

A glowing lightbulb is the central focus of the cover. The lightbulb is illuminated from within, casting a bright green glow. A butterfly with green and black wings is perched on the upper right part of the glass. The background is dark, making the lightbulb and butterfly stand out. The overall aesthetic is clean and modern, with a focus on technology and nature.

INTERNATIONAL STANDARDIZATION AS A STRATEGIC TOOL

The impacts of ICT standards: Three views

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1 Introduction

In the last few years, the issue of regulatory impact assessment (RIA) has become very attractive, in particular among European policy-makers. In contrast to the longer tradition of impact assessment of public activities in research and development (see the overview of tools in Fahrenkrog *et al.* (2002) [9]¹ and Ruegg and Feller (2003) [16]), regulatory impact assessment is a policy evaluation mechanism which has a long tradition only in the USA (OECD 1999). The growing interest in RIA in other countries, especially in Europe, reflects inter-related developments emerging over the past few years (OECD 2003). First, within a framework of tighter governmental budgets and stronger international competition, policy-makers involved in regulatory policies are being held more accountable for the significant economic resources, as well as the political capital invested in regulatory management systems now established in most OECD countries. Second, there is a growing interest in exploring how regulatory policies can be more evidence-based and supported by empirical findings. More evidence-based approaches to the assessment of regulatory quality allow a review of the effectiveness of policy tools used in practice, a review of their performance, and an improvement of the design and implementation of future policies.

Regarding the impact assessment of standards, two separate traditions of impact assessment have to be considered. Although we can observe a long tradition especially of ex-post-evaluation of R&D programmes (Fahrenkrog *et al.* 2002 [9]; Ruegg, Feller 2003) [16], the evaluation of standardization processes or standards themselves is a rather rare and only recent phenomenon in the United States (Tassej 2003) [19], where standard impact assessment is part of RTD evaluation, because of the assumption that standards are part of the technological infrastructure, which is provided by public institutions (for example, the National Institute for Standards and Technology (NIST)).

The main reason for the general lack of experience and activity in other countries is due to the fact that most standardization processes in other countries are mainly driven by industry initiatives, which are neither ordered nor funded by public institutions. Therefore, there is no legitimisation from the public perspective to conduct impact assessments, since the formal standardization bodies have just a mediator or platform function (i.e., they do not actually develop standards; this is done by the members of the respective working groups in charge). Consequently, a performance assessment in the sense of an ex-post- impact assessment should only concentrate on the correct performance of the standardization process, but not on the performance of the standards themselves. However, companies active in both informal industry consortia and formal standardization bodies may try to assess the impacts of their activities both ex ante and ex-post, to increase the efficiency of their resources spent and their strategies developed. In several European countries, like Germany, we have observed a strong decline in participation in, and

¹ Figures in square brackets refer to the Bibliography.

of resources spent on, standardization activities since the 1990s (for example, perceived by national standards development organisations). This may be an indication of a – at least perceived – restricted positive impact of standardization activities.

However, the impacts of European standards gain in relevance especially if they are integrated into the regulatory framework via the New Approach, which links them to European framework directives. Despite the establishment of the New Approach more than 20 years ago, European standards did not receive the necessary attention in the area of (regulatory) impact assessment. This misrepresentation is confirmed by the neglect of methodologies to assess the impacts of standards in the RTD Evaluation Toolbox published by Fahrenkrog et al. (2002) [9].

This paper will present three different methodological approaches to assess the impacts of ICT standards, ranging from very specific impacts of single standards to general impacts of the whole stock of ICT standards on growth in the ICT sector. We start with a case study on an e-business standard, then we present the results of a survey among stakeholders of European and international standardization organisations covering the ICT area. Finally, we conclude with the presentation of an econometric model determining the contribution of the stock of ICT standards to the growth in the German and British ICT sectors.²

This overview will not only provide new insights into methodological options, but will also provide a comprehensive picture of impact dimensions, ranging from single impacts of a specific ICT standard in a single company to a general economic impact of the whole stock of ICT standards at the sector level. The paper concludes with a comprehensive picture of various impact dimensions of ICT standards, but also an evaluation of the applied assessment methodologies. This might be the basis for further progress in the assessment of the impacts of ICT standards.

2 A case study on the impact of RosettaNet standards

The case-study approach is probably the most widespread methodology to assess the impact of standards, because it allows us to cover the various impact dimensions of standards, the different stakeholders involved and the use of different information sources required by the first two issues. The case-study approach calls for, but also allows, the application of multiple methods of data gathering and analysis, in which a range of stakeholders involved in the standardization process and also in the implementation of standards can be involved. Case studies entail the collection of both quantitative and qualitative data, even including surveys, qualitative content analysis, statistical analysis of secondary data and the interpretative synthesis of these different data sources to provide an overall interpretation of each case.

Since case studies help to answer the questions why and how, to explain roles and goals of stakeholders in the context of specific standards and to track the very specific impacts of these standards, the extrapolation of findings from case studies to other standards or whole families of standards is limited, especially in the case of heterogeneous technologies or applications, environments and actors. Nevertheless, important general lessons or structures on the impacts of standards learned from one case can be transferred to other cases.

We can rely on a rather large number of case studies dealing with ICT and even e-business standards in the context of electronic data exchange, which followed the large amount of theoretical literature published in 1980s and 1990s. However, most of these case studies deal more with the strategies and interactions of the stakeholders involved in the standardization process. Furthermore, Swann (2000) observes that there is remarkably little in the literature about the diffusion of standards, which is the necessary requirement for causing impacts; and most diffusion studies concentrate on the factors responsible for the diffusion of a standard, like in the

² These exercises were performed within the EU-funded project NO-REST (Networking Organisations – Research into Standards and Standardisation). See the webpage www.no-est.org.

case of the ISO 9000 series³, EDI standards (Belleflamme 1999 [1]; David P.A. & Foray 1994 [8]) or IT standards in general (West (1999)).

However, we selected a case study which allows the assessment of very specific impacts of an ICT standard in the companies applying it. RosettaNet is a so-called "business-related"⁴ standards consortium and refers to standards and services providing a common language for e-business transactions and the foundation of integrating critical processes among business partners within the global supply chain. This vision is reflected in the self-image of Rosetta while being underpinned by the supplement "eBusiness standards for the global supply chain".

RosettaNet e-business standards have been developed for concrete tasks connected with the exchange of commercially relevant information in the domains of information technology, semiconductor manufacturing, and electronic component supply chains. The basic idea was to create and implement industry-wide, open e-business process standards on a global basis (Wilkinson 2003) [23]. With a wider use of advanced technologies such as Web Services, organisations provide access to its services through public interfaces based on open standards and a common language (Masud 2003) [12]. Those common e-business interfaces refer to industry-level specifications for the dialogues among IT applications at different enterprises, needed to orchestrate a business process involving multiple supply chain-roles (Gosain et al. 2003) [10] and enabling business partners with completely different technology setups to communicate with each other without difficulty. A further step ahead is to use standardized dialogues, messages and vocabulary.

RosettaNet Partner Interface Processes (PIPs) are specifications of common e-business interfaces for high-tech industry supply chains that define the electronic execution of business processes between trading partners. This allows for an improved e-business communication with trading partners, but companies that implement and use RosettaNet's e-business standards also may realise other business benefits, at least partly crucial to survive the competition in hard-fought markets such as the semiconductor industry.

On a more general level, the RosettaNet consortium itself enumerates some very concrete numbers on its webpage (www.rosettanel.org) as to which benefits can be achieved and how RosettaNet standards have an impact on daily business.

- 100% error-free forecast-to-cash procurement processes
- 80% reduction in manual transactions
- 50% reduction in contract costs
- inventory level reduction from 4 to 2 weeks
- decrease in change orders from 16.5% to 7.8%
- 50% reduction in administrative costs
- 78% less shipments, lowering logistics costs
- reduction in planning time from 8 to 4 weeks
- 50% reduction in transaction processing operations.

However, it has to be proved in concrete business cases for each company aiming to implement and use RosettaNet if these above mentioned benefits occur and if the figures are real and can be achieved in their business environment.

In order to make the impacts or greater benefits of RosettaNet e-business standards more explicit and convincing, we present an example of its successful implementation. Intel Corporation is the world's largest chip maker, with revenues of \$26.5 billion in 2001. Shinko Electric Industries Co. Ltd. provides integrated circuit assembly and components for the semiconductor manufacturing

³ Temple (1997) found little evidence that certification to ISO 9000 increased either the productivity or profitability of the company, but he did find that certification combined with product development activity did have a significant impact on these performance variables.

⁴ Business-related standards can be subdivided into standards for: product identification, product classification and description, catalogue-exchange formats, transactions (exchange of business documents), and business processes (Berlecon 2003).

industry. Intel and Shinko have a long-standing collaborative business relationship. Shinko supplies components and assembly subcontracting services that are vital to Intel's semiconductor manufacturing business.

Intel objectives for using RosettaNet e-business standards were to reduce time and cost to integrate with value chain partners, reduce transaction error rate and ongoing B2B support costs and to improve/streamline internal and public processes. Intel and Shinko aimed to use RosettaNet standards to build a seamless "forecast-to-cash procurement process" which meant the replacement of manual procurement processes and establishment of 100% electronic forecast-to-cash procurement processes.

The business benefits were achieved in two phases. During phase one, a 50% reduction in manual workload at Shinko and the total elimination of substantial yearly autofax costs was achieved. The order management throughput time was reduced from 24 h to less than 1 h; with a 100% error-free purchase order processing. In phase two, 81% annual efficiency gain at Shinko from PIPs alone was realised, representing 1,352 saved hours and 100% error-free forecast-to-cash procurement process. Additionally, 47% forecast-related lead time reduction from real-time forecasting was accomplished. Finally, improved supply chain visibility for both of the business partners and support of Intel's B2Bi strategy was realised (RosettaNet 2003) [15].

This brief case study on the real impacts or better economic benefits of the implementation of the RosettaNet standards represents very well the advantages of the case study approach by focusing on very exact impact dimensions of a specific standard. It allows the quantification of these impacts in this specific context. However, the transfer of these results to other business-to-business relationship cannot be done without taking into account the framework conditions in the other context. Consequently, a simple extrapolation of the impacts or benefits to other circumstances of even the whole industry is not possible.

3 A survey approach to assess the impacts of ICT standards

Since the impacts case studies can, in general, not be extrapolated, surveys among stakeholders involved in ICT standardization and ICT standards implementation are able to provide more generalised results for a whole set of companies. Based on a series of online surveys among members of the ETSI (European Telecommunications Standards Institute), CEN/ISSS (Comité Européen de Normalisation /Information Society Standardization System) and ITU (International Telecommunication Union) performed between February and November 2005, we are able to present the assessment of various impact dimensions of ICT standards. The presentation of the following main results is based on more than 100 responses.

In order to take the different types of standards into account, the survey differentiates between

- formal standards
- informal standards as developed in forums and consortia and
- proprietary standards.

The respondents have to assess the various impacts of the three types of standards based on a 5-point Likert scale ranging from very negative (-2) to very positive (+2).

In the following paragraph, we focus on the assessment of the impacts of standards, both differentiating into the various impact dimensions and the three types of standards. In Figure 3.1, we present the ranking of the various impact dimensions for formal ICT standards. The most positive impact is attributed to the dimension of product, including service variety. This may be a contradiction at first glance, since standards are supposed to reduce variety. However, this contradiction can be explained by the fact that we are confronted with systems of various product or service components in the e-business area or the ICT sector. If standards exist, components or even services from different suppliers can be combined, which lead to a positive effect in product, service or systems variety. Furthermore, the existence of standards also makes the division of work within the value chain easier. If specific parts of the value chain can be provided by different

companies, the variations in the end product or final service will increase. Another explanation is that platform standards, like the European mobile communication standard GSM, provide the basis for numerous applications and services, which again increase the product and service variety.

The second series of impacts of e-business and ICT standards clusters around the issue of globalisation. International ICT and e-business standards are obviously a facilitator, not only for the worldwide procurement of goods, especially ICT goods, but also for performing research and development on a worldwide scale, for the organisation of worldwide production processes and for the opportunity to outsource various services. Standards are obviously also an important tool for an effective collaboration within the production process in the ICT sector and e-business-related area. A more traditional effect of standards among the top impacts is their positive influence on the degree of adoption of new ICT products or e-business-related services, based on the promotion of positive network externalities between users and consumers relying on the same standard.

If we focus on the impact dimensions with the lowest scores, we find that ICT and e-business-related standards have only a rather modest effect on the prices of components. Obviously, the cost-reducing effects of standards in components by exploiting economies of scale are limited, which explains also that they are not very effective for increasing turnovers or profits via cost reduction. Furthermore, formal standards also have a rather small, but still positive impact on the market shares of dominant companies, which sheds a rather ambivalent light on their function of levelling the playing field. Finally, formal standards are still beneficial, but to a lesser degree, for the speed of development and design costs of new products and services.

In summary, standards in the ICT sector and the e-business-related area are much more important for structuring relationships on the supply side by allowing worldwide procurement, outsourcing, production and even research and development. This is certainly positive for product and service variety. In contrast, the relevance of the traditional argument of the cost-reducing effects of standards is rather low and therefore also the related impact on the profitability and on the turnover of companies.

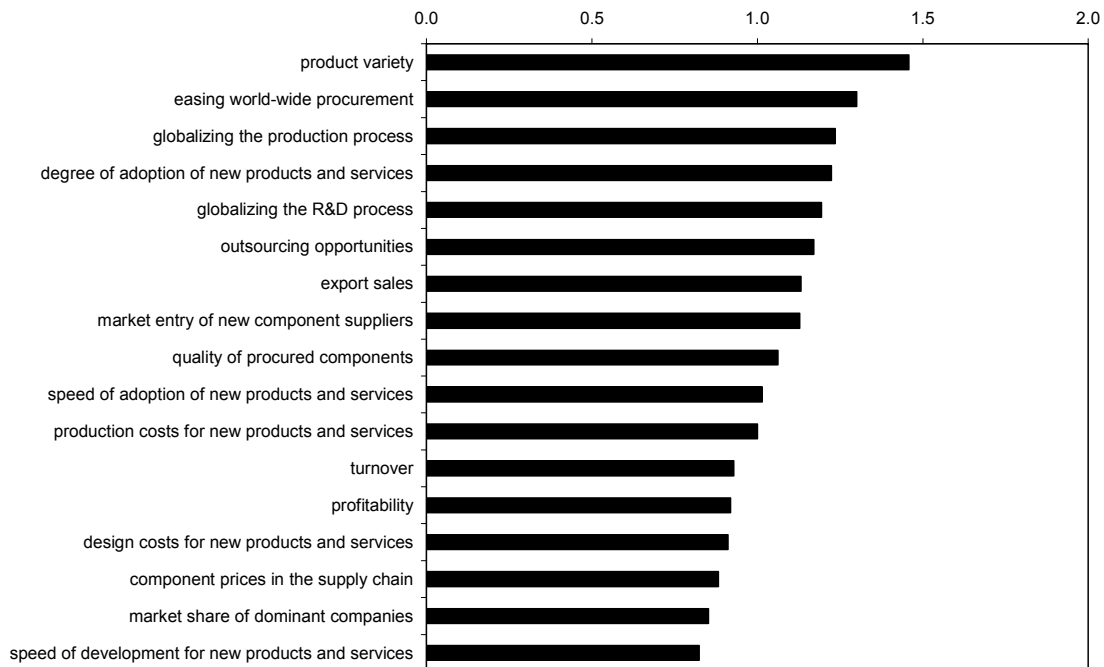


Figure 3.1 – Ranking of impact dimensions of formal standards
 (Source: Fraunhofer ISI NO-REST Survey 2005)
 (-2 = very negative to +2 = very positive)

Besides the ranking of the various impact dimensions of formal standards in the ICT sector, the comparison of the impacts of standards from different origins (see Figure 3.2) yields interesting

insights. First, it confirms that the assessment of proprietary de facto standards provided by a single company, like Microsoft, is in general less positive than those of consortia or formal standards.⁵ However, the majority of these stakeholders do not only contribute to formal standardization processes, but also try to produce and to promote own proprietary solutions as standards in the ICT markets and the e-business area. Second, the assessment of the impacts of formal and consortium standards is rather similar in its structure, which may be caused by the often very similar standardization processes and the stronger linkages between standardization consortia and standardization bodies. Third, there are some differences in the impacts between consortia and formal standards. First, in general formal standards are assessed more positively than consortia standards, which can be explained by the addressed target group.

The differences are largest regarding product variety, which can be explained by free use of formal standards only restricted by the requirement to pay licensing fees to owners of "essential patents" according to fair, reasonable and non-discriminatory (FRAND) conditions. Furthermore, formal ICT and e-business standards also have a higher impact regarding the globalisation of the production process. This reflects that formal ICT and e-business standards have in general obviously a higher world-wide reputation than consortia standards.⁶ In addition, the quality of procured components benefits more strongly from formal than from informal consortia standards. Finally, it has to be noted that all three types of standards have a similar positive impact on the market shares of dominant companies, which questions the openness of formal standardization processes.

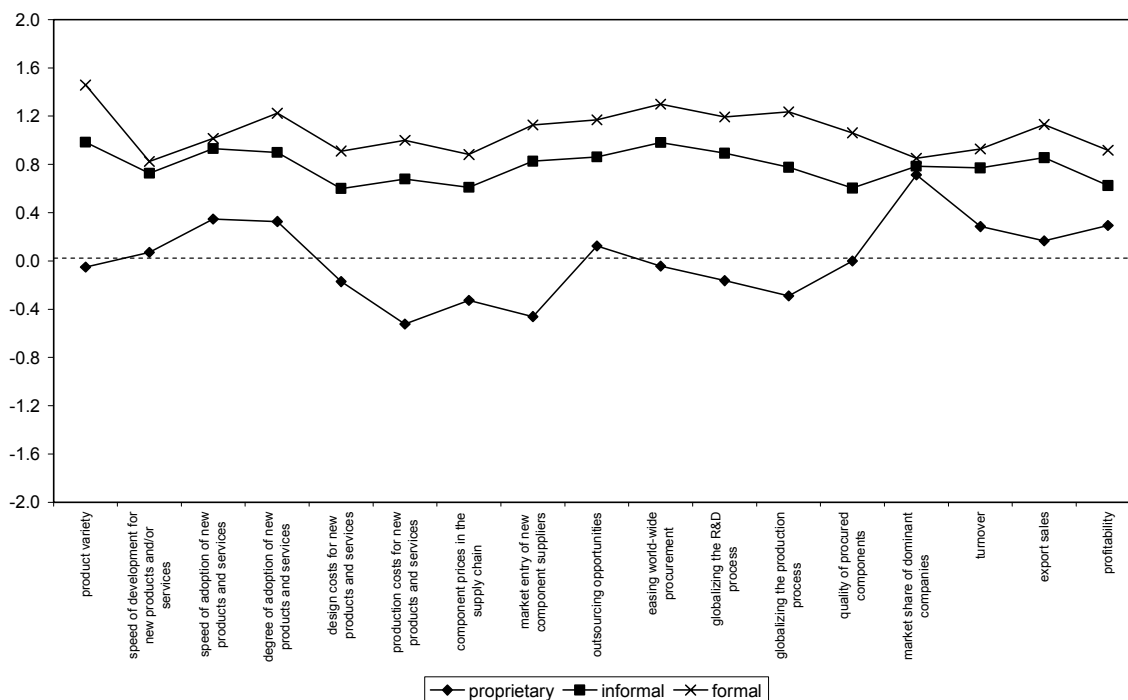


Figure 3.2 – Comparison of impacts between formal, consortia and proprietary standards (Source: Fraunhofer ISI NO-REST Survey 2005) (-2 = very negative to +2 = very positive)

In summary, two major developments have to be pointed out. First, formal ICT and e-business-related standards are obviously structuring the markets by opening up new options in producing ICT-based goods or e-business-related services, even including the R&D process. Second, the difference between the impacts of formal ICT and e-business standards and consortia standards is rather small, whereas proprietary ICT and e-business standards are assessed rather ambivalently.

⁵ This view was expressed by stakeholders involved in the work of formal standardisation bodies like ITU, CEN/ISSS or ETSI.

⁶ There are certainly exceptions, like the standards of the World Wide Web Consortium (W3C) leading to the development of the World Wide Web by developing common protocols.

4 An econometric model to assess the impact of ICT standards on growth

The only study on the macroeconomic impact of standards was conducted in the study of Blind and Grupp (2000) [5] and Blind (2004) [3]. Under the assumption that the stock of standards represents a significant share of the stock of codified technological knowledge besides the stock of patents, Jungmittag *et al.* (1999) [11] estimated a macroeconomic production function for Germany. Even for controlling other external effects, the econometric analysis revealed a significant impact of the stock of standards for growth in Germany, which is higher than for the patent stock. A replication of this approach for the United Kingdom was recently finished by Temple *et al.* (2005) [21] on behalf of the Department of Trade and Industry. The results confirm in general the results found for Germany, but to a slightly smaller extent. Within this study, Blind and Jungmittag (2005) [6], apply a pooling approach covering four countries, the UK, France, Germany and Italy, and twelve manufacturing sectors. The significant impact of the stocks of standards is confirmed, but in contrast to the result for Germany, the contribution of the patent stocks to growth is significantly higher.

In the same way as for the trade studies, standards have very different functions and importance for the development of sectors. Sectors requiring interoperability and well-defined interfaces between different components rely more on standards than other sectors where standards may trigger lock-ins in mature technologies, slowing down the sector's growth. Consequently, econometric models to assess the impacts of standards on growth have to take into account the sector-specific functions of standards.

To assess the impact of standards on growth in the ICT sector, we apply a simple growth model, which was applied for the macroeconomic level of Germany and the UK. This analysis focusing on the ICT sector follows the approach of Jungmittag *et al.* (1999) [11], in which estimates of the contribution of standards to growth is based upon a neo-classical production function:

$$Y(t) = A(t) [F(K(t),L(t))]. \quad (1)$$

Here, Y is a measure of aggregate value added, A is neutral technological change and K and L are measures of capital and labour input. The study by Jungmittag *et al.* (1999) seeks to establish the impact of standards by supposing that A is a function of various forces influencing technological change. If Z(t) is a vector of such influences, we can write:

$$A(t) = A[Z(t)]. \quad (2)$$

Jungmittag *et al.* (1999) [11] distinguish between

- technical progress which stems from domestic innovative activity, the role of domestic diffusion of technology;
- the import of technology from abroad; and
- the role of domestic diffusion of technology.

They suggest that the three factors can usefully be approximated by – respectively – domestic patent counts, the effective stock of standards at time t, and payments for technology licences. In our approach, we just use patents and standards, since payments for technology licences are not available at a differentiated level. Furthermore, data restrictions require that we focus our analysis on the three ICT-related sectors "Manufacture of office machinery" (NACE Code 30), "Manufacture of electric motors, generators and transformers" (NACE Code 31) and "Manufacture of electronic valves and tubes and other electronic components" (NACE Code 32) for just two countries, the UK and Germany, covering the time horizon between 1990 and 2001. The available data allows us to estimate the following general equation (3), linear in logarithms (which are denoted by lower case):

$$y_{ij}(t) = a_i + b_j + c_k + \alpha_{kij}(t) + \beta_{lij}(t) + \gamma_{patij}(t) + \delta_{totstdij}(t) + u_{ij}(t), \quad (3)$$

where

y(t) = added value at time t (Source: OECD STAN);

k(t) = capital stock at time t (Source: OECD STAN);

l(t) = employment input at time t (Source: OECD STAN),

$pat(t)$ = indicator of domestic patent stock applied for at the European Patent Office at time t ,⁷
 $totstd(t)$ = effective total stock of standards at time t (Source: PERINORM),
 $u(t)$ = error term;
 i = country dummy (UK, Germany);
 j = sector dummy (NACE 30, NACE 31, NACE 32);
 k = time dummy (1990-2001).

The results of the simple ordinary least square regression with the most statistically significant explanatory power are presented in Table 4.1. The coefficients of the four production factors reveal a rather strong impact of the stocks of standards in the three ICT-related sectors by comparison to the other three inputs, capital, labour and patent stock. Even more impressive is the comparison between the regression based on the three ICT-related sectors and a regression based on twelve industry sectors, covering almost the whole manufacturing sector, for the two countries United Kingdom and Germany. Whereas the other three input factors capital, labour and patent stock, have similar coefficients, the coefficient for the stocks of standards is just one-seventh compared to the coefficient for the ICT sectors. This result reveals and confirms that standards have a much higher impact on growth in the ICT-related sectors.⁸

Despite data restrictions, we were able to present a first econometric study on the impact of standards on growth in the ICT sector, which is much higher than the impact of standards in other sectors. Since both ICT and also e-business are meanwhile crucial for most manufacturing sectors, but even more so for service sectors, there is certainly also a major indirect impact of ICT and e-business-related standards on the whole economy. However, data restrictions do not allow us – at least at the moment – to assess their impacts on overall growth in economies.

Table 4.1 – Estimation results for the United Kingdom and Germany for the ICT-related sectors and for twelve industries⁹

Variables	ICT UK-Germany Model (n= 63)	Variables	Total UK-Germany Model (n=272)
Capital	0.133 (0.931)	Capital	0.170 (4.460)
Labour	0.617 (5.875)	Labour	0.797 (31.732)
Patent Stock	0.622 (3.357)	Patent Stock	0.682 (8.735)
Standards (total)	0.636 (7.354)	Standards (total)	0.092 (2.400)
Dummies		F-Tests	
UK	0.608 (3.077)	Country effects	147.473 (0.000) ^{b)}
NACE 31	-0.016 (-0.058)	Industry effects	35.276 (0.000)
NACE 32	-1.042 (-9.268)	Time effects	4.375 (0.000)
$R^2_{adj.}$	0.951	$R^2_{adj.}$	0.989

⁷ Based on Schmoch et al. (2003), a series of patent applications at the European Patent Office differentiated by country and the NACE 2-digit classification were available. These data formed the basis for the construction of a patent stock indicator.

⁸ This result is in line with the survey-based results by Blum et al. (2000), who find that standards have a stronger impact on companies' turnover in Germany's ICT-related sectors.

⁹ The coefficients are production elasticities, i.e. an increase in the stock of ICT standards by 1% increases added value by 0,6%.

5 Comparative overview of the impacts of ICT Standards

The presentation of the three approaches to assess the impacts of ICT standards reveals a rather complementary picture with regard to several dimensions. First, the degree of exactness of the quantified impacts differs. Whereas we are able to observe detailed cost reductions at the case study level, the assessment of the various impact dimensions in the survey reveals only qualitative results. Finally, we are able to determine the precise production elasticity of the stock of ICT standards, which are based on rather rigid assumptions. Second, the range of impact dimensions is complementary. On the case study level, we concentrate on the cost-saving aspects at the survey level. In the survey, these cost dimensions are of secondary importance and the market-structuring effects of ICT standards in the context of globalization are dominant, like outsourcing and procurement on the global level are assessed much higher. At this level, the aspect of network externalities – a crucial aspect in the ICT area – can also be considered, which is expressed by the highest impact of ICT standards on product variety – a perspective which would be not shared at the company level. In the econometric model, all the economic impacts are reduced to the single impact on growth in the ICT sectors. Third, the three approaches address different types of standards. The case study focuses on a consortia standard, although we could have selected also a proprietary or a formal standard to analyse the impact. The survey covers all three types of standards and we find similar impact patterns of consortia and formal standards. Finally, the econometric study is based on the stocks of formal ICT standards.

The comparison of the three methodological approaches reveals a very complementary relation between them. In Table 5.1, we summarize the findings and include some further options not covered in the three exercises. However, the strong complementarity among the approaches calls for a comprehensive approach which combines different methodologies to assess the impacts of standards.

Table 5.1 – Options of methodologies to assess the impacts of ICT Standards

	Case study at company Level	Survey	Econometric study
Degree of exactness	quantitative or qualitative	qualitative	quantitative
Impact dimensions	cost turnover profit	company-specific market-related social	growth trade market concentration
Types of standards	proprietary consortia formal	proprietary consortia formal	formal

Finally, regarding the impacts of ICT standards, we find mainly positive impacts. This is certainly due to the case selected or the assumption of the econometric model, which assumes that the expansion of qualitatively high stock of ICT standards is beneficial to growth. However, the survey also confirms a general positive impact of formal standards in almost all dimensions, whereas proprietary standards receive a rather ambiguous evaluation. Consortia standards have similar, but less positive, impacts than formal standards, which indicate a convergence of the two types of standards due to similar procedures and a closer collaboration between formal bodies and standardization consortia. Nevertheless, all types of ICT standards are obviously an instrument, which supports the dominance of the large players, which calls for policy action to increase the participation of the under-represented small and medium-sized enterprises (Blind 2006) [4] and other stakeholders of society, such as consumers and environmental organisations.

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