Methodology of the National Health Account for Germany - Database, compilation and results

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Methodology of the National Health Account for Germany
Database, compilation and results

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Abstract: The National Health Account for Germany is a standard reporting tool for the sector's contribution to economic growth, employment and international trade. Its compilation is based on the supply and use tables of national accounts. Consequently, it refers to a satellite system of the health economy within the overall German economy. It further contains a health input-output table (HIOT) enabling the calculation of multiplier effects. The HIOT is fully consistent with the official input-output table, but it facilitates a more thorough analysis of this heterogeneous inter-sectoral industry, dividing the economy into a number of 'core' health sectors, 'extended' health sectors, and 'non-health' sectors. Concepts and methodology have been developed within projects on behalf of the Federal Ministry of Economic Affairs and Energy of Germany over several years. This paper describes underlying approaches for the compilation of the National Health Account with special emphasis on recent developments due to revisions of statistical standards in the context of supply and use tables, NACE 2008 and ESA 2010. Consequently, its contribution to existing scientific research is the methodological point of view the paper addresses, which has not been discussed in detail before. The sector's relevance for export activities is evaluated as an exemplary field of application of the National Health Account by conducting input-output analysis.

JEL Classification: C67, E01, I11, I18

Key words: Input-Output analysis, economic footprint, health economy, Germany

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1 Introduction

The German health economy amounts to around 12.0 percent of overall GDP and contributes about 15.9 percent to the national labor market. Its share of 7.4 percent of German exports indicates the relevance of this mainly service dominated sector especially for industrial production. Based on indicators calculated for the period from 2000 until 2015, the population's higher awareness for health and demographic change is recognized, which results in an increase in the importance of the sector for the overall economy in terms of growth, employment and international trade.

These and other key indicators were compiled on behalf of the Federal Ministry for Economic Affairs and Energy. The resulting tool is called the "National Health Account" (Federal Ministry of Economic Affairs and Energy, 2016). It looks at the sector's contribution to the overall national economy by making use of the concepts, methodology and data of national accounts. Focusing on the relevance of the sector's contribution to labor market and economic growth enhances scientific research in the field of health economics, as the cost side of the supply of health care has been dominant over the last few centuries. It is undisputable however, that the cost-driving factor of health supply delivers important figures for decision making in politics. The health economy is indeed closely connected to costs incurred but it also has effects on the labor market, economic performance and international trade. Combining of the cost side of the health economy with its economic output can be captured within the supply and use side of national accounts. However, conclusions and resulting impact analyses on the overall economy cannot be conducted from available official data without making specific adjustments and calculations, as standard classifications (CPA and NACE) are in the most cases too aggregated to specify the health-specific product category or industry included. The health economy consists of a high amount of heterogeneous economic operators and products and services in demand itself. Components of the health economy range from health services to the production of medication and medical technology products, but can also involve areas such as research and development, health tourism or E-Health, depending on the definition used. A detailed list of areas involved within the National Health Account are shown in Table 1. Sectors defined by a high heterogeneity of involved products and economic operators are called 'cross-sectoral industries'. Depending on the field of interest, one can identify various cross-sectoral industries within the overall economy. Next to health, tourism or sports are prominent examples (GWS, 2015; Federal Ministry of Economic Affairs and Energy, 2012; Statistics Austria & WIFO, 2014; SpEA 2015). In order to evaluate these sectors as an integrated part of the overall economy, a satellite account approach is followed. As the author of this paper has developed significant parts of the current calculation concepts of the National Health Account, the aim of this paper is to document these methodological approach. Earlier work on this topic was based on different statistical databases and standards (Geigant, Holub & Schnabl, 1986; Essig & Reich; 1988, Sarrazin, 1992; Henke, Neumann & Schneider, 2010; Ostwald, Henke & Kim, 2014; Federal Ministry of Economic Affairs and Energy, 2015; Schneider, et al., 2016). Methodological concepts have not been discussed extensively within these contributions especially in recent times, but have emphasized on the description of results and political implications. This paper describes the methodological concepts of creating a National Health Account based on supply and use tables for the first time within the recently introduced statistical standards of NACE 2008 and ESA 2010. Not only the accuracy of results in terms of statistical standards but also the recently integrated framework of supply and use tables, instead of input-output tables, serves as a superior primary database compared to earlier work and the context of national accounts in general (Lenzen & Rueda-Cantuche, 2012). The intention behind this paper lies on one hand within the scientifically focused formation of the National Health Account itself. On the other hand, it serves as a solid basis for further stages in developments of the National Health Account. Although the health economy is a very heterogeneous part of the economy, it also shows different characteristics across the 16 federal states of Germany. The present underlying methodological framework does not allow the evaluation of the specific characteristics of regions. In order to do so, further papers will focus on creating up a Multiregional Health Account for the 16 federal states of Germany based on supply and use tables. This will resolve the gap in research concerning the detailed evaluation of characteristics and interregional dependencies emerging from the health economy in the German federal states.

The paper proceeds as follows: section 2 describes the objective function of the National Health Account in order to facilitate a better understanding of the aim this framework pursues. Section 3 focusses on earlier work on this topic and the paradigm shift concerning health care, in which the awareness of the health economy as a contributor for economic performance has emerged in the first place. That section is followed by a description of the main methodological background concerning international standards, data base and principles of the National Health Account within the respective subsections. Section 5 focusses on the compilation methodology at basic and purchasers' prices, handles the integration of secondary data for specific areas of health and describes the calculation procedure of input-output tables. Moreover, it looks at the procedure of constructing time series data. Section 6 shows an exemplary field of application of the health input-output table. Section 7 concludes and gives insight in further research areas.

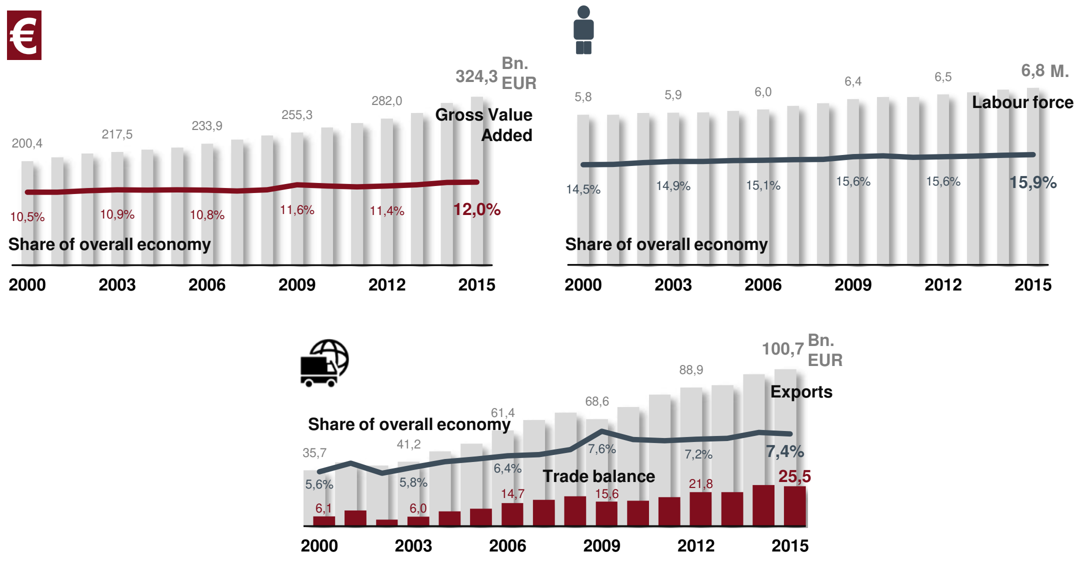
2 Objective function of the National Health Account

The National Health Account represents a standard reporting tool, which quantifies the contribution of the health economy to the overall German economic performance in terms of gross value added, labor market participation and international trade. Based on national accounts, the main objective function aims at quantifying this inter-sectoral industry's contribution as an integrated part of the overall economy's dynamics without disrupting the macroeconomic system. In order to facilitate a better understanding of the methodological framework discussed in this paper, key results of this developed standard reporting tool are presented in the following. Supplementary applications of the model and results of an input-output analysis are presented in section 6.

The German health economy's contribution to national GDP amounts to around 12.0 percent or 324 Bn. Euro Gross Value Added in 2015 (Federal Ministry of Economic Affairs and Energy 2016; Schwärzler & Legler, 2016). Put differently, about one out of eight Euros of overall German gross value added results from the health economy.

Between 2000 and 2015, the health economy recorded growth of gross value added in the extent of 124.0 Bn. Euro or 61.9 percent. Compound annual growth rate results in 3.3 percent, opposed by a 2.3 percent growth rate of the overall economy. Furthermore, share of the health economy on the overall economy increased from 10.5 percent up to the already mentioned 12.0 percent within those years. Especially during times of the main economic crisis, the health economy proved its characteristic as a contributor and stabilizer of economic growth as it recorded an increased share on the overall economy and a rise in overall gross value added.

Figure 1: Selected results from the Economic Footprint of the Health Economy



Source: Own illustration, based on Federal Ministry of Economic Affairs and Energy (2016), Schwärzler & Legler (2016)

Next to its contribution to economic growth, effects on the labor market show a high importance of the health economy. In 2015, the health economy employed about 6.8 M. people in Germany. This amounts to a share of 15.9 on the overall labor market force. Put differently, one out of six employees was working in this sector. In addition to a high number of employed people in the health economy in 2015, key indicators show an above average development. In total, the health economy generated about one million additional jobs between 2000 and 2015. Furthermore, relevance of the sector on the overall economy increased from 14.5 percent to the already mentioned share of 15.9 percent. Growth showed above average dynamics of a 1.1 percent compound annual growth rate, when overall labor market increased by 0.5 percent.

As the health economy does not only consist of services related to health care but includes industrial production as well, key indicators of the participation on export and import illustrate the importance of the sector on international grounds. It reflects the amount of internationalization of the market as well as dependencies on worldwide dynamics. Consequently, key indicators on export, import and trade balance are discussed in the following.

Exports of the health economy amount to 100.7 Bn. Euro in 2015. The sector contributes 7.4 percent to overall German export activities. Since 2000, volume of exports increased by 65.0 Bn. Euro or 181.9 percent. Compound annual growth rate amounts to 7.2 percent, which is around two percentage points higher compared to the growth rate of overall German exports. Imports show a significant rise in absolute as well as in relative terms since 2000. Compound annual growth rate amounts to 6.4 percent. This results in a rising trade balance during the last 16 years, which increased from 6.1 Bn. Euro to 25.5 Bn. Euro in 2015. The absolute amount of imports results in 75.2 Bn. Euro in 2015, which corresponds to a share of 6.7 percent on overall German imports.

Described key indicators represent a brief outline of basic analyses, which can be obtained from the National Health Account. It delivers first insights in advance to the discussion of the historical and methodological background and aims at a more focused understanding of the methodological approaches used to compile the National Health Account.

3 Historical background and paradigm shift concerning health care

First thoughts concerning a satellite system for health within national accounts arose in Germany as early as 1986. It consisted of four integrated health sectors within the official input-output table of 1975. These four sectors comprised pharmaceutical products, medical technology products, inpatient care and health care based on self-employed workers (Geigant, Holub & Schnabl, 1986). The authors did not conduct an input-output analysis, because due to discrepancies with the official table the interrelationships calculated with the overall economy could not be integrated consistently into the overall framework.

The conceptual framework for a combined approach of national accounts on the one hand and health expenditure on the other, which is still the basic principle of calculation today, was developed in the late 1980s (Essig & Reich, 1988). The authors stressed the necessity of picturing the overall sectoral interaction of health care, which goes in hand with the later definition of 'health economy' as an inter-sectoral industry, consisting of services as well as of the production of goods. In this context, they indicated the main challenge of the approach, which results from integrating health expenditures into the context of national accounts: whereas data on health expenditures focus on one side only – the costs of health care supply – national accounts have to model the overall monetary circulation flows.

As this approach consisted of a conceptual framework only, first attempts of modelling a health satellite account according to the elaborated approach were conducted a few years later (Sarrazin, 1992). Additional databases did not exist for health expenditures even though the data would have already been available at that point of time for Germany. This piece of work was not only the first implementation of a health satellite account, but also involved a high number of conceptual ideas and validity checks. It therefore seems legitimate as well as exemplary that existing data on overall health expenditures at this state of progress had not been used, but the respective underlying 'raw' data sources. Deviations from overall national accounts occurred in this calculation and were explicitly pointed out by the authors. In addition, this work did not include information on intermediate use. Therefore, the evaluation of interrelations of the health care sector with the overall economy – and consequently input-output analysis - was not possible.

From mid-1990 on, a paradigm shift has shaped the development and characteristic of the health economy within the political context (Goldschmidt & Hilbert, 2009). It can be assumed that methodological and conceptual work done by Geigant, Holub & Schnabl (1986), Essig & Reich (1988) and Sarrazin (1992) have contributed significantly to this development as the perspective on health care broadened from that point in time on. A focus only on the cost side health care services turned into a focus on the economic impacts of a higher number of involved agents and contributors to health. Interestingly, this paradigm shift evolved in a few single regions of Germany that started implementing health supply topics as an area of expertise within public policies concerning economic structure, labor market and technology.

On a national level, the economic significance of the supply of health care first found substantial consideration within the special report of the Advisory Council on the Assessment of Developments in the Health

Care System in 1997 (SVRKAiG, 1997). It named the supply of health care as a decisive element of the overall economy and its respective dynamics. Accordingly, its effects on GDP and employment were deemed to be important, in addition to its contribution to maintain, restore and promote health of the population.

While this section within the special report emphasized the service-oriented part of health, the National Conference on Health Economy provided a cross-sectoral industrial point of view of the sector. It defined the health economy as '[…] the production and marketing of goods and services, which serve for prevention as well as for the provision of health and for rehabilitation.' (BioCon Valley, 2005).

Therefore, the paradigm shift in the context of health is two-fold: first, supply of health care is not only service-oriented, it consists of much more, e.g. the production of medicine and medical technology. Second, politicians now started to see the health economy as a contributor and driver for economic output, employment and international trade as well. Previously, economists and politicians perceived the costs of health care supply as a major handicap for economic growth (Hilbert, Fretschner & Dülberg, 2002). Especially in combination with demographic change, the topic was mainly discussed as a burden.

There is one more aspect that surrounds the paradigm shift within the health economy. A higher demand for health care services and products does not only result from demographic change. Moreover, a higher consciousness regarding a healthier lifestyle, the willingness to prevent sickness and possibilities to alleviate certain health conditions have led to an expansion of the health economy in areas such as physical fitness, nutrition, health tourism and barrier-free housing (Goldschmidt & Hilbert, 2009). These developments do not only support a healthier and longer life but also contribute to the growing importance of the health economy.

Overall, analyses regarding the health economy aim neither to neglect nor to ignore the importance of expenditure dynamics. Instead, the sector's contribution is now seen alongside of costs incurred by the health system. In addition, the health economy is now considered as an important factor for innovations, which have the ability to facilitate a longer life.

Nefiodow (1996) also sees both the holistic view of health and the innovation impulse erupting from it as important factors for future developments within the economy. He defines health as the sixth Kondratieff cycle, following and partially overlapping with the information and communication technology cycle. In his opinion, health has characteristics of a 'leading sector', which initiates and carries the next long-term economic fluctuation. Requirements for developments of this kind are the existence of scarcity in some economic or social field, which can be eliminated by an increase in productivity. Both terms refer to biotechnology as well as to psychosocial health, whereas he defines the former as the 'hardware' and the latter as the 'software' of this innovation cycle. Scarcity arises from disrupted inner information processing and disruptive information relations within the population and labor force. Increases in productivity therefore result from a holistic view of health in terms of physical, emotional, mental and social health. This in turn enables successful communication, economic growth, collaboration and creativity.

In addition, national politics have recognized the high potential of innovations that arise from the health economy and to which Nefiodow refers to as 'hardware'. In 2010, the Federal Ministry of Education and Research identified five different fields that are of major concern for future developments and therefore deserve particular attention (Federal Ministry of Education and Research, 2010). Next to climate and energy, mobility, security and communication, health and nutrition also play an important role. The main intention of giving specific attention to those fields is not only to enable a better and more comfortable life, but also to trigger effects on gross value added for the economy, to generate jobs and to use special skills and talents more efficiently. One of the goals being set is the strengthening of these sectors in terms of economic growth, whereby the emphasis is laid on medical technology for the health economy in particular.

In summary, the paradigm shift concerning health care has been an important topic throughout the past few years. For Goldschmidt & Hilbert (2009) it is undeniable that the German health economy can only develop proper, if quality, efficiency and equity are of main importance within the sector. From a scientific point of view however, they say a lot remains to be done in that field today, in order to identify the next steps enabling the proper future development of the health economy.

The research activities initiated by the Federal Ministry of Economic Affairs and Energy a few years ago followed Goldschmidt & Hilbert's statements (2009). After the Advisory Council on the Assessment of Developments in the Health Care System named the sector of major significance not only in terms of costs but also of economic power (SVRKAiG, 1997) and after the health economy itself was defined (BioCon Valley, 2005), the first Health Satellite Account for Germany was compiled on behalf of the Ministry. It was published in 2010, under review being the years 2005 (Henke, Neumann & Schneider, 2010). Both the initial and updated version, which was published in 2014 (Ostwald, Henke & Kim, 2014) were based on ESA 1995 and NACE 2003. Underlying basic data, provided by the Federal Statistical Office, was received as an input-output table in a rectangular shape of 3,118 products and 120 sectors and a supply table consisting of 3,118 products and 221 sectors, both reflecting the overall economy, but divided into differing levels of aggregates. From this statistical segmentation of the whole economy into an overall number of 3.118 products, detailed information on 524 selected products with relevance to health were available to the authors. Remaining data on the non-health related parts of the economy was available on an aggregated level. While calculations conducted during the first research period concentrated on the year 2005 and two additional projections on future values in 2020 and 2030, the second project conducted in 2014 concentrated on annual data points for 2006 until 2008. Another accomplishment consisted of the introduction of the so-called 'Economic footprint' of the sector, which considered indirect and induced effects of the health economy on the overall economy for the first time. At this point of research, the initial name of the project changed from 'Health Satellite Account" (HSA) into 'National Health Account' (NHA). In order to conclude the dynamics up to the current period, the authors again projected key indicators by making use of a forecast model based on evaluated drivers of future dynamics.

Extensive revisions in the compilation of national accounts as well as in the classification of sectors and products required the reconciliation of the existing methodology in 2015 (Federal Ministry of Economic Affairs and Energy, 2015; Schneider, et al., 2016). Specifically, the changes contained the reclassification from NACE 2003 to NACE 2008 and the way of compiling input-output tables. Underlying basic data was no longer available in an input-output framework, but involved supply and use tables for Germany. From then on, calculations were based on supply and use tables in the shape of 2,643 products and 64 sectors for the overall economy, from which 888 partially or fully health-related product groups were available to the authors. Input-output tables emphasizing health, pictured as satellite accounts within the overall economy, were calculated based on health specific supply and use tables. As the special evaluation from the Federal Statistical Office in this type of shape and reclassification was only available for the time period of 2008 until 2010, previous work on the Health Satellite Account (Henke, Neumann & Schneider, 2010) as well as on the National Health Account (Ostwald, Henke & Kim, 2014) served as rough reference values only from that point of time on. This fundamental change in computation led to a revised way of projecting key indicators for the overall period of 2000 until 2014. At earlier stages, projection methodology relied on specific key indicators and their respective driving forces within the economy. From that point on, however, the overall economic framework of supply and use tables was projected by making use of the SUT-RAS compilation methodology (Temurshoev & Timmer, 2011). This approach enhances data accuracy as identical procedures can be used to extract the health economy from the overall economy. The reasoning behind this lies in projecting the special evaluation from the statistical office, and therefore the main underlying database, for those years for which no official supply and use tables, but only key indicators, are available. This way, the health economy can be extracted consistently from the overall economy consistently for every year under review.

Another revision followed at the end of 2014. The statistical standard ESA 1995 was replaced by ESA 2010 (Destatis, 2014). This made straight-forward updating and the usage of previous databases on national accounts impossible once again (Federal Ministry of Economic Affairs and Energy, 2016). Detailed data on product groups of supply and use tables were now available for 930 out of 2,643 rows for the years 2010 and 2011. Based on this, health specific supply, use and input-output tables were calculated for the period 2000 until 2015.

Publications and therefore the historical background end at this point. Recent and future work considers an even more detailed evaluation of the health economy with respect to subsectors such as biotechnology, the impact of generic drugs or an extensive analysis concerning investments in Research and Development within the several subsectors. The author of this paper joined the research activities in 2013, which is why the main emphasis is laid on methodological developments from that point in time on (Federal Ministry of Economic Affairs and Energy, 2015; Schneider, et al., 2016; Federal Ministry of Economic Affairs and Energy, 2016). This includes the compilation methodology based on supply and use tables as well as the revisions due to current statistical standards of NACE 2008 and ESA 2010. The present paper therefore follows the approach of Goldschmidt & Hilbert (2009), who emphasize the importance of a continuous improvement in scientific research in the field of the health economy. It serves as a foundation for scientific discussion and further developments with the explicit goal to arrive where the journey started: the health economy in a regional perspective, but in an integrated framework with emphasis on interregional dependencies – the Multiregional Health Account for the 16 German federal states.

4 Methodological background

The aim of this section is to describe the methodological background for the compilation of the National Health Account. This is presented in order to facilitate a better understanding of section 5 and the quality of results. Except for the description of the underlying database referring to supply and use tables in the statistical standard of NACE 2008 and ESA 2010, the contents and principles described have been implemented in earlier works on the National Health Account already (Henke, Neumann & Schneider, 2010; Ostwald, Henke & Kim, 2014; Federal Ministry of Economic Affairs and Energy, 2015; Schneider, et al., 2016; Federal Ministry of Economic Affairs and Energy, 2016) and do not refer to the author's contribution solely. The remainder of this section is structured as follows: First, subsection 4.1 is dedicated to present official standards on the international level, which promote the concepts of a National Health Account. Secondly, the underlying database is portrayed in 4.2. Subsection 4.3 supplements with information on the principles of the National Health Account, which have to be considered during the compilation.

4.1 International standards

In order to develop the National Health Account, two basic principles are of main concern – satellite accounts within national accounts on the one hand and health expenditures on the other hand. Underlying reasons will be discussed in the remainder of this section. For now, it is sufficient to know that the centerpiece of this work is to match national accounts with expenditures on health. This is conducted in order to establish a satellite account for health as a valid framework for ongoing analyses concerning this specific cross-sectoral industry. Both concepts, national accounts focusing on satellite accounts and data on health expenditure, underlie specific international standards. Therefore, the idea of a health satellite account is already integrated in international standards, whereas its implementation is still rare (i.e. Institute for Advances Studies, 2014) and differs in design. Named basic concepts of satellite accounts on the one hand and on expenditure on health on the other hand are described in the following subsections.

According to the System of National Accounts (SNA), satellite accounts are defined as follows:

'Satellite accounts or systems generally stress the need to expand the analytical capacity of national accounting for selected areas of social concern in a flexible manner, without overburdening or disrupting the central system.'

European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, World Bank, 2009

National accounts contain a high number of information about economic dynamics and conceptual interconnectedness between sectors. However, satellite accounts allow deeper analyses in the context of national accounts, focusing on certain fields or aspects of interest, which consist of information official data does not reveal. The objective of satellite accounts is therefore to quantify and describe components of national accounts that are hidden or shown only to a minor extent.

Special evaluations of national accounts promote the detailed selection and analysis of goods and services of the overall economy, in order to shape areas of interest within the official framework of preferably supply and use tables. The compilation of satellite accounts may involve some methodological differences from overall national accounts, which can go in hand with the treatment of auxiliary production or disaggregation of sectors. Basic concepts of national accounts however have to remain in order to prevent the disruption of the overall system.

Moreover, satellite accounts can follow a more detailed approach, which concentrates on patterns of i.e. consumption, investment or intermediary use. This is also the case for the National Health Account, which refers to the final consumption patterns from official data on health expenditures. Making use of this additional database within the compilation process of the satellite account assures the focus on human health solely. It allows to exclude health care services or medicine that do not promote better human health. These are important aspects especially in the case of plastic surgery, illegal drug consumption as part of the product range of the pharmaceutical industry but also intermediary use of pharmaceuticals for processing in veterinary medicine or agriculture.

Hence, official data on health expenditure from the Federal Statistical Office in Germany contributes to the validity of the National Health Account to a high extent. It serves as the second main database to quantify the economic performance of the health economy. Guidelines for the compilation of health expenditure data follow international standards as well, as described in the following.

The System of Health Accounts was developed in 2000 and aims to serve as an international guideline for the definition and accounting mechanisms of health expenditure (OECD, Eurostat, WHO, 2011). This enables internationally harmonized comparisons across countries and time in order to obtain analyses and monitoring of health systems and related expenditures. The conceptual framework is the tri-axial relationship of health care and long-term care expenditure consisting of consumption, provision and financing. According to the guideline of the System of Health Accounts, all services and products, which have the primary goal to improve and preserve health or prevent from illness, are considered as being related to health and are consequently considered within the health expenditure survey. Hence, the concept follows a functional approach. Questions of responsibility in terms of provision or funding do not decide upon the fact whether or not the amount spent on a certain service or good is considered within health expenditure.

These standards contributed to an increasing number of studies on the economic impact of health on international grounds (e.g. Bureau of Economic Analysis (2015); IBGE (2008); PAHO (2005); Statistics Portugal (2015). Those quantifications differ from the approach of the National Health Accounts for Germany in aspects such as focusing on health services only or relating health expenditure to GDP, the interrelations of the economy being unconsidered. As far as it is known, there is therefore no study of comparable scope available.

4.2 Underlying database

The two main underlying databases of the National Health Account are the national accounts itself on the one hand and the health expenditure survey on the other hand. The Federal Statistical Office of Germany produces both detailed figures on an annual basis. The former provides the macroeconomic statistical framework, into which the health economy is going to be integrated consistently as a satellite account. The intention of the latter database is to assure validity within the overall approach, acting as the statistical special evaluation in the field of health care supply.

As the previous section closed with international standards concerning health expenditures, shape and content of this database will be discussed in detail first in order to facilitate a better understanding for the reader.

The Federal Statistical Office for Germany provides official data on health expenditure within subject-matter series 12, series 7.1.1 and series 7.1.2 (Destatis, 2016a; Destatis, 2016b). Data are currently available for the period 1995 until 2014 in the different categories of function, providers and funding. Each of those is divided into subsections.

Functional categories are investments, health prevention and public health services, medical services, nursing and therapeutic services, food and lodging, health care goods, patient transport, emergency rescue and administrative services. Most areas show further segmentations with respect to the specific service applied or the product in use, e.g. pharmaceuticals, dentures or therapeutic appliances.

Types of providers are separated into investments, public health, ambulatory care, involving another six subsections, stationary/semi-stationary health care with respect to three further subsections, ambulance services, administration, other providers, private households and the rest of the world.

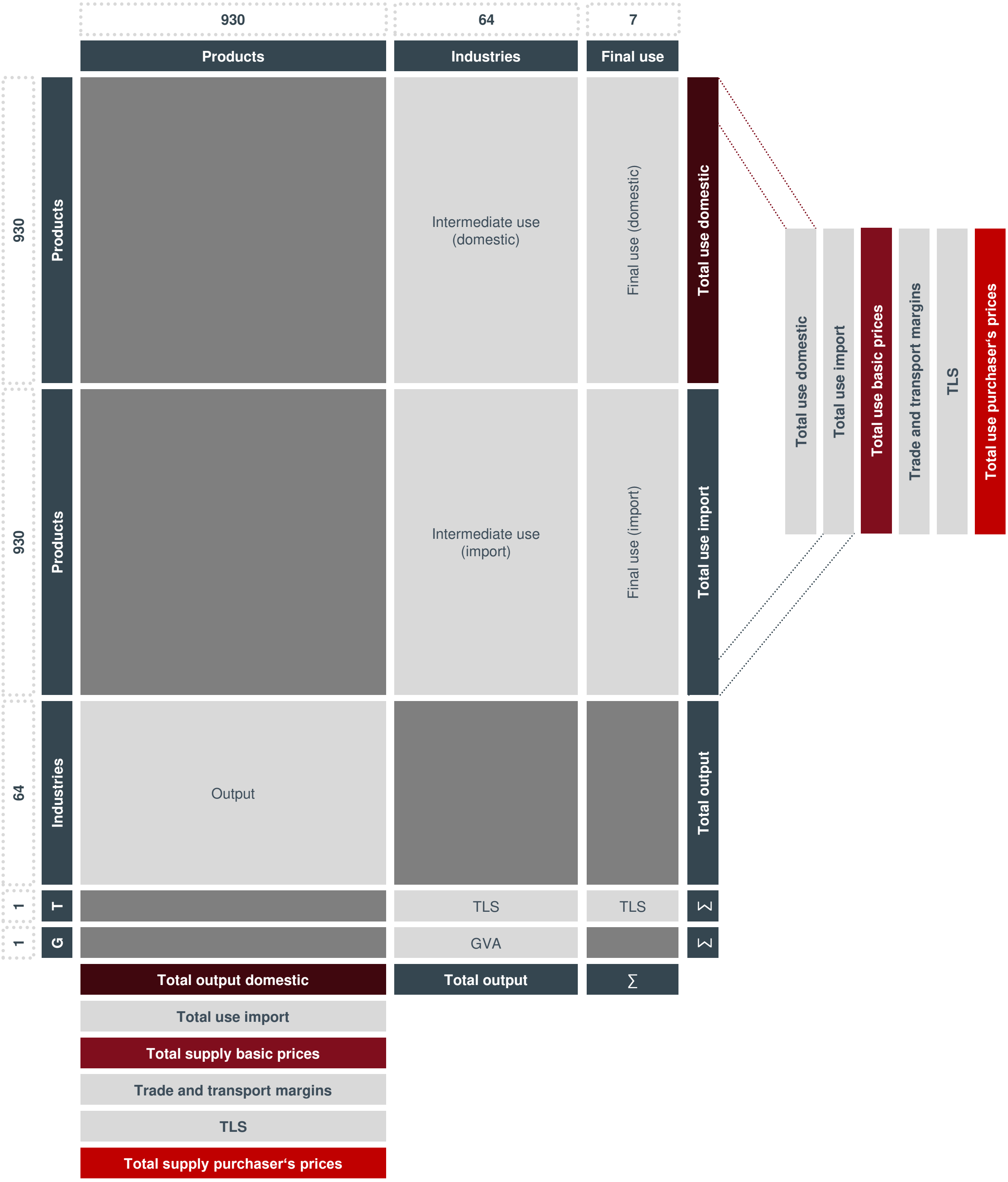
The third axis, called financing or sources of funding, is subdivided into general government excluding social security funds, statutory health insurance, social long-term care insurance, statutory pension insurance, statutory accident insurance, private health insurance, employers and private households/private non-profit organizations.

Expenditures on education and training of health personnel, research and development in health, health-related social services as well as health-related cash-benefits are shown in a separate area, but are not part of the overall amount of health expenditures.

As mentioned, the main underlying database for the compilation of the National Health Account is the specific evaluation of national accounts delivered by the Federal Statistical Office of Germany. The corresponding aggregated official tables of supply, use and input-output are published within subject-matter series 18, series 2. Subject-matter series 18, series 1.4 includes data on main aggregates of industries as well as of final use (Destatis, 2015a; Destatis, 2015b). Compiling the satellite account based on official tables, which consist of 64 industries and 88 product groups only, leads to an extremely time consuming work, as data on health related products have to be evaluated from additional secondary data in order to model intermediary product flows, final consumption and output in advance. Issues in terms of consistency would be of a main concern, as earlier projects have shown (see section 2 for more details). Fortunately, the special evaluation from the Federal Statistical Office consists of 64 industries and 2,643 product groups, from which 930 were assigned of being completely or partly health-related. Full information for those areas of supply and use tables are available to the author for domestically produced as well as for imported goods and services. Figure 2 shows main dependencies as well as shape and scope of available data. Both main underlying statistics – national accounts and data on health expenditures - follow international guidelines, as discussed in subsection 4.1. This aims not only to enable consistency over time and countries, but also to enhance compatibility with other related economic and social statistics. However, this is not always possible or reasonable to the whole extend. This results in inconsistencies regarding some accounting balances, which have to be considered within the calculation approach (OECD, Eurostat, WHO, 2011).

First, and from a broader perspective, the intention of the two statistics differ from each other. As national accounts focus on the supply and use of goods and services as well as the generation and distribution of income of the whole economy, they show a macroeconomic picture, involving monetary circulation flows in addition. Health expenditures, on the other hand, focus on the consumption, provision and financing patterns of health products and services solely, by aggregating partially micro-based data. This leads to a meso-economic accounting principle.

Figure 2: Dimension and shape of available data on national accounts



Source: Own illustration.

Another main underlying difference between the two databases is the domestic concept characterizing national accounts, opposed by the national concept, referring to the health expenditure survey. In concrete terms, the focus of use and supply tables lies on domestically used and supplied products, whereas health expenditures relate to residents of Germany treated within the country or abroad only. Therefore, expenditures from non-residents within Germany are not included in the survey, whereas 'exported' money to other countries are included in the statistics, referring to 'rest of the world'. Impacts on the calculations result in data on i.e. gross value added for the health economy, which do not include expenditures for non-residents within Germany, as underlying information is not available.

Another difference is the price concept of statistics. Supply and use tables refer to basic prices, whereas health expenditures are reflected in purchasers' prices. This conceptual difference has no impacts on results of the National Health Account, as available data on supply and use tables enable a conversion into purchasers' prices.

Next, costs borne by dependency allowances, are considered within health expenditures, whereas they are not part of final consumption in the use tables of national accounts. The same counts for household production. Social transfers for taking care of dependents are included in the health expenditure, but not considered within national accounts. Impact on key indicators is little, but existent.

As an exemption to main concepts, certain parts of expenditures on health prevention as well as expenditures of employers for occupational health services are recorded as intermediary use in national accounts instead of final consumption. The amount of expenditures is considered within the satellite account nevertheless, as the conceptual difference is only a matter of compilation.

4.3 Principles of the National Health Account

As the previous subsections concentrated on international standards and the databases used, this section focuses on the general principles of the National Health Account, which have been developed throughout a number of projects conducted so far in this specific context (Henke, Neumann & Schneider, 2010; Ostwald, Henke & Kim, 2014; Federal Ministry of Economic Affairs and Energy, 2015; Schneider, et al., 2016; Federal Ministry of Economic Affairs and Energy, 2016). From a compilation point of view, the overall goal perspective is to extract health related areas in product groups as well as sectors from the overall economy and reflect them in the edge of supply and use tables with respect to the common concepts of prices. This has to be conducted with respect to underlying concepts of national accounts to ensure that the National Health Account is pictures as an integrated, but analytically separated part of the overall economy. All balancing conditions and interdependencies of national accounting are maintained in order to obtain a consistent picture of this cross-sectoral industry within the German economy. Previous sections have already described the dimension of the underlying database of national accounts consisting of 930 product groups for 64 sectors. For use tables of domestic production and imports, components of final use are part of the special evaluation from the Federal Statistical Office as well.

Based on this, the National Health Account follows a product-specific definition of the health economy rather than a sector-specific one. There are three main reasons for this specific approach. First, the amount of data availability on the product side is much higher than on the sector side, which promotes this choice of procedure from the perspective of the database. Second, the functional approach of the health expenditure survey, to include all goods and services, which promote and preserve health as well as prevent from poor health conditions, supports this procedure in terms of the intended consistency with this secondary database. Third, from a national accounting framework, a sector specific selection and therefore underlying disaggregation would ignore the existence of auxiliary production of industries. For example, defining the pharmaceutical industry as a part of the health economy, would suggest including auxiliary production like veterinary medicine or possible financial activities some companies might undertake as a part of the health economy.

The product specific approach aims to separate the overall economy into a non-health related area, a core area and an extended area of health. One might wonder if this disaggregation into non-health related and health related areas has already taken place by selecting 930 out of 2,643 product groups of the overall economy. This is true to some extent, but ignores the fact that substantial shares of these product groups belong to health only to a minor extent in the sense defined within the concepts of the System of Health Accounts (OECD, Eurostat, WHO, 2011) or within the National Health Account. One example is plastic surgery, which is part of services within hospitals, but is not defined as being health-related. Another example is pharmaceuticals used for other purposes than to promote and preserve health or prevent from illness, e.g. anabolic agents.

Reasons for the differentiation between a core health area and an extended area of health derive from the definition of health within the System of Health Accounts. Each good and service, which is an integrated part of the health expenditure survey, is consistently quantified within the core area of health. Products related to health beyond this definition are included within the extended area of health of the National Health Account. Basically, each good and service, which is not considered within the core health area, but demonstrates health benefits as well as is consumed with a conscious personal decision for better health, is considered within the extended area of health. Moreover, the product in question has to have health promoting or preserving impacts or prevents from illness. Furthermore, goods and services, which play a decisive role for operations within the health economy, are quantified within this area as well. Examples are consultancy for health facilities, research and development, expenditures for education of health professionals, and construction investments.

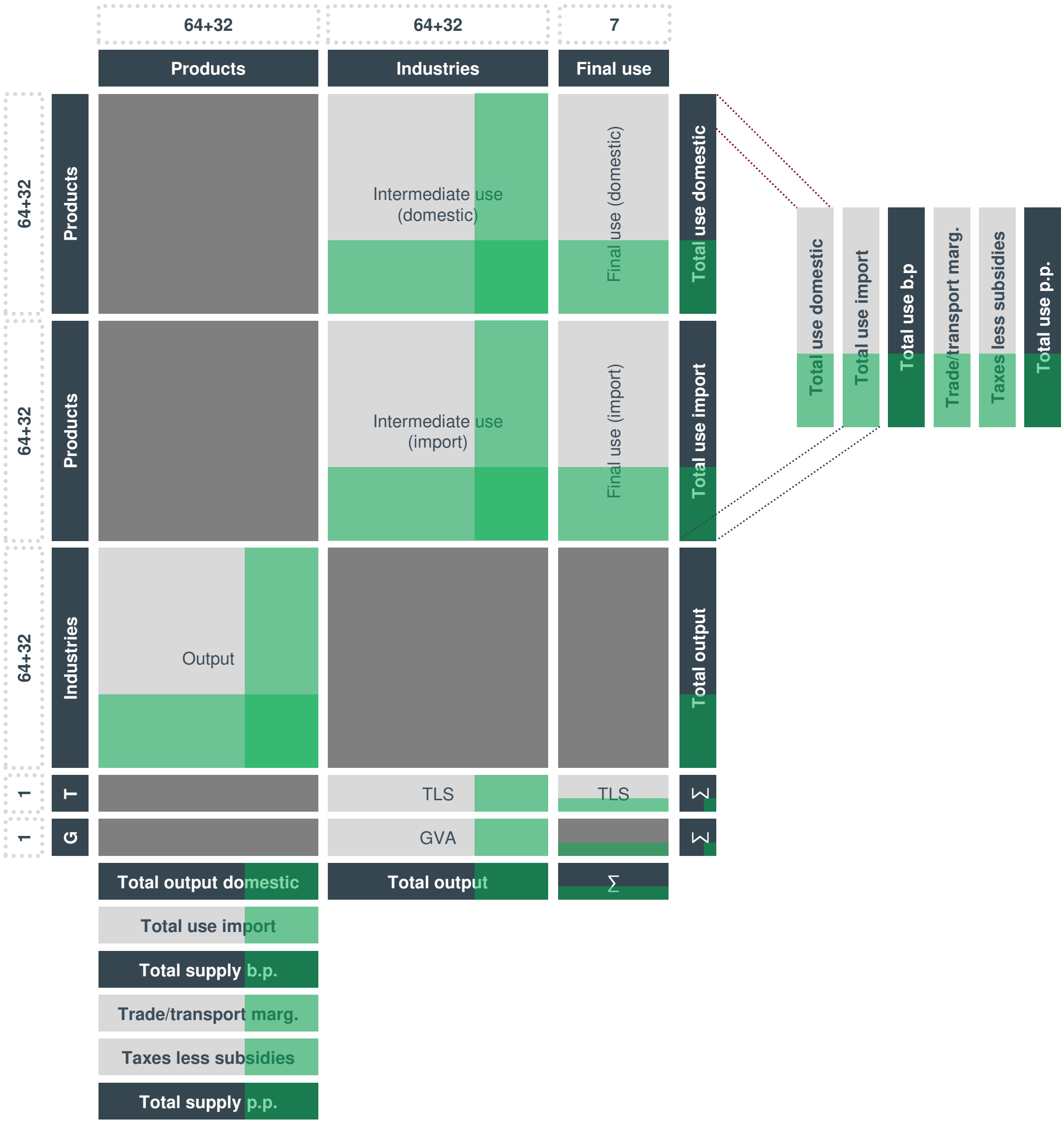
5 Compilation methodology

The motivation, main underlying databases and standards for the compilation of the National Health Account have been described in sections 3 and 4. The main contribution of this paper, the compilation of the National Health Account, is discussed within this section. Using derivations and tables, the author wants to facilitate the understanding of the concepts in order to discuss further developments within future contributions and to reveal strengths and weaknesses of the model. Subsections 5.1 and 5.2 describe the compilation of the health-specific supply and use tables at basic and purchaser's prices. Subsection 5.3 focuses on key indicators such as employment and components of gross value added in accordance to preceding calculations of health-specific supply and use tables. Subsection 5.4 comprises concepts of the compilation of input-output tables. While preceding steps describe the calculation for one year, section 5.5 targets the compilation of time series data.

5.1 Compilation of health-specific supply and use tables at basic prices

This section concentrates on the compilation of health-related supply and use tables at basic prices. Conversion into purchasers' prices is demonstrated within subsection 5.2, but is already part of the accounting framework pictured in Figure 3. It describes the situation at the end of subsection 5.2. In order to facilitate a better understanding, the goal setting is presented here already.

Figure 3: Conceptional setting of supply and use tables with emphasis on health



Source: Own illustration.

As already indicated, the challenge in compilation consists of matching data from national accounts with the health expenditure survey. Its purpose is to picture health-related products and respective producing entities within the overall economy without disrupting balancing conditions and concepts of national accounts. To achieve this goal, products as well as sectors are disaggregated first in order to obtain the three main areas, non-health related, core health area and extended area of health. Second, tables are aggregated in order to reconcile with full information of official aggregated data as details on non-health related areas are blanked within the special evaluation. Within the next step, health-specific categories are defined and aggregation is applied on the product side of the disaggregated health-specific tables in order to obtain tangible classifications. Furthermore, input structures are adjusted between the non-health area, the core area and the extended area of health, before data is aggregated sector-wise in accordance to the previously defined classifications on the product side. This complete procedure results in square supply and use tables, consisting of 64 non-health, 14 core health and 18 extended health related product and sector categories. Those steps in compilation just summarized are described in detail within the following subsections.

[Product specific disaggregation] For the compilation of supply and use tables with emphases on health in the overall economic setting, a product specific disaggregation of tables has to be conducted first. Based on supply and use tables for 930 product groups, 64 sectors and the components of final use, the disaggregation into the non-health related area, the core area and the extended area of health is compiled by applying weighting matrices on available data. Selecting 930 product groups from 2,643 may already seem sufficient in order to separate between non-health and health related areas. However, this is not the case due to the underlying definition of product groups within national accounts. A differentiation of the whole economy into overall 2,643 goods and services leaves certain specifications unconsidered in detail, which leads to mixed product groups within this classification. This reasoning is accompanied by splitting up existing information for 930 goods and services in order to analyze the health related part of specific product groups.

For the core area of health, respective weighting matrices are calculated with the intention of matching the health expenditure survey with the final use components of the use table of national accounts. In order to do so, household and government consumption is reconciled with private and public expenditure on health. In addition, intermediary use of sectors is adjusted with respect to product groups in consideration. Pharmaceutical products, for example, which are being used in agriculture, are not assumed to have any positive effect on human health and are weighted by the factor of zero as a consequence. Price concepts differ between the health expenditure survey and the use table at this stage of calculation. Consequently, these differences in prices, which consist in trade margins as well as taxes, have to be considered during the compilation of weighting matrices. Data on taxes are available at an aggregated level only, which makes a proportional allocation into the detailed level of data of the use table at basic prices necessary. Trade margins for wholesale and retail trade are available at a very detailed level, explicitly indicating the product group it refers to. Consequently, it becomes possible to consistently match health expenditure data at purchasers' prices and the use table at basic prices by considering the product specific information on trade margins and the proportionally allocated taxes when calculating weighting matrices.

Weighting factors for the supply table are compiled with main respect to balancing conditions in accordance with weighted use tables, as supply of domestically produced goods and services have to equal domestic use of respective products. In some cases however, e.g. services of research and development, the supply table serves as a starting point of compilation, as it reveals superior information on corresponding activities conducted by industries since ESA 2010.

In order to obtain the extended area of health, weighting matrices for supply and use tables are constructed similarly to the previously described procedure for the core health area, but with respect to various secondary data as the health expenditure survey does not cover this area of interest. Used secondary data refers to additional statistical material from the Federal Statistical Office, i.e. in the case of construction investments or expenditures on education of health specialists. This is different in the case of E-Health, health tourism, organic food or literature. In those cases, supplementing literature which does not originate from the statistical office is consulted or information on existing input structure is used in order to obtain a broad picture of the health economy. Calculated weighting factors for this area can be critically scrutinized, as well as the basic implementation and underlying definition of the extended area of health itself. This is the crucial reason to differentiate between a core area and an extended area of health, as the former refers to officially and internationally standardized data and the second one relies on additionally introduced classifications and databases. As the compilation methodology itself is the main concern of this paper however, the calculation of weighting matrices as well as the underlying secondary databases used are beyond the scope of this contribution and therefore not discussed in more detail.

The implementation of weighting factors on the supply and use tables is straightforward.

$$V_{ij} = V_{ij} * \left(1 - {K_{ij}}^{VC} - {K_{ij}}^{VE}\right) + V_{ij} * {K_{ij}}^{VC} + V_{ij} * {K_{ij}}^{VE}$$

$$U_{jl} = U_{jl} * \left(1 - {K_{jl}}^{UC} - {K_{jl}}^{UE}\right) + U_{ji} * {K_{jl}}^{UC} + U_{ji} * {K_{jl}}^{UE}$$

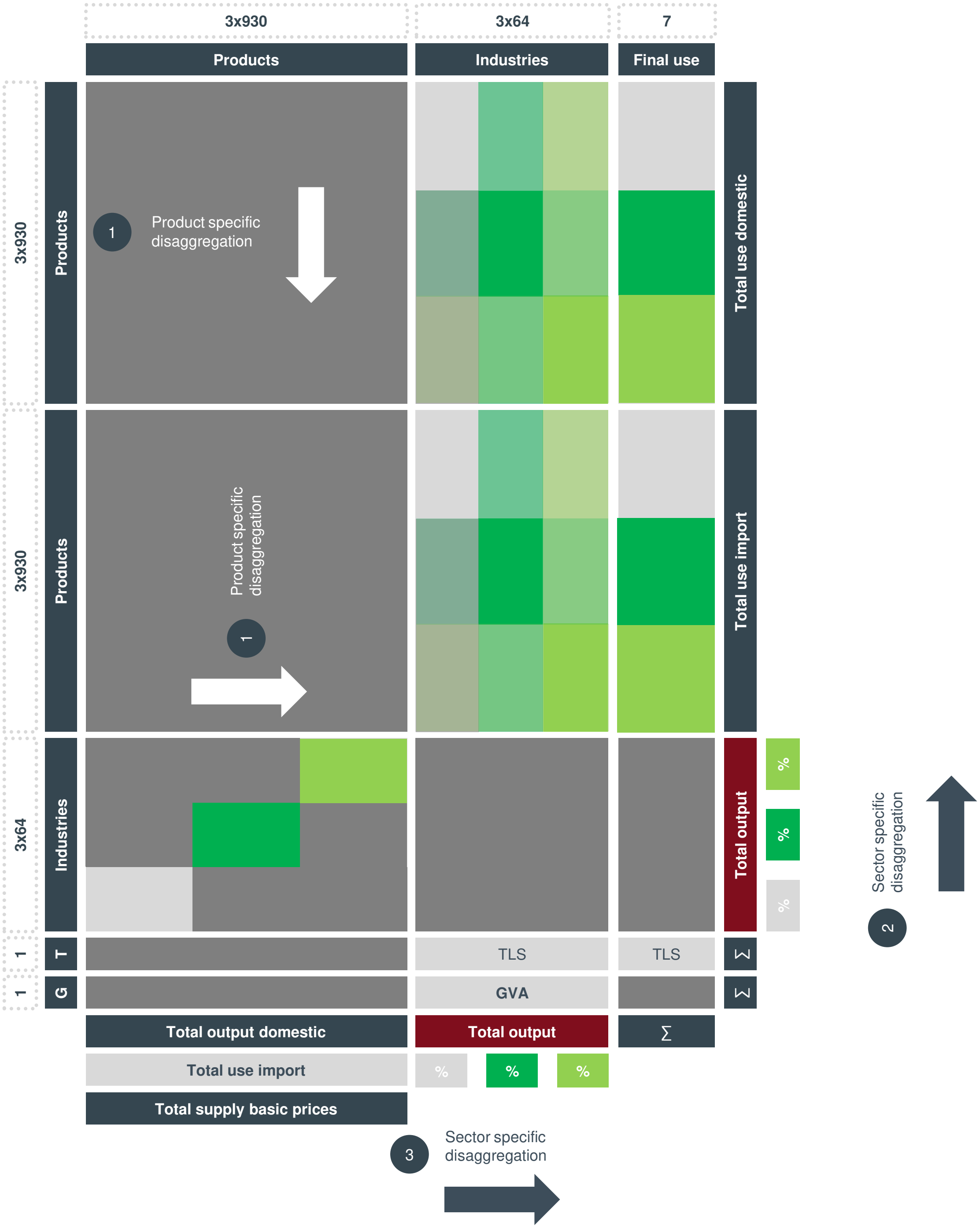
for ${K_{ij}}^{VC} + {K_{ij}}^{VE} \leq 1$ *and* ${K_{jl}}^{UC} + {K_{jl}}^{UE} \leq 1$ *and* ${K_{ij}}^{VC}, {K_{ij}}^{VC}, {K_{jl}}^{UC}, {K_{jl}}^{UE} > 0$

Where V denotes the supply table and U the use table. Consequently, V_{ij} and U_{jl} correspond to the elements of the supply and the use table. j indicates the number of product groups, which are the same for supply and use tables. i corresponds to the 64 sectors, whereas l indicates the number of sectors plus the seven components of final use within the use table. K indicates the weighting matrix and the letters V and U in superscript form denote the corresponding tables. Indexes refer to the respective elements. C and E indicate the core area and the extended area of health.

[Sector specific disaggregation] Product specific disaggregation of supply and use tables into the non-health related area, the core area and the extended area has been conducted in the previous subsection. This procedure is followed by the sector-specific disaggregation of tables in order to obtain industry-specific information on the categories of health areas, which have been defined product-wise beforehand. Industry-specific information include figures on intermediate use, gross value added, labor force or compensation of employees, which evolve from the production of goods and services by specific sectors. The supply table in its three-area shape acts as the starting point for the disaggregation of sectors. The underlying assumption implies that health specific goods and services are exclusively produced by health sectors, whereas non-health related goods and services are exclusively produced by non-health related sectors. This assumption does not follow realistic observations, as it neglects auxiliary production in between the areas of health- and non-health related sectors. In order to separate the health economy from the overall economy however, this segmentation has to be carried out similarly to the conceptual goal concerning input-output tables. This results in sectors being disaggregated with respect to the amount of non-health and health related goods and services they produce. Following this concept, the supply table is disaggregated sector-wise by modelling a block diagonal matrix with zeroes in off-diagonal areas. Sectors still carry out auxiliary production, but only within the area they belong to. In order to maintain sector specific input quota, sectoral disaggregation of use tables is straightforward. Input structures of the 64 sectors each are split up by using information on output share of the sector in consideration gathered from the block-diagonal shaped supply table.

Consequently, sector-wise disaggregation of use tables depends on the production structure of selected and weighted products in order to differentiate between the non-health related area, the core area and the extended area of health. The result of this procedure is supply and use tables, which consist of 3 x 930 product groups and 3 x 64 sectors. However, the relative input structure of each of the original 64 sectors is available threefold now, but differs in absolute terms in accordance to the output share, which evolves from the block-diagonal shaped supply table. A reconciliation of input-structure is conducted at a later point of compilation (see page 22 for more details). Figure 4 pictures the approach of disaggregating product groups and sectors in a supply-use framework. Numbers indicate the sequential steps of the procedure.

Figure 4: Disaggregation of supply and use table with respect to product groups and industries



Source: Own illustration.

The notation for sector specific disaggregation of use tables, based on the block diagonal matrix of supply table, is shown in the following:

$\tilde{v}_j{}'$is a vector of the dimension 64 x 3 X 1 and is defined by the three-fold sector-specific sums of the supply table V_0, which corresponds to the official supply table for the overall economy in its aggregated shape.

$$v_j = \sum_{i=1}^{88} v_{0_{ij}}$$

$$\text{and } \tilde{v}_j{}' = \left(v_j', v_j', v_j',\right)$$

$\hat{V}$ represents a block diagonal matrix of the dimension 930 x 3 X 64 x 3, with V^N, V^C and V^E indicating the non-health related area, the core health area and the extended area of the health economy.

$$\hat{V} = \begin{pmatrix} V^N & 0 & 0 \\ 0 & V^C & 0 \\ 0 & 0 & V^E \end{pmatrix}$$

$\hat{v}_j$ indicates the sector-wise sums of the block diagonal matrix:

$$\hat{v}_j = \sum_{i=1}^{3x\,930} \hat{v}_{ij}$$

Shares of the supply table adjusted to determinants of health on generic sectors' output of the overall economy are calculated as follows:

$$m_j = \frac{\hat{v}_j}{\tilde{v}_j} \; for \; j = 1, \dots, 3 \; x \; 64$$

The information on m is used to disaggregate the use table in the following, where

$$U = \begin{pmatrix} U^N \\ U^C \\ U^E \end{pmatrix}$$

denotes the use tables with emphases on health for both domestically produced and imported goods for the non-health, the core health and the extended area of the health economy. Next,

$$\tilde{U} = (U, U, U)$$

describes the use tables three-fold in the overall dimension of 930 x 3 X 64 x 3.

In order to obtain the sectors-wise disaggregation of the supply table, the following is calculated:

$$U_{ji} = \tilde{U}_{ji} * m_j + \tilde{U}_{j+64,i} * m_{j+64} + \tilde{U}_{j+64+64,i} * m_{j+64+64}$$

where $j = 1, \dots, 64$ and $i = 1, \dots, 3x930$ and $m_j + m_{j+64} + m_{j+64+64} = 1$

At the end of this procedure, supply and use tables have their most disaggregated dimensions they ever reach during the compilation of the National Health Account. The following steps focus on the aggregation of tables.

[Product specific aggregation] Available data on supply and use tables still refer to the selected data from the Federal Statistical Office only, which are chosen by its relevance with respect to health. It is necessary to include data on the overall economy at the earliest possible moment of time. This allows to analyze the health economy as an integrated part of the overall economic cycle. Next to specific data delivered by the Federal Statistical Office, supply and use tables for the overall economy are available in the dimension of 88 product groups and 64 sectors. In order to match use and supply tables from the current state of procedure with data on the overall economy, the former tables have to be aggregated into 88 product groups as well. In addition, data on official aggregates of the overall economy have to be disaggregated sector-wise with respect to the output shares calculated in the previous section. Subtracting the core and extended areas of use and supply tables in the dimension of 88 product groups each from official data leads to the non-health related area being filled up with data on the rest of the overall economy, which have been blanked within the special evaluation from the Federal Statistical Office. The supply and use tables now consist of 88 + 930 + 930 product groups and 3 x 64 sectors, as disaggregated data of core health and extended health area are attached to the non-health related area just calculated. At this point of compilation, the existing framework already pictures the overall economy with respect to health-related products and referring industries at the edges of the supply and use tables.

In order to transform tables into an input-output framework at a later stage, tables have to have square dimensions. Applying the sector specific amount of disaggregation on the product group level as well is one possibility to obtain this goal. This, however, would lead to a restriction of possible analyses at a later stage. Detailed information does not only enhance checks for the validity of calculations but also enables in-depth analyses for certain areas of the health economy.

Disaggregating sectors from 64 industries into the detailed level of product classifications is another possibility approach in order to obtain square tables. However, this does not display the intended level of analysis nor does it open up differing methodological approaches or alternative results from the following approach due to the distributive law.

Therefore, this third approach is pursued. Health-specific product groups are defined by fields of interest, which allow deeper analyses with respect to their extent of validity. The core health area, which is consistent with health expenditure with regard to defined areas as well as quantities of final consumption patterns, is categorized into 14 different categories. The extended area of health is more diverse in terms of composing structure, as a various number of different, but in monetary quantity and importance smaller, groups characterize this field. This leads to a differentiation of the extended area of health into 18 categories.

The detailed table of categories, which define the health economy in the core and the extended area of health in terms of products as well as industries, is shown in Table 1.

This classification of health categories follows a product specific definition. Consequently, the aggregation of the 930 goods and services within the core area and the extended area of the health economy each, results in a straightforward procedure.

Table 1: Definition of the health economy with respect to product groups and industries

Core area of health economy	**H1**	**Medication**	
		H11	Pharmaceuticals products
		H12	Chemical products
	H2	**Medical devices**	
		H21	Medical technology products
		H22	Wheelchairs
		H23	Digital medical technology products
	H3	**Retail trade services of the core area**	
		H31	Retail trade services for medication
		H32	Retail trade services for medical devices
	H4	**Health insurance**	
		H41	Social health insurance and public administration
		H42	Private health insurance
	H5	**Services of inpatient facilities**	
	H6	**Services of non-inpatient facilities**	
	H7	**Wholesale trade services of the core area**	
		H71	Wholesale trade services for medication
		H72	Wholesale trade services for medical devices
		H73	Commission trade services for the core area
Extended area of health economy	**E1**	**Products for self-contained health care**	
		E11	Products for personal hygiene, nutritional supplements
		E12	Organic food
		E13	Anti-allergenic clothing
		E14	Literature for health and medical science
		E15	Sports equipment
	E2	**Services for sports, wellness and tourism**	
		E21	Services for sports
		E22	Services for wellness and tourism
	E3	**Other services of the health economy**	
		E31	Consultancy for health care facilities
		E32	Other services of health care facilities
		E33	Advocacy and information services of the health economy
		E34	Trade services of the extended area
	E4	**Investment**	
		E41	Education of health professionals
		E42	Research and development of the health economy
		E43	Construction of health care facilities
		E44	Architectural services for the construction of health care facilities
	E5	**E-Health**	
		E51	Appliances of telecommunication technology and data processing for the health care sector
		E52	Services of information technology within the health care sector
		E53	Services of data processing within the health care sector

Source: Own illustration, based on Federal Ministry of Economic Affairs and Energy (2015)

[Reconciliation of input-structure] At this point of compilation, supply and use tables show the dimension of 88 non-health related goods and services and overall 32 product groups, which are related to health. On the sector side, the tables consist of 3 x 64 industries. Next, the input structure of use tables has to be reconciled before industries are aggregated with respect to defined health groups. The necessity for such adjustments arises from the assumptions taken within the sector-specific disaggregation of use tables in accordance to the shares the block diagonal supply table reflects. This implies identical input structures for the sectors in relative terms, independently from its appearance in the non-health, core health or extended area of health. In order to adjust the input structure of these sectors, a product sided approach is followed. Row by row is evaluated and checked for plausibility, whether the amount of the non-health-specific or health-specific product in concern is used within the input structure of the respective sector, non-health related or health related is legitimate. Following, a redistribution of shares with respect to the amount of one specific good or service is used within the sector of concern is conducted. Due to underlying assumptions taken during the disaggregation of sectors, each sector is available threefold – each for the non-health area, the core area and the extended area of the health economy.

The following figure shows the initial situation with shares of

$$r_{ji} + r_{j(i+64)} + r_{j(i+64+64)} = 1 \qquad \boldsymbol{for\ i = 1, \ldots, 64\ and\ r \leq 1}$$

And with

$$u_i = \sum_{j=1}^{88+32} u_{ji}$$

indicating the sector-specific sums and

$$u_j = \sum_{i=1}^{3\ x\ 64} u_{ji}$$

indicating the product-specific sums of the intermediate consumption within use tables.

Figure 5: Initial situation with identical relative input structures of disaggregated sectors

Source: Own illustration.

Based on this initial situation, shares are adjusted in consideration of secondary data or knowledge upon the specific intention assigned to the respective good or service. For r^* indicating the adjusted shares, the following applies, which assures consistency in row sums:

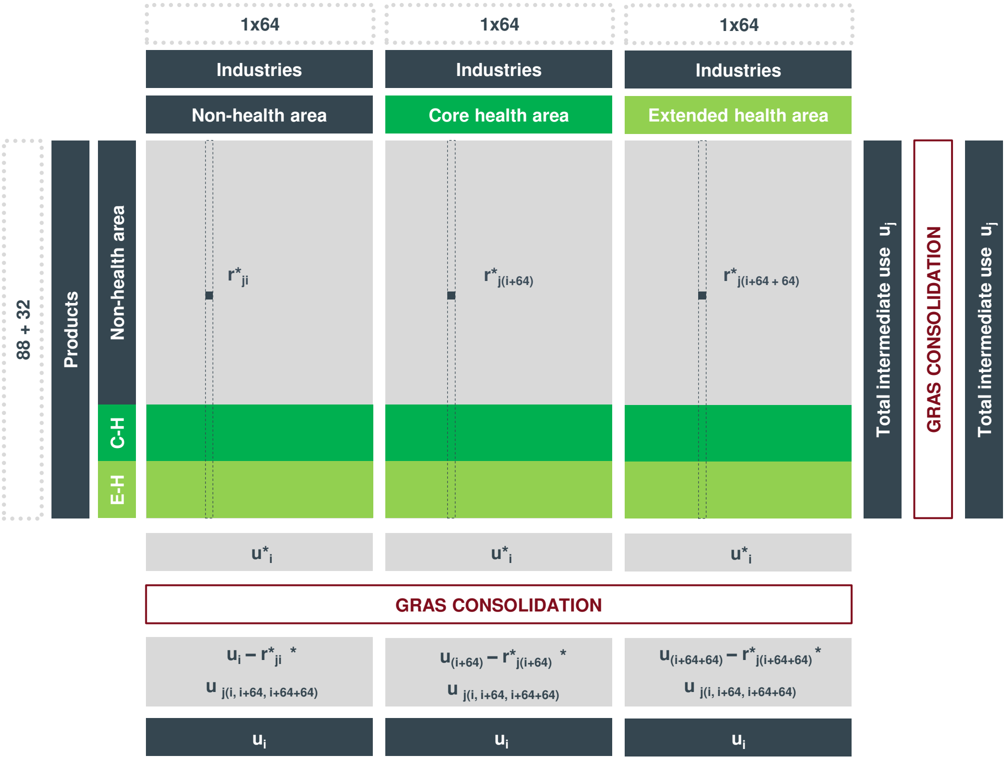
$$r^*_{ji} + r^*_{j(i+64)} + r^*_{j(i+64+64)} = 1$$

Column sums cannot be maintained by definition, as soon as adjusted shares are applied. This is an important restriction, as a change in the overall inputs of sectors has impacts on the amount of gross value added, as the supply table maintains a fixed output structure. A change in gross value added is not the intention of this procedure over here. Consequently, GRAS algorithm is used in order to obtain the initial value of column sums again (Temurshoev, U., Webb, C. & Yamano, N., 2011). GRAS algorithm is used in order to adjust matrices in accordance to given row and column sums. This approach can be applied on square as well as on rectangular matrices. In order to align the use table to the original column sums with respect to u^*_{ji}, indicating the adjusted absolute input structure, u^*_{ji} is subtracted from original column sums. This value corresponds to the column sum, which has to be obtained by making use of GRAS. As r_{ji} as well as r^*_{ji} sum up to 1, row sums do not change. GRAS procedure is applied upon each of the rows of the three related industries in concern, referring to the non-health area, the core health area and the extended health area, except for those product classifications with adjusted absolute input structure. This procedure can be applied to several row items from the three related sectors simultaneously within one step. The maximum number of adjustment steps is 64, if the input structure of each of the sector triplet is adjusted. The necessity of adjustments is particularly obvious in the case of relatively unspecific goods or services, defined of being health-related within a specific field of application only. For example, this applies to literature in the context of health, which is not available in this particular characteristic as one out of the 2,643 product groups shaping the overall economy. However, this particular literature is meant for the sector 'education of health professionals', which belongs to the extended area of health. As significant amounts of this literature are part of the input structure of education within the non-health area, input structure of the triplet sector 'education' is adjusted aiming at using inputs of health literature exclusively in the sector of education within the extended area of health.

There is also one special case. The sectors of health services and social services are combined and separated again in order to form inpatient and outpatient facilities. Accordingly, those two sectors are reconciled in their input structure and adjusted to information from secondary data such as cost data of hospitals (Destatis, 2015c), cost structure survey of doctors', dentists' and psychotherapists' practices (Destatis, 2013) and cost structure survey of facilities from health services (Destatis, 2012). Gross value added is therefore allowed to change in this specific field of interest, but only within the overall sum of the sectors in concern. This procedure is conducted in order to use a maximum of available secondary data for health care services, as this party of the health economy remains as a centerpiece of the health economy.

At the end of this procedure, the table's dimensions of 88 + 32 product groups and 3 x 64 sectors, plus components of final use for use tables, have not changed, nor do row and column sums. However, compared to the situation in advance of reconciling the input structure, the composition within the triplets of sectors is different now in its absolute and relative values.

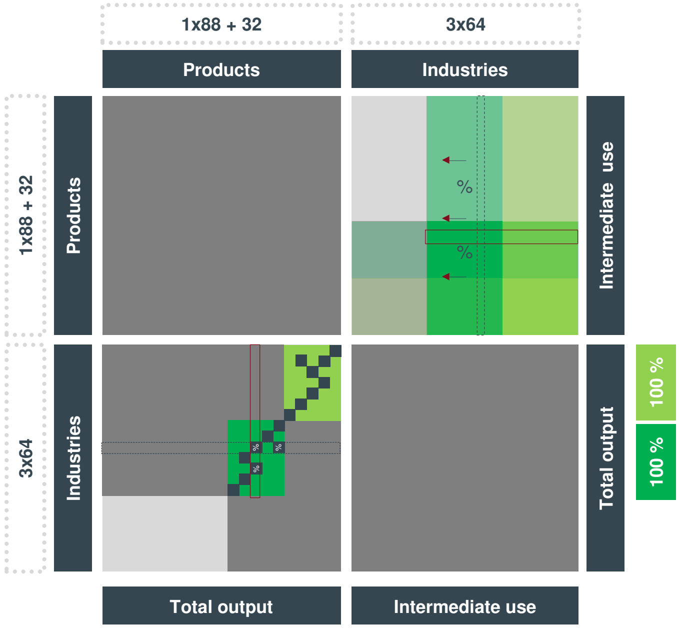
Figure 6: Adjustment of input structures and consolidation with GRAS algorithm



Source: Own illustration.

[Sector-specific aggregation] As a next step, sectors are aggregated in order to obtain square tables and to define sectors with respect to the health-specific categories previously defined on the product-side. Consequently, (health)sector-specific key indicators such as intermediate use, gross value added or employment for tangible categories, which are of main concern within the National Health Account, can be calculated. Leaving the specification of sectors unchanged at the recent state of procedure however, delivers results, which cannot be interpreted intuitively. Moreover, the evaluation of the quantity of people employed or gross-value added generated by producing categories of the health economy is of main concern. This already indicates an input-output framework, which is not directly intended, as auxiliary production is not explicitly excluded. However, this procedure would make it necessary to define sectors of main activity for the already created health categories. As those groups, defined by a functional approach, consist of different CPA (Classification of Products by Activity), an allocation is not straightforward. The assumption, which seems to be most appropriate within this approach is to define new sectors, which compromise of shares of different sectors, based on output of the health categories on output of the respective sectors. This approach creates sectors of main activity that allow the assignment of categories. Auxiliary production is excluded within that area, as directly assigning products to created sectors in the supply table results in a diagonal matrix. Figure 7 shows the initial situation and first steps in the compilation of health-specific sectors.

Figure 7: Initial situation of sectors before aggregation into health groups



Source: Own illustration.

The following equations explain the approach for aggregating sectors of the supply and use table, whereas the latter procedure is based on information gathered from the compilation of the former.

$$\ddot{V} = V_{ij} \qquad for\ i = 89, \dots, 120 \qquad \text{and} \qquad j = 65, \dots, 192$$

$$\ddot{U} = U_{jk} \qquad for\ j = 1, \dots, 120 \qquad \text{and} \qquad j = 65, \dots, 192$$

where $\ddot{V}$ and $\ddot{U}$ define specific areas of the supply and use tables. The corresponding defined supply table is restricted to health sectors and health product groups only, while the use tables are defined by the former restriction solely.

$\ddot{v}_j$ indicates the sector-specific sums of the selected area. Furthermore, $\bar{\bar{V}}$ is defined as a matrix containing information on shares of the restricted supply table on the calculated sector-specific sums.

$$\ddot{v}_j = \sum_{i=1}^{32} \ddot{v}_{ij}$$

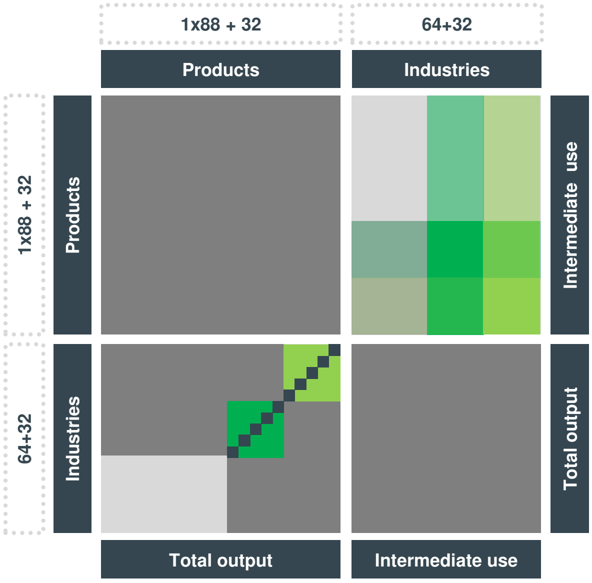
$$\bar{\bar{V}} = \frac{\ddot{v}_{i.}}{\ddot{v}_j}$$

For the supply table aggregating sectors is straight-forward, as simply the diagonal matrix of output values is calculated for the areas of health. For the aggregation of sectors within the use table, information gathered from the supply table is taken in order to obtain a consistent framework for supply and use. Focusing on the health sectors only leads to the following equations for these parts of supply and use tables, maintaining the structure of the non-health areas.

$$\dot{V} = \hat{\ddot{v}}_j$$

$$\dot{U} = \bar{\bar{V}} * \ \ddot{U}$$

Figure 8: Final situation of sector aggregation into health groups



Source: Own illustration.

At the end of this procedure, supply and use tables from domestic production as well as from imports are available in the dimension of 32 health categories each. No auxiliary production is available for health-specific sectors, as the assignment of product groups to a specific calculated composition of generic sectors involved in production is conducted by applying product technology.

In order to obtain a square structure of tables for input-output analysis, the existing 88 product groups from the non-health related area are aggregated consistently to the structure of sectors. Apart from conversion into purchasers' prices, the result from this section is shown in Figure 3 on page 15.

5.2 Compilation of health-specific supply and use tables at purchasers' prices

The compilation of health-specific supply and use tables at purchasers' is necessary in order to consistently match the health expenditure survey with final consumption patterns of the use table. The resulting tables allow straight-forward validation of calculations regarding the consistency with the health expenditure survey without adding any more information on taxes or trade margins to product-specific information. As the health expenditure survey provides detailed information on expenditures at purchasers' prices, weighting factors of tables at basic prices have already been calculated with respect to trade margins and taxes less subsidies. Consequently, no additional reconciliation of weighting matrices from sub-section 5.1 is necessary. Data availability supports considering trade margins from wholesale and retail trade in detail, which will be discussed first. The approach of calculating taxes less subsidies for health-specific supply and use tables is shown within the second step.

Detailed data on wholesale and retail trade are provided as part of the special evaluation on national accounts from the Federal Statistical Office, which serves as the main basis for the overall calculation of the National Health Account. As already mentioned, this data provides information on 2,643 product groups, which refer to the Classification of Products by Activity (CPA). This concept follows a certain categorization, classifying the 2,643 product groups at a 9-digits level and respective root categories. On overall, 254 of the 2,643 mentioned product categories refer to wholesale and retail trade. This specific data includes product-specific information of trade on a 3-digits level, which makes directly accounting of trade data to the referring goods possible. Making use of this data set and the weighting matrixes already calculated, tables for wholesale and retail trade each can be calculated. At this stage of procedure, no differentiation between imported and domestically produced products is conducted anymore. Weighting keys are again used equivalently to the basic price concept for the non-health, the core health and the extended health area. This way, product-specific information on wholesale and retail trade can be calculated for each product classification within the non-health, the core health and the extended area of health.

Taxes and subsidies are available on the aggregated 88 product group level only. Consequently, those two components are distributed over non-health, core health and extended area of health with respect to the elementwise shares of the product in consideration on the product in its generic appearance. Fortunately, use tables exist in the dimension of 3x88 and 3x64 at basic prices from an intermediate step already in order to reconcile with official data (see page 19 for more details). These specific use tables come into compilation over here again. By adding information on wholesale, retail trade and tables of taxes less subsidies to the use table at basic prices, reconciliation with official data at purchasers' prices can be conducted.

In the following steps, trade margins as well as taxes less subsidies are calculated for each specific product classifications of health in detail. Consequently trade margins and taxes less subsidies have been calculated in the dimension of 88 product groups to reconcile with official data, but in detail as well, in order to assign it to the defined categories of health. For this procedure, reconciled tables at the area of non-health products are attached to the health- specific areas of use tables from basic price calculation at the point of a dimension of 88+32 product groups and 3x64 industries. Trade margins and taxes less subsidies are added to the health-related areas. Remaining procedure is already familiar. The input-structure is adjusted, sectors are aggregated and the non-health product groups are aggregated into 64 areas.

The transition to purchasers' prices for the supply table is straight forward, as trade margins, respective counter-entries and taxes less subsidies are summed up by rows and are attached to the existing health-specific supply table at basic prices.

5.3 Employment, employees and composition of gross value added

Key indicators on employment and the composition of gross value added, which consists of compensation of employees, net taxes on production, consumption of fixed capital and net operating surplus, are of main interest for further analyses regarding the health economy in Germany.

As detailed information on respective indicators with main emphases on health are only available as secondary data for the area of health care services, the procedure for all areas apart from inpatient and outpatient health care is straightforward. From page 19 we know the calculation of shares on output of sector triplets. Those shares are applied on employment, employees and on the four components of gross value added. Within the next step, sector-aggregation is conducted according to page 24. This procedure ensures consistency with the relation of intermediate use and output of official national accounts.

Secondary data is used on inpatient and outpatient sectors within the core area of health. Employment refers to data from health personnel survey (Destatis, 2016c; Destatis, 2016d). Reconciliation of composition of gross value added is performed by including information from cost data of hospitals (Destatis, 2015c), cost structure survey of doctors', dentists' and psychotherapists' practices (Destatis, 2013) and cost structure survey of facilities from health services (Destatis, 2012).

However, reconciliation is obtained by making use of these indicators as guide values only, as conceptual differences appear, i.e. in the case of employment or employees compared to workforce from health personnel survey. These three terms are specific for the German labor market. Focusing on the term employment and employees, the difference consists in self-employed and unpaid family workers, which are considered within employment, next to employees. Workforce is to some extent equivalent to the term employees, whereas these two databases refer to different survey methodology. Employees from national accounts are calculated by referring to sample surveys, whereas workforce is evaluated from information on reported numbers on employment subject to social security contribution.

5.4 Calculation of Health-Input-Output Table (HIOT)

In order to analyze the health economy within an input-output framework, further compilation has to be conducted. The following refers to the concepts of supply and use tables from domestic production at basic prices, which is state of the art in order to analyze interrelations of the national economy. The applied methodology corresponds to the common way of compiling input-output tables. However, as it is interesting to focus on the compilation of input-output tables from manipulated supply and use tables, the approach of calculation is shown below by addressing challenges as well.

[Conceptual framework of Input-Output Tables] (Eurostat, 2008; Destatis, 2010; Miller & Blair, 2009; Statistik Austria, 2012) On the next few pages, the derivation of input-output tables from supply and use tables is demonstrated. In order to facilitate a better understanding, a two-step procedure is followed. First, the framework of an input-output table is explained in order to point out the necessary information that has to be gathered from the supply and use tables. Second, the perspective is changed. We proceed from the supply and use tables and derive the information we proved to be necessary in the first step. This way, we approach from two different perspectives and finally meet in the middle.

The square matrix Z is the core of an input-output table, which reflects intermediary use of production entities. Next to intermediary use, final use is the second way a product enters an economy. Final use refers to the vector y and consists of final consumption expenditure by households, non-profit institutions serving households, governments, gross capital formation and exports. Total output is equal to total use and is assigned by the vector x in the input-output framework as the sum of intermediary and final use in rows. By defining

$$z_i = \sum_{j=1}^{\dim(Z)[2]} z_{ij}$$

the input-output framework can be described as follows:

$$z_i + y_i = x_i$$

In columns, output x is calculated from intermediary use by sector plus gross value added by sector. Departing from this, the main centerpiece of an input-output table, the technology matrix A, can be calculated. It reflects the way intermediate consumption and production are related to each other as it reports the share of output from sector A on the overall production of sector B.

Consequently, the technology matrix A is defined as follows:

$$A = Z * \hat{x}^{-1}.$$

Transforming to $Z = A * \hat{x}$ leads to an alternative notation of the input-output framework:

$$A * x + y = x$$

Solving for x:

$$y = x - A * x$$

$$y = (I - A) * x$$

$$x = (I - A)^{-1} * y$$

Above shown formula represents the Leontief standard model.

$(I - A)^{-1}$ corresponds to the Leontief inverse matrix, which is also called the matrix of cumulative input-coefficients. It identifies shares of directly dependent inputs on output of the sector in consideration. Multiplier effects result from the direct and indirect use of intermediate products, to which both can be referred to interdependencies of production structures within an economy. The Leontief model refers to a geometric series, which enables to sum up all indirectly involved processes of production.

It becomes obvious that the technology matrix A acts as a juncture between the input-output table and the supply and use tables, as it includes information on intermediate consumption and on output. Within the next step, it is shown how Z differs from intermediate consumption within the use table and why it is legitimate to connect Z with the product specific output sector-wise.

[Derivation of the technology matrix A from the supply and use tables] In order to derive the technology matrix A from supply and use tables, specific assumptions have to be taken. The underlying approach relies on transforming industries including auxiliary production into producing entities according to their main activity. This way, input structures can be analyzed, which are necessary for the production of one specific good or service. This differs from the use table framework, as the latter refers to necessary inputs of whole industries in order to produce their overall product range, which refers to their main activity as well as auxiliary production. Consequently, the calculation of an input-output table follows the underlying concept of restructuring the supply table into a diagonal matrix with only zeroes in the off-diagonal areas. In order to relocate necessary inputs equivalently in the use table, certain assumptions have to be taken.

These assumptions relate to the production structure of auxiliary products. The two common concepts refer to product technology and industry technology. The former assumes an input structure of auxiliary goods and services, which is identical to the one being used by their industries of main activity. In other words: one good or service is always produced in accordance with the input structure of the industry it belongs to as a main activity, independently of the industry it is actually produced by. Industry technology, on the other hand, assumes goods and services from auxiliary production being manufactured in accordance with the identical input technology of their actual producing industry. In other words: An industry, even if it produces more than one good or service, produces each good or service from its range by utilizing the same input-structure.

In the following, product technology is in the center of discussion for several reasons. First of all, the concept of industry technology has already been discussed in sub-section 5.1 on page 24 to some extent. Second, several studies show that product technology is more likely to picture reality (Eurostat, 2008). Third, input-output tables from the Federal Statistical Office of Germany are calculated according to product technology. Therefore, in order to follow the recent state of the art and to maintain greatest possible consistencies with national tables, input-output tables are computed by making use of the product technology.

Following these arguments, the derivation of the technology matrix from supply and use table in accordance to product technology is shown below.

Departing from the supply table product mix matrix C can be calculated. It indicates the share of different outputs on overall output of the sector:

$$C = V' * \hat{q}^{-1}$$

$$where\ q = \sum_{i=1}^{\dim(V)[2]} v_{ij}$$

V' indicates the transposed supply table in the structure of products in rows and industries in columns. $\hat{q}$ corresponds to the diagonal matrix of outputs per industry. As supply of products is equal to use of products, the following applies:

$$C * \hat{q} = V'$$

$$C * q = x$$

Similar procedure is applied upon the use table in the following. It is important to note that U corresponds to the intermediate use matrix only, in contrast to the notation used in preceding sections. The matrix of input coefficients indicates the share of products used on total output of the sector:

$$B = U * \hat{q}^{-1}$$

From a mechanical point of view, the underlying concept consists in gathering information upon the input structure of a sector. Transforming leads to the following:

$$B * \hat{q} = U$$

In order to obtain overall output, final use has to be added to intermediary consumption:

$$B * q + y = x$$

q is now replaced by $q = C^{-1} * x$, which is obtained from the derivation of the product mix matrix. It follows:

$$B * C^{-1} * x + y = x$$

Solving for x leads to the following expression:

$$y = x - B * C^{-1} * x$$

$$x = (I - \mathrm{B} * \mathrm{C}^{-1})^{-1} * y$$

The structure itself should already be familiar, as it corresponds to the Leontief notation. It therefore defines the ratio of the input coefficient matrix on the product mix matrix. Consequently, the expression $(B * C^{-1})$ refers to the technology matrix A. Both, B and C can be replaced from expressions derived above within the next steps, since

$$A = B * C^{-1}$$

$$C = V' * \hat{q}^{-1}$$

$$A = B * \hat{q} * V'^{-1}$$

$$B = U * \hat{q}^{-1}$$

$$A = U * \hat{q}^{-1} * \hat{q} * V'^{-1}$$

As the elements in the middle results in an identity matrix, it follows:

$$A = U * V'^{-1}$$

Keeping the identity of $= Z * \hat{x}^{-1}$, with a similar expression of $Z = A * \hat{x}$ in mind, the following counts in order to obtain the intermediate use table of an input-output table in absolute terms:

$$Z = U * V'^{-1} * \hat{x}$$

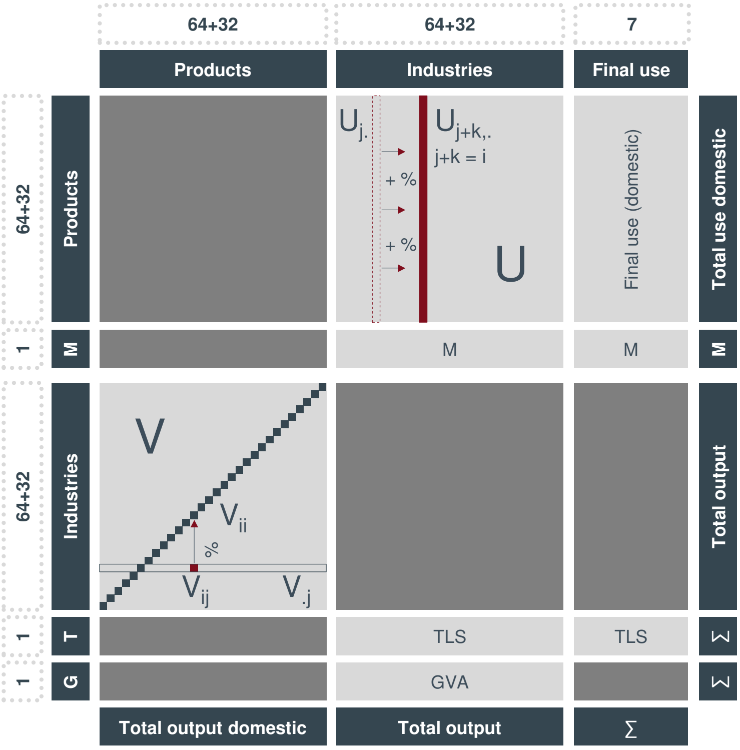
[Manual manipulation of negatives] (Ten Raa & Rueda-Cantuche, 2013; Statistics Austria, 2012) One main disadvantage of the product technology assumption arises from negative values, which result from applying this assumption for the calculation of input-output tables. Nevertheless, there are other reasons for negatives values as well, which have to be considered. One reason refers to an industry showing a diverse range of auxiliary production next to its main activity. Consequently, the evaluated input structure of this industry is strongly influenced by many different products. This results in a wide range of transfer bookings when compiling an input-output table on the one hand. On the other hand, this great variety of auxiliary produced goods and services reduces the possibility of evaluating a realistic input structure for the production of one specific product. Another reason for misspecifications within the input structure and negative values in the input-output table is further processing of manufactured products within one industry, which does not show up as intermediate use. For the situation that above named cases do not occur and product technology assumption itself is not the origin of negative values, the case, which will be discussed in detail in the following, negative values can result from errors in the calculation of the supply and use tables as well. These errors mostly occur due to an insufficient elevation of input-structures from secondary statistics.

As technology assumption itself delivers negative values for some cases due to its underlying conceptual framework, reasons as well as solutions are discussed in the following.

As demonstrated in the prior paragraph, the main intention of an input-output table is to evaluate input structures used in the production process. However, as use tables picture input structure of industries, which in reality – and pictured in the supply table – consist of auxiliary production next to their main activity as well, a transformation has to be conducted in order to evaluate the input structure with focus on specific goods and services. Therefore, auxiliary production from the supply table is shifted to its area of main activity, which results in a supply table of a diagonal shape. Inputs used for this auxiliary production have to be transferred to the industry of main activity as well in the use table consistently. The resulting challenge is to decide upon the specific input structure this auxiliary production shows. This is where assumptions on the technology structure become relevant.

The product technology assumption implies the input structure being used is assembled by the average of the main activity it will be transferred to. However, this implies that exactly this input structure has to be subtracted from the industry, where it actually had been produced. Negative values arise in situations of inputs shares of the main activity being subtracted from the input structure of the producing entity, but certain inputs do not exist in this structure or at least only to a lower amount. In those cases, it is highly plausible to reconsider the technology assumption for that specific auxiliary production. A prominent example is the production of wine, which is an auxiliary product of agriculture, but is assigned to beverage manufacturing as a main activity. Certain inputs of the beverage manufacturing cannot be subtracted from agriculture, as they are not in use over there. It is highly plausible in that case however, that wine is produced with the input structure of average agricultural products. This actually means a shift from the product technology to industry technology. The concept is illustrated in Figure 9:

Figure 9: Concept of manual manipulation of negative entries due to product technology



Source: Own illustration.

In the case the input-output table delivers negative entries, manually transferring of input structures is recommendable in the basic tables of supply and use. In order to do so, auxiliary production is shifted to its main activity within the supply table, to prevent the calculation mechanism to obtain certain input structures from the producing entity.

$$V_{ij} - V_{ij} = 0$$

$$V_{ii} + V_{ij} = V^*_{ii}$$

$$for\ V_{ij} \in V \qquad for\ i \neq j$$

V^*_{ii} indicates the adjusted value for V_{ii}. The share, which accounts to this auxiliary production is identical to the share, which has to be subtracted from the use table consistently in order to maintain the amount of gross value added. The full amount of inputs subtracted from the producing entity stays the same as a result, independently of using industry or product technology assumption. However, the composition of the input structure differs, as the average input structure of the producing entity instead of the industry of main activity is subtracted. This cannot result in negative values by definition, as the values subtracted are shares of the generic input structure of the respective industry.

$$v_j = \sum_{i=1}^{\dim(V)[1]} v_{ij}$$

$$U_{j.} - \frac{V_{ij}}{v_j} * U_{j.} = U^*_{j.}$$

$$U_{j+k,.} + \frac{V_{ij}}{v_j} * U_{j.} = U^*_{j+k,.}$$

$$for\ U_{j.} \in U \qquad for\ j + k = i$$

By making use of the demonstrated procedure, it is emphasized to resolve the highest and especially verifiable sources of error. It is sensible however to pay attention to the highest relative negative values, next to negative values in absolute terms. The procedure should be conducted until residual negative values can be assigned as noise.

5.5 Compilation of time series data

Previous sub-sections have concentrated on the compilation of supply, use and input-output tables for one year. However, as it is one main objective to compile tables for the period of years 2000 until 2015, the underlying special evaluation on supply and use tables from the Federal Statistical Office has to be projected for the periods before and after the point of time, to which the database actually refers. Due to statistical revisions this database on national accounts is only available for the years 2010 and 2011 according to the ESA 2010 standard. Consequently, the objective is to construct equivalent databases for several selected years. The second main underlying database, health expenditure survey, is available for a sufficient period of time, which implies that projecting this corresponding data is not necessary.

Applying the identical methodology to compile health-specific tables as it was described in the previous sections is argued with the highest possible validity of results. In order to enable this, the underlying procedure for the projection of supply and use tables is conducted by making use of the SUT-RAS Algorithm (Temurshoev & Timmer, 2011). The author of this paper is however aware of the fact that not too much emphases should be laid on the interpretation of input structures and underlying possible, but not conducted, input-output analyses in a time perspective. It is however possible to match data on health expenditures with projected tables of national accounts, which enables quantifying the contribution of the health economy on the overall economy in terms of the main key indicators.

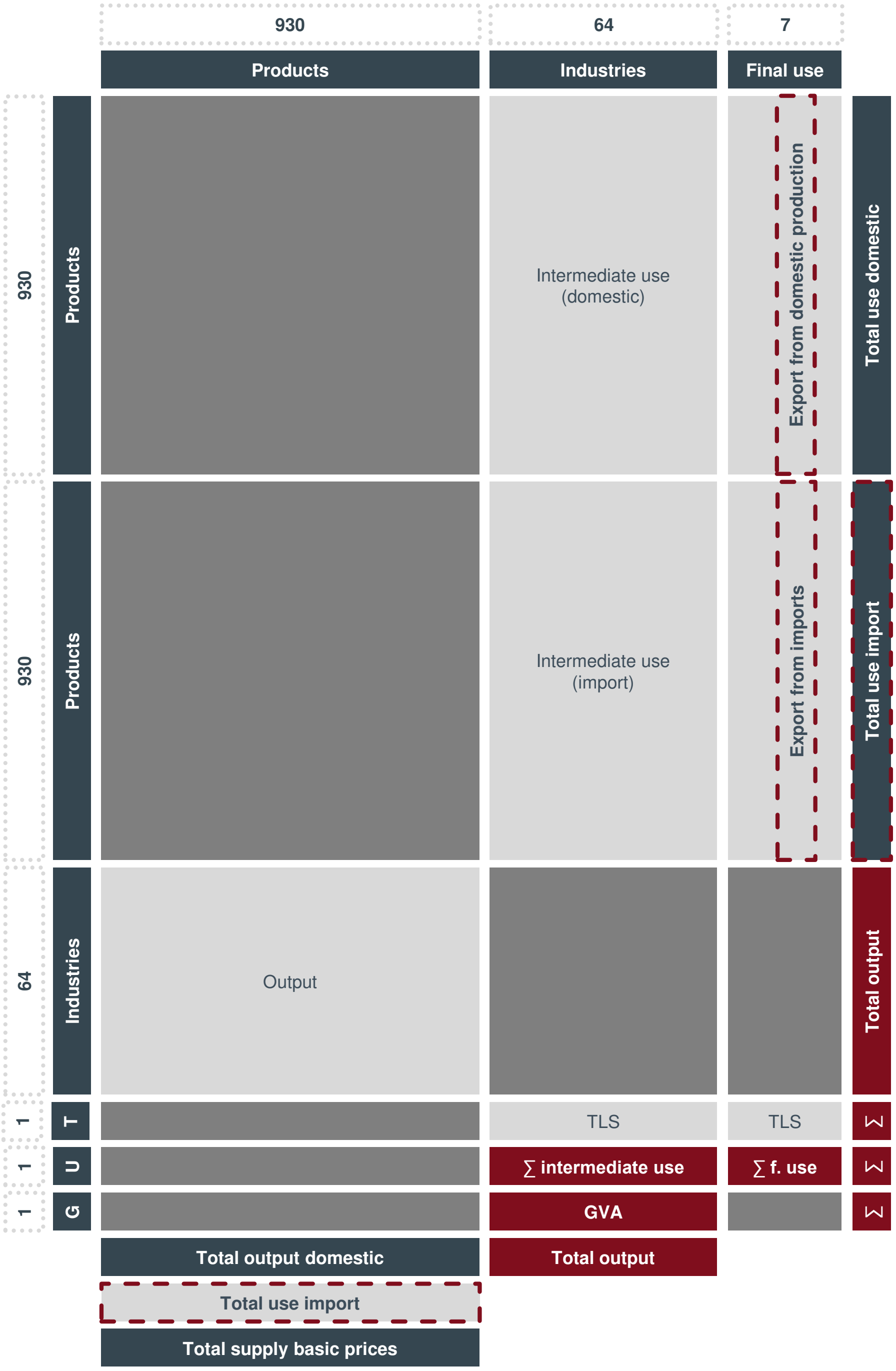
[Underlying database] In order to update and project available supply and use tables in accordance to SUT-RAS, information on industries as well as on components of final use need to be available. Subject-matter series 18, series 1.4 provides information on output, intermediary use in purchasers' prices and gross value added for the 64 sectors of the economy for several years (Destatis, 2015b). Moreover, data on the components of final use (final consumption expenditure by households, non-profit institutions serving household and governments, as well as gross capital formation and exports) are available. Use tables are going to be updated for domestic production and imports separately, which leads to making use of data on the overall sum of imports from the corresponding subject-matter series as well. The concept of basic prices wants to be maintained for the projected supply and use tables on 930 product categories and 64 sectors. This approach is followed for two reasons. First, projecting data aims to produce consistent tables to the underlying database on 2010 and 2011. Reasons evolve from providing a consistent procedure of compiling a satellite account with respect to the health economy. Second, the underlying database on the 930 goods and services and 64 sectors is only available at basic prices. Consequently, switching to purchasers' prices implies the underlying detailed information on supply and use tables to become rather restricted, as supply and use tables for the overall economy are only available in an aggregated dimension of 88 X 64. In order to conduct the SUT-RAS algorithm based on available data on the use of sectors referring to purchasers' prices, additional data on the overall sum of taxes less subsidies are necessary and obtained from the same subject-matter series. Concluding, the provided information is already sufficient to conduct the SUT-RAS algorithm on supply and use tables for domestically produced and imported data.

However, one essential step has to be conducted in advance to updating of supply and use tables. Available data on 930 product groups and 64 sectors do not contain full information on the overall economy, as these refer to the health economy only. As aggregated data is available for supply and use tables, which reflect the overall economy, residual data is calculated and included within the very same tables. The SUT-RAS procedure can be conducted at this point. Figure 10 pictures the dimension of available basic data again in accordance to Figure 2, but indicates necessary and available data for the projection in the red shaded areas.

In order to achieve the highest possible validity of projected tables, additional data is used to improve quality of projected tables. Product specific information on exports and imports is provided for 88 product categories within subject-matter series 18, series 1.4. Consequently, this information is used within an adjusted version of SUT-RAS as suggested in Temurshoev & Timmer (2011). In order to do so, however, this information has to be disaggregated into the 930 available product groups and the rest of the economy by making use of the respective shares according to the original table. Moreover, exports have to be separated with respect to their place of origin, domestic or import. The red dotted line within Figure 10 reflects this additionally used data. All basic and additional requirements for the SUT-RAS procedure are now fulfilled. The compilation mechanism of the SUT-RAS algorithm with respect to product specific information on exports and imports is presented in the following paragraphs.

[Conceptual framework of SUT-RAS] The underlying idea of SUT-RAS is to project supply and use tables consistently within one algorithm. The term 'consistently' refers to equilibrium condition of supply and use in goods and services. For this procedure, only sector specific data is explicitly necessary. This is one major advantage of this approach, as product specific information on national accounts is hardly available in general.

Figure 10: Basic data for SUT-RAS algorithm



Source: Own illustration.

The calculation procedure of the SUT-RAS algorithm refers to an iterative approach of compiling four different, but depending on each other, adjusting vectors. The vectors r_d and r_m intend to adjust product specific information on domestically produced and imported products, whereas s_u and r_v focus on the sector side of adjustment. In more detail, r_d is applied on use and supply tables of domestically produced goods and services and assures product specific balancing of supply and use table. The vector r_m obtains consistency with given product specific data on imports. On the sector side, s_u assures consistency of domestically produced and imported products in order to sum up to given sector specific data on intermediary use. Main purpose of r_v is to adjust the supply table to given output data of sectors.

N_0^v and P_0^v denote the generic supply table, split up into negative and positive values. The same applies for use tables of domestic production N_0^d and P_0^d and for use tables of imported products N_0^m and P_0^d. The vector m_0 indicates product specific generic values for imports.

Target values on output by sector are denoted by $\bar{x}$, while $\bar{u}$ refers to intermediary and final use. The vector $(-f)$ indicates product-specific information on exports from domestic production. Considering this variable within the compilation procedure implies the necessity of exports to be subtracted from original tables as well as from $\bar{u}$. As $\overline{mt}$ refers to product-specific target values for imports, respective exports from imports have to be subtracted from target values consistently.

$$r_d = 0.5 * \widehat{p_d}^{-1}(f + \sqrt{f \circ f + 4 * p_d \circ n_d})$$

$$where\ p_d = P_0^d s_u + N_0^{v\prime} \hat{r}_v^{-1} i \qquad \text{and} \qquad n_d = N_0^d \widehat{s_u}^{-1} i + P_0^{v\prime} r_v$$

$$r_m = \sqrt{\widehat{P_0^m s_u}^{-1} (\widehat{N_0^m \hat{s}_u}^{-1} \imath + r m_0)}$$

$$where\ r = \overline{mt}/(m'_0 \hat{r}_m^{-1} i)$$

$$s_u = 0.5 * \widehat{p_s}^{-1}(\bar{u} + \sqrt{\bar{u} \circ \bar{u} + 4 * p_s \circ n_s})$$

$$where\ p_s = P_0^{d\prime} r_d + P_0^{m\prime} r_m \qquad \text{and} \qquad n_s = N_0^{d\prime} \widehat{r_d}^{-1} i + N_0^{m\prime} r_m{}^{-1} i$$

$$r_v = 0.5 * \widehat{P_0^v \hat{r}_d^{-1} \imath}^{-1} \left(\bar{x} + \sqrt{\bar{x} \circ \bar{x} + 4 * (P_0^v \hat{r}_d^{-1} i) \circ (N_0^v r_d)} \right)$$

As soon as r_d and r_m even out on a specific level of convergence, which is chosen beforehand, projected supply and use tables are obtained by performing the following procedure:

$$\bar{V} = \hat{r}_v P_0^v \hat{r}_d{}^{-1} - \hat{r}_v^{-1} N_0^v \widehat{r_d}$$

$$\bar{U}_d = \hat{r}_d P_0^d \hat{s}_u - \hat{r}_d^{-1} N_0^d \widehat{s_u}^{-1}$$

$$\bar{U}_m = \hat{r}_m P_0^m \hat{s}_u - \hat{r}_m^{-1} N_0^m \widehat{s_u}^{-1}$$

In order to obtain consistent tables in accordance with the special evaluation on national accounts provided by the Federal Statistical office, reconciliation with given data on product-specific exports and imports has to be conducted. At the end of this procedure supply and use tables are available at basic prices for domestic production and imports each in the dimension of 930 products and 64 sectors plus final consumption patterns. In addition, residual data on non-health areas have been included in the overall approach of projection. This provides the possibility to calculate aggregated tables for the overall economy in the dimension of 88 product groups and 64 industries plus final use components in order to obtain a consistent data set compared to the generic data provided by the Federal Statistical Office.

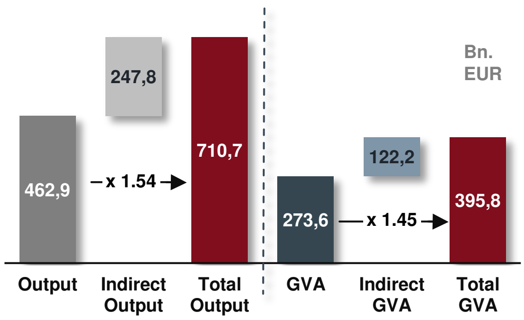
6 Application of the National Health Account

Previous sections have discussed the main underlying concepts and methodological approaches applied to compile a National Health Account. The final step – calculating an input-output table from health-specific supply and use tables – has been described in the preceding sub-section. Next to the direct effects the health economy contributes to the overall economy, input-output analyses allow a deeper evaluation of the sector's effects on the overall economy. The Economic Footprint of the Health Economy quantifies existing interrelations between this sector and the overall German economy in addition to the key indicators presented in section 2. The analyses are based on a static input-output model, defined by given final demand. The most recent and valid database to perform the underlying analysis is the health input-output table for 2011, as the special evaluation on supply and use tables provided by the Federal Statistical Office refers to the years 2010 and 2011.

Results show that the health economy generated output of 462.9 bn. Euro in 2011. In addition, indirect output effects amount to another 247.8 bn. Euro within the overall economy. This sums up to an overall output of 710.7 bn. Euro. Put differently, each Euro of output generated within the health economy is responsible for 0.54 Euro of indirect output. As gross value added is highly related to GDP, the analysis of related effects gives insights into the overall significance of the sector for economic growth. Based on 273.6 Bn. Euro of gross value added generated by the health economy in 2011, indirect effects result in 122.2 Bn. Euro. Put differently, one Euro of gross value added generated by the health economy results in 0.45 Euros within the overall economy.

The Economic Footprint of the Health Economy pictures a comprehensive picture of the sector within the overall economy. Accordingly, the health economy generates an important amount of gross value added, involves a high share of labor market force, and records a rising contribution on international trade. Moreover, its interrelations with overall economy show important dynamics for the development of the overall German economy.

Figure 11: Direct and indirect spill-over effects of the health economy



Source: Own illustration, based on Federal Ministry of Economic Affairs and Energy (2016.), Schwärzler & Legler (2016)

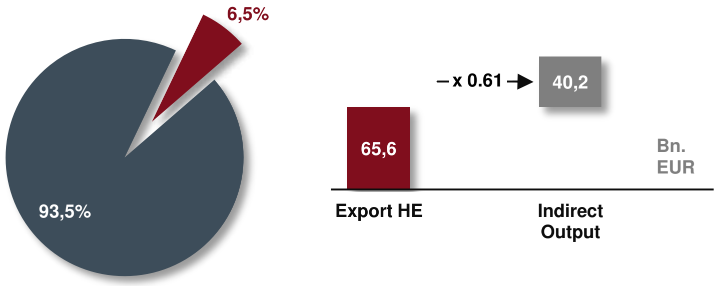
Next to the above shown basic analysis on output effects of the health economy, the sector's cross-sectoral characteristic enables a various number of possible further applications of the National Health Account. Consequently, implications differ, depending on which area of the health economy the application focusses on. Analyses with respect to the overall health economy, however, can give a first impression of the sector itself in terms of its contribution to growth, labor market participation and international trade in the way it has been described in the previous section. Moreover, it pictures the sector within a broad perspective, which leads to analyses having the ability to point out gaps in research that might be interesting to consider in detail.

In the following, one selected analysis is demonstrated, which follows the previous approach. It evaluates the amount the overall health economy contributes to German exports. Some key figures have already been presented in the preceding section. In 2015, the German health economy participates on overall exports with a share of 7.4 percent. As input-output analysis is conducted for the year 2011 however, which corresponds to the most recent and valid database, the respective share for that year is 7.1 percent or 84.2 Bn. Euro. This indicator refers to exports from the overall sum of domestic production and imports. In order to evaluate the impact on domestic production solely, referencing to the respective use table only is necessary. Accordingly, exports of the health economy from domestic production amount to 65.6 Bn. Euro or 6.5 percent on overall German exports in 2011. This already indicates one important characteristic of the health economy. An above average amount of exports results from imported goods in the case of medical technology and pharmaceutical products. Since ESA 2010, trade with goods for further processing are excluded from international trade statistics. Accordingly, the reason for the above average amount of re-exports cannot be attributed to these mechanisms. In the case of pharmaceutical products, price setting of different health systems in respective countries can be a main contributor for a high amount of re-exports and re-imports (Scholz, Schulte, Weißenfeldt, 2015). For example, German pharmacies have to sell at least 5 percent of their entire turnover from re-imports. The underlying incentive is to save money within the health system (Prognos, 2014). Accordingly, pharmaceuticals are produced within Germany and exported to a country with lower prices regarding the product in concern. Pharmacies re-importing the respective medicine again and selling it to patients, circumvent price settings of the domestic market and save money. This refers to re-imports from a German perspective. However, other countries conduct re-imports as well, even though to a lower amount, which causes in turn re-exports for Germany. In addition, wholesale discount contributes to re-export activities of pharmaceuticals and medical technology products. The latter has a high significance for re-exports of the health economy. It amounts to more than 50 percent of overall re-exports of the German health economy, but only 26.4 percent of domestically produced goods and services.

The preceding short digression already indicates areas for further research with respect to the health economy. The concept of re-exports and re-imports does not lie in the focus of this application however, but seems worth mentioning in order to facilitate a better understanding at this point. However, the following concentrates on exports with respect to domestic production solely. Consequently, indirect effects on the economy can be calculated by conducting input-output analysis, based on the 65.6 Bn. Euro or 6.5 percent share on overall domestically produced exports, which are contributable to the health economy. The underlying methodology refers to a static input-output model. The indirect output effects from intermediate use amount to 40.2 Bn. Euro. This corresponds to a multiplier effect of 1.61, which is shown in Figure 12.

Equivalently, output effects can be calculated for overall exports, irrespective of export activities undertaken by the health economy, which amounts to 93.5 percent or 939.0 Bn. Euros. Those exports generate indirect effects to an overall amount of 721.4 Bn. Euros. This corresponds to a multiplier of 1.76. Apparently, this multiplier is higher than the one calculated within the preceding analysis with respect to exports from the health economy. First, this could reflect a higher propensity of value added within the health economy and its preceding industries, as less intermediate use is necessary to produce the same amount of output. The health economy's share of gross value added on the overall economy amounts to 11.2 percent compared to the share on output of 9.0 percent. This at least supports this hypothesis to some point. Secondly, results could indicate a higher amount of imports, which are involved in the production process of the health economy and its respective suppliers. This hypothesis is not supported by making use of the import quota on overall intermediate use of the health economy, which amounts to 18.0 percent in comparison to the share of 22.1 percent calculated for the overall economy. Again, this is just an indicator and does not include the specific dynamics of supplier relationships in the case of import dependency. In order to analyze this in detail, input-output tables on imported products have to be constructed.

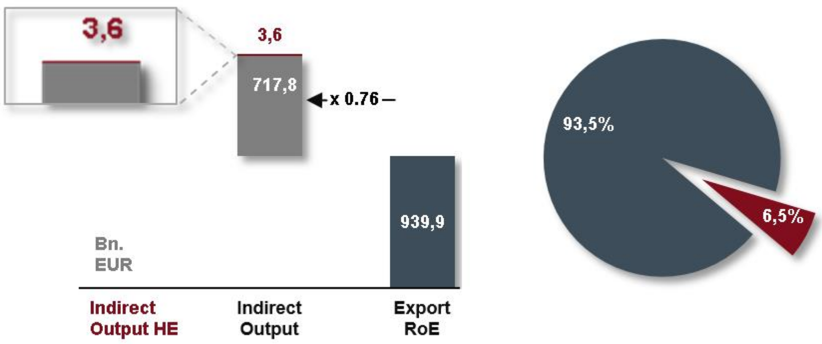
Figure 12: Export effects of the health economy on domestic production, 2011



Source: Own illustration and calculation, based on Federal Ministry of Economic Affairs and Energy (2016.)

Next to a simple comparison of multiplier effects, which already points out the specific characteristics of the health economy in more detail, looking at the sector's contribution to indirect output effects from exports of the rest of the economy leads to interesting results. Based on the already mentioned indirect output effects of 721.4 Bn. Euros, the health economy contributes 3.6 Bn. Euros.

Figure 13: Indirect output effects of exports on health economy, 2011



Source: Own illustration and calculation, based on Federal Ministry of Economic Affairs and Energy (2016.)

In order to enable an approximate estimation of the relevance of this finding, reference numbers are described in the following. The mentioned 3.6 Bn. Euros amount to a 0.8 percent share on overall indirect output, which is far below the share on overall direct output, which is 9.0 percent. The health economy mainly consists of services, which are not necessarily associated with exports. Consequently, calculating the output share of goods and services only, which show export activities, is one approach to consider this characteristic within comparisons. However, the output share of the health economy on the overall economy, both with respect to exporting activities only, amounts to 3.9 percent. By comparing this indicator with the 9.0 percentage share on direct output, it can be concluded that the health economy does not contribute to export activities of the rest of the economy in any particular extent.

Even if the sector itself participates on international trade with a share of 6.5 percent, it is of minor relevance for exporting activities of the rest of the economy. This is reasoned with the circumstance of intermediate use not being recorded as intermediate use in its entire impact, but only with respect to occupational health services. Further research would suggest taking into account health services and products as intermediate consumption in order to maintain a healthy workforce and enable production processes.

7 Concluding remarks

The present contribution aims at describing the methodology of compiling the National Health Account for Germany. The latter represents a satellite system within national accounts, which achieves the goal of matching macroeconomic data with the health expenditure survey in a consistent way, without disrupting the overall economic system. Moreover, it refers to international standards in compiling satellite systems with respect to health and includes present standards of statistical accounting in terms of NACE 2008 and ESA 2010. The starting point of supply and use tables can be seen as an important improvement regarding the quality of the model compared to calculations performed at earlier points in time. The latter were based on special evaluations of input-output tables provided by the Federal Statistical Office. Consequently, the recent methodological approach and data base allow to start at a more genuine point of the macroeconomic framework, which is unaffected by technology assumptions. Moreover, the compilation of the health input-output table based on health-specific supply and use tables avoids the necessity of disaggregating sectors of an input-output table, compared to studies conducted at earlier point in time. Making use of the SUT-RAS algorithm in order to create time series data can be seen as another main improvement. Available data on the overall national economy satisfy all conditions this algorithm requires. Accordingly, no additional assumptions have to be taken in order to compile supply and use tables for the overall economy for 2000 until 2015. This enables consistently reconciling it with official data on health expenditures.

Consequently, analyses based on key indicators of the health economy for the years 2000 until 2015 can be conducted. Moreover, the health input-output table enables analyses concerning the interconnectedness of this inter-sectoral industry with the overall economy and in-depth analyses departing from changes within the economy.

Based on the present state of methodology, further research should be conducted in order to carry out advanced analyses of particular fields of health services such as hospitals, nursing and practicing doctors among others. This, however, still needs an even more precise matching between health expenditure survey and national accounts. The present calculation framework and the close cooperation with both the national accounts division and the health expenditure survey division of the Federal Statistical Office reveal inconsistencies between the two main data bases when more detailed aspects of the health economy are considered. Given that reported inconsistencies are going to be considered within further revisions of national accounts and the health expenditure survey, improving the quality of data of the Federal Statistical Office could be seen as another achievement the compilation of the National Health Account contributes to scientific research.

The application in the case of exports points out the systematic neglect of a holistic approach on the health economy within national accounts. Further research is needed in order to reflect the sector's contribution to a healthy and productive workforce, which enables production and subsequent export. Consequently, it would become possible to quantify the health economy as a crucial factor not only in terms of its direct economic impact, but also in terms of a major contributor to maintaining the overall economic dynamics. However, one has to be aware of the fact that this would lead to a partial shift of analyses, as health gets a higher attention compared to other sectors, which also contribute to the overall economic performance beyond available tangible economic parameters.

Moreover, analyses regarding the health economy reveal another specific characteristic. Detailed data on the health economy show a high heterogeneity among the different components of the sector in terms of the respective contribution to gross value added, labor market participation or international trade. Embedding a regional aspect within the calculations adds additional facets to the analyses. In the special case of Germany, which has been divided for several centuries, a high heterogeneity of economic performance and respective dynamics among federal states is recognizable. As demand and supply of health services and products are influenced by regional characteristics and embedded interrelationships within and between federal states, a Multiregional Health Account for Germany could bring up additional insights into the dynamics within this sector. Demand for services and goods of the health economy, which is induced by health status and demographic constitution is opposed by health supply and accordingly economic performance. In cases of demand and supply of products in question are differing in place, output and consequently taxes are not generated within the region in need for investments in infrastructure of health facilities. A Multiregional Health Account could reveal this imbalance and establish a monetary transfer system in order to compile a foundation for the same level of quality of infrastructure within health facilities in each of the 16 federal states of Germany.

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