm participates in ICR-projects

Table 9 catalogues marginal effects from the probit model of firm success. The results show, first of all, that enterprise size does not correlate significantly with firms' success regarding the development of employment. Thus, SME aren't stronger or weaker than large enterprises. The variables denoting the location of the firm are insignificant, too. Obviously, basic structural factors like size and spatial proximity are not able to explain business success in German textile industry. It seems to be more important, how firms effectively operate within these structures.

TABLE 9: Probit analysis of the determinants of firm prosperity (increase in employment)

Variable	dF/dx	Standard Error	Significance
SME	0.003	0.074	
R&D	0.146	0.074	*
TECHTEX	0.262	0.073	***
REGION	-0.055	0.070	
FOREIGN	0.002	0.070	
ICR-RESULTS	0.183	0.069	***
ICR-PARTICIPATION	-0.093	0.068	

Level of significance: *: $p < 0.10$; **: $p < 0.05$;***: $p < 0.01$. N = 335

As expected, the probability that a firm in German textile industries has provided new jobs in the last decade is significantly higher if the firm is performing own R&D. In terms of our first identified success factor (collective research) it is to mention that the participation in ICR-projects isn't significantly connected with entrepreneurial success. But firms that really use ICR results have a higher probability of prosperity. Regarding the second point (new markets) it's obvious that specialisation in technical textiles is a very strong success factor for German textile industry. In this case, the probability of firm growth increases by 26%.

As some variables might be affected by endogenity problems, the coefficients estimated should not be interpreted as indicating causalities. Of course, there might be other reason why firms use ICR project results, focus on technical textiles and are in consequence more successful than others. Nevertheless, it seems to be convincing that performing collective research and opening up new markets play an important role for the recovery of significant parts of the German textile industry.

5. Conclusions

With respect to the development of the German TIS as the base for collective R&D we found a large number of interacting players – representatives of firms, intermediary organisations and public agencies - who centred around 17 textile research institutes with altogether 1.000 scientists. In the course of time three regionally bound TIS emerged. A striking feature is the strong involvement of regional firms and intermediary organisations in the different types of advisory boards and project groups of the research institutes. At the same time many actors from outside the respective region participate in their work. The involved firms influence remarkably the long term research strategies as well as the course of projects at the R&D institutes.

However, there are also strong linkages between the three regional systems. Their actors form a nationwide operating umbrella organisation. Therein the member organisations coordinate the research strategies of the different research institutes on the base of a national research strategy. In this context the research institutes are constantly competing with each other in order to gain public funds for industrial collective R&D. This is a strong driving force to develop SME oriented research proposals with a view on new markets. Such projects are often funded by a national programme for SME oriented collected research (ICR), which is in operation since around five decades.

With regard to new markets our survey indicated, that a remarkable share of the German textile firms entered with success the field of technical textiles, which is linked to a large number of new customers. And there is evidence that the number of TT firms will further grow. We also noted that the research institutes play an important role as mediator between textile firms and new customers, while they arrange a dialogue in workshops, conferences and project boards. Further, the majority of projects in the textile part of the ICR program is at present related to technical textiles.

With respect to the different types of proximity we could find certain notices that the work of the overall TIS is first of all positively influenced by professional proximity. In many but not in all cases spatial proximity of the actors seems to be an additional boosting factor for a trustful interaction of firms, research institutes, intermediary and public organizations.

With our econometric analyses we could find indications of positive effects – i.e. employment growth - of collective R&D at the firm level, for those which are using ICR project results. Moreover, we found a significant relation between the engagement in the field of technical textiles and employment growth. With respect to globalization our regression models show, that firms with abroad locations are not necessarily more successful in terms of employment growth than firms with production centres only in Germany. Therefore, we believe the central precondition for success seems to be the integration of a firm into the German TIS and its ability to take up the thereby given chances for collective R&D at national and/or regional level and the follow up innovations at the firm level.

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E-BUSINESS IN MICRO AND SMALL ENTERPRISES: A CHANCE FOR GROWTH OR A SHEET ANCHOR FOR SURVIVAL?

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E-BUSINESS IN MICRO AND SMALL ENTERPRISES: A CHANCE FOR GROWTH OR A SHEET ANCHOR FOR SURVIVAL?

ABSTRACT

This paper discusses the use of E-Business Solutions (EBS) in Micro- and Small Enterprises (MSEs) in low-technology industries and its contribution to growth and survival for these firms. Our analysis is based on a survey of 619 MSEs of the German craft sector as well as 43 qualitative interviews in the bakery and construction trades. With regard to our survey we apply econometric techniques to test empirically on the relevance of several internal and external factors to implement EBS applications.

The main results of our paper are that (i) the application of EBS differs to a large extent by trade and firm size, (ii) embeddedness in particular value chains is of importance for decisions on the implementation of EBS, (iii) organisational innovations are positively related to the usage of EBS, and (iv) firms that use e-commerce solutions would have performed badly in terms of sales growth if they had refused to apply this type of EBS.

JEL: L25, M15, O31, O32

1. E -Business solutions in MSEs: State of knowledge and open questions

The rapid development of Information and Communication Technologies (ICT) as well as the declining prices for its use provide the chance to rebuild internal and overall value chains in such a way, that even micro and small-sized enterprises (MSE) in very different economic sectors are enabled to realize economies of scale and scope (Leamer/Storper 2001, Picot/Neuburger 2005).

While earlier research focussed on the impact of ICT on firm performance, more recent studies concentrate on those types of ICT-applications which cover large parts or the entire intracorporate value chain, i.e. E-Business Solutions (EBS) and their impact on firm competitiveness and growth. EBS can be defined in this context as automatised business processes within a firm or between firms on the base of ICT-networks (OECD 2004). Hence, EBS encompass a wider range of ICT-supported business processes than e-commerce, which refers to the transaction of a firm with customers, public authorities and alike. Instead EBS refers to all types of interlinked ICT-applications which can join at all parts of a value chain (Bertschek et al. 2006).

Empirical studies on the impact of EBS on firm performance focus either on large firms or - to a moderate extend - on medium sized firms. They show that quite often large firms are the early adaptors of EBS which are able to realize comprehensive competitive advantages (EC 2003, OECD 2004, EITO 2007). Micro enterprises, with less than 10 employees, and even small firms with 10 to 50 employees are either not explicitly considered or even excluded (e.g. KPMG & BDA 2001, EITO 2007, Bharadwaj/Soni 2007, Eriksson et al. 2008). Additionally, studies on EBS in MSEs are mainly focused on the technology intensive sectors. With respect to less technology intensive MSEs the comparatively small number of studies mainly discuss either the access to ICT-infrastructure (Dixon et al. 2002) or the purpose to use the internet or some single ICT-application within the firm, like using E-Mails or setting up websites (ZDH 2000, Fry et al. 2004, Warren 2004). Thus, the potential of EBS to transform the business organisation and operation remained widely ignored (Taylor/Murphey 2004: 281).

This paper contributes to the knowledge about the use of EBS in the large group of MSEs in low-technology industries. Based on the example of craft trades in Germany, we address the following questions empirically by using quantitative and qualitative methods:

- What types of EBS are applied by MSEs in different branches?
- Which internal and external factors affect the implementation of EBS applications?
- What are the effects of EBS with respect to firm performance? Are the E-Business solutions an overall important mode of growth for MSEs or just a suitable way to survive in precarious competitive environments?

The paper consists of six sections. Section 2 reviews the existing literature. In section 3 we describe briefly our study design and the data base. Section 4 contains main findings of 43 qualitative interviews, while the results of our econometric analysis of survey data are presented in section 5. The main findings are summarized in the concluding section.

2. A brief review of related literature

2.1 Factors that determine application of EBS

Several papers focus on the identification and classification of main factors which determine the adoption of EBS. Peffers et al. (1998) distinguish between three sets of internal factors (organisation, innovation, communication) and two sets of external factors (industry, national) to explain e-commerce adoption. In a broader view on EBS, the present literature addresses three factors, (a) firm's resource base and innovation capabilities, (b) industry effects and (c) the embeddedness of the firm in particular value chains.

First of all, firm specific factors (e.g., size, knowledge base, organisational structure and culture) may matter to large extent in the adoption of EBS. Size effects could be identified with regard to the quality of computer equipment (Morikawa 2004), the patterns of Internet use (Sadowski et al. 2002) and B2B e-commerce (van Beveren/Thomson 2002). With regard to production integrated EBS (e.g. CAD, CNC) Lucchetti/Sterlacchini (2004) show that their application takes mainly place in larger SMEs and in firms with a well qualified staff. For Germany, technoconsult (2005, 2008) identified a growing digital divide between small, medium and large size firms. The share of users of more sophisticated EBS grows over time in the upper size classes while MSE have started to use EBS with a remarkable time lag (Zoch 2007: 20).A recent study of Eriksson et al. (2008) on Swedish SMEs corroborates all these findings. The main reasons for the size effects are comparatively high initial costs and risks for micro firms. Moreover, there are serious time restrictions for the owner-managers of micro enterprises. Hence, the thorough examination of advanced EBS proceeds slowly in smaller firms (IIG 2000, Eriksson et al. 2008). With respect to firms' innovation capabilities, efforts to introduce technological and organisational innovations may be positively linked with a firm's willingness to adopt EBS applications (e.g. Piscittelo/Sgobbi 2004).

Early studies on the adoption of e-commerce (cf. Bonaccorsi/ Rossi 2002) underline the importance of the affiliation to a particular industry or trade regarding the degree of penetration of relevant EBS. He finds that the extensive use of Internet facilities – such as e-commerce – takes mainly place in export oriented businesses. Within this group, differences can occur that relate to firm size and qualification of the staff (Moodley 2003). A similar point of discussion is the bandwagon effect: The more firms in a particular industry use a particular computer technique or EBS, the higher appears to be the probability that an individual firm will decide in favour of it (Bertscheck/ Fryges 2002).

This affiliation to an industry influences the range of products and services offered by a company as well as the choice of particular EBS according to the MSEs' position within a particular value chain (Bharadwaj/Soni 2007). Both industry affiliation and position in the value chain influence the modes of electronically based interaction between business firms. It is often argued that strong EBS based cooperation enlarges the resource base of the individual firm virtually, and will be, therefore, increasingly accepted by MSEs (Santorelli/D'Altri 2003). Moreover, since the advent of the Internet, technical complexity has been reduced drastically and compatibility between different computer systems improved remarkably. Hence, the costs of electronically based interaction and the related risks declined (Wymbs 2004). In the meanwhile, the implementation of EBS becomes obligatory for MSEs in manifold contexts, in order to at least remain within ancestral value chains (Kenney/Curry 2001, EITO 2007: 156).

However, most studies do not address the questions, which particular types of EBS applications – such as e-commerce - are really useful for MSEs and whether EBS yields the expected economic rewards (Taylor/Murphy 2004: 280). For example, Daniel et al. (2002) point out that many firms which focus on the large array of personal services need computer techniques and EBS of any kind to a much smaller extend in comparison to business oriented service firms. Ramsey et al. (2004) underline, that still many MSEs tend use the modern technology in a very passive way like checking the Internet for information purpose. Matlay (2004: 411) reminds us, that small firms are not scaled down versions of their larger counterparts but face specific challenges due to specific ways of interaction with large firms in particular valueadded processes. In fact, dominant firms which govern particular value chains may implement a broader range of EBS applications than single firms within the chain which act as "team members". The former often tend to take the control over the latter and influence smaller firms' decisions on the usage of ICT and EBS to a remarkable extent (e.g. Symons 1997, Halder 2004).

2.2 Economic effects of EBS application

Within the last ten years, the effect of EBS application on economic growth and productivity on the macro and sector level has received much attention (e.g. Daveri/Silva 2004, Oliner/Sichel 2000, Daveri 2002). Especially, high tech sectors that produce EBS realized considerable a productivity growth that was associated with capital intensive production techniques (Stiroh 2001, McKinsey Global Institute 2001). In respect of the effect of the use of EBS in other sectors of the economy, the results were much more mixed. While some sectors realized productivity increases, others did not (Dehio et al. 2005: 259).

At the firm level, the work of Brynjolfsson/Hitt (2000, 2003) indicates a positive relationship between EBS investment and multifactor productivity on the firm level. However, the results also show a wide individual variation in firms' success in using EBS. Further, direct effects of IT investment (short term) differ from medium- and long term effects when EBS are combined with related investments in organisational change. EBS capital seems to be disproportionately associated with other intangible assets like the cost of developing new software, qualification of staff or organisational transformation. These types of "adjustment cost" must be met before the potential of EBS in business firms can be utilized.

Hempell (2003: 31) showed that firms which invest strongly in both training and EBS equipment perform significantly better than competitors that pursue isolated investment strategies. The author argues that the ability of a firm to reap productivity gains from EBS is crucially determined by the investment in EBS-related qualification.

A study on Japanese SMEs indicates that small firms (with less than 20 employees) equipped with EBS tend to be more profitable than others (Morikawa 2004: 174). Foley and Ram (2002) found that ethnic minority businesses in the UK – often retail traders - realize a remarkably higher proportion of online sales as their non ethnic counterparts do. This might be seen as an indicator that e-commerce facilities help to address particular market segments which are characterized by a large spatial dispersion of customers.

In a study on ICT use in the US construction sector, the EBS based performance of smaller and bigger firms were studied without distinguishing between different size groups (El Mashaleh et al. 2004, 2006). Nevertheless, the papers provide some indications about a positive relation between ICT use in smaller firms on the one hand and adherence to schedule as well as cost performance on the other hand. But no significant relationship was found yet with respect to profitability. For Germany, technoconsult (2005, 2008) finds that between 2005 and 2008 a growing share of small firms indicates that they observe positive effects of EBS applications, e.g. with respect to sales growth, cost reduction for warehousing, distribution and business organisation.

3. Study design, data and methodology

In our analysis we combine quantitative and qualitative methods and draw on a questionnaire survey among MSEs in the German craft sector, and two case studies on the application of EBS within overall value chains. The case studies are based on 43 qualitative interviews with firm owners, project managers and representatives of crafts organizations. Thereby 13 interviews were related to handicraft bakeries (Lageman et al. 2004, Trettin et al. 2005) and 30 interviews to construction trade firms (Trettin et al. 2006, Espig 2009). Therewith, the qualitative results cover two large segments of the German craft sector with respect to number of firms and employment.

Between 2002 and 2004, we conducted a comprehensive survey on ICT usage in the German craft sector which is used for our quantitative analysis. The basic population for our survey comprehends the craft sector as it is defined by law in Germany. While in most countries, the terms "handicraft" and "craft" focus on the production of goods and services mainly done by hand, the German craft sector refers to a substantial part of the economy with around half a million of companies and around five million workers (table 1, Lageman et al. 2004).

TABLE 1: Trades and trade groups of the German craft sector (2003)

	Trade group	Trades (examples)	Range of typical firm size
I	Building and construction industries	Bricklayer and concrete worker, carpenter, roofer, painter and lacquerer, insulator (heat, cold, noise)	3 to 9 workers
II	Electrical and metal – working	Mechanical engineer, toolmaker, automobile mechanic, plumber, electrical engineer, surgical instrument maker, watchmaker, gold/silver smith	4 to 10 workers
III	Woodwork trades	Joiner, boatbuilder / shipfitter, basket weaver, wood sculptor, cooper	2 to 8 workers
IV	Clothing, textile and leather trades	Tailor, weaver, furrier, shoe maker, tanner	1 to 5 workers
V	Foodstuff trades	Baker, butcher, grain miller, brewer / maltster,	8 to 20 workers
VI	Trades related to health and hygiene, chemical and cleaning trades	Optometrist, dental prosthesis maker, orthopaedic mechanic and shoe maker, hairdresser, textile cleaner, building cleaner	6 to 15 workers
VII	Glass, paper, ceramic and other trades	Glazier, precession optical worker, photographer, book printer, bookbinder, musical instrument maker (diverse), ceramic worker	2 to 8 workers

This structure was valid up to the 31.12.2003 and changed by the 01.01.2004 (FME 1994).
Own calculation based on FSO 1996. Lageman et al. 2004.

According to the structure of the German craft sector and the spatial distribution of firms and workers, a sample of 4000 craft firms was designed in cooperation with handwerk.de/AG, a firm which runs the largest databank on craft businesses in Germany. Since the response rate was 15.5 %, the random sample consists finally of 619 respondents. The sample represents the craft sector quite well in respect to (i) the trade and spatial distribution, (ii) firm size, (iii) the composition of the client group and (iv) the spatial orientation of the sales market.

In contrast to many other studies on innovation and EBS application in the German economy, the survey comprises even the smallest establishments. Around 67 % of the firms are micro enterprises with 1 to 9 workers including the owner. Another 17% of the firms have a labour force of 10 to 19 (cf. Rothgang / Trettin 2005).

4. E-Business in German MSEs – results from two case studies

4.1 EBS in the Construction Sector

Our study on the construction sector of Northwest Saxony / Germany (cf. Espig 2009) revealed four specific conditions which exert a considerable influence on the application of EBS application:

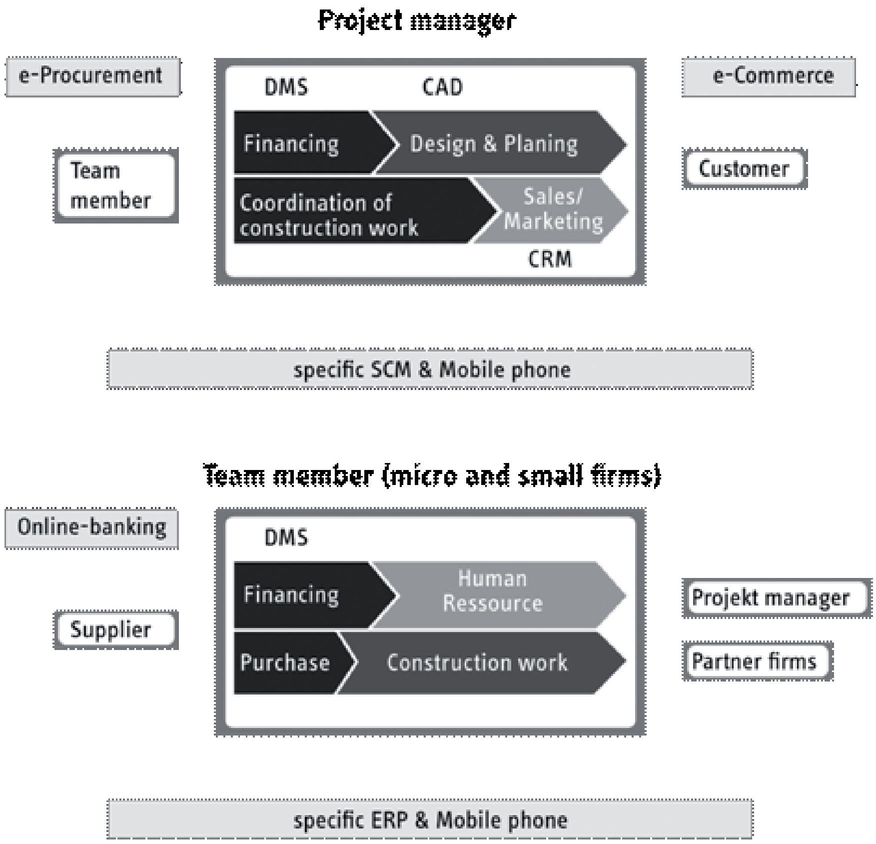
- The construction of a building requires the efficient organization of many firms from different craft trades (project teams, see table 1) and a related project management.
- The individual construction firm has the permanent task to bridge distances between head office and place of production (i.e. the construction site which changes regularly).
- Often one firm has to operate in several construction sites at the same time.
- The role of project managers will be taken by either specialised main contractors (architects, engineers), core managers in individual construction firms as heads of project teams or specially appointed individuals.

Under such conditions, EBS can be used by construction firms and project managers for two major reasons: to ensure the proper allocation of materials, machinery and workers and to assure the successful cooperation with partner firms at the construction place (figure 1).

The project managers operate to a large extent with EBS, e.g. in order to handle digitalized construction plans, journals and minutes for the interaction with the principal. Specific SCM software is used to synchronize the work of different firms in the same place and to ensure the continuous flow of resources and services from the team members within the construction project. Furthermore, EBS is applied for marketing purposes in order to acquire new projects for a team of firms (figure 1 above). These findings are in a line with studies on the US construction sector (cf. Haas et al. 2000).

The project team managers we interviewed strongly force the integrated micro firms to implement the MSE friendly software “handicraft” for branch specific calculations in the sense of ERP. In addition, the team members – very often subcontractors – operate with EBS that are easy to handle for the purpose of invoicing, purchasing of materials, (wage) accountancy, and alike. Still, the mobile phone is always used as the main instrument for communication, since the micro firm managers have to organise the work on spot and resource flows within a few minutes. Thus, we found that modern EBS is used in micro firms in a very limited manner, mainly to satisfy the demand of the project manager but not with an orientation towards the end consumer (figure 1 below).

Figure 1: EBS applications in firms and project teams of the construction sector



CAD = Computer aided design CRM = Customer-relationship-management DMS = Document management system ERP = Enterprise ressource planning SCM = Supply chain management
Source: own design based on Bertscheck et al. (2006)

Nevertheless, the micro firms scrutinized reported that the application of appropriate EBS helps to enhance remarkably the service quality of the whole project teams. Further, it helps to generate more orders within a radius of about 50 km (“our region”). The rationality of MSE project teams is to gain profitable orders through EBS-based interaction within a short and therefore time saving distance from the individual firm’s office to save costs.

All of these findings indicate that micro firms in the construction sector mainly use EBS because it proves to be necessary in order to be part of the project teams and to survive in the regional market. Therefore, the use of certain simple EBS applications can be seen as an anchor sheet in a turbulent competitive environment.

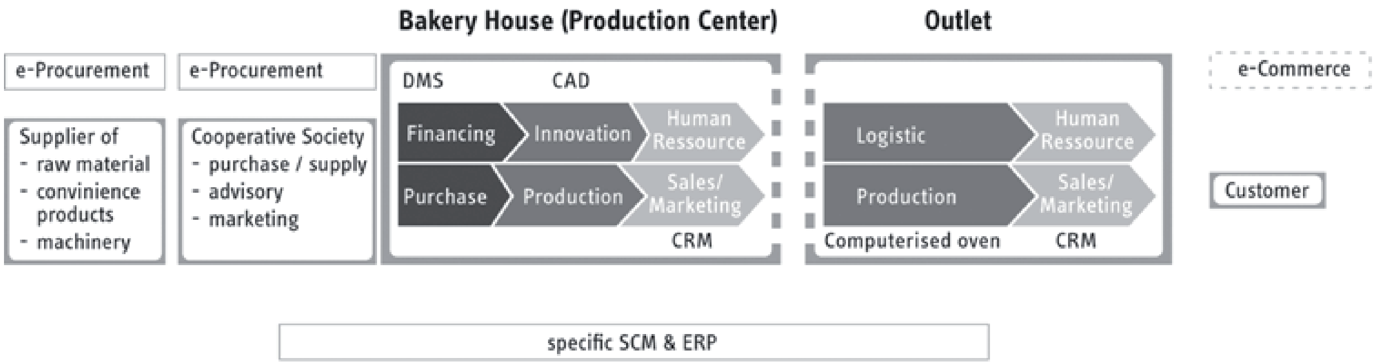
4.2 EBS in bakeries

German bakeries use EBS since nearly two decades quite intensively. The specific competitive situation within this craft trade was an important driving force. With the advent of large food stores in the 1970s, a tight competition started between baking factories and supermarkets on the one hand and small scale bakeries on the other hand. As a result, the traditional bakery – one bake house and one adjacent shop – could not exist any longer in the urban agglomerations and even not in many urban centres of rural areas.

Thus, a large number of micro firms closed their business. In contrast, a remarkable number of bakeries developed a chain store system with a central bake house and several outlets. These companies expanded from micro firms with 3 to 6 full-time employees to small and medium sized firms with sometimes about 50 full-time employees. There are bakery chains which consist of 3 outlets and others with 30 shops. Within this process the sales area of many firms also grew continuously (cf. Trettin et al. 2005).

A related important factor of success is the existence of around 50 regional cooperative societies which are owned by nearly 90% of all German handicraft bakeries. They organise the joint purchase and distribution of raw materials, provide advisory service related to business organisation and innovation, and organise joint marketing activities in the different regions. Within this context EBS plays an important role by helping each individual firm to harmonise the whole production chain (figure 2).

Figure 2: EBS applications in German handicraft bakeries



CAD – Computer aided design CRM – Customer-relationship-management DMS – Document management system ERP – Enterprise ressource planning SCM – Supply chain management
Source: own design based on Bertscheck et al. (2006)

For the purpose of purchase the bakeries and their regional cooperative societies use specific and partly different software applications for e-procurement, documentation and all financial matters. This enables the individual firm to align its internal accounts with its account at the cooperative society warehouse. Again, this provides the basis for a proper enterprise resource management within the individual firm with the help of specific EBS applications. Furthermore, using specific software for centralized purchasing ensures a continuous resource and product flow until the outlet.

The outlets of each bakery are a very important segment of their production chain, where specific EBS applications are of particular importance. This is because the bake house produces preliminary products just up to a certain stage. These preliminary products will be finally baked in the outlets with the help of computerized mini ovens. This procedure requires a perfect logistics in order to distribute the preproducts just in time. Thus, the (remaining) handicraft bakeries use EBS for the purpose of extensive supply chain management, as many large firms do.

Finally we can note that EBS application in German bakeries can be seen as both, (i) a mode of survival in a competition against large contesters as well as (ii) a mode of growth, once the chain store systems are established and the competition between handicraft bakery chains aggravates in the local markets.

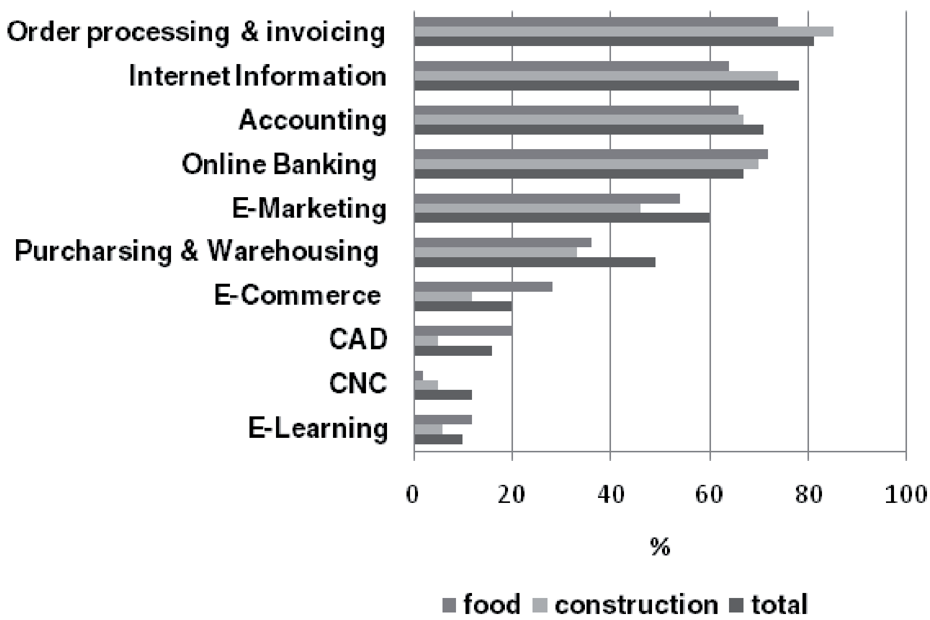
5. E-Business in German MSEs – Results from sample data

5.1 EBS application in craft firms

In our questionnaire survey we distinguish between ten different EBS applications: accounting, purchase & warehousing, e-commerce (sales), order & invoice, online banking, information gathering via Internet, marketing via Internet, e-learning, computer aided design (CAD) and usage of computerized numeric control machines (CNC).

Figure 3 displays that the share of ICT users with respect to marketing, online banking, accounting, gathering market information and order & invoice is between 60% and 85% out of the 575 firms with valid answers. Other studies on the German craft sector underline the pre-ferred usage of very easy to handle EBS (ZDH 2000:12, Zoch 2007: 14). Altogether, just a small percentage of craft firms apply more sophisticated EBS such as for the promotion of sales, for production processes (CAD, CNC) and for e-learning.

Figure 3: EBS applications in micro firms of the German craft sector



Notes:

1) for "total" n = 575, for "foodstuff trade" n = 50, for "construction sector" n = 155 .
2) The individual results for "total" are Order proces¬sing & invoicing (80.07), Internet Information (75.70), Accounting (68.18), Online Banking (67.13), E-Marketing (55.59), Purcharsing & Warehousing (45.10), E-Commerce (18.88), CNC (12.59), E-Learning (9.27), CAD (8.92). Source: Own survey.

Within the heterogeneous German craft sector we observe certain remarkable differences. On average, around half of the craft firms use EBS to fulfil the function of purchasing and warehousing. For firms from the construction sector, this share is only 33 % (cf. the results from our case study above). Therefore, the high average for the craft sector is based on much higher rates of EBS use in other craft industries, such as in technology intensive health trades (see table 1). On the other hand, a remarkably higher percentage of firms from food stuff trades try to use e-commerce in comparison to the craft sector as a whole. A simple explanation can be given for this result: Certain food items can be ordered, delivered and paid easily with the help of the internet (catering in a wider sense). But this is hardly possible in the case of an individual car repair service or a haircut.

5.2 Determinants of EBS application

One major implication of our case studies is that taking into consideration single firm's embeddedness in particular value chains and temporarily project teams is strongly related with organisational change and associated innovations. This in turn is virtually of great importance to understand the implementation and use of modern types of EBS applications. In our quantitative study, we aim to evaluate in particular whether we can generalize this finding.

We apply econometric techniques to test empirically on the relevance of several internal and external factors to implement EBS applications. The endogenous variable y_{1i} takes on the value one if a firm reports on EBS adoption since the year 2000 and zero outcomes for remaining cases. The binary outcome results from the unobserved propensity to adopt EBS applications y^*_{1i} which depends on a vector of firm specific characteristic X_{1i} (i.e. firm size, owner's qualification, industry). The EBS adoption equation is

$$y_{1i} = \begin{cases} \mathbf{0} & \text{if } y^*_{1i} = X_{1i}\beta_1 + \varepsilon_{1i} \leq 0 \\ \mathbf{1} & \text{if } y^*_{1i} = X_{1i}\beta_1 + \varepsilon_{1i} > 0 \end{cases}$$

with the coefficient vector $_{1}$ to be estimated. The error term $_{1i}$ is assumed to be normally distributed with mean zero and variance one. The equation is estimated by Probit regression technique (e.g. Wooldridge 2005: 555).

The estimation results are presented in appendix 1. As expected the implementation of EBS applications is almost significant positively related to firm size. For 7 out of 10 types of EBS application we found that micro firms with 1 worker show a significant lower probability to use EBS compared to firms with 10 and more workers. Further, e-marketing and accounting is applied to a significant lower extent by firms with up to 9 workers. Against this, firms with 4 to 9 worker use e-learning and CAD to a significant higher extent than larger firms. The first result might be driven by the trade-off between the need of continuous training for micro firms and the relatively high costs for micro firms compared to larger ones. The latter result seems to be related to the fact that many micro firms in craft trades are engaged in providing designs for products and buildings. Unfortunately, our data do not allow identifying exactly this kind of business emphasis.

The second remarkable finding is that innovation efforts are positively related to the implementation of EBS applications. Significant positive signs for organisational innovations are detected in almost all models, apart from order & invoice and CAD. Firms which develop new products show a significant higher probability to apply CAD, CNC, e-commerce and e-marketing. The significant positive signs for innovation variables should be interpreted with caution with respect to a causal impact of the introduction of new or improved technical and organisational solutions, however. As a matter of fact, unobservable characteristics (e.g., unobservable abilities of top management) may affect the introduction of innovations and EBS applications simultaneously.

With respect to the affiliation of a firm to a particular trade group we could not identify significant relations with a larger number of EBS applications. Nevertheless, with regard to foodstuff trades and the construction trade we could find for some EBS a significant negative correlation compared to the reference group "Glass, paper, ceramic, instruments". However, the foodstuff trades comprise of quite different trades such as bakers, breweries or butchers. The same is true for building and construction trades (see table 1).
Against our expectations, the membership in cooperatives as well as engagement in cooperation is almost not significantly related with the implementation of EBS applications. While both variables also affect innovation efforts we expect that innovation variables measure some effects of the embededdness in firm networks. By eliminating innovation variables from our model we observe that cooperating firms show a significant higher probability to apply 7 out of 10 EBS applications (see appendix 5). Firms which are member of cooperative societies (e.g. wholesale cooperative) exhibit a higher probability to use online banking, e-commerce and purchase and warehouse.

All in all, we detect many positive correlations between a firms embeddedness in a bigger group of MSEs and implementation of EBS. Similarly to the interpretation of innovation variables, the significant positive signs can also potentially be driven by unobservable characteristics (e.g., unobservable abilities of top management) to enter cooperatives, project teams or long lasting firm networks and to implement EBS applications simultaneously.

5.3 Effects of EBS application on firms performance

In the performance equation, the endogenous variable y_{2i} takes the value one if a firm reports a positive change in our firm performance measures (sales) between the years 2000 and 2002 and zero values in remaining cases. The binary outcome results from the unobserved propensity to grow y^*_{2i} which depends on EBS adoption (EBSi) and on a vector of firm specific characteristic X_{2i}. The firm performance equation is

$$y_{2i} = \begin{cases} \mathbf{0} & \text{if } y^*_{2i} = X_{2i}\beta_2 + \alpha EBS_i + \varepsilon_{2i} \leq 0 \\ \mathbf{1} & \text{if } y^*_{2i} = X_{2i}\beta_2 + \alpha EBS_i + \varepsilon_{2i} > 0 \end{cases}$$

with the coefficient vector α and $_2$ to be estimated. The error term $_{2i}$ is also assumed to be normally distributed with mean zero and variance one.

The results of this Probit regression are shown in appendix 2. We controlled for determinants such as firm age, affiliation to trade groups, owner managers' qualification, organisational and product innovations. The regression model reveals only one significant correlation between sales growth and EBS application. Firms which implement ICT with respect to e-commerce show a significant positive correlation with sales growth. The regression model shows another interesting result. For all EBS applications, we find a significant correlation between organisational innovations and sales growth, i.e. firms which undergo processes of business reorganisation achieve significantly higher probabilities to grow in terms of sales. Considering the results of the first regression model it can be assumed that firms with ICT linked organisational innovations tend to perform comparatively better than the others.

However it is not possible to conclude from a significant relationship on a causal effect between the EBS application variables and our endogenous variable, namely sales growth. Plausible considerations as well as empirical evidence suggest that unobservable variables are correlated with EBS_i and the endogenous variable y_{2i}. For example, entrepreneurial abilities may be positively related to abilities to identify market niches, to adopt new technologies, and to handle the implementation of new technologies. In this case, the estimated parameters on the EBS adoption variables EBS_i are upward biased.

In order to eliminate biased estimates due to unobserved firm heterogeneity, we follow the standard procedure and apply an instrumental variable (IV) approach. This approach yields unbiased estimates of α if the instruments Ii for EBS_i satisfy two identification assumptions: First, Ii has to be partially correlated with the endogenous explanatory variable EBSi. Second, Ii must be uncorrelated with i, the error term in the firm performance equation. The dataset used contains only limited information on instruments for the endogenous explanatory variable EBS_i. We consider the time period from the establishment of the firm website as a suitable measure. Here we defined three groupvariables: (1) no website (reference group), (2) website was established within the last five years, (3) website was established more than five years ago.

The rationale for using this variable follows from the technology affinity argument. The date of establishment of the website could signalize whether a MSE is open towards new technology or not. We assume that the date of establishment of the website has no influence on recent sales growth. The pure existence of a website will not affect sales growth, but what the website is used for in terms of EBS. The test statistics for the IV approach to instrument EBS in the estimation of sales growth suggests that the relevance assumption is valid, because the Partial-R^2 and F-statistic are rather high (Partial-R^2 = 0.0715, F-Test (2, 484) = 18.29, Appendix 3).

The first stage result of the estimation, which is displayed in appendix 3, shows a highly significant and positive coefficient for the date of website establishment. This result supports the use of the variable as an instrument for e-commerce application. The date of establishment of the website is considered to be exogenous to the growth rate of sales. Appendix 4 shows the second stage estimation results. It can be seen that the coefficient for e-commerce is significant positive. After the control of endogenous effects, the effect of the EBS related to e-commerce on sales growth is four times higher. Hence, a clear causality between the use of EBS and firm performance becomes visible. The regression models show, that those firms which applied EBS to enhance e-commerce would have performed badly if they would not have done so. In this context we interpret that EBS is used as a sheet anchor by the respective MSEs. Further, for the organisational innovations our IV approach indicates that there is a strong relation with EBS applications but no significant correlation with sales growth.

At this stage, the limitations of quantitative empirical analyses become obvious. These are too often fixed on easy to measure indicators such as the development of sales – and perhaps workforce – within a comparatively short time period. Samples are often too small in order to identify clear differences related to the affiliation to branches, particular production systems or value chains. With respect to networks' push to implement EBS applications, effects of this implementation might matter on the level of the network rather than on the level of individual firms. All in all, EBS is not an overall important mode of growth for MSEs but EBS may matter remarkably in specific business contexts.

6. Concluding Remarks

In this study we analyzed the implementation of EBS applications in German MSEs in low tech industries. Our case studies and the econometric analysis indicated clearly that MSEs tend to use EBS to a smaller extend than larger firms and that the EBS that are implemented are very often not as sophisticated as in bigger companies. Nevertheless, the empirical results also indicate that innovation activities in technical and organisational terms as well as firms embeddedness in cooperation arrangements are significant positively related with the implementation of EBS. Results from our case studies confirm that these positive correlations are not only driven by unobservable firm specific abilities but also by these activities themselves.

With the exception of e-commerce, we fail to detect any significant effect of EBS application on firm level sales growth in our econometric analyses. Also, our case studies show, that EBSs are not an overall important mode of growth for MSEs. Rather the specific competitive environment, in particular the affiliation to an individual craft trade, determines the EBS that are applied and the related economic effects. Thus, the study on handicraft bakeries shows, that the survival of a larger number of MSEs as contestant requires proper EBS based growth of the firms and otherwise the innovative usage of EBS – related with radical business reorganization - permits remarkable growth and strengthens the competitiveness of them.

All in all, our findings have shown the need to study the handling of EBS in MSEs comprehensively. Though, focusing on a particular size class of business firms bears rather limited new insights with respect to the benefits of EBS applications for MSEs in a competitive environment. Therefore, we consider case studies as a promising avenue for future research, which should aim at analysing complete value chains and firm networks. Such studies could help to understand the question, whether and how EBS may help smaller firms to upgrade their position within the overall process of value creation.

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Appendix 1: Determinants of EBS application in German craft firms – marginal Probit coefficients

	Online Banking	Internet Information	E-Learning	CAD	CNC
Business size					Reference group:
1 worker	-0.393**	-0.483**	0.306	0.035	-0.489*
	(0.177)	(0.189)	(0.273)	(0.262)	(0.257)
2 to 3 worker	-0.160	-0.356*	0.088	0.082	-0.179
	(0.190)	(0.200)	(0.292)	(0.257)	(0.240)
4 to 9 worker	-0.141	-0.050	0.662***	0.461**	-0.184
	(0.169)	(0.183)	(0.226)	(0.228)	(0.195)
Age of enterprise					
Years	-0.003	-0.019*	0.003	-0.019	-0.000
	(0.010)	(0.010)	(0.012)	(0.013)	(0.012)
$(Years)^2$	-0.000	0.000*	0.000	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Trade groups					Reference group:
Building and	0.360	-0.196	-0.543	-0.578	0.128
construction		(0.306)	(0.340)	(0.379)	(0.416)
Electrical and metal	0.349	0.059	-0.437	-0.257	0.535
	(0.297)	(0.331)	(0.375)	(0.387)	(0.502)
Woodwork	0.308	0.088	-0.154	0.232	0.958*
	(0.334)	(0.374)	(0.409)	(0.419)	(0.524)
Clothing, textile, leather	-0.498	-0.443			
	(0.436)	(0.445)			
Foodstuff	0.209	-0.680*	-0.170	-1.062*	0.541
	(0.356)	(0.381)	(0.438)	(0.624)	(0.544)
Health, hygiene,	0.043	-0.144	-0.484	-0.356	0.620
cleaning	(0.329)	(0.370)	(0.417)	(0.440)	(0.523)
Miscellaneous variables					
Member	0.295*	0.157	0.184	0.001	-0.066
of cooperatives	(0.164)	(0.175)	(0.212)	(0.230)	(0.186)
Cooperation	-0.163	0.259*	0.434**	0.213	-0.039
	(0.128)	(0.134)	(0.178)	(0.177)	(0.171)
University education	0.474**	0.138	0.069	0.571**	-0.574
	(0.241)	(0.248)	(0.257)	(0.279)	(0.382)
Organis. Innovations	0.296*	0.471**	0.540***	0.308	0.406**
	(0.176)	(0.207)	(0.203)	(0.216)	(0.200)
Product Innovations	0.043	0.069	0.077	0.494**	0.505***
	(0.130)	(0.137)	(0.182)	(0.192)	(0.171)
Constant	0.370	0.989***	-1.810***	-1.533***	-1.849***
	(0.343)	(0.379)	(0.443)	(0.445)	(0.547)
No. of observations	485	485	469	469	469
Pseudo R^2	0.049	0.067	0.081	0.139	0.112

Notes: The estimation is based on the Probit – Method. The coefficient describes the „marginal effects“. Standard errors in parenthesis.

	E-Commerce	Purchase & Warehouse	E-Marketing	Accounting	Order & invoice
Firms with 10 and more workers					
	-0.413*	-0.379**	-0.623***	-1.038***	-0.245
	(0.219)	(0.178)	(0.172)	(0.188)	(0.190)
	-0.167	0.111	-0.587***	-0.769***	0.051
	(0.208)	(0.184)	(0.187)	(0.197)	(0.209)
	-0.078	-0.033	-0.387**	-0.698***	0.103
	(0.183)	(0.159)	(0.163)	(0.175)	(0.186)
	0.014	-0.012	0.003	-0.024**	-0.005
	(0.011)	(0.010)	(0.010)	(0.011)	(0.010)
	-0.000	0.000**	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Trade group “Glass, paper, ceramic, instruments”					
	-0.630*	0.111	-0.661**	-0.107	0.086
	(0.530)	(0.356)	(0.317)	(0.316)	(0.311) (0.359)
	-0.272	0.738**	-0.218	0.206	-0.094
	(0.342)	(0.306)	(0.308)	(0.304)	(0.345)
	0.203	0.299	-0.005	0.152	0.103
	(0.373)	(0.343)	(0.349)	(0.347)	(0.387)
	-0.953	0.026	0.287	-0.066	-0.410
	(0.593)	(0.433)	(0.463)	(0.430)	(0.472)
	-0.345	-0.030	-0.816**	-0.311	-0.350
	(0.405)	(0.363)	(0.363)	(0.362)	(0.395)
	-0.836**	0.388	-0.579*	0.112	0.054
	(0.405)	(0.336)	(0.340)	(0.335)	(0.386)
	0.249	0.242	0.142	-0.063	0.221
	(0.177)	(0.156)	(0.160)	(0.162)	(0.186)
	0.149	0.050	0.074	0.174	0.223
	(0.146)	(0.123)	(0.127)	(0.131)	(0.142)
	0.260	0.148	0.593**	-0.010	0.041
	(0.241)	(0.214)	(0.236)	(0.225)	(0.241)
	0.562***	0.346**	0.533***	0.450**	0.022
	(0.183)	(0.168)	(0.186)	(0.193)	(0.195)
	0.259*	0.141	0.462***	-0.020	0.093
	(0.156)	(0.127)	(0.130)	(0.136)	(0.146)
	-1.025**	-0.568	0.488	1.197***	0.823**
	(0.400)	(0.353)	(0.346)	(0.351)	(0.394)
	485	485	485	485	485
	0.111	0.073	0.112	0.089	0.038

*Significant at the 10 % level; ** Significant at the 5% level, *** Significant at the 1% level.

Appendix 2: EBS application and firm's sales growth– marginal Probit coefficients

					Sales
	Online Banking	Internet Information	E-Learning	CAD	CNC
EBS application	0.167	0.193	-0.221	-0.156	0.107
	(0.139)	(0.154)	(0.221)	(0.226)	(0.196)
Business size					Reference group:
1 worker	0.017	0.022	0.007	-0.002	0.008
	(0.179)	(0.179)	(0.178)	(0.178)	(0.179)
2 to 3 worker	-0.056	-0.047	0.060	-0.063	-0.059
	(0.186)	(0.186)	(0.185)	(0.185)	(0.185)
4 to 9 worker	-0.080	-0.086	-0.060	-0.078	-0.082
	(0.168)	(0.167)	(0.169)	(0.168)	(0.168)
Trade groups					Reference group:
Building and construction	-0.198	-0.170	-0.205	-0.203	-0.185
	(0.325)	(0.327)	(0.323)	(0.325)	(0.324)
Electrical and metal	0.092	0.111	0.092	0.098	0.102
	(0.312)	(0.314)	(0.311)	(0.313)	(0.312)
Woodwork	-0.152	-0.137	-0.145	-0.128	-0.160
	(0.345)	(0.347)	(0.345)	(0.347)	(0.349)
Clothing, textile, leather	-0.420	-0.442	-0.497	-0.484	-0.458
	(0.487)	(0.492)	(0.492)	(0.493)	(0.489)
Foodstuff	0.109	0.157	0.103	0.093	0.110
	(0.367)	(0.371)	(0.367)	(0.370)	(0.367)
Health, hygiene, cleaning	0.490	0.495	0.468	0.471	0.475
	(0.342)	(0.344)	(0.342)	(0.343)	(0.343)
Miscellaneous variables					
Member of cooperatives	0.087	0.095	0.106	0.100	0.101
	(0.159)	(0.160)	(0.161)	(0.160)	(0.160)
Cooperation	0.079	0.055	0.081	0.073	0.067
	(0.129)	(0.130)	(0.129)	(0.129)	(0.129)
University education owner	-0.576***	-0.561***	-0.552***	-0.540***	-0.547***
	(0.248)	(0.247)	(0.244)	(0.247)	(0.246)
Product Innovations	0.129	0.131	0.136	0.146	0.124
	(0.132)	(0.132)	(0.132)	(0.132)	(0.133)
Organisational Innovations	0.450***	0.444***	0.487***	0.471***	0.458***
	(0.170)	(0.170)	(0.172)	(0.171)	(0.171)
Constant	-0.237	-0.286	-0.112	-0.108	-0.128
	(0.363)	(0.378)	(0.354)	(0.355)	(0.355)
No. of observations	467	467	467	467	467
Pseudo R^2	0.081	0.081	0.080	0.079	0.079

Notes: The estimation is based on the Probit – Method. The coefficient describes the „marginal effects". Standard errors in parenthesis.

Growth					
	E-Commerce	Purchase & Warehouse	E-Marketing	Accounting	Order & invoice
	0.324**	-0.022	0.105	-0.137	0.090
	(0.163)	(0.129)	(0.132)	(0.140)	(0.156)
Firms with 10 and more workers					
	0.030	-0.005	0.019	-0.046	0.005
	(0.179)	(0.178)	(0.179)	(0.181)	(0.179)
	-0.054	-0.063	-0.041	-0.097	-0.066
	(0.186)	(0.185)	(0.186)	(0.189)	(0.185)
	-0.088	-0.087	-0.073	-0.116	-0.090
	(0.167)	(0.168)	(0.168)	(0.170)	(0.168)
Trade group "Glass, paper, ceramic, instruments"					
	-0.124	-0.185	-0.161	-0.191	-0.186
	(0.329)	(0.324)	(0.326)	(0.325)	(0.322)
	0.140	0.115	0.118	0.118	0.113
	(0.317)	(0.314)	(0.312)	(0.313)	(0.310)
	-0.146	-0.137	-0.139	-0.132	-0.141
	(0.354)	(0.346)	(0.346)	(0.346)	(0.344)
	-0.386	-0.460	-0.478	-0.456	-0.456
	(0.494)	(0.488)	(0.485)	(0.493)	(0.489)
	0.160	0.116	0.145	0.100	0.127
	(0.371)	(0.367)	(0.369)	(0.368)	(0.366)
	0.566*	0.488	0.508	0.486	0.486
	(0.348)	(0.343)	(0.343)	(0.344)	(0.341)
	0.087	0.101	0.097	0.097	0.094
	(0.161)	(0.161)	(0.161)	(0.161)	(0.161)
	0.060	0.068	0.064	0.075	0.061
	(0.130)	(0.129)	(0.129)	(0.129)	(0.129)
	-0.571**	-0.554**	-0.577**	-0.558**	-0.588**
	(0.248)	(0.245)	(0.245)	(0.246)	(0.246)
	0.120	0.135	0.116	0.134	0.131
	(0.132)	(0.132)	(0.134)	(0.132)	(0.132)
	0.415**	0.465***	0.447***	0.478***	0.465***
	(0.173)	(0.171)	(0.170)	(0.171)	(0.170)
	-0.198	-0.115	-0.194	0.002	-0.192
	(0.360)	(0.356)	(0.365)	(0.377)	(0.372)
	467	467	467	467	467
	0.084	0.079	0.079	0.080	0.079

*Significant at the 10 % level; ** Significant at

Appendix 3. Sales growth estimation results – first stage

Dependent Variable: E-Commerce	Coeff.	Std. Err.
Years	0.0035	0.0026
$(Years)^2$	0.0000	0.0000
Building and construction industries	-0.0732	0.0908
Electrical and metal – working	-0.0272	0.0891
Woodwork trades	0.1037	0.0997
Clothing, textile and leather trades	-0.1891	0.1265
Foodstuff trades	0.0290	0.1024
Trades related to health, hygiene and cleaning	-0.0797	0.0966
University education owner	0.0417	0.0603
Organisational Innovations	0.1344***	0.0454
Website was established in the last five years	0.1990***	0.0357
Website was established more than five years ago	0.2504***	0.0649
Constant	0.0468	0.0919
Partial R^2	0.0715	
F(2, 484)	18.29	
Sargan statistic (Chi-sq(1) P-val)	0.367 (0.5445)	
Number of Observations	484	

Notes: The coefficient describes the „marginal effects". Standard Errors are shown in the Std. Err. columns.
*Significant at the 10 % level; ** Significant at the 5% level, *** Significant at the 1% level.

Appendix 4. Sales growth estimation results – second stage

Dependent Variable: sales growth (99-03)	Coeff.	Std. Err.
E-Commerce	0.5402***	0.2170
Years	-0.0142***	0.0035
$(Years)^2$	0.0002***	0.0001
Building and construction industries	-0.0028	0.1220
Electrical and metal – working	0.0623	0.1173
Woodwork trades	-0.0804	0.1310
Clothing, textile and leather trades	-0.0462	0.1720
Foodstuff trades	0.0772	0.1333
Trades related to health, hygiene and cleaning	0.2556**	0.1298
University education owner	-0.2031***	0.0803
Organisational Innovations	0.1002	0.0700
Constant	0.3650***	0.1236
Number of observations	484	

Notes: The estimation is based on the Probit – Method. The coefficient describes the „marginal effects". Standard Errors are shown in the Std. Err. columns. *Significant at the 10 % level; ** Significant at the 5% level, *** Significant at the 1% level.

MANAGEMENT TOOLS IN PRACTICE

BALANCED SCORECARD AS A POSSIBLE KEY FOR BUSINESS STRATEGY

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KEYWORDS:
BALANCED SCORECARD, STRATEGY, PERFORMANCE MEASUREMENT, PERSPECTIVE.

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BALANCED SCORECARD AS A POSSIBLE KEY FOR BUSINESS STRATEGY

ABSTRACT

The purpose of the presented article is to discuss the idea of Balanced Scorecard as a key factor to improve company's competitive advantage. The Balanced Scorecard creates a measurement system used to monitor and create strategy. It looks at strategy from a more focused perspective in that it takes a company specific view. The article describes the essence, characteristics and basic advantages of Balanced Scorecard. It combines the mission and company's strategy with the aims and measures related to four different perspectives: financial, customer, internal business process, learning and growth. Balanced Scorecard is a method which enables the board of directors to implement the management of the company in a socially responsible way, respecting the balanced rules for economy, ethics in relations with shareholders, clients and employees.

JEL Classification: M21

1. Introduction

The Balanced Scorecard is a strategic planning and management system that is used extensively in business and industry, government, and nonprofit organizations worldwide to align business activities to the vision and strategy of the organization, improve internal and external communications, and monitor organization performance against strategic goals.

It was created in 1992 by Robert Kaplan and David Norton as a performance measurement framework. The balanced scorecard methodology is a comprehensive approach that analyzes an organization's overall performance in four areas:

- financial analysis, the most traditionally used performance indicator, includes assessments of measures such as operating costs and return-on-investment;
- customer analysis looks at customer satisfaction and retention;
- internal analysis looks at production and innovation, measuring performance in terms of maximizing profit from current products and following indicators for future productivity;
- learning and growth analysis explores the effectiveness of management in terms of measures of employee satisfaction and retention and information system performance.

These perspectives foster a balance between short- and long-term objectives, between quantitative-objective measures and qualitative-subjective measures. Balanced Scorecard offers a measurement and management system that links strategic objectives to comprehensive performance indicators. The success of this approach lies in its ability to unify and integrate a set of indicators that measure the performance of the activities and processes at the core of the organization's operations. This is seen as being valuable because it presents a balanced picture of overall performance, highlighting activities that need to be completed[1].

A successful implementation and efficient functioning of BSC requires the adaptation of many processes in the field of the company's organizational structure.
In order to make strategy more readily executable through the use of performance measurement, Robert Kaplan and David Norton developed the concept of a 'balanced scorecard', an organizational scorecard that would facilitate the integration of functional measures and enable better organization-wide strategy execution[2].

2. Balanced Scorecard characteristics.

The Balanced Scorecard (BSC) is the most widely applied performance management system today. It was originally developed as a performance measurement system in 1992 by Robert Kaplan and David Norton at the Harvard Business School. Unlike earlier performance measurement systems, the BSC measures performance across a number of different perspectives — a financial perspective, a customer perspective, an internal business process perspective, and an innovation and learning perspective.

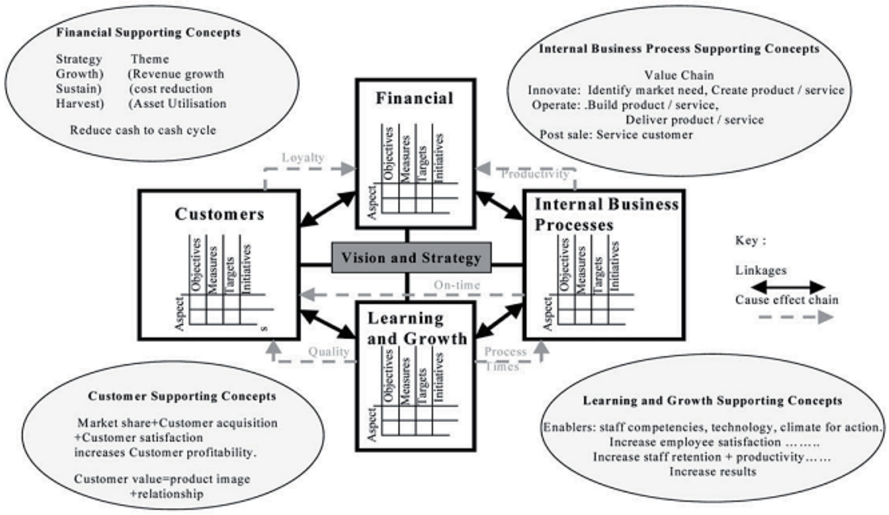
1) Kourdi (2003, p. 42).

2) Spitzer (2007, p. 91).

The idea of Balanced Scorecard is shown in Figure 1.

Figure 1: Balanced Scorecard

Translating Strategy and Operational Items.



Source: Southern (2002, p. 401–402).

Through the use of the various perspectives, the BSC captures both leading and lagging performance measures, thereby providing a more “balanced” view of company performance. Leading indicators include measures, such as customer satisfaction, new product development, on-time delivery, employee competency development, etc. Traditional lagging indicators include financial measures, such as revenue growth and profitability. The BSC performance management systems have been widely adopted globally, in part, because this approach enables organizations to align all levels of staff around a single strategy so that it can be executed more successfully.[3]

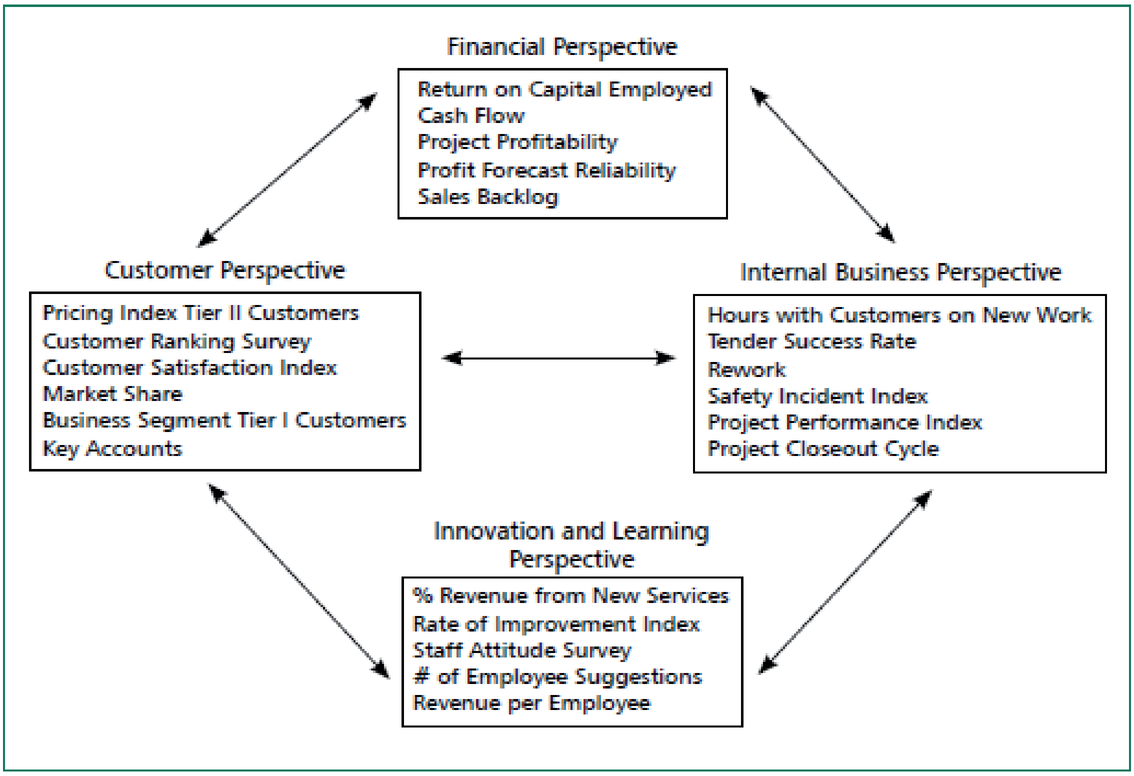
Realizing the need of an integrated management system that would incorporate both traditional quantitative and more abstract qualitative performance measures, Kaplan and Norton (1996) developed the concept of the Balanced Scorecard, which aims at providing a framework that translates strategy into action.[4] The BSC is developed along the four well known perspectives of Financial, Customer, Internal Business Process, and Learning and Growth Performance, which, at any point in time of measurement, characterize the current status and future potential of organizations. These perspectives foster a balance between short- and long-term objectives, between desired outcomes (lag performance measures) and the performance drivers of these outcomes (lead performance measures), and between quantitative-objective measures and qualitative-subjective measures. Through the years, the Balanced Scorecard has evolved, from the performance measurement tool originally introduced by Kaplan and Norton, to a tool for implementing strategies and a framework for determining the alignment of an organization’s human, information and organization capital with its strategy. This shift has prompted companies to view the BSC as a strategic communication and management system, thus placing significant weight on several implementation issues that have not previously been documented in the literature.

3) Johnson (2007, p. 2).

4) Kaplan/Norton (1996, p. 126).

The example of a Balanced Scorecard is shown in Figure 2.

Figure 2: Example of a Balanced Scorecard



Source: Kaplan/Norton (1993).

The popularity of the Balanced Scorecard is attributed to the following three innovative principles:

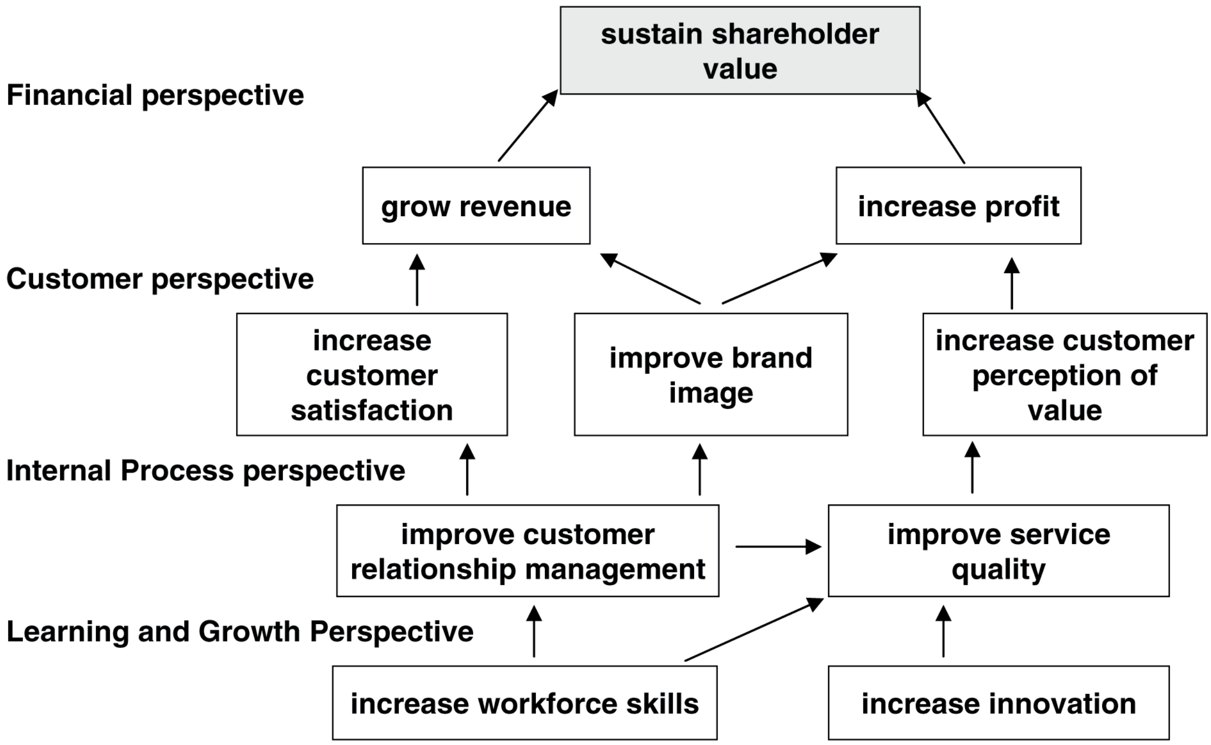
- It is a management system, not just a measurement system. The aim it that BSC be used to manage the communication and development of the strategy, not just to measure it after-the-fact,
- The four perspectives of the scorecard are supposed to be casually related,
- The scorecard is supposed to focus attention on creating capability in the present and future value.

The Financial and Customer perspectives describe the outcomes the company wants to achieve. The Internal and Learning and Growth perspectives describe how the organization intends to achieve these outlines. While financial outcomes measure the desired final score, the key is to use the drivers in the other perspectives to move the financials in the right direction.

A strategy map is a visual representation of the organization's strategy, which provides a discipline for linking objectives in the four objectives to promote greater understating of the strategy. Once created the strategy map becomes a powerful communication and strategy execution tool. It also visualizes at least part of the organization's value creation process[5]. An example of measurement framework using the strategy map perspective is depicted in Figure 3.

5) Dean (2007, p. 93).

Figure 3: Measurement Framework: strategy map format



Source: Dean (2007, p. 93).

Organizations have adapted the BSC to their particular external and internal circumstances. Both commercial and not for-profit organizations have successfully used the BSC framework.
Since 1992, Kaplan/Norton have studied the success of various applications of the BSC in different types of organizations. Companies have used as few as four measures and as many as several hundred measures when designing a BSC performance measurement system. Based on this research, it has been found that a BSC framework using about 20–25 measures is the usual recommended best practice. Smaller organizations might use fewer measures, but it is generally not advisable to go beyond a total of 25 measures for any single organization, holding company, or conglomerate group of holding companies.[6]

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6) Johnson (2007, p.2).

The example an "Ideal" Balanced Scorecard is shown in Table 1.

TABLE 1
Example of an 'Ideal' Balanced Scorecard

Perspective	Number of Metrics	Weight
Financial	5	22%
Customer	5	22%
Learning and Innovation	5	22%
Internal Processes	9	34%
	24 measures	100%

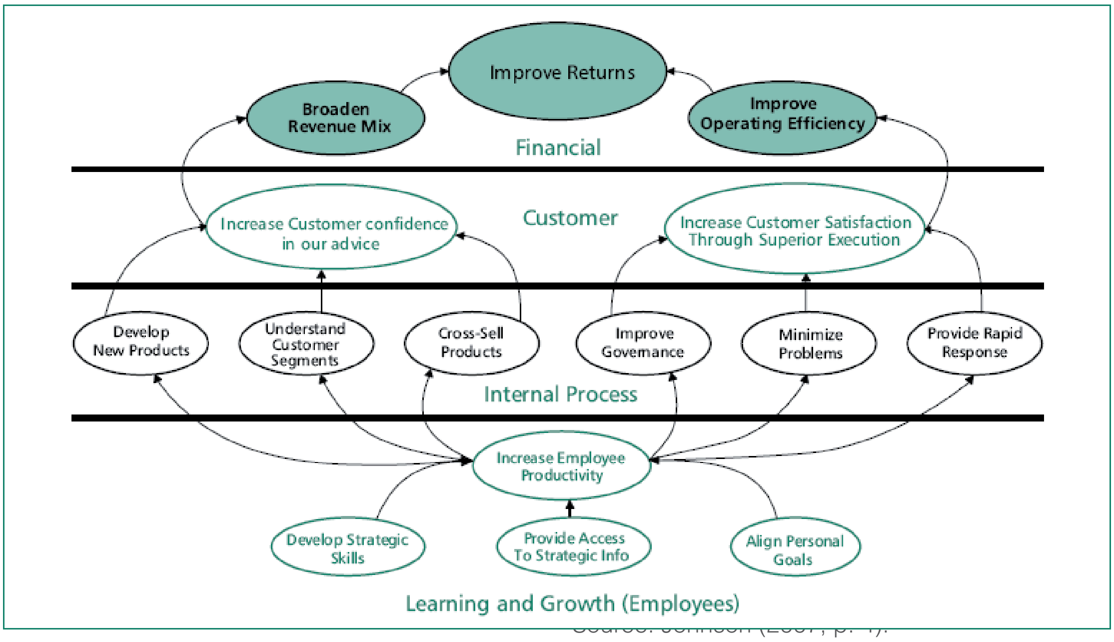
Source: Norton (2000).

The brief article explained the need for balancing the number of measures in all four perspectives, with greater emphasis on process measures, because the process perspective is the primary domain through which organizational strategy is implemented. Eight years after introducing the BSC, Kaplan/Norton published an article entitled, Having Trouble with Strategy, Then Map It! The article introduced the concept of a 'Strategy Map' to the BSC framework. A 'Strategy Map' enables organizations to clarify their strategy and assist organizations with creating their BSC framework and measures.

Organizations need tools for communicating both their strategy and the processes and systems that will help them implement that strategy. Strategy maps provide such a tool. They give employees a clear line of sight into how their jobs are linked to the overall objectives of the organization, enabling them to work in a coordinated, collaborative fashion toward the company's desired goals. The maps provide a visual representation of a company's critical objectives and the crucial relationships among them that drive organizational performance.
Strategy maps can depict objectives for revenue growth; targeted customer markets in which profitable growth will occur; value propositions that will lead to customers doing more business and at higher margins, the key role of innovation and excellence in products, services, and processes; and the investments required in people and systems to generate and sustain the projected growth[7].

A generic corporate strategy map is provided below (Figure 4) to illustrate the 'Strategy Map' concept.

Figure 4: Example of a "Generic" Strategy Map



Source: Johnson (2007, p. 4).

7) Kaplan/Norton (2000, p.168).

3. Perspectives (quadrants) of Balanced Scorecard

The financial perspective (quadrant) of the Balanced Scorecard measures performance in three major categories: revenue growth, productivity, and return on investment. These categories are connected to the maturity of a company's business. This perspective is depicted in Table 2.

TABLE 2
Financial quadrant representative metrics.

Metric	Pioneer	Expansion	Stabilization
Reveune Growth	% Reveune Growth	Revenue by Market	Revenue by Product
Productivity	Revenue per Employee	Profit per Employee	Unit cost
ROI	Revenue Turnover (Revenue/Assets)	Return on Assets	Return on Equity

Source: Trotta/Hudick (2003, p. 134).

The Internal business process quadrant is divided in three main categories: 1) innovation, production and postsale service. These aspects are shown in Table 3.

TABLE 3
Internal business process metrics.

Process	Function	Metric
Innovation	Strategy	Revenue Growth
	Product Development	Revenue from New Products
Operations	Manufacturing	Cost per Unit
	Delivery	Average Delivery Time
Post Sale Service	Customer	Satisfaction Index

Source: Trotta/Hudick (2003, p.137).

The aims of the learning and growth perspective provide the infrastructure to enable ambitious objectives in other three perspectives to be achieved. This is a key to a long-term growth of all of the companies. The quadrant is described in three areas: employee capabilities, information systems capabilities and alignment & motivation. The detailed description of this issue is shown in Table 4.

TABLE 4
Learning and growth metrics.

Area of Focus	Measurement Target	Metric
Employee capabilities	Satisfaction	Satisfaction Index
	Retention	Turnover Rate
	Productivity	Net Income per Employee
Information Systems Capabilities	Technology Platform	Availability, Reliability, Scalability
	Software	Ability to Perform Functional Requirements
	Database	Ability to Capture Customer Experience
Organizational	Motivation	Cultural Climate
Alignment & Motivation	Strategic Alignment	Goodness of Fit to Departmental Goals

Source: Trotta/Hudick (2003, p. 139).

Lack of attention to learning and growth perspective may over time build to dramatic proportions. It may have devastating effects on a company's ability to be productive and generate shareholder value.[8]

Companies that do not take into consideration customers' need will probably fail. The core measurements is customers perspective are shown in Table 5.

TABLE 5
Customer metrics

Measurement	Definition	Metric
Market Share	The percentage of sales that a company holds in a specific market	% of total loan volume generated by small business in the community area
Customer Acquisition	The number of new customers a company obtains in a specific time period	Ration of new customers to existing customers in a year
Customer Satisfaction	The overall customer affinity for good or services delivered by a company	Index of satisfaction based n survey in results
Customer profitability	Profit measured on a customer by customer basis	Total income less cost of sales products and service on a per customer basis

Source: Trotta/Hudick (2003, p.136).

8) Trotta/Hudick (2003, p.138).

4. Problems associated with the Balanced Scorecard

Literature estimates 70% failure rate for attempted Balanced Scorecard implementations. Lack of awareness is unlikely to be an explanatory factor. Performance may be deemed satisfactory and there may be no incentive for changes. Furthermore, the cost and potentially disruptive effects of such changes may be deemed a high price to pay in return for uncertain, less measurable and distant benefits.

Lack of top management support is often cities. The key factors for that reason are: poor communication, inadequate training and failure to secure widespread participation and support. Some managers may be reluctant to let their operations become more visible and may see accountants who stray beyond their traditional domain of pure financial matters as intruders. Some accountants may see the decentralization of accounting information as the erosion of their power base.

In literature we can find five main problems with using the Balanced Scorecard system:

1. Poorly defined metrics

Metrics should be relevant and clear. They should be depicted with visual indicators that are easily understood. In addition, metrics need to be collected at the ideal frequency for making decisions, and defined in such a way that the measurement can be consistently applied across the firm, even if their targets of performance differ.

2. Lack of efficient data collection and reporting

Companies that deliberately plan to define the vital few metrics and commit the resources to automate data collection and subsequent reporting tend to achieve good results. In most organizations, if collecting metrics data consumes too much time and energy, they will not be captured. That is why it is important to prioritize key performance indicators.

3. Lack of a formal review structure

The stricture of Balanced Scorecards should be reviewed frequently enough to make a difference. If a metric value changes on a daily basis and the variables within the control of management can be affected on a daily basis, then the metric should be reviewed on a daily basis. Additionally, metrics review meetings should follow a standard agenda, with clearly defined roles for all attendees and an expectation that follow through on any agreed upon actions will be monitored at each meeting.

4. No process improvement methodology

The value of Balanced Scorecard systems relies on the premise that once performance problems are identified, there is an efficient and effective method for diagnosing and addressing root causes. Solutions can then be developed and performance gaps can be closed. If the organization does not have standard methodologies and toolkits for addressing process problems, the amount of effort required to derive a problem solving approach for each new performance gap could eventually damage the performance improvement program as it will be seen as taking too many resources away from daily operations. When this happens, there can be no adaptation and performance will continue to deteriorate.

5. Too much internal focus

It is said that Balanced Scorecard encourages an internal focus. To overcome this problem, companies should start with an external focus. The aim is to achieve a balance of enterprise level metrics as you assess the organization's market, shareholders, competitors, employees and stakeholders. Executives will use data to assess Strengths, Weaknesses, Opportunities and Threats (SWOT). This will then guide them to gaps in their enterprise level metrics. Then, all other levels of metrics are tested for alignment with the enterprise level metrics, thereby ensuring that even internal metrics link to external performance drivers.

5. Advantages of Balanced Scorecard implementation

When Balanced Scorecard is used correctly it empowers the company by operationalising the strategy discussion and assigning the accountability for well-defined results. The major advantages of Balanced Scorecard are:

- It breaks down the company's financial targets, thus creating a dialogue as to the strategy to achieve them,
- It makes the strategy transparent, thereby reducing the risks of delegation,
- The non- financial indicators provide a sense check to see whether targets have been set legitimately, or through financial manipulation.[9]

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9) Fahy et al. (2005, pp. 151-152).

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DIE ENTWICKLUNG VON AKTIENKURSEN UND RENDITEN ALS STOCHASTISCHE PROZESSE

(MODELLING STOCK PRICES AND YIELDS AS STOCHASTIC PROCESSES)

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KEYWORDS:
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(MODELLING STOCK PRICES AND YIELDS AS STOCHASTIC PROCESSES)

ABSTRACT

This article presents a short tutorial about basic mathematic-statistical models to model the evolution of stock prices. As a matter of fact, main assumptions of these models are often violated in reality. This is an important issue to understand the benefits and limitations of these models to forecast future changes in stock prices and yield on shares.

JEL Classification: G13, C46

1. Einleitung

In der Finanzwirtschaft (Finance), bei der Entwicklung und Bewertung von Geldanlagen und Investitionen im Zeitverlauf spielen mathematisch-statistische Modelle eine wesentliche Rolle. Mit Hilfe statistischer Modelle wird versucht, Kurs- und Renditeschwankungen zu erfassen, Unsicherheiten zu quantifizieren und unsichere zukünftige Zahlungen abzubilden. In dieser Arbeit sollen einige wesentliche statistische Basisinstrumente zur Lösung dieser Aufgabe zusammenfassend dargelegt werden.

2. Kurse und Renditen als Zufallsvariablen

Man kann den gegenwärtigen Kurs einer Aktie oder deren Rendite betrachten, ihr Kurswert oder ihre Rendite zu einem späteren Zeitpunkt lässt sich jedoch nicht eindeutig vorhersagen. Aufgrund zahlreicher unbekannter, nicht beherrschbarer, unsystematischer Einflüsse, man spricht auch von Zufallseinflüssen, variieren die Werte. Sie hängen vom Zufall ab, d.h. über zukünftige Kurse und Renditen lassen sich nur mehr oder weniger begründete Vermutungen anstellen. Wahrscheinlichkeitsmodelle erlauben jedoch, Zufallseinflüsse zu quantifizieren, zu modellieren und begründete Prognosen über die Höhe von Aktienkursen und Renditen in der Zukunft abzuleiten. Aktienkurse oder Renditen hängen also vom Zufall ab und können deshalb als Zufallsvariablen mit gewissen Wahrscheinlichkeitsverteilungen betrachtet werden.

Eine Zufallsvariable ist eine Funktion, die zufällige Ereignisse (zufällig eingetretene Zustände, die zu bestimmten Kurswerten bzw. Renditen zu gewissen Zeitpunkten führen) eines Wahrscheinlichkeitsraumes (alle möglichen Zustände) in die Menge der reellen Zahlen (konkreter beobachteter Wert) abbildet[1]. Jede Zufallsvariable *X* besitzt eine Verteilungsfunktion $F(x)=P(X\leq x)$, die jeder reellen Zahl **x** diejenige Wahrscheinlichkeit zuordnet, die das zufällige Ereignis besitzt, dem die Zufallsvariable einen Wert kleiner oder gleich x, $x\in R$, zuweist. Welcher Art die Verteilungsfunktion ist, hängt von verschiedenen komplexen ökonomischen Phänomenen ab.

Bezeichne r^{ein} die Zufallsvariable der einfachen Rendite und sei r^{stet} die Zufallsvariable der stetigen Rendite. Des Weiteren sei die Zufallsvariable der Kurse zum Zeitpunkt t mit S_t bezeichnet.

Dann gilt:

– Die einfache Durchschnittsrendite $r_t^{e\inf} = \frac{S_t}{S_{t-1}} - 1$ im Intervall Δt =[t-1, t] ist im Allgemeinen nicht normalverteilt.[2]
– Man betrachtet deshalb anstelle der einfachen Renditen deren Logarithmen, die stetigen Renditen

$$r^{stet} = \ln(1 + r_t^{e\inf}) = \ln\left(\frac{S_t}{S_{t-1}}\right) = \ln S_t - \ln S_{t-1}$$

welche einer Normalverteilung folgen.[3]
– Die Größe $1 + r_t^{e\inf}$ wird auch Verzinsungsfaktor genannt.[4]
– Die einfachen Renditen bzw. die Kurse selbst sind dann logarithmisch normalverteilt.

3. Normalverteilung und logarithmische Normalverteilung

In der Wahrscheinlichkeitstheorie unterscheidet man zwischen stetigen und diskreten Zufallsvariablen. Eine Zufallsvariable X heißt diskret, wenn sie nur endlich viele oder höchstens abzählbar unendlich viele Werte annehmen kann, während die Werte einer stetigen Zufallsgröße überabzählbar unendlich sind.

Eine stetige Zufallsgröße X heißt normalverteilt mit den Parametern μ und σ, wenn ihre Dichtefunktion f(x) gegeben ist durch:

$$f(x) = \frac{1}{\sigma \cdot \sqrt{2\pi}} \cdot e^{-(x-\mu)^2/2\sigma^2}$$

1) Vgl. Sandmann, K., 2010, S. 21-22.

2) Vgl. Spremann, K., 2003, S.132, S.163.

3) Vgl. Hull, John C., 2009, S. 277-280.

4) Vgl. Spremann, K., 2005, S. 80.

5) Vgl. Hull, John C., 2009, S. 277-280.

Symbolisch schreibt man kurz: X~ NV(μ;σ); μ bezeichnet hier den Erwartungswert der Zufallsvariablen und σ deren Standardabweichung.

Eine Zufallsvariable X, die nur Werte größer als Null annehmen kann, heißt logarithmisch normalverteilt (oder lognormalverteilt), wenn die transformierte Zufallsvariable Y=ln(X) normalverteilt ist mit den Parametern μ_{LN}, σ_{LN} , wobei E(Y)=μ_{LN} und Var(Y)=σ^2_{LN}. Es gelten dann für den Erwartungswert und die Varianz der lognormalverteilten Zufallsvariablen X:[6]

$$E(X) = e^{\mu_{LN} + \sigma^2_{LN}/2} \qquad Var(X) = e^{2\mu_{LN} + \sigma^2_{LN}} \cdot (e^{\sigma^2_{LN}} - 1)$$

4. Stochastische Prozesse

Jede Variable, deren Werte in unbestimmter Weise über einen Zeitraum schwanken, folgt einem stochastischen Prozess. Ein stochastischer Prozess ist deshalb definiert∈als eine geordnete Folge von Zufallsvariablen {X(t), t T}, wobei T den Parameterraum bezeichnet, der in vielen Fällen, insbesondere in der Finanzwirtschaft, als Zeit zu interpretieren ist. Bei einem stochastischen Prozess handelt es sich dann um eine Menge von Zufallsvariablen, deren Ergebnisse reelle Funktionen in Abhängigkeit von der Zeit sind. Die Menge aller Werte der Zufallsvariablen, welche die X(t) für alle t∈T annehmen können, heißt Zustandsraum Z.

Stochastische Prozesse werden wie Zufallsvariablen in stetige und diskrete Prozesse eingeteilt. Bei einem diskreten Prozess ist der Zustandsraum endlich oder höchstens abzählbar unendlich, während bei stetigen Prozessen dieser überabzählbar unendlich ist. Außerdem teilt man stochastische Prozesse in Abhängigkeit vom Parameterraum in Prozesse mit diskretem oder stetigem Parameterraum ein. Man unterscheidet also zwischen stochastischen Prozessen mit diskreter Zeit, d.h. die Zufallsvariablen lassen sich als eine zeitlich geordnete Folge darstellen, und stochastischen Prozessen mit stetiger Zeit, d.h. die Zeitpunkte füllen ein ganzes Intervall der reellen Zahlenachse dicht aus. Eine beobachtete Reihe von stetigen Jahresrenditen $x_1, x_2, \ldots, x_n$ eines Wertpapiers kann dann zum Beispiel als Realisierung eines stetigen stochastischen Prozesses mit diskretem Parameterraum aufgefasst werden.[7]

4.1 Parameter stochastischer Prozesse

Die Menge $\{F_t(x), t \in T\}$ mit $F_t(x) = P(X(t) \le x, x \in R)$
heißt Menge der Verteilungsfunktionen des stochastischen
heißt Menge der Verteilungsfunktionen des stochastischen
Prozesses. Für stochastische Prozesse mit endlich vielen diskreten Zeitpunkten
$t_1, t_2, \ldots, t_n$ kann die gemeinsame Verteilungsfunktion wie folgt vollständig beschrieben werden∈

$$F_{t_1, t_2, \ldots, t_n}(x_1, x_2, \ldots, x_n) = P(X(t_1) \le x_1, X(t_2) \le x_2, \ldots, X(t_n) \le x_n).$$

Die durchschnittliche Entwicklung μ(t) des stochastischen Prozesses wird durch den Erwartungswert als Funktion der Zeit beschrieben: μ(t)=E(X(t)), t T. Man nennt diese Funktion auch Mittelwertfunktion, Trendfunktion oder Driftrate.[8] [9] Die zeitabhängigen Schwankungen der Werte der Zufallsvariablen werden durch die Varianzfunktion $\sigma_2(t)$ erfasst. Des Weiteren kann man die Beziehungen zwischen Zufallsvariablen innerhalb des Prozesses messen, in dem man die Kovarianz zwischen den Zufallsvariablen X(ti) und X(tj) bestimmt, ti, tj T, ti ≠ tj. Dabei heißt die Funktion, welche die Kovarianzen zwischen den Zufallsvariablen zum Zeitpunkt t und den um j Perioden versetzten Zeitpunkt (t-j) betrachtet, Autokovarianzfunktion Cov(t)=Cov(X(t), X(t-j)), t∈T, j∈N.[10]

4.2 Spezielle stochastische Prozesse

4.2.1 Stationäre stochastische Prozesse

Einfache stochastische Prozesse sind solche, bei denen die einzelnen statistischen Parameter über die Zeit betrachtet konstant bleiben. Sie hängen nicht von den absoluten Zeitwerten ab, sondern werden nur von Abständen zwischen ihnen beeinflusst. Man nennt einen stochastischen Prozess {X(t), t T} stationär im engeren (strengen) Sinne[11], wenn die Wahrscheinlichkeitsverteilung invariant gegen absolute Zeitverschiebungen ist, d.h. für jede endliche zusammenhängende Teilmenge
$X_{t1}, \ldots, X_{tm}$ von Zufallsvariablen des stochastischen Prozesses ist die gemeinsame Verteilungsfunktion gleich der Verteilungsfunktion der um j Zeitpunkte verschobenen Menge von Zufallsvariablen

6) Vgl. Spremann, K., 2005, S.411.

7) Vgl. Beichelt, F., 1997, S. 53.

8) Vgl. Beichelt, F., 1997, S. 56.

9) Vgl. Hull, John C., 2009, S. 263.

10) Vgl. Beichelt, F., 1997, S. 56-57.

11) Vgl. Beichelt, F., 1997, S. 57-58.

12) Vgl. Beichelt, F., 1997, S. 59.

Xt1-j ,..., Xtm-j. Insbesondere gilt dann für alle Zeitpunkte t:

1. $\mu(t) = \mu$
2. $\sigma^2(t) = \sigma^2$
3. Cov(t) = Cov(j), d.h. die Kovarianzen hängen lediglich von der Anzahl j der zeitversetzten Perioden, nicht aber von der Zeit selber ab.

Hingegen heißt ein stochastischer Prozess stationär im weiten Sinne[12], wenn lediglich Trend-, Varianz- und Autokovarianzfunktion, sofern sie existieren, nicht vom Zeitpunkt t abhängen.

4.2.2 Markov Prozesse

Ein Markov Prozess ist ein spezieller stochastischer Prozess, bei dem nur der gegenwärtige Wert der Variablen für die Vorhersage des zukünftigen Wertes relevant ist. Mathematisch formuliert bedeutet die Markov-Eigenschaft, dass für die bedingten Wahrscheinlichkeiten gilt:

$$P(X(t_{n+1}) \in A_{n+1} | X(t_n) \in A_n, X(t_{n-1}) \in A_{n-1}, X(t_1) \in A_1) = P(X(t_{n+1}) \in A_{n+1} | X(t_n) \in A_n)$$

für alle n=1,2, ...,n,... und alle (n+1)-Tupel $(t_1, \ldots, t_{n+1})$ mit $t_i \in T$, $t_1 < t_2 < \ldots < t_{n+1}$ und beliebige $A_i \subseteq Z$.[13]
Man kann zeigen, dass die Zuwächse $X(_{t2}) - X(_{t1})$, $X(_{t3}) - X(_{t2})$, ..., $X(_{tn}) - X(_{tn-1})$ für alle n-Tupel $(t_1, \ldots, t_n)$ mit $t_i \in T$, $t_1 < t_2 < \ldots < t_n$ bei Markov-Prozessen stets unabhängig sind.[14]
Besitzt ein stochastischer Prozess mit diskretem Zustandsraum die Markov-Eigenschaft, so nennt man diesen Prozess auch Markov-Kette[15]. Man unterscheidet zwischen diskreten und stetigen Markovschen Ketten, je nach diskretem oder stetigem Parameterraum.

4.2.3 Random Walk

Ein Random Walk ist ein in diskreter Zeit ablaufender spezieller Markov-Prozess. Dabei ist jeder Zustand gleich dem vorangegangenen Zustand plus einer zufälligen Änderung. Man geht auf einem Pfad pro Zeiteinheit einen Schritt vorwärts und weicht dabei gleichzeitig zufällig entweder nach links oder rechts vom Weg ab, der Pfad verzweigt sich also. Des Weiteren sind die zufälligen Änderungen, die Differenzen der zwischen zwei Zuständen, identisch verteilte, unabhängige Zufallsvariablen. Der Erwartungswert μ, der bei allen die Differenzen bezeichnenden Zufallsvariablen gleich ist, wird als Drift bezeichnet und die bei allen Differenzen identische Varianz mit σ^2.[16 17]

4.2.4 Brownsche Bewegung oder Wiener Prozess

Überträgt man die Eigenschaften des Random Walk auf stetige stochastische Prozesse mit stetiger Zeit gelangt man zu dem Begriff der Brownschen Bewegung, der hauptsächlich im englischsprachigen Bereich verwendet wird, während im deutschsprachigen Raum eher der Begriff Wiener Prozess verwendet wird.[18]

Ein stetiger stochastischer Prozess $\{X(t), t \in T, t \geq 0\}$ mit stetiger Zeit heißt Wiener Prozess mit Drift, wenn gilt:

1. {X(t)} besitzt unabhängige Zuwächse, d.h. für alle $0 \leq t_0 \leq t_1 \leq \ldots \leq t_n$ sind die Zuwächse
 $X(t_1)-X(t_0)$, ..., $X(t_n)-X(t_{n-1})$ unabhängige Zufallsvariablen.
2. Die Zuwächse sind stationär, d.h. die Verteilung der Zuwächse ist nicht abhängig von
 der Lage des Zeitintervalls $[t, t+\Delta t]$, sondern nur von der Breite Δt.
3. Die Zuwächse sind normalverteilt, d.h. es gilt $X(t+\Delta t)-X(t) \sim NV(\mu\Delta t; \sigma^2 \cdot \Delta t)$.[19]

Der Parameter μ wird auch als Drift bezeichnet. Für einen Wiener Prozess mit Drift folgt aus der 2. Eigenschaft, dass der erwartete Werteverlauf zeitproportional zum Drift ist. Ist speziell $\mu=0$ und $\sigma=1$, handelt es sich um einen Standard-Wiener Prozess.[20]
Des Weiteren folgt aus der obigen Definition unmittelbar, dass Wiener Prozesse spezielle Markov Prozesse sind. Außerdem kann man zeigen, dass ein Wiener Prozess als Grenzwert eines Random Walk aufgefasst werden kann.[21]
Für das Folgende betrachten wir ein Zeitintervall $[0,\Delta T]$, welches in n gleiche Teilstücke der Länge Δt zerlegt ist. In jedem Teilstück sind die Zuwächse dann Zufallsvariablen, die sich aus einem festen deterministischen Verlauf und zufälligen Schwankungen zusammensetzen. Die Verteilungsfunktionen für die Zuwächse sind in jedem Teilstück identisch.
Für die Änderung ΔX in einem kleinen Zeitintervall Δt wird angenommen: $\Delta X = a \cdot \Delta t + b \cdot \varepsilon \cdot \sqrt{\Delta t}$
Hierbei beschreibt $a \cdot \Delta t$ den deterministischen Verlauf und $b \cdot \Delta z = b \cdot \varepsilon \cdot \sqrt{\Delta t}$ den zufälligen Verlauf, wobei ε eine standardnormalverteilte Zufallsgröße sei mit $\mu=0$ und $\sigma=1$, a, b bezeichnen reelle Konstanten.

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13) Vgl. Beichelt, F., 1997, S. 60.

14) Vgl. Beichelt, F., 1997, S. 60.

15) Vgl. Beichelt, F., 1997, S. 60.

16) Vgl. Spremann, K., 2003, S. 394-395.

17) Vgl. Albrecht, P., Maurer, R.,2008, S. 164.

18) Vgl. Beichelt, F., 1997, S.268.

19) Vgl. Albrecht, P., Maurer, R.,2008, S.170-171.

20/21) Vgl. Albrecht, P., Maurer, R.,2008, S. 171.

Man kann zeigen, dass dann auch ΔX einer Normalverteilung folgt mit den Parametern $\mu = a \cdot \Delta t; \sigma = b\sqrt{\Delta t}$
Symbolisch schreibt man: $\Delta X \sim NV(\mu = a \cdot \Delta t; \sigma = b\sqrt{\Delta t})$

Betrachtet man nun den Zuwachs des stochastischen Prozesses {X(t)} über dem gesamten Intervall [0, T], so setzt sich dieser dann zusammen aus der Summe der unabhängigen, identisch verteilten Zuwächse
X_i, i=1, ..,n, der n Zeitintervalle t:

$$X(0) - X(T) = \sum_{i=1}^{n} \Delta X_i = n \cdot a \cdot \Delta t + b\sqrt{\Delta t} \cdot \sum_{i=1}^{n} \varepsilon_i$$

Für den Erwartungswert und die Varianz der Summe gilt:
E[X(0)-X(T)]= naΔt und Var[X(0)-X(T)]=b^2nΔt.

Wenn wir uns nun vorstellen, dass die Anzahl der Teilstücke immer größer wird, d.h. n gegen unendlich strebt (n→∞), ist nach dem zentralen Grenzwertsatz der Wahrscheinlichkeitsrechnung Wahrscheinlichkeitsrechnung die Summe $\sum_{i=1}^{n} \varepsilon_i$ für n , ebenfalls normalverteilt und damit auch der Zuwachs X(0)-X(T) über einem festen Intervall [0, T], unabhängig davon, welcher Wahrscheinlichkeitsverteilung die εi folgen.
Ein immer größeres n bedeutet, dass Δt und damit auch ΔX gegen Null geht, so dass schließlich aus der Differenzengleichung eine Differentialgleichung wird, die den Grenzwert der Folge der diskreten Zuwächse beschreibt, wenn diese in immer kleineren Intervallen betrachtet werden. Man kann den Grenzwert somit auch als Zuwachs in einem Punkt ansehen dx = adt + bdz (a, b sind reelle Konstanten). Hierbei bedeutet adt, dass ΔX eine Drift-Rate von a pro Zeiteinheit hat. Der Term bdz kann als zusätzliches Rauschen oder Schwankung der Variablen ΔX auf ihrem Pfad betrachtet werden. Der Betrag der Variabilität beträgt b mal einem Standard-Wiener Prozess.[22]

Geometrischer Wiener Prozess
Ist X(t), t∈T, t≥0} ein Wiener Prozess, so nennt man {Z(t), t∈T, t≥0} mit $Z(t) = e^{X(t)}$ einen geometrischen Wiener Prozess mit Drift. Für geometrische Wiener Prozesse gilt:

$$E(Z(t)) = e^{t(\mu+\sigma^2/2)} \quad \text{und} \quad Var(Z(t)) = e^{t(2\mu+\sigma^2)}(e^{t\sigma^2} - 1)$$

Verallgemeinerter Wiener Prozess oder Itô-Prozess
Lässt man zu, dass bei einem Wiener Prozess der Erwartungswert des Zuwachses im Zeitintervall [t, t+Δt] nicht stationär ist, d.h. nicht nur von der Breite Δt, sondern auch vom Zeitpunkt t abhängt, so spricht man von einem verallgemeinerten Wiener Prozess oder auch einem Itô-Prozess.[24][25] Allgemein lässt sich dies durch die folgende Differentialgleichung ausdrücken: dx=a(x,t)dt+b(x,t)dz
Hierbei bezeichnet dz einen Standard-Wiener-Prozess, d.h. der erwartete Zuwachs pro Zeiteinheit ist Null und die Varianzrate beträgt Eins. Die Parameter a bzw. b sind jetzt allerdings Funktionen von t als auch von x, können sich also mit der Zeit und den Werten von X verändern.
Die Bezeichnungen für die oben eingeführten speziellen stochastischen Prozesse sind in der Literatur allerdings nicht einheitlich. Häufig wird auch ein Standard-Wiener-Prozess lediglich Wiener Prozess genannt und ein verallgemeinerter Wiener Prozess ist ein Wiener Prozess mit Drift. Sind dann Drift und Varianzrate eine Funktion von x und t, heißt der Prozess Itô-Prozess. Die Begriffe "verallgemeinerter Wiener Prozess" und "Itô-Prozess" sind dann nicht mehr identisch.[26]

Lemma von Ito´
Es soll nun der Frage nachgegangen werden, was geschieht, wenn man einen Itô-Prozess transformiert, d.h. eine Funktion dieses speziellen stochastischen Prozesses betrachtet. Sei Y= G(x, t) eine Funktion des Itô-Prozesses x und der Zeit t. Dann gilt:
Der Prozess $\{Y_t | t \geq 0\}$ ist wiederum ein verallgemeinerter Wiener Prozess (Lemma von Ito´).[27][28]
$\{Y_t | t \geq 0\}$ wird durch folgende Differentialgleichung beschrieben:

$$dy = \left(\frac{\partial G}{\partial x} \cdot a(x,t) + \frac{\partial G}{\partial t} + \frac{1}{2} \cdot \frac{\partial^2 G}{\partial x^2} \cdot b^2(x,t) \right) \cdot dt + \frac{\partial G}{\partial x} \cdot b(x,t) \cdot dz$$

5. Die Wertentwicklung von Aktienkursen und Renditen als spezielle stochastische Prozesse

5.1 Die Wertentwicklung von Aktienkursen als Random Walk

Die zukünftigen Kurse bzw. Renditen sind aus heutiger Sicht unsicher, d.h. zufällig. Ihre Wertentwicklung vom Zeitpunkt 0 über T Jahre kann als Zufallsprozess in diskreter Zeit betrachtet werden.

22) Vgl. Hull, John C., 2009, S. 263-264.

23) Vgl. Beichelt, F., 1997, S. 288-289.

24) Vgl. Joshi, Mark S., 2008, S. 105-106

25) Vgl. Spremann, K., 2003, S. 449.

26) Vgl. Hull, John C., 2009, S.261-265.

27) Vgl. Hull, John C., 2009, S.269.

28) Vgl. Joshi, Mark S., 2008, S.109-110.

$$S_1 = S_0 \cdot (1 + r_1)$$
$$S_2 = S_1 \cdot (1 + r_2) = S_0 \cdot (1 + r_1) \cdot (1 + r_2)$$
....
$$S_T = S_{T-1} \cdot (1 + r_T) = S_0 \cdot (1 + r_1) \cdot (1 + r_2) \ldots \cdot (1 + r_T)$$

Hierbei bezeichne r_t, t=1,..,T, die zufällige einfache durchschnittliche Jahresrendite.

Betrachtet man anstelle der Kurswerte deren natürliche Logarithmen, so ergibt sich:

$$\ln S_T = \ln S_0 + \ln(1+r_1) + \ln(1+r_2) + \ldots + \ln(1+r_T) = \ln S_0 + r_1^{stet} + r_2^{stet} + \ldots + r_T^{stet}$$

wobei r_t^{stet} die stetige Jahresrendite bezeichnet.

Sei nun $Y_t = \ln S_t$, t = 1, …T, so kann die Entwicklung der logarithmierten Anlageergebnisse als stochastischer Prozess in diskreter Zeit betrachtet werden.

Für diesen Prozess werden des Weiteren folgende Annahmen getroffen:

- die zufälligen stetigen Jahresrenditen besitzen alle dieselbe Verteilung (Stationarität) mit den Parametern μ und σ.
- die Wahrscheinlichkeitsverteilung der stetigen Rendite im Jahr t ist unabhängig von den zuvor resultierenden Renditen, d.h. der Prozess besitzt die Markov-Eigenschaft.

Man erhält damit einen Random Walk, d.h. einen stochastischen Prozess mit zufälligen Zuwächsen

$X_t = Y_t - Y_{t-1} = r_t^{stet}$, die außerdem identisch verteilt und unabhängig voneinander sind. Alle Zuwächse besitzen den gleichen Erwartungswert μ sowie die gleiche Varianz σ^2. Der Erwartungswert μ wird auch Driftparameter des Zuwachses X_t und σ^2 (bezogen auf ein Jahr) Volatilität genannt. Da in unserem Beispiel der Zuwachs X_t gleich der stetigen Jahresrendite ist, bezeichnet μ letztlich den Driftparameter der stetigen Jahresrendite bzw. σ deren Standardabweichung.

Es gilt nun, dass aufgrund der identischen Verteilung und der Unabhängigkeit der ΔX_t nach jeweils einem Jahr, der erwartete Zuwachs $X_{0,T}$ nach T Jahren Tμ und die Varianz $T\sigma^2$ beträgt.[29] Des Weiteren weiß man, dass die stetigen Jahresrenditen einer Normalverteilung folgen mit den Parametern μ und σ (siehe Abschnitt 2). Folglich ist auch der Zuwachs X_t normalverteilt mit eben diesen Parametern und damit auch die Summe der Zuwächse, d.h. der Gesamtzu-wachs $X_{0,T}$ nach T Jahren, allerdings mit $E(X_{0,T})=T\mu$ und $Var(X_{0,T})=T\sigma2$.

5.2 Die Wertentwicklung von Aktienkursen als Wiener-Prozess

5.2.1 Entwicklung der Gesamtrendite

Der stochastische Prozess der Entwicklung der stetigen Renditen wird nun als ein in kontinuierlicher Zeit ablaufender Zufallsprozess betrachtet. Für jeden Zeitpunkt t gibt es eine Verteilung der Gesamtrendite ro,t in stetiger Notation, von der angenommen wird, dass die drei folgenden Bedingungen erfüllt sind:

- Normalverteilung, d.h. die stetigen Renditen sind normalverteilt.
- Stationarität, d.h. die Verteilungsparameter der stetigen Rendite sind unabhängig vom Startpunkt des Anlageprozesses und konstant über die Zeit.
- Unabhängigkeit, d.h. die zufällige n Renditen in zwei Zeitintervallen, die sich nicht überlappen, sind stochastisch unabhängig.

Die Entwicklung der Gesamtrendite kann somit als Wiener Prozess $\{r_{0,t} | t \geq 0\}$ aufgefasst werden.

Betrachtet wird die Veränderung *r* der stetigen Gesamtrendite, wenn sich der Zeithorizont von t um *t* verschiebt.

Es gilt dann: $r_{0,t+\Delta t} = r_{0,t} + \Delta r$ und $\Delta r = \mu \cdot \Delta t + \sigma \cdot \varepsilon \cdot \sqrt{\Delta t}$

ε bezeichnet eine standardnormalverteilte Zufallsgröße, die von $r_{o,t}$ unabhängig ist, μ ist der Erwartungswert der stetigen Rendite pro Zeiteinheit. Geht *t* gegen Null, lässt sich die Bewegungsgleichung Δ*r* als Differentialgleichung schreiben:[30]

$$r_{0\,t+dt} = r_{0,t} + dr$$

und man erhält: $dr = \mu \cdot dt + \sigma \cdot \varepsilon \cdot \sqrt{dt}$

5.2.2 Entwicklung der Kurse

Betrachtet werden nun die zeitlichen Veränderungen der Kurse selbst.

Es gelte: $\widetilde{S}_{t+\Delta t} = \widetilde{S}_t + \Delta S$

Die relative Kursänderung kann dann wie folgt ausgedrückt werden: $\frac{\Delta \widetilde{S}}{\widetilde{S}_t} = \frac{\widetilde{S}_{t+\Delta t} - \widetilde{S}_t}{\widetilde{S}_t} = \frac{\widetilde{S}_{t+\Delta t}}{\widetilde{S}_t} - 1$

29) Vgl. Schlittgen, R., 1993, S. 129, S.146.

30) Vgl. Spremann, K. 2003, S. 442.

Es wird jetzt angenommen, dass die relative Kursänderung einem Wiener Prozess folgt.
Die zugehörige, die relative Kursänderung beschreibende Differentialgleichung lautet dann
wie folgt $\frac{dS_t}{S_t} = \mu \cdot dt + \sigma \cdot dz$, wobei $dz = \varepsilon \cdot \sqrt{dt}$ gilt.
Setzt man dann G=ln(S), so lässt sich aus dem Lemma von Ito´ ableiten, dass die logarithmierten Kurse ebenfalls einem Wiener Prozess folgen, und zwar gilt
(siehe Abschnitt 4.2.4 „Lemma von Ito´"):

$$dG = \left(\frac{\partial G}{\partial S} \cdot \mu \cdot S + \frac{\partial G}{\partial t} + \frac{1}{2} \cdot \frac{\partial^2 G}{\partial S^2} \cdot \sigma^2 \cdot S^2 \right) dt + \frac{\partial G}{\partial S} \cdot \sigma \cdot S \cdot dz$$

Mit den entsprechenden Ableitungen von G:

$$\frac{\partial^2 G}{\partial S^2} = -\frac{1}{S^2}, \quad \frac{\partial G}{\partial S} = \frac{1}{S} \quad \text{und} \quad \frac{\partial G}{\partial t} = 0$$

erhält man somit:

$$dG = \left(\mu - \frac{1}{2} \cdot \sigma^2 \right) dt + \sigma \, dz$$

Das bedeutet, dass die logarithmierten Kurse einem Wiener Prozess folgen, allerdings mit
dem Driftparameter $\left(\mu - \frac{1}{2} \cdot \sigma^2 \right)$

Insgesamt gilt also:[31]
Wenn μ den Driftparameter des Prozesses der relativen Kursänderung bezeichnet, dann besitzt der Prozess der logarithmierten Kurse den Driftparameter μ-(1/2)σ^2.
Bezeichnet umgekehrt μ den Driftparameter des Prozesses der logarithmierten Kurse, ergibt sich für den Prozess der relativen Kursänderung ein Drift von μ+(1/2)σ^2.

Aus der stochastischen Differentialgleichung der logarithmierten Kurse folgt des Weiteren für die zufallsabhängige Entwicklung des Kursverlaufes eines Wertpapiers

$$d(\ln S) = \left(\mu - \frac{1}{2} \cdot \sigma^2 \right) dt + \sigma \cdot dz.$$

Somit erhält man:

$$\ln(S_t) = \ln(S_{t_0}) + \left(\mu - \frac{\sigma^2}{2} \right) \cdot (t - t_0) + \sigma \cdot (z_t - z_{t_0})$$

und folglich

$$S_t = S_{t_0} e^{\left(\mu - \frac{1}{2} \cdot \sigma^2 \right)(t - t_0) + \sigma \cdot \sqrt{(t - t_0)} \cdot \varepsilon}$$

als geometrischen Wiener Prozess,

wobei μ und σ die Parameter des zugrunde liegenden ursprünglichen Wiener Prozesses bezeichnen, hier Erwartungswert und Standardabweichung der relativen Kursänderung.[32]

6. Ausblick

Da die Entwicklung stetiger Renditen und logarithmierter Kurse als stochastische Wiener Prozesse betrachtet werden können, kommt es in der Anwendung, z.B. bei der Schätzung von Kurs- und Renditeschwankungen, darauf an, die Modellparameter μ und σ zu schätzen. Die Schätzungen können sich jedoch als problematisch erweisen, wenn in der Praxis Modellvoraussetzungen nicht erfüllt sind. Wird die Volatilität von Renditen und logarithmierten Kursen aus historischen Daten geschätzt, so kann sie nur dann auf zukünftige Zeitperioden übertragen werden, wenn unterstellt wird, dass die Varianz auch in der zukünftigen Periode konstant bleibt. Andererseits ist die Schätzung umso genauer, je größer die Anzahl der einbezogenen vergangenen Werte, d.h. je länger der betrachtete Zeitraum ist. Damit vergrößert sich jedoch die Gefahr inhomogener Varianz und daraus folgend verzerrter, d.h. an der Realität vorbeigehender Schätzergebnisse. Des Weiteren ist die beim Wiener Prozess vorausgesetzte Stetigkeit des Zeitverlaufs häufig verletzt, da Transaktionen in der Regel nur zu diskreten Zeitpunkten realisiert werden. Die Frage ist dann, wie viele Zeitintervalle in die Parameterschätzung einbezogen werden sollten. Insgesamt ergibt sich, dass Parameterschätzer, insbesondere Varianzschätzer so zu modifizieren sind, dass sie bezüglich verletzter Voraussetzungen stabil sind und möglichst unverzerrte Schätzwerte liefern. Neuere Forschungen beschäftigen sich intensiv mit diesem Thema und sind zukünftig den mathematisch-statistischen Basisinstrumenten in der Kapitalmarktkommunikation hinzuzufügen.

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31) Vgl. Spremann, K. 2003, S. 443-444.

32) Vgl. Albrecht, P., Maurer, R.,2008, S. 175.

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