Measurement of the productivity of the health economy

Summary

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Content

Figures

Tables

Infoboxes

Abbreviations

BMAS	Federal Ministry of Labour and Social Affairs
BMBF	Federal Ministry of Education and Research
BMWi	Federal Ministry of Economics and Technology
EQR	European Qualifications Framework
GDP	Gross domestic product
GKV	Statutory health insurance
GVA	Gross value added
HSA	Health Satellite Account
ICT	Information and Communication Technologies
INQA	Initiative New Quality of Labour
KZBV	Federal Association of Dentists of Statutory Health Insurance
MFP	Multifactor productivity
MTP	Medical-technological progress
OECD	Organisation for Economic Co-operation and Development
ONS	Office for National Statistics
PIM	Perpetual Inventory Method
QALY	Quality Adjusted Life Years
R&D	Research and Development
RV	Statutory pension insurance
SHA	System of Health Accounts
SME	Small Medium-sized Enterprises
SNA	System of National Accounts
TU	Technical University
ZIM	The Central Innovation Program SME - Zentrales Innovationsprogramm Mittelstand

1. Introduction

Productivity is an important concept for assessing economic performance. Productivity growth measures technological progress. This study concentrates on the productivity of the health economy, which is dominated by service activities. Economic studies have presented contradicting results about productivity growth of the health sector, depending on the borderlines of the health economy, the taxonomy of activities included and the approach of productivity measurement. This study uses the framework of the satellite accounts, which consistently links the System of Health Accounts (SHA) to the input-output tables of the System of National Accounts (SNA) (see *Henke, Neumann, Schneider et al. 2009*). The compilations present figures for the period 2002 – 2010. Six questions are discussed:

(1) Which indicators are suitable for measuring the productivity of the health economy and their various production activities?

(2) Does productivity growth differ between the health economy and the total economy? Which differences exist between the „basic“ and „voluntary“ market of the health economy?

(3) What are the contributions of the medical-technical progress and other input factors to the productivity growth of the branches of the health economy?

(4) Do the medical-technical progress and other factors relieve the future need of health manpower and the financial burden of the statutory health and pension insurance?

(5) Which measures will help stimulate further productivity growth of the health economy?

(6) Which recommendations are given by for economic policy?

The Health Satellite Account aggregates more than 500 health-related goods and services from the national goods and service account into a health input-output table by rules of the System of National Accounts into groups of goods and production activities. In the framework of this study, these goods are further classified either as health goods or as health services in order to distinguish the different factor inputs. The underlying idea is, that services have less potential to increase productivity than industrial produced commodities (see *Baumol 2010*, *Hartwig 2008*).

2. Productivity indicators

„Total factor productivity“ measures best productivity.[1] It shows how much more output increased than input. The approach can be applied for the total economy and for economic sectors. Prerequisite for the compilation of productivity is the measurement of the following variables (see *Atkinson 2005*, *Department of Health 2005*):

(1) Input (intermediate services, labour and capital) and the development of these terms over time,

(2) Output (volume and quality changes of health care activities),

[1] The terms „total factor productivity“ and multifactor productivity are synonymously used.

(3) Outcome (health gains as consequence of health sector activities, incapacity for work, invalidity and mortality – e.g. as lost working years or premature deaths).

Productivity and productivity growth is derived from indices or index numbers (see figure 2). Compilations of sectoral productivity growth in the framework of national accounts data apply the Törnqvist index. The Tornqvist aggregates the growth rates of the outputs and inputs of the various sector outputs with annual weights based on the value shares in total value of sector outputs and inputs. The study distinguishes between different productivity indicators (labour productivity, capital productivity, and multifactor productivity) as well as between subsectors of the health economy (manufactured health goods, health services).

Infobox 1: Health Satellite Accounts (HSA), System of Health Accounts (SHA), Basic and voluntary health commodity market

The **Health Satellite Account** is a functional accounting system for the health economy, linked to the System of National Accounts (SNA) for the total economy. Establishments producing health goods are classified as separate sector by using SNA-rules while considering the linkages with the central framework.

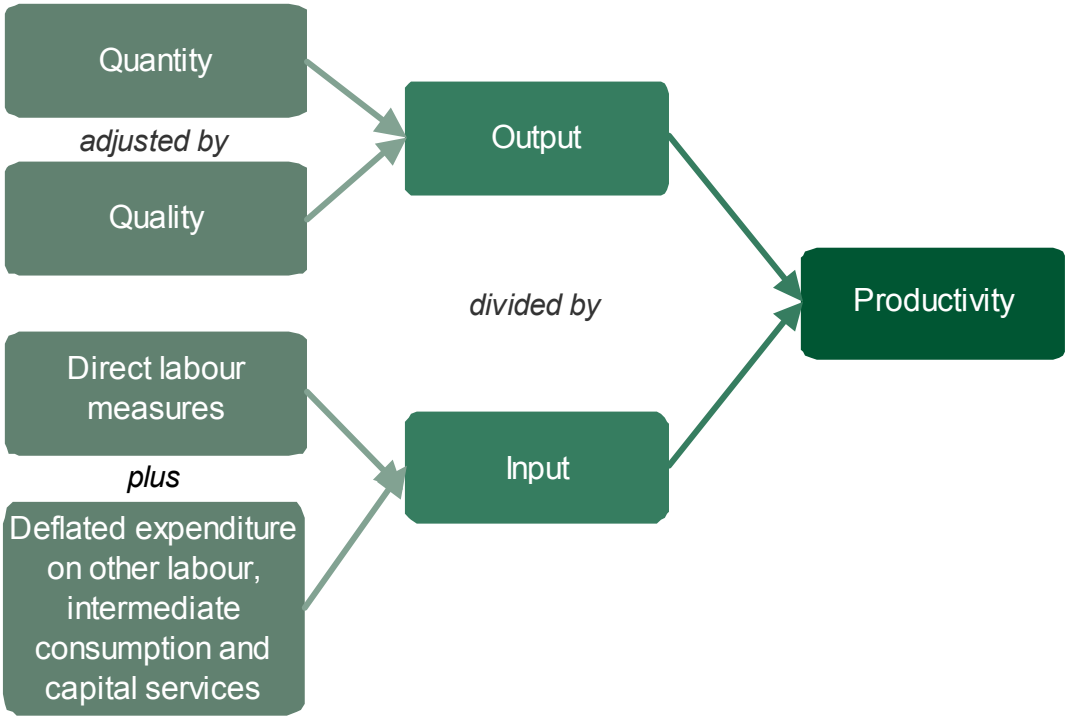
The German **System of Health Accounts** is a functional statistical system, which gathers the healthcare transactions by type, value and volume, the used factors of production, in order compile aggregates in line with national accounts and the future developments of the health economy. Major sub-accounts are the health expenditure accounts, the health labour accounts and the cost of illness accounts. All of them are part of the federal reporting system.

The **Basic health commodity market** includes all health related goods and services and is characterized by compulsory coverage, mainly publicly financed (particularly by the health and long-term-care insurance). In contrast, the **Voluntary health commodity market** is completely privately financed, either by voluntary insurance or out-of-pocket payments. This market comprises all those health related services and commodities, which are not covered by compulsory social insurance or are publicly financed.

Within this study the output is measured by the volume of gross output, the labour inputs by the effective hours worked, and the capital inputs by the stock of capital. In addition, the input-output-tables of the health satellite accounts provide detailed information about the use of intermediate goods and services. The comprehensive data structure consequently allows further estimate effective multifactor productivity and by this more precise interpretations of the sector-specific productivity growth.

Therefore, the measurement of the multifactor productivity requires summarizing the quantities of output into an output index (production or value added) as well as the inputs (labour, capital, if applicable intermediate inputs) into an input index. Besides, the deflation of the production values should also take quality improvements into account (see Figure 1 and *Aizcorbe, Nestoriak 2010, Berndt et al. 2001, Bradley 2010*).

Figure 1: Productivity components



Source: *Wild 2009*.

The **Malmquist index** is based on distance functions, which illustrate multiple input and multiple output technologies (*Malmquist 1953*). For calculation only quantity specifications are needed for inputs and outputs – not information on costs or revenues. This also makes the difference to the **Törnqvist index**, which aggregates the various input and output terms using cost-shares (*Färe et al. 1994*). However, the Törnqvist approach offers also a crucial advantage: While with the Malmquist approach compellingly several observations per time period are indispensable to sketch the efficiency front, with the Törnqvist one observation per time period is sufficient to compile the **productivity growth**.

Various empirical approaches are internationally applied for the measurement of the productivity growth, which partly differ in the measurement of input and output as well in the analytical value (*OECD 2001*). The concept of the multifactor productivity offers with correct implementation a promising approach for the measurement of the productivity of individual sectors of the economy (*Hulten 2001, O'Mahony, Timmer 2009*) – and concomitantly to the health economy. Based on the experiences as well as pro and cons of the existing empirical concepts, an approach could be developed in the context of this study, which considers three important aspects thoroughly:

1. Limitations of **data**, in particular with view of the satellite account for the health economy, concerning the availability of price indices as well as regarding the information about the individual input factors.
2. A view after the desired **subject** is possible - total health economy and/or selected diseases.
3. **Additional evidence** about the compiled figures by the triangulation principle, which is checking the plausibility of the results („genuine" productivity growth vs. measuring errors and incompleteness of markets) recognising the limitations in reducing productivity to a single number.

A commonly agreed international concept of quality adjustments is still missing. The implementation of such a concept both within the health economy and comparatively to other industries of the economy must guarantee comparability and consistency. It is, however, recommended to take explicitly into consideration, while analyzing specific questions to subsectors of the health economy, that today technology used in therapy of a given illness is hardly comparable with the treatment five or ten years ago.

Infobox 2: Triangulation

The **triangulation** is to support the interpretation of productivity developments within the public sector by supply of additional context information, in order to avoid misinterpretations. By the inclusion of further information and examination of the interrelations it serves the validation of the found results. Uncertainties in the measurement of the input and output sizes are to be reduced thereby (see *ONS 2010*).

3. Productivity growth of the health economy

3.1 Output indicators: production and value added

Over the period 2002 – 2010, the growth of gross output of the health economy at constant prices (2005 = 100) averaged annually 3.0 %. The output of the total economy, hit by the financial and economic crises, rose only at an average rate of 1.8 % in the same time (see Table 1). Significant for this difference is the lower inflation of health commodity prices as compared to the overall prices of the total economy (0.5 % versus 0.9 %). Within the health economy, the output of health goods (pharmaceuticals and medical devices) inclusive trade shows the highest annual growth rate of 5.5 %.[2] By comparison, the output of health services grew at the lower rate of 2.3 % (see Table 1).

Innovations particularly contribute to the fast development of the subsector **health goods and trade services** and the high productivity growth – e.g. almost one third of revenues of the medical device industry results from products, which are less than three years of age, and in the biotechnology the share of the R&D expenses is up to 40 % of the turnover (see *BMBF 2013:* 17/18). Therefore, it is not surprising, that this part of the health economy shows a high productivity growth.

[2] Trade and manufacturing of goods were comprised because official statistics classify many pharmaceutical companies as wholesalers due to their large share of external trade. In the case of health services inpatient and outpatient care were comprised because both subsectors organize the distribution of pharmaceuticals and medical devices in different ways.

Table 1: Production (real), value added (real) and intermediate use (real) in the health and total economy, 2002 and 2010

Production areas	at constant prices (2005 = 100)		
	Gross output	Gross value added	Intermediate consumption
2002	**in mio. €**	**in mio. €**	**in thousand**
Total	**3.895.730**	**1.962.447**	**1.933.283**
Health economy	**320.184**	**194.234**	**125.950**
Core area	*240.767*	*149.444*	*91.323*
Health goods and trade	*62.542*	*27.525*	*35.017*
Services	*178.225*	*121.919*	*56.306*
Extended area	*79.417*	*44.790*	*34.627*
Health goods and trade	*27.875*	*9.910*	*17.965*
Services	*51.542*	*34.881*	*16.662*
Non-health economy	***3.575.546***	***1.768.212***	***1.807.334***
Goods and trade	2.302.210	943.093	1.359.117
Services	1.273.336	825.120	448.217
2010	**in mio. €**	**in mio. €**	**in thousand**
Total	**4.483.690**	**2.160.845**	**2.322.845**
Health economy	**406.852**	**251.982**	**154.870**
Core area	*309.679*	*195.701*	*113.978*
Health goods and trade	*95.679*	*48.106*	*47.574*
Services	*214.000*	*147.595*	*66.405*
Extended area	*97.173*	*56.282*	*40.892*
Health goods and trade	*33.806*	*13.003*	*20.803*
Services	*63.367*	*43.278*	*20.089*
Non-health economy	***4.076.838***	***1.908.862***	***2.167.975***
Goods and trade	2.664.058	1.020.188	1.643.870
Services	1.412.780	888.674	524.106
Annual change 2002-2010	**in %**	**in %**	**in %**
Total	**1,8**	**1,2**	**2,3**
Health economy	**3,0**	**3,3**	**2,6**
Core area	3,2	3,4	2,8
Health goods and trade	*5,5*	*7,2*	*3,9*
Services	*2,3*	*2,4*	*2,1*
Extended area	2,6	2,9	2,1
Health goods and trade	*2,4*	*3,5*	*1,9*
Services	*2,6*	*2,7*	*2,4*
Non-health economy	*1,7*	*1,0*	*2,3*
Goods and trade	1,8	1,0	2,4
Services	**1,3**	**0,9**	**2,0**

Source: *BASYS, Statistisches Bundesamt 2012a, b.*

The higher growth, on average, of the health economy as compared to the non-health is even more evident for indicator "gross value added". While in the total economy gross value added at constant prices only increased at the rate of 1.2 %, the health economy grew at an average rate of 3.3 % (see Table 1). This higher growth results from several factors: stable development during the economic crises, low inflation rates, and increasing export shares. The last factor fuelled the soaring expansion of the gross value added of the industrial manufactured health goods and their trade.

Infobox 3: Output, intermediate consumption, and value added

The **gross output** of an enterprise or industry is the total value of all goods and services that it produces. It comprises the changes of inventories of goods for sale and own-account produced fixed capital goods. The gross output contains all intermediate inputs used for production. **Intermediate inputs** consist of the value of the goods and services consumed as inputs by the process of production. In the production account of the System of National Accounts (SNA), intermediate inputs are called intermediate consumption. To determine the performance of enterprises or industries the intermediate consumption will be deducted from the value of output. Accordingly, the result, **Gross value added** (GVA), is the balancing item between total output and intermediate consumption for any given sector or industry. That is the difference between the value of goods and services produced and the cost of raw materials and other inputs, which are used up in production.

3.2 Input indicators: Primary inputs and intermediate inputs

In the health economy, the cost shares of primary and intermediate inputs diverge very much among subsectors. Inpatient services have the highest cost share of the primary inputs, the health goods, in contrast, the lowest. This again confirms the significance of intermediate inputs for productivity accounting.

Infobox 4: Primary inputs and intermediate inputs

Primary inputs, labour and capital, are the components of value added, which are treated as outside the production process. The components of Gross Value Added, accordingly, measure the remuneration of these primary inputs (consumption of fixed capital, taxes less subsidies on production, compensation of employees, net operating surplus). In this study, for the purpose of productivity accounting, the primary inputs are measured as real capital stock and volume of hours worked. The capital stock estimates of the health economy are derived from the time series of the German Statistical Office, which are based on the Perpetual Inventory Method (PIM).

Intermediate Inputs are goods and services, which domestic economic units purchase from other economic units for use in the process of production and for trade. Intermediate input categories comprise water, energy, raw materials, maintenance, repair and installation services, transportation, postal and telecommunication services, rents, legal and accounting services, user fees for public services and infrastructure as well as fees for patents, etc.

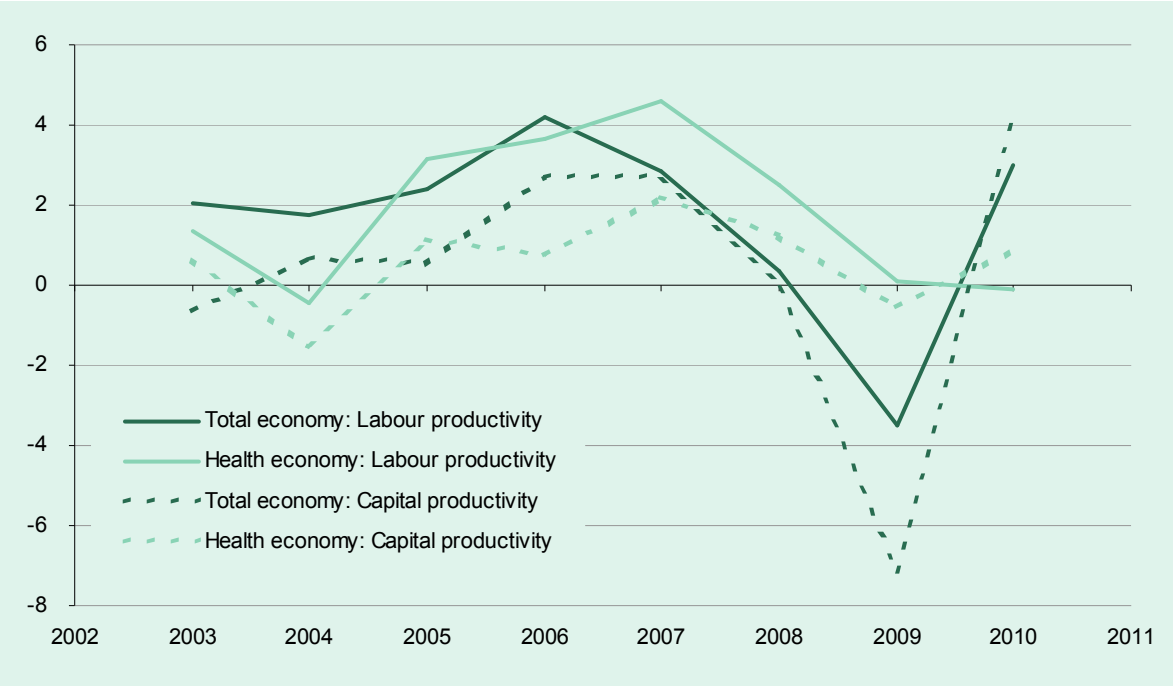
3.3 Productivity differences between health and total economy by Törnqvist

Labour productivity and capital productivity

In the period 2002 – 2010, **labour productivity** of all economic sectors grew on average. Labour productivity rose both in the health economy and in the total economy by a similar annual average of 1.6 percent. The common rate is insofar remarkable as the total working hours in the non-health economy marginally decreased (- 0.1 %) while in the health economy the working hours substantially increased (1.3 %) – both in the core health sector and in the extended health sector. Despite this increase of the volume of hours worked, labour productivity of the core health economy grew

even faster than in the total economy (1.9 % vs 1,6% per year). Main driver was the labour productivity growth of health goods and trade, which surpassed by almost 3 % the above rate of the core health sector.

Figure 2: Labour and capital productivity growth of the national economy and the health economy, 2002 - 2010



Source: Own illustration and compilations.

The growth rates of the **capital productivity** of both, the total and the health economy were, except in 2010, always below those of the labour productivity. The growth rates of the health economy, however, present a quite different story in the two years 2004 and 2009 (see Figure 2). Cost containment led in 2004 to the drop of the capital productivity of health care services. In the years 2008 and 2009, the economic and financial crises hit only manufactured health products, not health care services. Mainly, because of the strong impact of the 2009 crises on total exports and of the fiscal stabilisation, health services productivity growth was higher in the health economy.

The low growth rates of capital productivity of the total economy are in line with figures of the European Commission, which even estimated negative capital productivity rates for Germany on average since 1961 (*Hishow 2005*). Two reasons have been discussed:

1. "Capital deepening" or „capital based growth model" which had led to lower employment growth in Germany until 2005 (*Hishow 2005*).
2. Data restrictions: advances in the quality of capital, that is captured when calculating the contribution in capital, should be taken into account, for example by the improvement in the quality of information technology. In the given study the capital stock is only captured quantitatively, a second-best solution. The efficiency and composition of the capital inputs might be not sufficiently reflected.

Capital productivity of manufactured health goods and trade grew by annually 2.3 %, much more than of the health services sector by 0.5 %. Rates of capital productivity growth of the given sectors are almost everywhere positive, apart from the years 2004 and 2009.

Infobox 5: Capital productivity and capital intensity

Capital productivity is the ratio of output to capital inputs. The German National Accounts measure the output of the total economy by the volume of GDP in constant prices or, in the case of industries, by the Gross Value Added in constant prices. Average annual gross fixed assets at constant prices are referred to as capital stock. However, this study compiles capital productivity as the ratio of the deflated gross output to the deflated stock of fixed assets in use.

Capital intensity reflects capital-labour ratio. Actually, it describes input of fixed capital per hour worked or per person employed.

Multifactor productivity

The technological progress measured, as **multifactor productivity** in growth accounting is beside labour, capital and intermediate inputs the fourth source of sectoral and total growth. The multifactor productivity results as residual of the average annual growth rates of gross output minus the **weighted** sum of growth rates of the factors intermediate consumption, labour, and capital.

Table 2: Growth of the multifactor productivity of the health economy and non-health economy (in %), 2003 - 2010

	2002 - 2003	2003 - 2004	2004 - 2005	2005 - 2006	2006 - 2007	2007 - 2008	2008 - 2009	2009 - 2010	Average
Total Economy	**0,0**	**0,5**	**0,3**	**1,5**	**1,1**	**0,0**	**-2,1**	**1,2**	**0,3**
Non-health economy	**-0,1**	**0,5**	**0,2**	**1,5**	**1,0**	**-0,3**	**-2,2**	**1,3**	**0,2**
Goods and trade	0,3	1,1	0,4	1,8	0,8	-0,8	-1,7	2,4	0,5
Services	-0,6	-0,5	0,0	1,0	1,4	0,7	-3,1	-0,7	-0,2
Health economy	**0,6**	**-0,2**	**1,9**	**1,8**	**1,9**	**2,5**	**-0,4**	**0,4**	**1,1**
Health goods and trade	4,9	1,8	7,4	3,6	3,1	2,9	-2,6	-0,3	2,6
Health services	-0,8	-0,8	-0,5	1,0	1,4	2,2	0,7	0,7	0,5

Source: Own illustration and compilations.

Table 2 presents large discrepancies of multifactor productivity growth between the non-health economy and the health economy in the period 2002 - 2010. The different drop of output in most industries during the economic and financial crises is a major reason. Multifactor productivity of the health economy grew at average annual rate of 1.1 %, much more than of the total economy at only 0.3 %.

Driver of the productivity growth of the health economy is the sector health industry and trade, whose productivity rose by 2.6 % far above the productivity of health services. The hypothesis, that the health industry represents the „motor“ of the medical-technological progress, can be thus confirmed. By comparison, the less restrictive institutions and market regulations of pharmaceuticals and medical devices than in health services might have contributed to this result. The sector health services, characterised by rationing and cost containment, reached only an average annual multifactor productivity growth rate of 0,5 %. The sector of the health services is because of the non-market

conditions more independent of cyclical fluctuations. The growth rate of the multifactor productivity at a rate of about 0,9 % in the year of the financial and economic crises, 2009, made alone a significant contribution to the total productivity growth of the economy.

The productivity growth is generally higher in manufacturing and trade of health goods than in inpatient and outpatient health care services. The structure of the input factors is likely one reason for these differences, especially the higher research intensity in manufacturing and the higher labour intensity in health services. Furthermore, economies of scale and scope in manufacturing, which cannot be realized in health care services, contribute to the higher manufacturing productivity.

3.4 Extended productivity compilations

Effective multifactor productivity (consideration of intersectoral linkages)

The consideration of intersectoral linkages expands the approach used for the compilation of the multifactor productivity. For this, the input-output table of the health satellite account provides the structure of the intermediate inputs. The growth impacts of the interconnections of the **direct** or **indirect** productivity gains by the intermediate inputs can be measured, which is neglected in the „traditional" sectoral multifactor productivity measurement. As a result, the growth contribution of the intermediate inputs tends to be higher; whereas the contribution of the technological change is rather underestimated. The „**effective multifactor productivity**" (*Aulin-Ahmavaara 1999*) aims to offset this bias.

Table 3: Growth of the effective multifactor productivity of the core health sector and in the non-health economy (in %), 2002 - 2010

	2002 - 2003	2003 - 2004	2004 - 2005	2005 - 2006	2006 - 2007	2007 - 2008	2008 - 2009	2009 - 2010	Average	ΔeMFP*
Non-health economy										
Goods and trade	0,0	1,1	0,4	2,8	1,7	-0,6	-3,8	2,5	**0,5**	0,3
Services	0,4	1,6	0,5	2,7	1,3	-1,1	-2,6	3,4	**0,8**	0,2
Health economy										
Health goods and trade	5,0	2,3	7,7	4,6	3,7	2,7	-3,8	0,6	**2,9**	0,3
Health services	-0,6	-0,4	-0,1	1,7	1,8	2,3	0,0	1,2	**0,7**	0,3

* ΔeMFP measures the difference of „traditional" and actual multifactor productivity-rate in percentage points.

Source: Own illustration and compilation.

Effective multifactor productivity has been about 0.2 – 0.3 percent points above the traditionally compiled MFP (see column ΔeMFP* in Table 3). In the sectoral split of activities the effective multifactor productivity in the health economy has been again higher than in the non-health economy. The less regulated sector health commodities and trade as compared to sector of health services is again the driver of the effective multifactor productivity growth, also in the light of the development of the general economy. The health industries embody by far the highest growth rates of all sectors (2.9 % p. a.). Secondly, the productivity growth of these industries is mainly fuelled by intermediate inputs. Both technological and non-technological innovations in the area of phar-

maceutical products and medical devices make as a result in total a decisive contribution to the national productivity growth.

Productivity estimates using the Malmquist index: the case of hospital services

In the following the estimates of the application of the Törnqvist index are compared with those of the output-based Malmquist index for hospital services, which represent a major part of health services activities, requiring particularly higher investments in fixed capital than most other health services.[3] Disaggregated data are a prerequisite for the compilation of the Malmquist index, e.g. economic units like the German Laender. The hospital statistics make such data available. The output has been approximated by the number of hospital cases, weighted by hospital mortality in the respective regions. Quality is explicitly taken into account, in contrast to the above-presented analysis by using the Törnqvist.

Table 4: Efficiency change and technical change (Malmquist as compared to Törnqvist) in the German hospitals 2002 – 2010

	Malmquist-Index	Törnqvist-Index
Efficiency change	0.996	
Technical change	1.008	
Total	1.004	1.002

Values >1 represent positive growth, values < 1 represent negative growth; for comparability, the Törnqvist results are shown analogously.

Source: Own illustration and compilations.

Over the whole period 2002 - 2010 the Malmquist average annual rate of productivity growth was about 0.4%, the Törnqvist 0.2%[4]. These figures are in line with the above compilation of the productivity of health services of the core sector in Table 3. Also by using a different data set a small increase of productivity can be confirmed by both indices in Germany. This productivity gain is the result of technological advances (labour processes, applied medical technologies). By the Malmquist decomposition productivity growth is split into changes of efficiency and of technical changes. The Malmquist analysis helps better identify the reasons of productivity growth than the approach of Törnqvist and, in a further step, to explain these changes, for example by regression analysis. In the present study, the Malmquist index only serves as an example, applied only to hospitals because of data limitations.

Differences of productivity growth between basic and voluntary health commodity market

Basic and voluntary health commodity markets differ by prices and products, and, as a result, by GVA. In the period 2002 – 2010 multifactor productivity grew at an average annual rate of 1.0 % in the basic market of the core health sector, in the voluntary market at a rate of 1.1 %.

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[3] The authors are grateful to *Dipl.-Kfm. Thomas Topf* for data analysis, compilations, and interpretation of the Malmquist index.

[4] To the results of the Törnqvist index the number one was added to allow comparison with the Malmquist index. Index-numbers greater one show positive multifactor productivity growth.

In general, one might expect, higher productivity growth in the voluntary market, because the input of manufactured products is higher. The voluntary market is generally more „good intensive“, by using relatively more pharmaceuticals, medical devices and medical technological equipments than in basic care. However, there is a large variation of different products in the voluntary market, further analysis is therefore useful.

Reimbursement of services by patients dominates in the voluntary market. Partly, these services are not included in the basic benefit package of the statutory health insurance; partly, private insurance coverage is offered at voluntary basis. The voluntary health market is therefore for both insurance companies and health care providers of interest. Furthermore, this market relates to household production, e.g. in the case of self-medication.

Disease related productivity measurement: the case of oral health

Concerning direct cost, the cost of illness accounts of the German Statistical Office is based on the expenditures of care, but does not compile the factors of inputs used. Therefore, disease specific productivity estimates are not possible with these accounts, except in one case, in the class of dental diseases, the sector specific organisation of care makes the compilation of multifactor productivity possible, at least approximately. Dental care including denture, amounting to 11.65 bn € expenditure share of the statutory health insurance in 2011, is a significant part of the German health economy. The particularity of this disease class is the far-reaching communality between the sectoral activities by outpatient dental and orthodontic offices and the borderline of the disease class. Therefore, the sectoral data can be directly linked with the disease class to compile disease specific multifactor productivity. Outputs, inputs and cost weights have been compiled based on various statistics of the German Statistical Office and the Federal Association of Dentists of Statutory Health Insurance (KZBV).

Table 5: Quality adjusted multifactor productivity of dental care in %, 2002 - 2010

	Growth components in %	Input	Output/ Outcome	Multifactor productivity
(1)	Quantity		-0,1	
(2)	Quality		3,3	
(3)=(1)+(2)	Total Output *		3,2	
(4)	Intermediate use	0,5		
(5)	Labour	0,4		
(6)	Capital	0,1		
(7)=(4)+(5)+(6)	Total Input	1,0		
(8)=(7)-(3)	Productivity			2,2

* Quality adjusted output

Source: Own compilation.

Over the period 2002 through 2010 the output grew quality adjusted at an average annual rate of 3.2 %, which is completely determined by the quality component (see Table 5). Inputs increased at a rate of 1 %. Therefore, the compiled rate of **average annual growth** of the **multifactor productivity of 2.2 %** was significantly positive. This quality-adjusted rate has been higher than the rate

of the effective multifactor productivity, which was above compiled for health care services over the same period. To consider quality improvements in the measurement of the medical-technological progress is therefore rather essential. However, because of the data limitations, the present quality adjustments can only be a first step and require further analysis (triangulation).

4. Effects of the productivity growth

4.1 Outcome

The activities of the health economy aim at prevention, protection of health, cure of diseases, rehabilitation and care. Results of these activities, or outputs – improvements of quality of life and of the performance capacity of the population – can often be measured and assessed only indirectly.[5] Depending on the type of disease the assessment has to take different parameters into account: the spectrum spans from an increase of the survival rates in cancer therapy, over periods without pain, improvement of mobility, or reducing vision loss until earlier rehabilitation for work.

The direct effects of these activities can also be described by indicators of human capital development as improved population health. Diseases generate losses of resources by lower value added as consequence of morbidity (incapacity for work, invalidity) and premature mortality as well as losses of quality of life. Of particular economic interest is the loss of supply of work. The German Statistical Office measures those losses attributed to classes of diseases by lost years in work through the incapacity for work and invalidity of individuals aged 15 - 64 (working age) as well as by premature mortality (deaths below 65 years of age).

The **premature mortality** measures the deaths of the population before the age of 65. These deaths are defined as premature, because better prevention and treatment could in many cases avoid them. The reduction of premature mortality is related to the performance of the health system. Therefore, premature mortality can be used as indicator of the health gains of advances in medical technology.

The number of premature deaths decreased at an average annual rate of 2.1 % in the period 2002 – 2010, in total by 25,545 cases (see Table 6). By far the largest reduction exhibits the circulatory diseases – by more than 10,000 deaths less, a total decline by 3.9 % annually. But also the premature deaths by cancer dropped by almost 8,300 cases (1.8 % annually). The following groups of diseases show a falling premature mortality: cancer, heart and circulatory diseases, injuries, and diseases of the digestive system. Only in few disease classes premature mortality increased in the period 2002 to 2010. Musculoskeletal disorders show the highest increase by 3.1 % annually for premature deaths.

[5] In health economic analysis the concept of the Quality Adjusted Life Years (QALY) is applied, which values life years depending on the health status. In practice, there is still not a consensus on the monetary valuation of the quality of life years.

Table 6: Selected outcome indicators by disease class, 2002 and 2010

Indicators	Disease classes by ICD 10							
	Neoplasms and blood disorders (C, D)	Mental illness (F, G)	Cardiovascular diseases (I)	Metabolic, digestive and genitourinary disorders (E, K, N)	Musculoskeletal disorders (M)	Injuries (S, T)	Other diseases	Total
	Average annual change 2002/2010 (%)							
Deaths (age-standardized)	-1,1	5,0	-3,6	-0,6	5,2	-1,7	-4,3	-1,7
Premature mortality	-1,8	0,1	-3,9	-2,0	3,1	-3,6	0,6	-2,1
Premature years of life lost *	-1,5	-0,8	-3,3	-2,5	5,8	-4,8	-0,6	-2,5
Lost years of employment	1,0	3,1	-1,9	-1,6	-3,4	-4,8	0,2	-1,1

* 2002 – 2008

Source: Own illustration.

A second indicator of premature mortality is the indicator **premature years of lost life** before the age 65. The compilation of this indicator involves adding age-specific deaths occurring at each age and weighing them by the number of remaining years to live up to age 65 (see Table 6). By an annual rate of 2.5 %, the number of lost life years (all diseases) decreases more than the number of deaths (-2.1 %). From that one can conclude that more deaths occurring at young age cohorts could be avoided. The comparison by disease class shows the particular role of injuries for premature deaths, ascending to the first position in the rank of diseases, contributing to the decline of work years lost. Almost one third of the decline of premature lost life years fall in this class (see Figure 3). Both, the descending number of cases of injuries and the increasing survival rates by advances of medical-technological progress could have contributed to this decline. The other disease classes show no major differences in ranking as compared to the indicator of premature mortality.

A further indicator of the national economic losses of resources by disease, invalidity, and premature death is the number of **lost working years**. In 2008, the loss of working years amounted to about 4,23 million years (see *Statistisches Bundesamt 2010*). The various disease categories contributed rather differently to theses losses, the so-called indirect cost of illness resulting in loss of production and value added: While in 2002 the class of injuries caused the heaviest losses of hours worked, in 2008, mental diseases made the greatest burden. The class of cancer diseases, in 2002, ranking at the fourth position, climbed to the third position in 2008. Mental diseases and cancer diseases (neoplasms), not considering the class of other diseases, are the only classes with increasing indirect cost of illness.

Work incapacity resulting from disease, invalidity, and mortality had different impacts on the loss of human resources: The lost years of employment through incapacity for work and mortality fall at an average annual rate of 1.4 % and of 1.3 % in the period 2002 - 2008, the losses attributable to invalidity fall at a significantly lower rate of 0.6 %. More pronounced were the differences by the disease classes under consideration (see Figure 3).

Figure 3: Annual change of the loss of working years by cause and disease class (in %), 2002 - 2008

Source: Own compilations according to compilations of the Federal Statistical Office.

4.2 Social insurance

Following the results of the above compilations, the medical-technological progress (MTP) had generated, on average, an additional annual growth of the gross output of 1 % during the period 2002 - 2010. To estimate the effects of the medical-technological progress on distribution and re-distribution of incomes and revenues of the social insurance system, it is worthwhile, to compile first the impact on gross value added, which is the starting point of the distribution of incomes in the National Accounts.

Which are the drivers of the health expenditures, is a long discussed question of health economics. Since decades health expenditures rise not only in absolute values, but also in relation to the gross value added. Medical-technological progress beside the demographic development is listed as major driver for this relative growth. As third component, particularly in the extended health economy, the income elasticity of health services is to be added. Finally, the missing price competition is made responsible for the increase of health expenditures, mostly in interconnection with the before mentioned drivers of health expenditure.

On the other side, MTP has positive effects on revenues for social insurance. MTP generates growth of production and value added and enlarge by this the base of revenues of the statutory health insurance (GKV) and the statutory pension insurance (RV). Actually, productivity gains resulting from cost savings by the improvement of technologies in use (process innovations) are often in contrast to additional cost by new technologies (product innovations), e.g. prescription of new pharmaceutical substances in cancer treatment. In fact, the medical-technological progress affects both sides of the accounts of the social insurance, revenues and expenditures.

MTP is difficult to quantify. Therefore, the impact of the MTP on the **revenues of the social insurance** has been estimated by simulation. The systematic measurement of the MTP, which goes beyond approximate quantification by indicators such as patent registration of medical technologies, is made as residual term, capturing those influences of the expansion of expenditures, which cannot be explained by observed factors. One possibility, used in this study, is the approach for the measurement of multifactor productivity. In the simulation, therefore, the estimated figures of the multifactor productivity of the health economy are applied. This approach is based on the idea, that from a national point of view technological progress is only realized if given inputs produce higher outputs or if the less inputs produce the same output (*Häckl 2010*). For example, MTP of inpatient care allows to treat, with given human resources, material, and equipment, more patient and to generate by this additional value added. This growth of the sectoral multifactor productivity of the health economy is interpreted in the following as direct MTP-effect (*Henke, Reimers 2006*).

Based on estimated multifactor productivity growth, the actual development of the output of the health economy and of the total economy **with** MTP will be compared to a hypothetical growth scenario **without** MTP over the period 2002 to 2010. In addition, in both sectors – health and non-health economy - the gained working years resulting from MTP will be considered (system effect of the employment gained). In the hypothetical scenario (without MTP), it is presumed, that labour inputs will grow less than with medical progress because of the lost working life years (system effect).

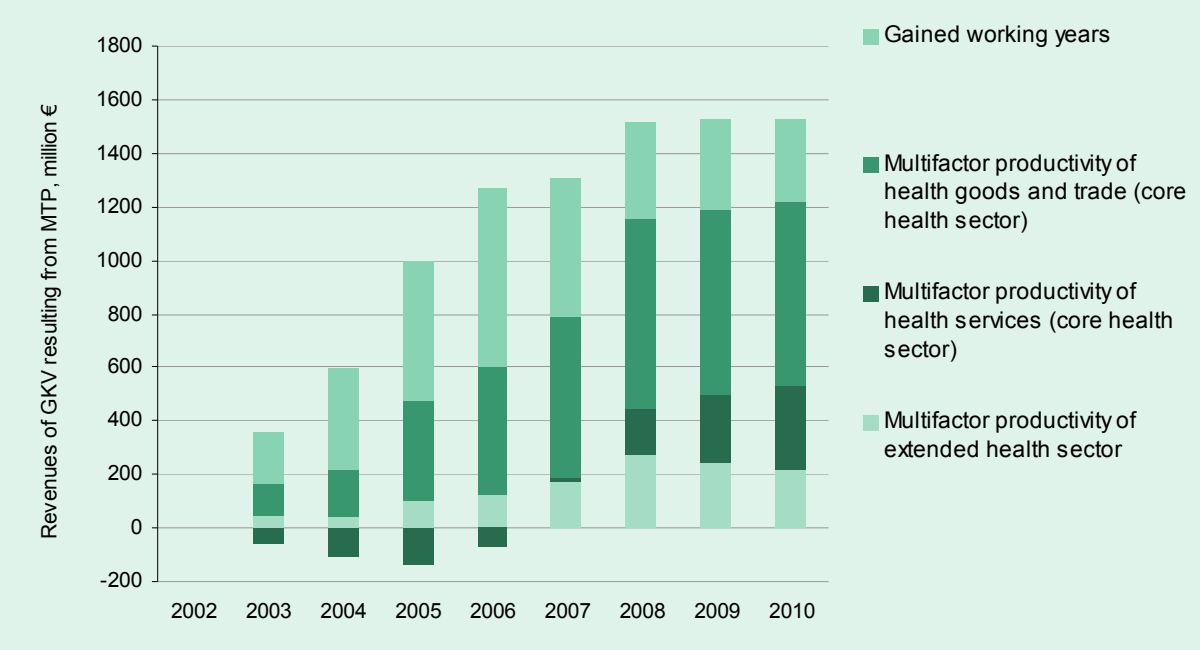
The difference in economic growth of the total economy between the actual and hypothetical development over the 8-year period since 2002 we have defined as “MTP-effect” on gross output and on value-added. This output plus **generates at the same time an increase of the contribution base,** the amount of incomes obligatory for contribution payments, for GKV and RV and as a consequence for additional income through the MTP. Even more, the system effect of the MTP lessens the shortage of health professionals.

The simulation shows, under the assumption of absence of MTP, that over the whole period 2002 - 2010 the cumulated national gross output grew about 234 bn € less than with MTP. The growth rate of the gross output would have been only at a rate of 1.6 % as compared to 1.8 %. Under the assumption, that the changes in gross output would translate into proportional changes of revenues, GKV would have without MTP over the whole period 8.7 bn € less resources available, the RV 13.3 bn € less. Together, the effects resulting from MTP have been cumulated to total 22 bn € over the 8-year period, thereof 61 % due to the MTP effect and 39 % due to the system effect. In 2010, 1.2 bn € cumulated revenues of GKV was equivalent to a rate of contribution of about 0.1 per cent (2002 to 2010 cumulated) (see *Bundesministerium für Gesundheit 2010*).

The amount of 22 bn € presents a low estimate of the MTP on the revenues of the social insurance. Not considered in this compilation are the positive impacts of the MTP on the health status of the

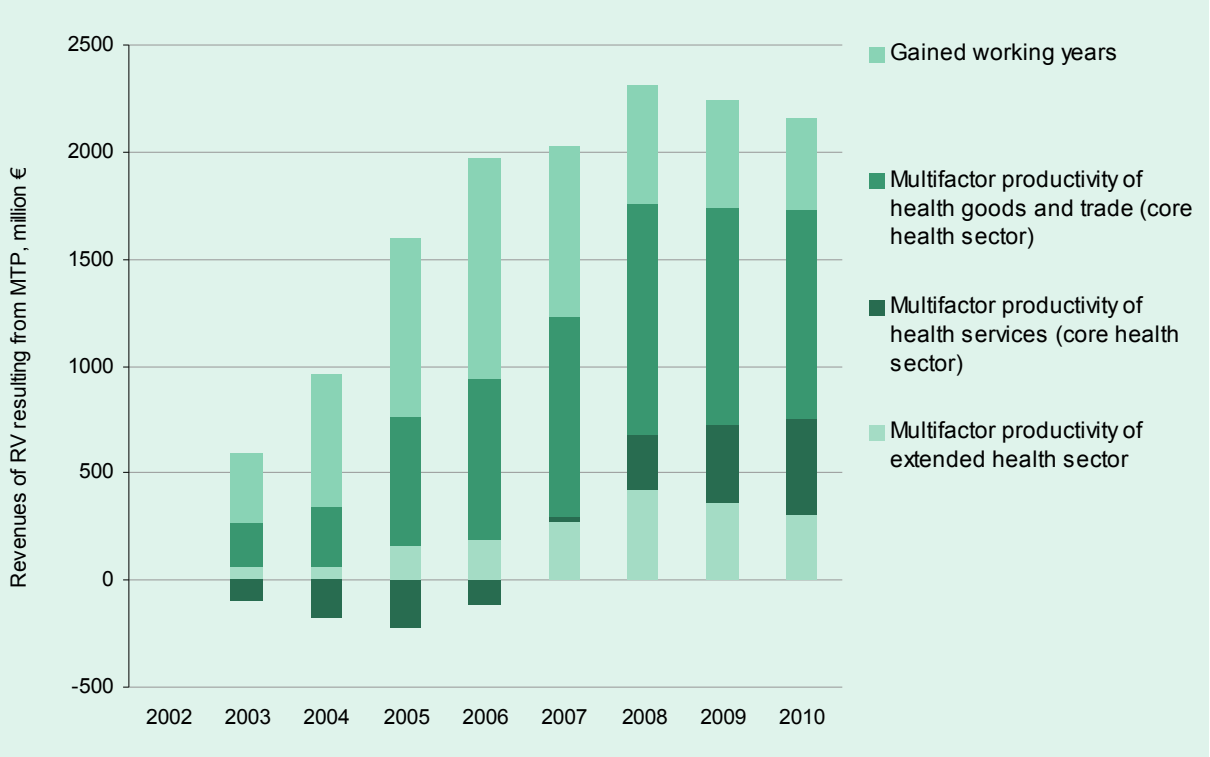
population, the productivity on life years and prolongation of working time as well as indirect and induced effects on tax and contribution revenues (see *Schneider 1999: 591ff.*, *Bräuninger et al. 2007: 26 ff.*).

Figure 4: Contribution of health sectors to the revenues of the GKV (resulting from MTP), 2002 – 2010



Source: Own presentation.

Figure 5: Contribution of health sectors to the revenues of the RV (resulting from MTP), 2002 – 2010



Source: Own presentation.

Figures 4 and 5 present the growth contributions of the subsectors of the health economy on the financing of GKV and RV. Except of the health services of the core sector in the period 2003 to 2007 all sectors generate a positive contribution to the revenues of the GKV. Since 2008, the strong multifactor productivity growth of health services also contributes to the financing of the social insurance. Main driver is the MTP of the subsector health industry and trade in the core sector. Specifically, medical-technological and pharmaceutical innovations significantly generate to **value added and output growth** and therefore to societal welfare gains.

4.3 Labour market

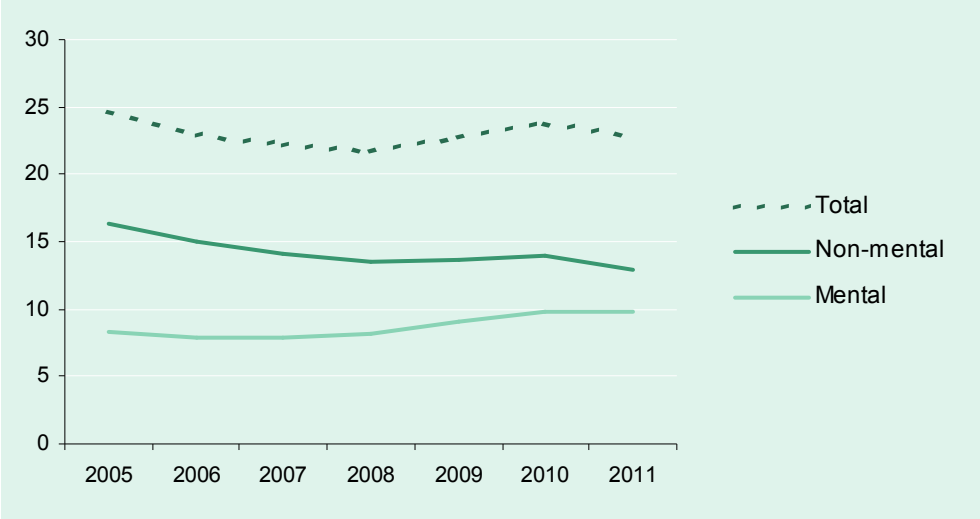
In a further step, the positive labour market effect of the MTP has been compiled. Thus, the rate of growth of gross output is multiplied with the cost weight of the labour input (share of compensation on gross output used to determine share attributable to the factor labour. This term multiplied by the sectoral labour force equals the annual labour force effect of the MTP. This effect defines the hypothetical number of employment, who would have been necessary in the period 2002 to 2010 in order to generate the same output as in case of presence of MTP.

During the period 2002 - 2010 nearly all sectors of the economy report increasing employment. In total, the MTP (direct effect plus effect through reduced mortality, incapacity for work and invalidity) could generate 660,000 employment years.

Decreasing the disability risks

One can expect that the various population groups will likely profit from the drivers of MTP in different way. Figure 6 summarises the development of the new entries to German disability pensions per 1,000 employees attributed to reduced work capacity (including the 65 aged of years and older) over the 6-year period 2005 – 2011: in total, the average annual incidence of new pension entries slightly decreased by 0.1 %.

Figure 6: New pensioners with mental disorder and other diseases per 1,000 employees, 2005 and 2011.



Source: *German statutory pension insurance 2013* and own compilation.

The reduction of new disability pensions in almost all disease classes at the annual rate of 2.4 % is in contrast to the significant increase of mental diseases at the rate of 3.3 %. In the period 2005 - 2011, the new pensioners attributable to mental disorders grew from 54,000 to 73,300 persons in 2011. While already in 2005 every third new pension entry occurred because of mental illness, in 2011 it increased on 41 %.

The literature discusses the increasing burden at the work place and advances in diagnostic diseases as factors causing this steady increase of early disability pensions by mental diseases. However, relevant seems to be also the fact, that mostly no rehabilitation measures were taken in the case of major mental diseases before retirement, because of the low probability of successful reintegration into employment (*Richter 2006: 213*).

Shortage of professionals

The direct contribution of the MTP for reduction of the hours worked respective the need of health professions creates a notable labour productivity gain, which is, however, in manufacturing of health goods, in trade and in the health care administration higher than in the provision of health care services. Without labour productivity growth an additional need of manpower inputs in worked hours of about 1.6 % would have been necessary in the total health economy to generate the actual output growth of 3.0 %. But, in reality, the growth of worked hours in the health economy averaged only about 1.4 % annually in the period 2002 – 2010. The number of employment increased slightly more by annually 0.3 %, which means effectively by 1.7 %. As a result the growth of labour productivity helped downsizing the additional demand of labour in the health economy. Nonetheless, remarkable differences exist in the given subsectors. The production of **manufactured commodities and trade** show

- an increasing specialisation, which has led to a decreasing demand for "non-health-professions",
- changes of the demand for professions by the skilled crafts sector, which are presumably driven by the ageing of the population (more opticians, less dental technicians),
- higher quality of pharmaceutical professions (more pharmaceutical-technical assistants and less pharmaceutical-accounting professions) as well as
- compared to the health services a lower growth rate of the demand for health professions.

In contrast, the provision of health services shows the following trends:

- a strongly increasing demand for nursing professions, particularly for long-term care,
- an increasing demand for medical professions (physicians, psychologists and psychotherapists),
- an increasing demand for therapists,
- no additional demand for rather technological assistant professions, and
- a decrease of non-health professions.

Concerning further development of qualifications of health professions working in health services these trends show diverse results.

Health capital

Finally the question arise, which effects one can expect on health from measures of the health economy, but also activities outside the health economy? How can the „health economic circle" be closed in the framework of the input-output system? The extended input-output table of the health satellite accounts offers the possibility to simulate the potential health gains by reduced invalidity, incapacity for work, and mortality in connection with activities of the health economy. Modelling such impacts of health activities on the health capital in the health satellite account can start from the ideas of *Leontief 1970* and of *Stone 1975*. Further to the capital stock the extension includes the human capital of the population as stock of expected life years cumulated over all age cohorts. Starting from these ideas the input-output-table will be expanded by additional rows for the impacts on labour force by diseases on the one hand and by additional columns for the health gains by the various activities of the health economy on the other hand. This will close the „health economic circle" in the framework of the input-output-system (see *BMWi 2013*).

As a result, the net effects on health gains depend not only on the MTP but also on the quantity and the structure of the health related activities "outside the health economy" in the extended input-output model. A particular aspect is the quantification of the health risks, which have impacts on the health capital, independently of the processes of the health care activities, for example through environmental repercussions, .

5. Recommendations and measures for productivity growth

5.1 Measures towards productivity growth

Productivity growth requires particular efforts of the enterprises and providers of the health economy. These have to be financed. Measures for productivity growth could be either directed to the structure and quality of the various input factors, or to the institutional framework governing the production process. These measures might also focus on the economies of scale and scope in and between the given sectors of the health economy. Economic studies have recommended the following actions to improve productivity growth of the health economy:

- improve the incentives (payment for performance - P4P, including performance contracts with pharmaceutical companies),
- optimise clinical pathways,
- enhance co-ordination of health services of prevention, acute care, rehabilitation, and long-term care,
- enforce the role of the patients (patient empowerment), and
- use consequently information and communication technologies - ICT (electronic patient records, etc.).

Even health services are bound to economic considerations because of scarce resources. Contributing meanwhile to more than 10 % of the gross domestic product, macro economic observation of the health economy via a satellite account of National Accounts can help in the analysis of the in-

terconnections with the total economy. In this study the issues of productivity measurement were investigated within the framework of such an accounting approach.

The drivers of the productivity of the health economy were analysed by decomposition of the factor inputs on the side and the structures of the real outputs of goods and services. Furthermore, scenario techniques were applied to estimate the impacts of the medical-technological progress. Output was compiled in constant prices and decomposed by disease groups. Quality adjustment was identified as an important issue of the measurement of productivity of the health economy. The prevention and postponement of disability resulting from multifactor productivity and MTP in health care was considered in the impact on revenues of the German statutory health and pension insurance systems.

The comparative measurement of productivity growth and its analysis provide new information for the design of economic policy. The drivers of productivity growth and the innovative sectors of the health economy can be observed and their development assessed as base for economic policy actions.

5.2 Policy recommendations

1. Result:

In the health economy, over the period 2002 – 2010, productivity grew more than twice as in the total economy (see Table 2). The results show the health economy can be both a driver of growth, and in crises a stabilizer of the total economy and the German investment location.

Recommendations:

The contribution of the health economy to economic growth requires further reflection in the public to overcome the image of the health sector as cost driver. In future, health policy activities should be more assessed with regard to their economic impacts, not only with regard to their fiscal effects (expenditure containment, stability of the contribution rate, etc.). The impacts of planned regulations of the health markets should be assessed on economic growth, technological progress and the labour market.

2. Result:

In the period since 2002, the average annual rate of the multifactor productivity growth of the health economy of about 1.5 % was significantly higher than of the total economy of 0.9 %. Driver of this medical-technological progress in the core health economy has been particular the innovations at manufactured health goods.

Recommendations:

In the case of manufacturing of goods, where markets are more competitive organised, and determined by market prices, industries of pharmaceutical and medical devices have also to focus on exports and strive for competitiveness in international markets. In order to beware the strong productivity of these industries, impacts of regulations on the internal competitiveness should be considered in particular. In the case of outpatient and inpatient health services, which are overwhelmingly at communities or national organised, governed by administered prices and sectoral budgets, the institutions for competitive structures need successively to be further developed. The enforced

competition among statutory health insurance funds had obviously contributed to efficiency gains in the health insurance administration.

3. Result:

The comparison of selected outcome indicators by disease classes shows increasing incidence of mental disorders and cancer diseases, while decreasing rates of circulatory and musculoskeletal diseases. For enterprises the growing absenteeism and presenteeism resulting from mental disorders causes an increasing burden - the lost working years grew at an annual rate of 3.1 % over the period 2002 to 2008.

Recommendations:

Policy should pay more attention to the prevention and treatment of mental disorders, resulting increasingly from the work place. Companies and social insurance funds are encouraged, to strengthen further the conditions for a healthy and productive life. Economic studies show a significant rate of return of investment of respective health management of enterprises (*Lück, Eberle, Bonitz 2008*). In past years, both public and private initiatives have started projects to improve the working conditions (e.g. Initiative New Quality of Labour – INQA, programs of the BMAS to combat work-related diseases, "Best employer of Great Place to Work", and manifold projects of the industrial accident insurance and the other accident funds). Many approaches and concepts exist, but the knowledge transfer into company practice, especially into SME, is still challenging. Further targeted measures could help to increase productivity growth of the whole economy.

4. Results:

As a consequence of the medical-technological progress, one can observe within labour market of health professions different effects on health commodities on the one side and health services on the other side. In the period 2000 - 2010 health service professions got more and more important, especially in nursing and medical professions, while the demand for certain health professionals in the industrial production of health goods and in the trade of these goods had decreased.

Recommendations:

In the provision of health services, the medical-technological progress will likely generate only a small reduction of the expected future demand for health professionals. In light of the shrinking labour force due to demographic changes the future imbalances in the labour market of health professionals require particular attention. Forecasts about the need of health professionals should, however, take into consideration the drivers of the labour productivity and the effects of the MTP occurring in the various activities of health profession and health care organisations.

5. Results:

Per saldo, multifactor productivity growth of hospitals was positive in the 8-year period investigated. The measured productivity increase resulted completely from technical change, while efficiency improvements had rarely taken place or were even negative.

Recommendations:

Efficiency growth is closely linked with process development and reorganisation. These activities on the other hand might require investments to adjust buildings and equipment (e.g. elevators to improve transportation, reconstruction of hospital wards to adapt to geriatric clients, etc.). The access of hospital to capital formation needs to be facilitated, because the German „Laender" have

reduced their financial subsidies during the last years, a result of the actual hospital rating report 2013: the average capacity to invest, particularly of the public and private not-for profit hospitals, is too low to sustain in the long-run. 13 % of all hospitals were at insolvency risk in 2013 as compared to 10 % in 2010 (*Augurzky 2013*).

Further, it needs to be checked, whether the outpatient and inpatient facilities of the health economy benefit from the federal funded innovation program. The statistics of the central innovation program SME (ZIM) lists only health research and medical technology (subsidies of 193 million €, status June 2013).

5.3 Recommendations for health research

6. Results:

This study made a first step into the analysis of the productivity of the health economy and of its subsectors. The complete depth and link with the goods and service accounts and the sector accounts of the national accounts would be desirable as next step. Furthermore, the analysed classes of diseases could be further decomposed and integrated into the health economic accounts.

Recommendations:

Based on the results of this study the further development of the data base and the analytical methods should be developed by research projects. Particularly, these activities should aim

- to develop a comprehensive statistical price of the national health satellite accounts,
- to monitor the ongoing capital needs of the health economy, because over and over stakeholders report underinvestment and too low investment subsidies,
- to continuously analyse the development of labour inputs regarding levels of qualification and education – e.g. by (EQF)-classifications,
- to elaborate evidence based quality indices for the subsectors of the health economy (outpatient, inpatient, rehabilitation and long-term care) and for diseases.

7. Results:

The growth of the labour productivity of the health economy was at a comparable rate as of the total economy. Within the health economy the productivity growth had been much higher for the health goods and lower for the health services.

Recommendations:

The quality dimension plays a key role for the provision of health services. Medical-technological progress and increasing legal standards for the quality lead often to additional labour cost – though they also result in improved outcomes of care (fasten recovery, higher life quality, etc.). Presently, the measurement of the output captures these improvements of quality rather insufficiently. The better measurement of the productivity growth of health services requires methodological developments, which should be supported by policy.

8. Results:

Over the period 2002 – 2010, the medical-technological progress contributed about 12,6 bn € directly to the revenues of the GKV and the RV.

Recommendation:

This makes clear that the development of the medical-technological progress is a national task. Presently, about 6 % of the federal expenditures for research and development are devoted to health research and medical technology, but among that only 0.6 % (2010) for patient centred research and health service research (see *BMBF 2012*)– considering the social importance of health it should be checked, whether this share needs to be increased.

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