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The Economic Benefits of Standardization

An update of the study carried out by DIN in 2000

Issued by
DIN German Institute
for Standardization

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Axel Mangelsdorf studied economics in Berlin and Montreal. From 2008 to 2010 he was a researcher within the HARTING Graduate Programme »Mittelstand und Innovation« at the Berlin University of Technology (TU Berlin), from which he received his doctorate with honours in fall 2010. His dissertation titled »Five Essays on the Management and the Economics of Standards and Standardization« was also awarded a special »Science« prize by DIN German Institute for Standardization. Axel Mangelsdorf now works as a consultant at the World Bank and the World Trade Organization (WTO), and since 2011 has been a research assistant at the Federal Institute for Materials Research and Testing (BAM), where he deals with economic aspects of the national quality infrastructure.

1 Introduction

Economists have been searching for the sources of economic growth since the end of the 18th century. For Adam Smith the division of labour and the accumulation of capital were causes for the increasing wealth of nations. The Austrian-American economist Joseph Alois Schumpeter further established that innovations in products and processes are prerequisites for economic growth:

> »The fundamental drive that starts up the capitalist machine and keeps it running comes from the new consumer goods, the new production and transport methods, the new markets, the new forms of industrial organisation, which capitalist entrepreneurship creates.«[1]

Building on these fundamental ideas, during the 1950s American Robert M. Solow – later a Nobel prize winner – developed the first formal mathematical model of economic growth. Solow was able to use a simple model to show that economic growth within the USA could be described by three determinants: an increase in capital (e.g. machinery and infrastructure), an increase in labour, and technical progress. Later other economists were able to further refine Solow's growth theory. While technical progress was accepted during the early years as a fact, it became ever easier to theoretically describe and quantify its causes. The central idea of these new models is that the state and businesses invest in research and development, thus continually stimulating economic growth through new products and production methods.

But what role do standards and standardization play in this? To ensure continual economic growth it is not sufficient to only create new knowledge through research and development. This knowledge must also be broadly disseminated so that as many companies as possible can make use of it. Standards that are developed in consensus with the participation of companies are particularly suitable for disseminating technical knowledge. Standardization experts record the current technological standard in documents, thus facilitating its broad diffusion in the market. As opposed to information in patents, which are subject to intellectual property rights, the information codified in standards is accessible to all and therefore its dissemination is not restricted.

The role of standards in the dissemination/diffusion of technical knowledge and their resulting contribution to continual economic growth have already been demonstrated in past studies. For the time period between 1961 and

1 Schumpeter, Joseph Alois (1980): Kapitalismus, Sozialismus und Demokratie, (Capitalism, Socialism and Democracy). Munich: Francke, 5th ed.

1996, calculations showed that the information contained in standards and technical rules was responsible for 1% of Germany's gross national product (1998: 15.8 billion Euros) (DIN 2000).

The aim of the present analysis is to recalculate the economic benefits of standardization on the basis of current data. This new calculation is necessary because standardization in Germany has changed in many ways. Today about 80% of all standards published in Germany are of European or international origin. Furthermore, a number of studies have been published in other countries since the last study was carried out in 2000, and it is necessary to make all of their results comparable. The current study also makes use of new knowledge regarding data structure.

2 Overview of the literature

The German study on the micro- and macroeconomic benefits of standardization was used as a model for several other national studies. The 2000 German study was followed by further analyses which not only used similar methodological approaches and covered similar time frames, but also led to comparable results. As a whole, all of the national studies demonstrate that standards have a positive influence on economic growth due to the resulting improved diffusion of knowledge. The contribution of standards to the growth rate in each country is equivalent to 0.9% in Germany, 0.8% in France and Australia, 0.3% in the UK and 0.2% in Canada.

TABLE 2.1: NATIONAL STUDIES OF THE EFFECTS OF STANDARDS ON ECONOMIC GROWTH

Country	Publisher	Time frame	Growth rate of GDP	Contribution of standards
Germany	DIN (2000)	1960–1996	3.3%	0.9%
France	AFNOR (2009)	1950–2007	3.4%	0.8%
United Kingdom	DTI (2005)	1948–2002	2.5%	0.3%
Canada	Standards Council of Canada (2007)	1981–2004	2.7%	0.2%
Australia	Standards Australia (2006)	1962–2003	3.6%	0.8%

3 New empirical investigation

It has been ten years since the last study on the economic benefits of standardization was carried out. The question now is what impact do standards currently have on economic growth in Germany? A growth model is presented below to answer this question. An econometric investigation will show the extent of the impact standards have on German economic growth through the diffusion of knowledge. Section 3.1 presents the data used for the model both graphically and in text form. Section 3.2 then shows how the variables were integrated into the econometric model. The results of the calculations (estimations) are presented and interpreted in Section 3.3 and then compared with the actual economic growth realized in Germany.

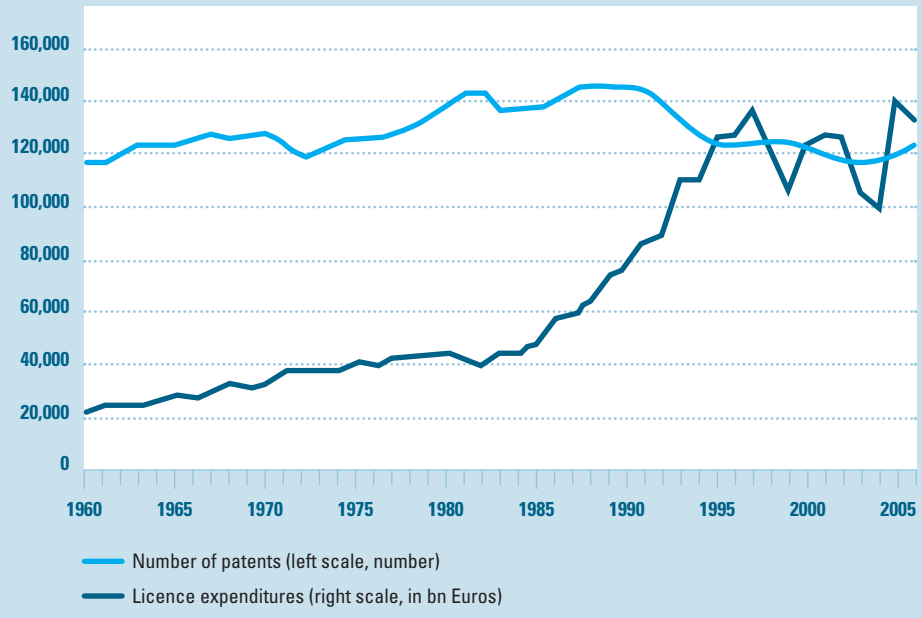
3.1 Overview of data

In order for companies in national economies to be able to produce goods and provide services (output), they must have access to the necessary production factors (input). In classical economic theory since the time of Adam Smith and David Ricardo three factors are considered: labour, capital and land. The significance of land in terms of agriculture is of secondary importance as a production factor, however, as this cannot be increased indefinitely. Instead, ever since Robert Solow carried out his empirical work another factor has taken the forefront: human knowledge. Solow was able to show that not only is the quantitative increase of capital and labour important for the US economy, but above all the qualitative improvement of labour and capital through technical progress leads to sustainable economic growth. It is extremely difficult to quantify these qualitative components – referred to as »total factor productivity (TFP)« in growth economics – in empirical investigations. Economists must therefore identify and/or gather data that approximates the generation of new knowledge on the one hand and the dissemination of this knowledge on the other.

In general – and for this study, specifically – the number of patents is used to describe the generation of new knowledge within Germany, and the number of (technology) licence payments abroad is used to describe the import of knowledge from other countries. Figure 3.1 shows the development of both indicators from 1960 to 2006. It is shown that the number of patents has decreased since the nineties, whereas the number of licence payments for know-how from abroad continued to increase throughout the same time period. This

means that Germany is becoming increasingly reliant on inventions from abroad. The volatility of licence payments over the last two decades can be explained by the great significance of multinational companies for research and development activities. Whether or not a transfer of technical knowledge occurs within these companies not only depends on the actual services provided, but also on accounting practices, i.e. the taxation of profits domestically or abroad. However, a precise analysis of internal knowledge flows within companies cannot be carried out due to non-disclosure issues.

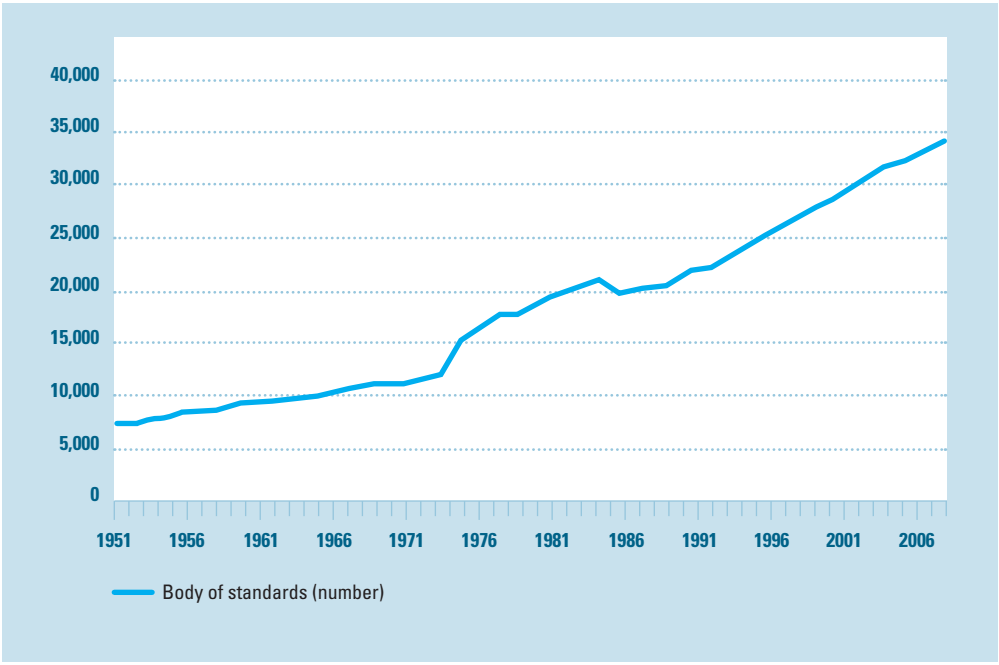
FIGURE 3.1: NUMBER OF PATENTS AND LICENCE EXPENDITURES IN GERMANY 1960–2006



Source: German Federal Statistical Office; Deutsche Bundesbank

For economic growth it is not only necessary that knowledge be generated or imported, it must also be disseminated or – in other words – diffused throughout the entire economy as rapidly and broadly as possible. The diffusion of knowledge – i.e. above all technical knowledge – is described in this empirical model by the number of standards. Standards are an excellent indicator of knowledge diffusion due to their following characteristics: As opposed to patents, standards are not normally subject to intellectual property rights and therefore any company can obtain them for a low price that covers the cost of the standardization process, which is carried out in non-profit organizations (in Germany, by DIN). Standards are documents developed by experts in consensus within various committees to which these experts from industry bring current technological knowledge from their own companies. Internal knowledge from companies is supplemented by knowledge from research and scien-

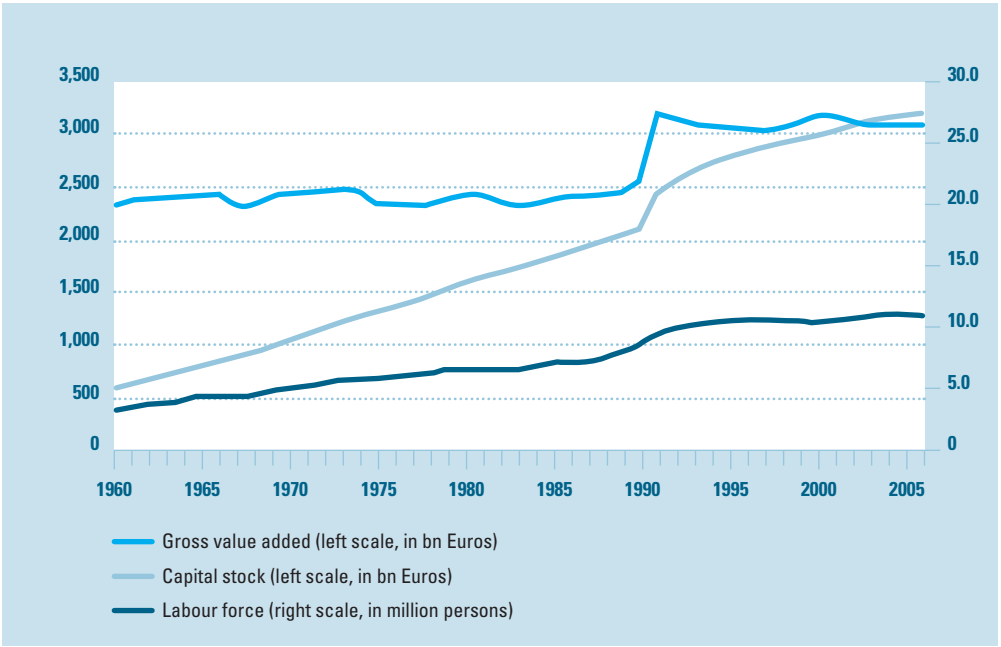
FIGURE 3.2: BODY OF GERMAN STANDARDS 1951–2008



Source: For 1951–1990, DIN Annual Reports; for 1991–2008, PERINORM

tific organizations, as well as that from specialists with particular interests – e.g. consumer protection or occupation health and safety. Standards are developed which contain a considerable amount of technological knowledge in codified form. In our empirical analysis these standards are described as a body of documents, that is, new documents increase this body while withdrawn documents decrease it. This assumption is realistic because the consistency of the body of standards is continually being evaluated to avoid duplication of work and discrepancies. Figure 3.2 shows the body of standards in Germany – including those of national, European and international origin – from 1951 to 2008. The graphic shows that this body continually grew throughout this time period. The sudden downturn in 1985 was a result of the simultaneous withdrawal without replacement of around 1,300 standards on graphical symbols.

FIGURE 3.3: GROSS VALUE ADDED, CAPITAL STOCK AND LABOUR FORCE IN GERMANY 1960–2006



Source: German Federal Statistical Office

The two classic production factors – capital and labour – are depicted in Figure 3.3. The capital stock is the result of previous investments, and during the current period contributes to the production of goods and services. Here capital stock is represented approximately by the gross fixed assets (Bruttoanlagevermögen), which are defined by the German Federal Statistical Office as those assets which are continually used in production, such as machinery, equipment, vehicles and buildings. The production factor »labour« is depicted here by the number of employed persons subject to social security contributions (labour force), excluding those working in the agriculture and forestry sector, in property services, or in domestic services. Figure 3.3 also shows the total value of goods and services produced in Germany (gross value added) – this is the output that is empirically described by the input factors in Section 3.3 below. In Figure 3.3 there is a sharp upturn in these indicators around 1991 as a result of German reunification.

3.2 Model specification

The first step in the empirical calculation of the economic benefits of standardization is to set up a production function that encompasses the entire business sector. This function describes the relationship between overall economic output, i.e. the gross value added and/or gross domestic product, and the input factors capital, labour and technical progress. At the beginning of the last century, Swedish economist Knut Wicksell succeeded in mathematically depicting this relationship, and the American economists Cobb and Douglas were the first to statistically validate this relationship. The Cobb-Douglas production function takes the form:

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

where Y(t) is the total economic production over the time period t, K(t) is the capital input over the time period (t) and L(t) is the size of the workforce (labour input) at the time (t). However, the Cobb-Douglas production function is characterized by the so-called »diminishing returns«, that is, although economic growth continually increases with increasing capital and labour input, the magnitude of this increase diminishes over time.[2] This effect is counteracted by technical progress, or »total factor productivity (TFP)«, A(t). Even if labour and capital remain constant, there is still economic growth as a result of

2 The concept of diminishing (marginal) returns is a consequence of the classic law of variable proportions. In agriculture, for example, although the crop yield (output) initially increases proportionally with an increase in the production factor fertilizer (input), this increase in output nevertheless diminishes over time.

technical progress. The more technological knowledge exists within the companies of a particular country, the greater that country's technical progress will be. This means that economic growth is not solely dependent on the inventions of a few companies, and also that technological knowledge disseminates widely among as many companies as possible. In mathematical terms, technical progress A(t) is a function of technological knowledge Z(t).

$$A(t) = F(Z(t))$$

Technical progress comprises the following three factors:

- **technological knowledge generated in Germany,**
- **technological knowledge imported from abroad,**
- **the diffusion of this technological knowledge.**

The benefits of standardization for economic growth are thus generated through the dissemination of technological knowledge among as many companies as possible. As a result, the innovative strength of the national economy increases and the rate of technical progress rises. This in turn counteracts the effect of diminishing marginal returns of capital and labour and leads to sustained economic growth.

In the next step, we take the logarithm of both sides of equation (1), transforming the initial non-linear equation into the simplified linear equation (2). This also has the advantage that the coefficients or elasticities resulting from the regression – these are the Greek letters in equation (2) – show what effect a 1% increase of a variable – here the Latin letters – would have on economic growth y(t). The resulting equation (2) is the starting point for the following simple linear regression.

$$y(t) = a + \alpha\, k(t) + \beta\, l(t) + \gamma\, pat(t) + \delta\, ex(t) + \varepsilon\, std(t) + \zeta\, dum(t) + u(t) \qquad \textbf{(2)}$$

where y(t) is the economic growth – the variable to be explained – which is described by means of the independent variables on the right side of the equation. Here

- k(t) are the gross fixed assets (capital),
- l(t) is the number of persons employed (labour),

- pat(t) is the number of patents,
- ex(t) is the licence expenditure, and
- std(t) is the number of standards.

In addition to economic effects such as innovative strength or the dissemination of knowledge, a national economy is naturally also affected by external political factors which the model needs to take into consideration. These additional effects, such as the oil crises, German reunification, and the »New Economy« bubble burst, are negated by means of dummy variables, so that the effects of the economic variables can be described correctly. In the model such additional effects, or »special factors«, are represented by dum(t). The variable u(t) is the error term of the model representing all effects which lie outside the model.

3.3 Empirical results

After the regression model has been specified, the data is entered into the statistical software and the regression analysis is carried out on the basis of past results. The elasticity for capital and labour is set at 0.3 and 0.7, respectively. Table 3.1 shows the results for the parameters describing technical progress (patents, licences and standards) and for the special factors (such as the German economic crisis in 1966/7, the oil crises, etc.). The positive coefficients show that patents, licence expenditure and standards have a positive impact on economic growth, while the negative coefficients for the special factors have – as expected – a negative impact. The t-statistics in the last column indicate the probability at which the null hypothesis (that is, the variable has no influence) can be rejected. For instance, a t-statistic greater than 1.96 means that at a significance level of 10 percent the variable has a significant impact on economic growth.

What do the results tell us regarding the significance of standardization for the national economy? The positive coefficient shows that standardization has a positive impact on growth. The larger the standards collection is, the greater the effect in the form of the diffusion of technological knowledge will be, and the greater will German economic growth be. The impact of standards is roughly the same as the effect of knowledge imported from abroad (licences) and half as great as the effect of innovations (patents). Thus, for the entire

period under investigation, 1960 to 2006, it has been empirically shown that standardization has a significant impact on economic growth in Germany.

Table 3.2 shows the contribution to growth of production factors over several five-year periods. As regards standards, the results show an increasing contribution throughout the 1970s. After German reunification the values stabilize at 0.7 to 0.8%.

Figure 3.4 shows a graph of the realized economic growth compared with the growth estimated on the basis of the model. As the figure shows, the growth rates calculated on the basis of the model reflect the actual growth realized in Germany with a great amount of precision.

TABLE 3.1: COEFFICIENTS OF PARAMETERS OF TECHNICAL PROGRESS AND OF SPECIAL FACTORS

	Coefficient	Standard deviation	t-statistic
Constants	– 9.43	0.67	– 13.99
Patents	0.34	0.05	6.37
Licences	0.17	0.01	8.78
Standards	0.18	0.02	7.90
German 1966/7 economic crisis	– 0.03	0.01	–2.82
1st oil crisis	– 0.03	0.02	–1.60
2nd oil crisis	– 0.05	0.01	– 3.04
Reunification	– 0.08	0.01	– 5.91
New Economy bubble burst	– 0.04	0.01	– 4.20

The positive impact of standardization can not only be expressed as a percentage contribution to economic growth, but also in terms of monetary value. Figure 3.5 shows the contribution of standards to growth in Germany for various time periods in monetary terms (adjusted for inflation). This contribution – 13.77 billion Euros – is slightly less than that originally calculated in 1998 (16 billion Euros). After reunification standardization's contribution to growth lies at about 14.59 billion Euros. During the time periods before reunification this contribution rises at first before it begins to fall starting from the mid-1970s. Because 1,300 standards on graphic symbols were withdrawn during the mid-eighties, the size of the standards collection during that time only marginally reflects the dissemination of technological knowledge. The negative values for the period from 1986 to 1990 can thus be seen as reflecting the adjustment of the standards collection. After reunification the contribution of standards to growth begins to rise again and for the last five-year period reaches a value of 16.77 billion Euros.

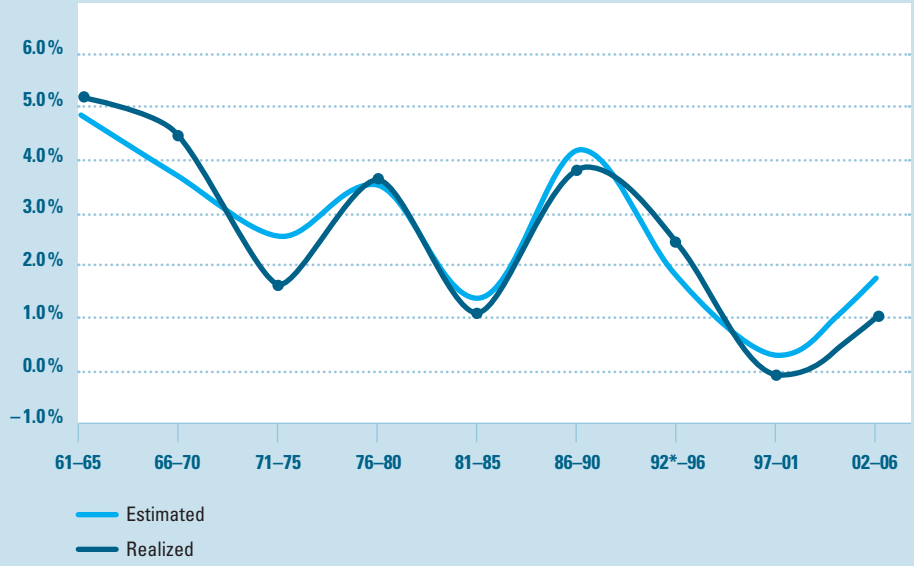
TABLE 3.2: CONTRIBUTION TO GROWTH OF VARIOUS PRODUCTION FACTORS, IN %

	1961–1965	1966–1970	1971–1975	1976–1980	1981–1985	1986–1990	1992*–1996	1997–2001	2002–2006
Capital	2.30 %	1.70 %	1.60 %	1.10 %	0.90 %	0.90 %	0.90 %	0.50 %	0.30 %
Labour	0.70 %	0.10 %	–0.50 %	0.60 %	–0.40 %	1.20 %	–0.70 %	0.60 %	–0.30 %
Patents	0.50 %	0.50 %	–0.60 %	0.60 %	1.00 %	0.00 %	–0.70 %	–0.60 %	–0.60 %
Licences	0.90 %	0.80 %	0.90 %	0.30 %	0.50 %	2.00 %	1.70 %	0.10 %	0.50 %
Standards	0.40 %	0.60 %	1.80 %	1.20 %	0.70 %	–0.02 %	0.70 %	0.80 %	0.70 %
Special factors	0.01 %	0.01 %	–0.70 %	–0.20 %	–1.30 %	0.01 %	0.01 %	–1.10 %	1.10 %

* There is no reliable data for 1991 due to German reunification.

As a whole, the present results slightly revise those of the past study of about 1% of the GNP. However, it has been shown that the economic benefits of standardization since 1992 stabilize within a range between 0.7% and 0.8% of GDP, indicating that standardization does help stabilize economic growth. For the period from 2002 to 2006 the total economic benefit of standardization averages about 16.77 billion Euros per year.

FIGURE 3.4: ECONOMIC GROWTH IN GERMANY 1961–2006

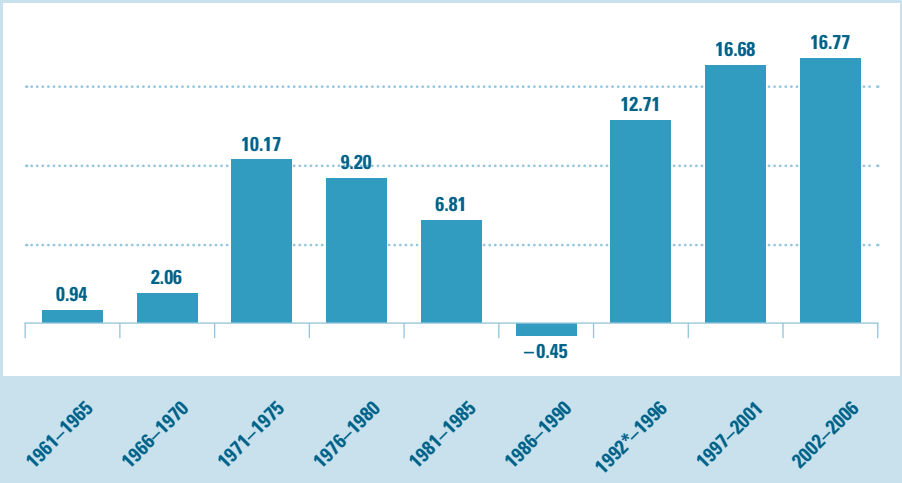


Source: Own calculations

* There is no reliable data for 1991 due to German reunification.

Comparable studies have been carried out in other countries, which have led to similar results. In France and Germany the contribution of standards is equal to 0.7 to 0.8% of GDP, while in the United Kingdom and Canada this contribution lies within a range of 0.2 to 0.3%.

FIGURE 3.5: CONTRIBUTION OF STANDARDS TO ECONOMIC GROWTH IN GERMANY IN BN EUROS



Source: Own calculations

* There is no reliable data for 1991 due to German reunification.

4 Summary and conclusion

»The economic benefit of the current body of standards amounts to 16.77 billion Euros a year.«

Economic growth depends on the development of various input factors; in classical economics these are capital and labour. However, in heavily knowledge-based economies these factors alone are no longer sufficient for simulating and/or predicting the development of economic growth. This is because the knowledge available in an economy has a strong influence on the productivity of the production factors and thus on growth. And this knowledge is influenced considerably by technical progress, which is very difficult to quantify. However, there are a number of indicators which have proven useful in roughly determining the current level of knowledge. These are the number of valid patents and licences paid to foreign intellectual property owners, as in the case of software. These indicators represent that part of technical progress which is the result of successful investments in research and development. However, technical progress has an impact primarily when it is widely diffused throughout the economy. In concrete terms this means that a company develops a new product or a greatly improved production method, then other companies pick up on this product or method, implementing and perhaps further developing it. This results in a positive interaction and ultimately in an increase in productivity, for instance through the dissemination of the newly created knowledge and the resulting improvement in the quality of the factors labour and capital.

The comprehensive and relatively accurate quantification of the diffusion of innovative products and processes within an economy poses a great challenge. Standards – as opposed to patents – are available to all and the knowledge codified in them leads to the diffusion effects discussed earlier. This means that, by increasing this diffusion, standards contribute to economic growth.

By integrating all indicators for all production factors in an econometric model, it is possible to quantify economic growth on the basis of this model. It is also possible to determine the contribution to this growth of each individual factor, so that it follows that a precise economic benefit of the current body of standards can be calculated. Such an investigation was carried out for the first time in 1999 for Germany, and later for other economies. The present investigation replicates the previous investigation by using current data that has become available in the meantime; the result determined – an economic benefit of 16.77 billion Euros a year – approximately corresponds to the value obtained ten years ago. Relatively speaking this is 0.72 % of Germany's GDP, a slightly

»Standards have a stabilizing effect on growth corresponding to about 0.7% to 0.8% of the gross domestic product.«

lower value than that obtained in the first study in 2000. At the same time, it has been shown that after German reunification standards have had a stabilizing effect on growth corresponding to about 0.7% to 0.8% of the gross domestic product.

The positive economic impacts of standards extend well beyond the benefits calculated here. In addition to the economic growth generated through the function of standards as diffusers of knowledge, there are further economic benefits gained through other functions of standardization. For example, many standards lay down requirements for workplace safety, reducing the number of occupational accidents and thus lowering absenteeism. Environmental standards help protect the environment, which improves the quality of life and general well-being throughout the economy. Furthermore, standards ensure greater safety and security in many areas, which helps lower the cost of safety/security measures and obtaining the necessary insurance. In this manner technical standards relieve the burden on the state, thus legitimizing the support of standardization through public funding and justifying standardization's established position as a useful instrument in many policy areas.

5 Annexe

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Imprint

Publisher:
DIN German Institute for Standardization

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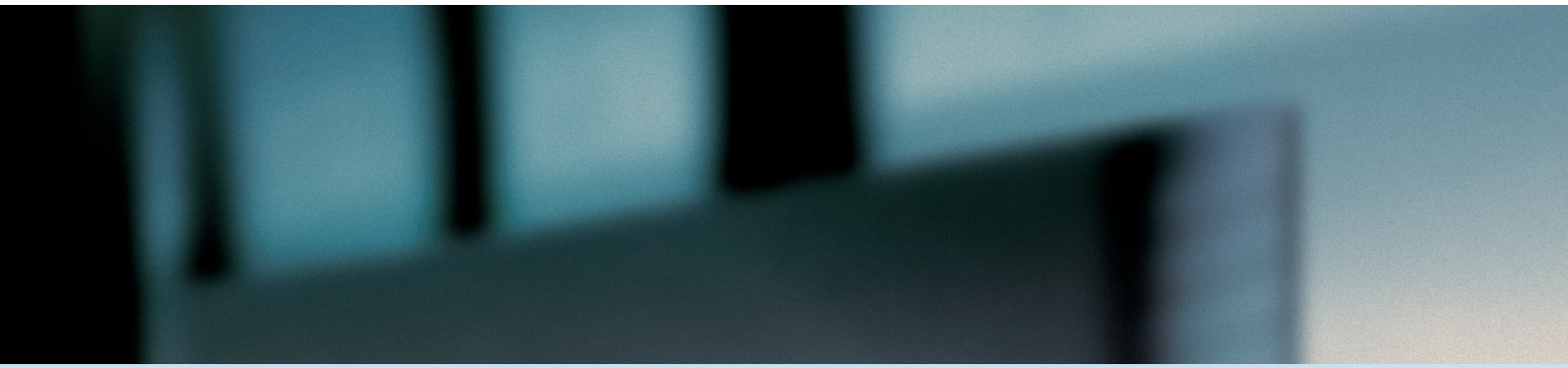
Editorial deadline: June 2011

Designed and set by:
ERGO Industriewerbung GmbH, Berlin



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