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Application of the Multiregional Health Account for Germany

A financial equalization scheme to cope with lagging investments in German hospitals

Marion Cornelia Schwärzler¹, Tobias Kronenberg²

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Abstract: Lagging investments in German hospitals have become a serious challenge in recent decades. The responsibility for investment financing lies with the German federal states, the “*Bundesländer*”, due to the dualistic financing framework applying for German hospitals. Yet, hospital investments experience a field of tension between the availability of financial resources and necessary investments. A possible solution could be a financial equalization scheme for the health economy incorporating an earmarked fund for hospital investments. The rationale for such a system is that health economies of federal states do not represent single closed systems, but depend on interregional trade flows to supply patient treatment. The respective calculations in this paper are based on our recently compiled Multiregional Health Account for Germany. The model represents a satellite account of the health economy based on national accounts. Consequently, we are able to calculate spillover effects from patient treatment in federal states by conducting input-output analysis. Based on the results, we derive a sketch of a financial equalization scheme in order to ensure needs-based hospital infrastructure in German federal states.

JEL Classification: C67, H51, H75, I11, R15

Key words: Health economy, hospital investments, financial equalization scheme, input-output analysis, multiregional, federal states, Germany

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1 Introduction

For a long time, health care supply has been perceived as an economic burden (Hilbert et. al., 2002). From the mid-1990s on, however, a paradigm shift shaped its perception in Germany (Goldschmidt & Hilbert, 2009). Health care supply was no longer seen as a cost factor exclusively, but also as an important contributor to economic growth, employment and international trade. In addition, a definition of the health economy was established, according to which it comprises both health care services and products, 'which serve for prevention as well as for the provision of health and for rehabilitation.' (BioCon Valley, 2005).

This additional perspective was supported by activities of the Federal Ministry for Economic Affairs and Energy from 2010 on (Henke et al., 2010; Ostwald et al., 2014; BMWi, 2015; Schneider, et al., 2016; BMWi, 2016; BMWi, 2017a). These activities concentrated on developing and updating the National Health Account (NHA) for Germany, which quantifies the economic contribution of the health economy to the German economy in total. The underlying methodology is based on the macroeconomic framework of national accounts, incorporates official data on health expenditures and follows international standards (Schwärzler & Kronenberg, 2016).

The NHA reveals a high heterogeneity among single categories of the health economy in terms of their contribution to gross value added (GVA), employment and trade. In addition, first attempts to establish a similar database on the federal state level stressed different characteristics among regions of Germany (Ostwald et al., 2015a; Ostwald et al., 2015b; Ostwald et al. 2014, 2015c; Ostwald & Schwärzler, 2015; Ranscht, 2009; AG GGRdL, 2016; Schneider, 2013, 2014; BASYS & GÖZ, 2012). In order to establish a data base, which incorporates both the heterogeneity of involved categories and of regions in a consistent manner, we compiled the Multiregional Health Account (MRHA). It corresponds to the national model in terms of methodology and overall results but adds a further component in terms of regional diversification (BMWi, 2017b; Schwärzler & Kronenberg, 2017a; Schwärzler & Kronenberg 2017b). The underlying methodology of both the NHA and the MRHA is based on national accounts and hence allows to conduct input-output analysis. The latter is frequently used to study several fields of policy action (Eurostat, 2008).

Hence, we pursue to apply input-output analysis in the context of the health economy in this paper not only to address a current serious challenge in German health policy but also to demonstrate the relevance of the health economy in the political context. In this framework, we establish an approach to cope with lagging investments in hospitals by making use of multiregional input-output analysis.

The remainder of this paper is structured as follows: Section 2 describes background and challenges of lagging investments in German hospitals. We discuss existing approaches and address the problem formulation in section 3. Section 4 describes the data base and the empirical approach used in order to establish the financial equalization scheme that aims to cope with lagging investments in hospitals. We present and discuss the results in section 5, followed by concluding remarks in section 6.

2 Background and challenges in the context of investments in German hospitals

This section aims at describing the general setting of hospital investments. Subsection 2.1 focusses on determining factors, which is existing heterogeneities among federal states and the policy setting influencing hospital investments. Subsection 2.2 describes the current situation on lagging investments in German hospitals and subsection 2.3 addresses future challenges, which may even toughen the existing situation.

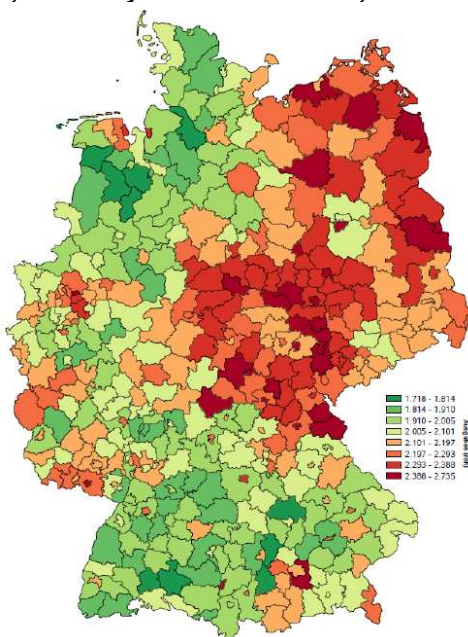
2.1 Determining factors

In this subsection, we first describe regional heterogeneities regarding influencing factors of health in order to establish a fundamental understanding for the regional setting of the subsequent analysis. Second, we introduce the legal framework regulating the financing responsibilities of hospital investments. Third, we evaluate existing compensation mechanisms in order to figure out whether sufficient attention is paid to federal states' responsibilities in this matter.

2.1.1 Heterogeneities among federal states

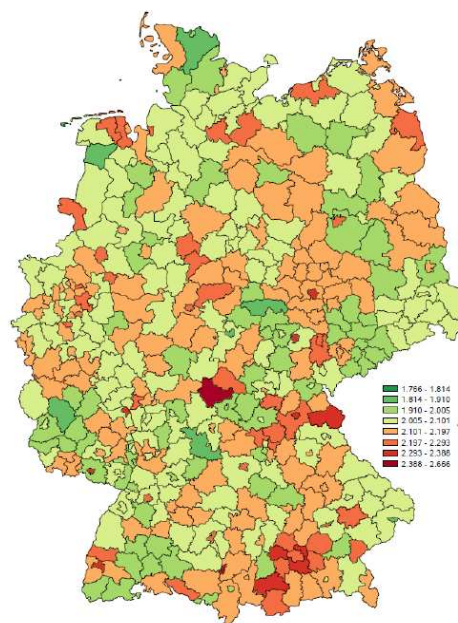
Influencing determinants of peoples' health status represent important aspects for the design of a health system. A high heterogeneity concerning demographic constitution, life expectancy and status of health across federal states requires a regionally differentiating health policy. Both health expenditures and demand for inpatient health care supply are affected by current and future heterogeneities of federal states.

Figure 1: Expenses per insured people, statutory health insurance, 2009



Source: Göpfarth (2011).

Figure 2: Adjusted expenditures for publicly insured people, 2009



Source: Göpfarth (2011).

In Figure 1, we observe expenses per person insured under the statutory health insurance scheme in German districts. Figure 2 exhibits the same expenses, but adjusted by gender, age and morbidity derived from conducting a regression analysis on several defined risk categories of patients' characteristics (Drösler, et al., 2011). Hence, we observe the reasonability of these influencing factors on health expenditures and therefore on financing of the health care system. We also observe higher costs in Eastern Germany, which

reflects a certain relationship with regional characteristics. There are also additional, so far unconsidered, influencing factors, which still cause differences in expenditures even after this adjustment.

Needs-based health care is a major criterion for health care provision (SVR-G, 2014). It pursues equal treatment in qualitative and quantitative measures in accordance to objective patient needs. This implies that the severity and kind of illness decides upon the treatment irrespective of the patient's financial and family status, income, gender, place of residence, profession, social background or origin.

Hence, supply of needs-based health care has to cope with several influencing factors, which exhibit certain interdependencies to regional characteristics. In this paper, we focus on one prerequisite of needs-based health care, which is hospital infrastructure.

2.1.2 Hospital Finance Act

The Hospital Finance Act regulates financing of expenditures in German hospitals (KHG, 1972). It goes back to the year 1972 and was revised in 2016. Its purpose aim at safeguarding the economic basis of hospitals in order to supply high-quality, patient- and needs-based health care for the population by means of efficient, high-quality and independently economizing hospitals. Over here, we again find the term 'needs-based health care'. It implies that the quality of treatment is supposed to apply in accordance to objective patient needs in all hospitals.

According to the Hospital Financing Act, the financing of private, public and charitable hospitals is performed in a dualistic way. Operating costs, including expenses for treatments, are financed by health insurance funds on the one hand. On the other hand, investments are financed by public funds of the federal states.

Investment expenditures include costs for construction of hospitals next to purchasing and replacement of fixed assets. It does not include costs for properties. The kind of public investment can be distinguished between individual and global funding. The first applies upon request to expenses of new buildings, modifications and extension of hospitals, next to purchasing and replacement of fixed assets with useful life over three years. Global funding addresses annually expenses for replacements of short-term assets and minor construction measures.

Current challenges regarding financing of investments in hospitals led to adjustments in the Hospital Financing Act in 2016. Accordingly, federal states are currently obligated to provide at least the annual average amount of the years 2012 to 2014 for further investments in hospitals in each year from 2016 to 2018. On top to this, and therefore unrelated to investments, 500 M. € are provided for restructuring of hospitals, such as initiatives regarding scaling down excess capacities or concentration of locations.

Observed heterogeneities among federal states regarding age, gender and morbidity hence influence financial resources of health insurance funds and federal states. Therefore, we focus on existing compensation mechanisms, which may influence the regionally different characteristics of health care financing in the following.

2.1.3 Existing compensation mechanisms in the German health system

Since hospital financing is performed according to a dualistic framework, there are two compensation mechanisms with potential influence on respective financial resources. On the one hand, the morbidity-oriented risk structure compensation (Morbi-RSA) focusses on compensating expenditures among health insurance companies in terms of age, gender and morbidity of patients. On the other hand, the Federal Financial Equalization System (*Länderfinanzausgleich*) distributes revenues among federal states so the latter are able to fulfill their assigned tasks.

Both compensation mechanisms are relevant in our case. We want to gather arguments for compensation from the Morbi-RSA, which do not only apply to current expenditures, but also to financing of investments. The Federal Financial Equalization System is not related to health, but aims to enable federal states to fulfill their duties. Clearly, we exhibit a direct link to financing of hospital infrastructure at this point. We describe main characteristics of both in the following.

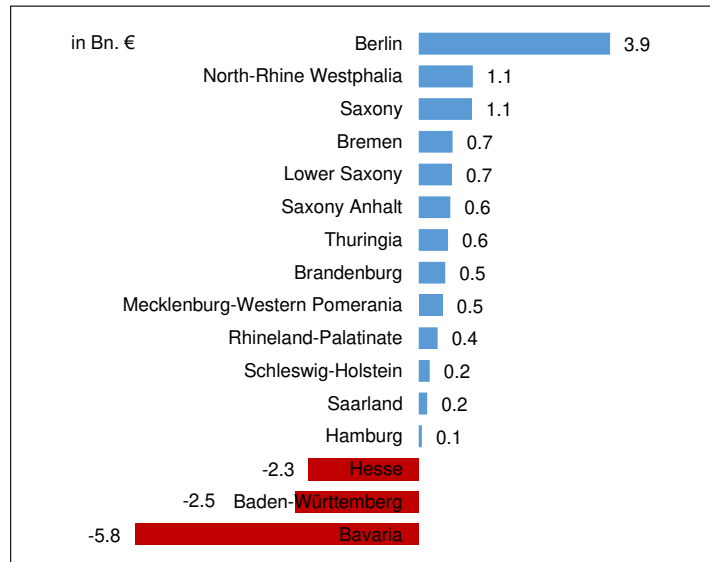
The Morbi-RSA aims to enable both solidarity and competition in the statutory health insurance market (BVA, 2008). Solidarity applies since the patient's contribution rate does not depend on health risk but on income. Moreover, statutory health insurance is subject to the obligation to contract, irrespective of age, gender or well-being of the person. Under normal circumstances, competition for young and healthy individuals would arise among insurance companies. The Morbi-RSA, however, aims to adjust influencing factors of insurers' characteristics in order to enable fair competition among health insurance companies based on effective and efficient economizing only. In Figure 1 and Figure 2 we can observe the difference between 'original' health expenditures and health expenditures subject to adjustments according to the Morbi-RSA in terms of age, gender, morbidity and reduced earning capacity. Some literature suggests there are additional so far unconsidered exogenous regional factors, which influence supply and demand of health care, such as level of prices and income (Ulrich & Wille, 2014; Göppfarth, 2011). Hence, they propose to implement a regional factor to the Morbi-RSA to increase fairness of competition among health insurance companies in addition.

We suggest that differences in demand for health care regarding age, gender and morbidity among others, apply not only to current costs, but also to investments of hospitals. Federal states and their hospitals just as much need to be able to supply needs-based health care, run their business economically and compete in a fair environment, which is independent of the financial resources of federal states. The Morbi-RSA has no effects on financial resources of federal states. Hence, we turn to the Federal Financial Equalization System in the next step, aiming to figure out whether it copes with regional heterogeneity in health care supply in a similar way the Morbi-RSA does.

Since tax revenues are unequally distributed among German regions due to a diversified economy, certain instruments are necessary to ensure federal states to be able to meet their responsibilities. The existing Federal Financial Equalization System is meant to represent this instrument and aims to establish 'equivalent living conditions throughout the federal territory', based on the German Constitution (Lenk, 2008). Figure 3 exhibits the preliminary calculations of the Federal Financial Equalization System for 2016 in order to enable a general assessment on its impact for the reader.

The legal framework of the German Federal Financial Equalization System is revised at the moment. Basic principles, to be applied from 2020 on, have already been settled. Unfortunately, it turns out that the reorganization did not lead to the intended reduction in complexity of the redistribution mechanisms. Hence it lacks improvements, which make it more transparent, systemic and computable in order to fuel financial incentives of federal states (BMF, 2017b).

Figure 3: Preliminary calculations of the German equalization scheme for 2016.



Source: own illustration based on BMF (2017a).

According to the recent adjustments, the federal government will support federal states with a higher amount of additional 9.5 Bn. € from 2020 on in order to enable them to meet their responsibilities. Associated therewith, the completion of tasks of the federal states will be adjusted and the competencies of the federal government regarding investment decisions will be increased. Special attention is brought to investments in education, federal motorways, the indebted federal states Saarland and Bremen, seaports and Local Community Transport. Apart from this, value-added tax continues to be distributed among federal states in consideration of the number of inhabitants (BMF, 2016a).

So far, we observe no special attention to health. Therefore, we take a closer look at the applied distribution concept based on the number of inhabitants, which may impact health-related characteristics. Different weights apply for inhabitants in order to include certain characteristics of federal states. This is 1.35 for city states, 1.05 for Mecklenburg-Western Pomerania, 1.03 for Brandenburg and 1.02 for Saxony-Anhalt. This weighting is argued with higher financial needs for city states and sparsely populated regions. The ratio of actual financial capacity and the accordingly weighted target figure reflects the relative position of a federal state. A value below 1 indicates the federal state in consideration is entitled to receive funds and vice versa. Allocation does not lead to a complete equalization of tax revenues, in order to maintain incentives for effective economizing (Lenk, 2008).

Hence, we observe a relatively unspecific mechanism to distribute financial resources. Reform proposals suggested to assert fixed amounts to investments for education, science, family policy, environment and nature protection (Lenk, 2008). Moreover, different literature addresses implementing health-related factors, which enable rural regions to keep up with economic and social developments and prevent a further

growing disparity among regions (Kersten et al, 2015). In addition, a demographic factor was discussed in order to consider a decreasing population. However, this is challenging, since the direction of interdependencies of expenditures and demographic constitution depends on the applied field, such as education or health among others (BMF, 2013). Moreover, the weighting factors applied on the number of inhabitants are criticized by some commentators, who argue that in the case of city states the weighting is too high and too general (SVR, 2014) and does not represent a reliable and verifiable indicator (Bönte & Lucke, 2004). In addition, it has been argued that the weighting factors for sparsely populated regions lack a clear scientific foundation (Fuest & Thöne, 2012).

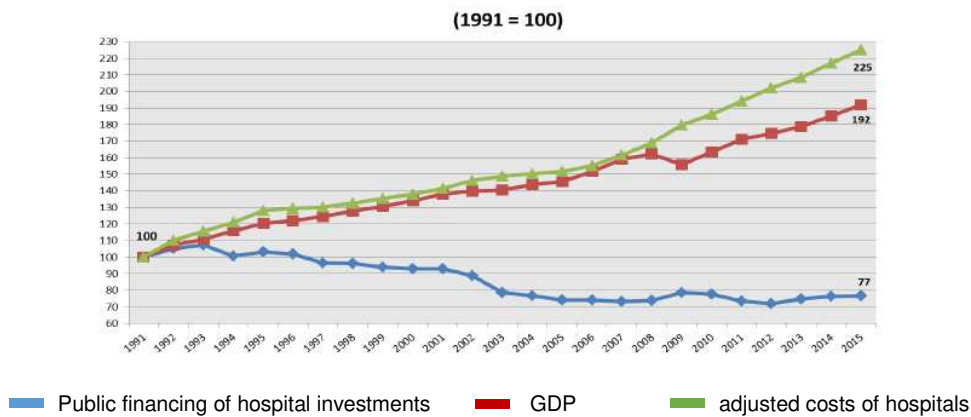
So far, we conclude that influencing factors of health are not a subject of the current and future Federal Financial Equalization System. However, since there are adjustments in current expenses regarding gender, age and morbidity in the context of the Morbi-RSA, we can clearly identify need for action regarding the financial resources of the federal states in the context of health.

2.2 Current situation on the lagging investments in German hospitals

Federal states increasingly fail to comply their obligation to finance investments in hospitals (BDO & DKI, 2015, SVR-G, 2014). To a reasonable amount, this is due to a lack of their financial resources (Clade, 2002; Henke, 2002; Rehborn & Thomae, 2008; Porther & Guth, 2012). An analysis conducted by Rösel (2013) confirms this interdependency among other influencing factors such as interest burden and demographic constitution.

Federal states financed about 2.79 Bn. € investments in hospitals in 2015. This is about half of the 6.01 Bn. € projected required investments for 2016. The aforementioned amount of the yearly necessary investment needs of hospitals is derived from investment allocation assessments, which were recently elaborated by the DRG Institute for Hospital Reimbursement (InEK) on behalf of the German Hospital Federation (DKG), the National Association of Statutory Health Insurance Funds (GKV-Spitzenverband) and the Private Health Insurance Association according to the official mandate of § 10 the Hospital Finance Act (KHG). Moreover, the 2.79 Bn. € hospital investments financed by federal states corresponds to a 50 percent real erosion in value since 1991. The investment ratio, calculated as the quota of investments and adjusted costs of hospitals, decreased from 9.7 percent in 1991 to 3.3 percent in 2015. (DKG, 2017) Nominal development of GDP, adjusted costs of hospitals and public investments in hospitals are depicted in Figure 4.

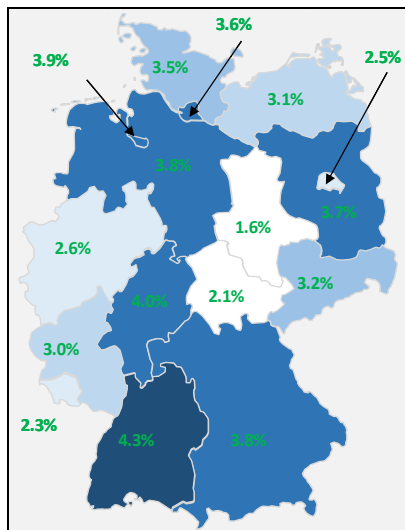
Figure 4: GDP, adjusted costs of hospitals² and public investments in hospitals, 1991-2015



Source: DKG (2017).

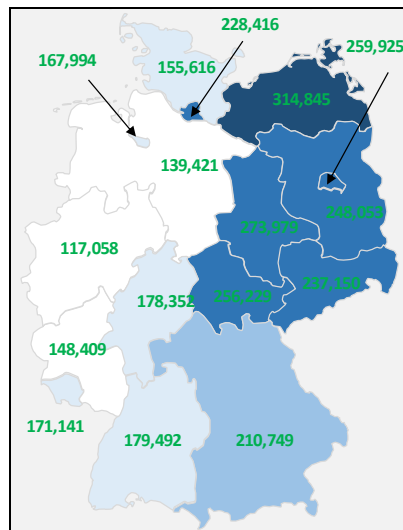
Financing of federal states corresponds to only half of actual hospital investments (BDO & DKI, 2015). From an economic perspective necessary additional investments are financed by hospitals themselves, for example from surpluses of current expenses. This circumstance puts several hospitals into financial troubles since surpluses are not meant for financing of investments. Moreover, lacking investments can cause erosion of structural and technical infrastructure, in extreme cases causing limitations in health care supply. In addition, innovative treatments and technical progress are more unlikely to be implemented when hospitals lack investments in structural and medical infrastructure.

Figure 5: Investment ratio of hospitals in federal states, 2015



Source: own illustration based on DKG (2017).

Figure 6: Investment sum 1991-2015 per hospital bed



Source: own illustration based on DKG (2017).

Figure 5 and Figure 6 show hospital investments for the German federal states in 2015 and the period 1991 to 2015. The difference between the two figures is mostly due to an investment program for the Eastern federal states initiated in the course of the Health Care Structure Reform Act of 1992. It aimed to assure equal standards of infrastructure after the unification of Germany by providing around 10 Bn. € for investments in hospitals of Eastern Germany during the period of 1995 to 2014 (DKG, 2017). In the perspective

² Adjusted costs of hospitals refer to gross hospital costs less expenses for outpatient services.

of overall Germany, however, each federal state supplies less financial resources in real terms for investments in hospitals today compared to 1991.

Current discussions focus on a mechanism to calculate the actual need for investments, called investment allocation assessment. Respective calculations have led to the projected need for investments to the amount of 6.01 Bn. € mentioned before (DKG, 2017). The investment allocation assessment aims to provide a basis for federal states' decision making regarding the actual investment need of their hospitals. The mechanism is closely related to Diagnosis Related Groups (DRG) and hence incorporates information on medical and demographic data (Schmid et al, 2016).

For the sake of completeness we want to point out that some literature mentions the so-called 'investment bottleneck of hospitals', which does not lie in the focus here. We proceed accordingly, since the amount of the investment bottleneck is difficult to measure in an objective way (SVR-G, 2007). This causes the according calculated amount to differ in a broad range from e.g. 14.6 Bn. € (Augurzky et al, 2014) to 50 Bn. € (DKG, 2009).

We conclude that the German health policy observes severe challenges resulting from the dualistic framework of health care financing in hospitals. We sympathize with the attempts to improve decision making in the context of investment allocation assessments, since they rely on actual health-related data. However, we find it surprising that this system does not involve a reallocation mechanism between federal states, since financial recourses are to some degree responsible for lagging investments. From what we will see in the next subsection, future challenges may even aggravate the current situation.

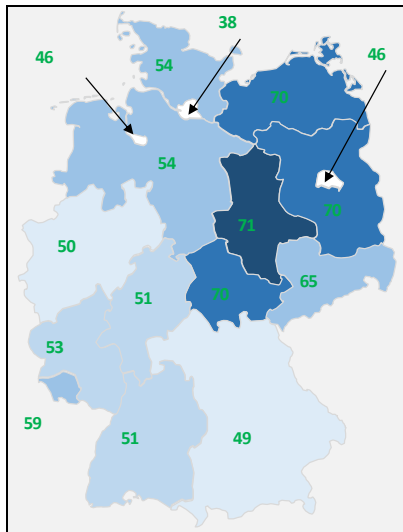
2.3 Future challenges

We described determining factors and the current situation regarding lacking investments in hospitals in the previous subsections. Now we will look at future developments, which are likely to have reasonable impacts on the existing challenge.

First, the demographic constitution of federal states will influence the further development of hospital infrastructure in different ways. A decreasing population will impact the financial resources of federal states due to the current and future design of the Federal Financial Equalization System (Lenk & Starke, 2015). Moreover, the amount of tax revenues generated depend on the number of people in employment, which is again affected by demographic factors. In addition, the latter also impacts the nature and extent of public expenditures, e.g. education for the younger population and retirement homes for elderly people.

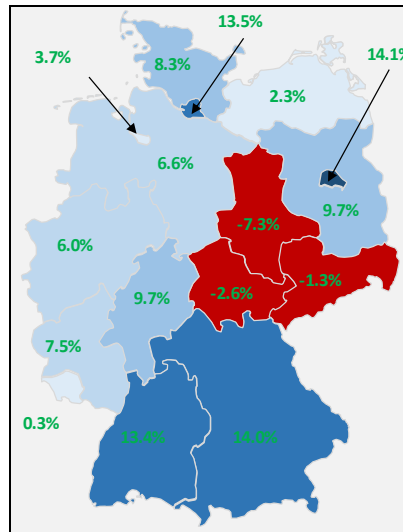
Figure 7 exhibits the projected old-age dependency ratio for 2030 in German federal states with highest values for the Eastern federal states. Literature also reveals highest increases compared to 2008 in the same area (Destatis, 2010). Hence, it is likely that Eastern federal states observe greater challenges when it comes to public financing and therefore fulfilling their public duties.

Figure 7: Projected old-age dependency ratio, 2030



Source: own illustration based on Destatis (2011).

Figure 8: Change of hospital cases 2008-2030



Source: own illustration based on Destatis (2010)

Projected changes in hospital cases in the period 2008 to 2030 are depicted in Figure 8. The reduction of hospital cases in Saxony-Anhalt is caused by a decrease in population until 2030 while Berlin and Bavaria are expected to cope with the opposite effect due to a slight increase of the corresponding population. Observed changes in hospital cases indicate towards the necessity for adjustments in the context of health care facilities and medical staff. A lower utilization of health care facilities is especially challenging for larger federal states and regions with low population density and long travel distances in the context of emergency care.³

Fortunately, a so-called ‘cost explosion’ of health care costs is not expected (Nowossadeck, 2012; Bowles & Greiner, 2012). The slow but long lasting impacts of demographic changes favor planning of a variety of activities in medical research, aiming at improved health care provision, prevention, rehabilitation and allocation of resources (Nowossadeck, 2012).

Moreover, the impact of financial resources on financing of hospitals are likely to toughen from 2020 on, when the debt brake is introduced (SVR-G, 2014). It prohibits federal states from incurring new debt (Deutsche Bundesbank, 2011). As already mentioned, the indebted federal states Saarland and Bremen receive special attention in the new German equalization scheme (BMF, 2016a).

Furthermore, the aforementioned additional resources for hospital investments in Eastern federal states, which were provided from 1995 on, stopped in 2014 (DKG, 2017). This obligates Eastern federal states to provide an even higher amount of financial resources from 2015 on. However, this effect is expected to become visible with delay since hospitals in Eastern Germany currently exhibit a relatively favorable situation due to the expired additional funding (SVR-G, 2014).

³ Both projections are based on assumptions, which do not incorporate unexpected demographic developments occurred lately such as the large influx of refugees. At this point there are no revised projections available. Hence, we suggest to interpret this data with respect to a reasonable amount of uncertainty.

Concluding, we observe additional challenges in the future, which may toughen the current situation of lagging hospital investments. In the following, we consider previous approaches, summarize the problem and end with a description on the proposed approach.

3 Existing approaches and introduction to the proposed approach

Up to this point, we have introduced the background and challenges in the context of lagging investments in German hospitals. This section focusses on problem solving. Therefore, we summarize existing approaches in subsection 3.1, define the problem from our perspective in subsection 3.2 and describe our proposed approach in subsection 3.3.

3.1 Existing approaches

Mentioned adjustments in the Hospital Financing Act from 2016 consist in obligating federal states to finance at least the average annual amount of 2012 to 2014 in each year from 2016 to 2018. There is consensus among several associations about the inadequacy of this regulation (BÄK, 2015; GKV-Spitzenverband, 2015; vdek, 2015; VUD-MFT, 2015). Accordingly, it represents an absolute lower limit of investments but appears to be the only compromise federal states are willing to accept (vdek, 2015).

The German Advisory Council on the Assessment of Developments in the Healthcare System pursues to introduce monistic hospital financing (SVR-G, 2007). Health insurance companies would be responsible for financing current expenses and investments in hospitals. The Council suggests to directly link investments to DRG. Consequently, a certain fund is at the free disposal of hospitals. Federal states should nevertheless still be able to oblige hospitals to supply certain services such as emergency care in order to maintain regional and social policy of federal states. The investment fund should still be financed by taxes to avoid additional burden for the statutory health insurance. The opposite would result in a rise of health insurance contribution impacting negatively on the labor market. Federal state contributions to the fund are suggested to be defined according to the number of inhabitants.

This setting considers some challenges of the dualistic financing framework. First, inpatient and outpatient treatment is treated equally, without one of them being partly publicly financed. Second, business decisions in hospitals are made by one player instead of two, which is supposed to improve efficiency and economic profitability. Third, it decreases distorted competition among hospitals, since their equipment is no longer influenced by federal states' decisions. (DIHK, 2010) Fourth, political influence on investments decisions is reduced, which is favorable in respect of the relationship between the short-term budgetary position and lagging investments in hospitals to supply needs-based health care (SVR, 2012).

A more detailed description on the exact procedures of a potential monistic financing framework can be found in Rürup et al. (2008). They pursue to focus on a to-be defined share of value-added tax revenues as part of the current Federal Financial Equalization System. Financial resources are distributed among hospitals in accordance to DRG under the supervision of federal states. Ten percent of the available financial resources should be kept back for financing hospitals in disadvantaged regions.

So far, we observe a general renunciation from the dualistic framework of hospital financing and consensus about relating payments to DRG. However, the source of financing is not quite clear. While the Advisory Council suggests tax payments in accordance to inhabitants, Rürup et al. (2008) suggests to link payments

to a specific amount of value-added tax. Both approaches seem relatively unsophisticated considering the heterogeneity among regions and the current inadequacy of federal states' financial contribution. We propose a clear calculation method in this context to favor policy rationale. We think, multiregional input-output analysis is a suitable approach.

3.2 Problem formulation

We observe a heterogeneity of German federal states in determinants of health care expenditures, which are considered in financing of current costs by the concepts of the Morbi-RSA. However, no compensation mechanism is available to adjust budgets of federal states enabling them to meet their responsibility of financing hospital investments.

This is crucial since budgetary restrictions play a decisive role in this matter. Neither the current nor the future Federal Financial Equalization System considers determinants of health. However, its future design considers e.g. expenditures for education and hence recognizes financial needs beyond general equalization mechanisms. Therefore, it is surprising that the same mechanism lacks an equivalent adjustment in the context of health especially when we compare its allocation volume of 10.6 Bn. € (BMF, 2017a) with annual needs for hospital infrastructure of 6.01 Bn. € in 2016 (DKG, 2017). This dimensions clearly indicate the relevance of this topic.

Theoretical approaches suggest to introduce a monistic financing framework, in which health insurance companies come up for current costs and investments. Binding federal states' contributions are supposed to be the source of funding of the latter. We criticize that suggested individual contributions are not linked to any health related characteristics and do not show advantages over the Federal Financial Equalization System regarding the criticized design of the distribution mechanism.

Hence, we aim to establish a macroeconomic model specifying each federal states' contribution to the earmarked fund. This model offers reasonable explanations for due contributions of federal states in the context of the health economy. We propose this direct linkage to the health economy since it potentially promotes understanding and therefore willingness to cooperate of contributing federal states.

3.3 Proposed approach

In previous research we compiled the MRHA, which is a multiregional satellite account of the health economy based on the macroeconomic framework of national accounts. It reveals intra- and interregional next to interindustry dependencies of the German economy with special emphasis on health. The model enables input-output analysis in order to examine triggered indirect relationships next to the direct contributions of the health economy to the regional economy. Hence, instead of relying on indicators such as the number of inhabitants to establish an earmarked fund for hospital investments, we make use of modelled interdependencies of federal states with direct link to health care supply.

Indirect effects arise from the interconnectedness of industries and federal states in terms of exchanging products and services for further processing or final consumption. For example, they emerge from producing medication and therewith related necessary inputs such as energy. Federal states, which profit to an above average amount from patient treatment in other federal states, since they provide e.g. a high amount

of necessary medication or energy, accordingly contribute to the fund to a higher proportion. The allocation of the fund is carried out in accordance to DRG as proposed by previous approaches.

4 Data base and empirical approach

This section focusses on the data base used and the empirical approach pursued to establish a compensation mechanism for federal states in order to enable needs-based hospital investments.

4.1 Data base

The MRHA represents the main data base for further calculations. This satellite account was compiled as a methodological enhancement of the already established NHA and aims at quantifying the economic contribution of the health economy in terms of GVA, employment and trade for the German federal states. While the NHA reveals economic interdependencies of the health economy with the overall economy, the MRHA separates these interdependencies also among federal states in order to evaluate interregional next to interindustry dependencies. The foundation for both models is national accounts. We provide the official definition of national accounts in order to point out its versatility and recognition in the following.

National accounts are a coherent, consistent and integrated set of macroeconomic accounts, balance sheets and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules.

National accounts provide a comprehensive accounting framework within which economic data can be compiled and presented in a format that is designed for purposes of economic analysis, decision-taking and policy-making.

OECD Glossary of Statistical Terms

Commissioned by the Federal Ministry for Economic Affairs and Energy, we derived the methodology of the current NHA (Schwärzler & Kronenberg, 2016), elaborated the methodology to compile the MRHA (Schwärzler & Kronenberg, 2017a) and checked its plausibility and results (Schwärzler & Kronenberg, 2017b) in order to address a current challenge of political matter in this paper.

For the purpose of this analysis, we use the input-output table of the MRHA, which is derived from the corresponding supply and use tables. Schwärzler & Kronenberg (2016) provide a detailed description on the derivation of the input-output table for the NHA, which applies identically for the multiregional context.

The derived multiregional input-output table with emphasis on the health economy provides information on the production process and the use of goods. Since the economies of federal states do not represent enclosed systems but are related to each other in terms of the supply for and demand of goods and services, this multiregional input-output table allows to calculate interregional dependencies. Emphasis on the health economy enable to specifically evaluate categories of the health economy, which cannot be derived from official national tables neither collectively nor separately.

Figure 9: Multiregional input-output table in a 3-region-economy

		Industries		Final consumption			Industries		Final consumption			Industries		Final consumption	
CPA	01	Federal state 1			Dom. total use federal state 1	Export Federal state 1 to federal state 2			Imp. total use FS 2 from FS 1	Export Federal state 1 to federal state 3			Imp. total use FS 3 from FS 1	Dom. output = domestic use Federal state 1	
	02														
	05														
	...														
	95														
CPA	01	Export Federal state 2 to federal state 1			Imp. total use FS 1 from FS 2	Federal state 2			Dom. total use federal state 2	Export Federal state 2 to federal state 3			Imp. total use FS 3 from FS 2	Dom. output = domestic use Federal state 2	
	02														
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	...														
	95														
CPA	01	Export Federal state 3 to federal state 1			Imp. total use FS 1 from FS 3	Export Federal state 3 to federal state 2			Imp. total use FS 2 from FS 3	Federal state 3			Dom. total use federal state 3	Dom. output = domestic use Federal state 3	
	02														
	05														
	...														
	95														
		∑ Intermediate use from Germany	Final consumption				∑ Intermediate use from Germany	Final consumption				∑ Intermediate use from Germany	Final consumption		
		Intermediate use from int. imports				Intermediate use from int. imports						Intermediate use from int. imports			
		Gross value added federal state 1				Gross value added federal state 2						Gross value added federal state 3			
		Output federal state 1				Output federal state 2						Output federal state 3			

Source: Schwärzler & Kronenberg, 2017a.

In order to provide a better understanding for the reader, we indicate towards Figure 9, which exhibits the framework of a multiregional input-output table for a three region economy. Included data reveals information on inputs necessary to produce a certain amount of a specific product on the one hand and use of products either for further production or final use on the other hand.

We provide the general notation according to Miller & Blair (2009) over here. Let x_i be the overall produced output of one specific industry i , which only produces one type of good. This output is used as input z_i in n industries or for final consumption f_i , such as private household consumption or exports among others.⁴

$$x_i = z_{i1} + \dots + z_{ij} + \dots + z_{in} + f_i = \sum_{j=1}^n z_{ij} + f_i \quad (1)$$

Since each industry produces exactly one kind of product, we obtain n industries and hence an $n \times (n+1)$ matrix, the plus one indicating to final consumption as a single vector. In matrix notation we get

$$x = Zi + f \quad (2)$$

where i denotes a column vector of 1's resulting in a row-wise summation of Z .

4.2 Empirical approach

We aim to establish a fund for hospital investments, into which federal states make payments according to their direct and indirect benefits from patient treatment in the rest of the country. Input-output analysis

⁴ For the sake of consistency with existing literature, we refer to final consumption as a vector.

represents the foundation for quantifying indirect effects. In the following we describe the basics of input-output analysis, according to Miller & Blair (2009).

In this context, we rely on the Leontief production function, which is characterized by fixed proportions of inputs. To obtain additional output, all involved inputs need to be increased proportionally. Hence, there is a direct relationship between necessary inputs and obtained output, defined by the ‘technical coefficient’

$$a_{ij} = \frac{z_{ij}}{x_j} \quad (3)$$

Hence, we can replace z_{ij} by $a_{ij}x_j$ in equation (2) resulting in

$$x = Ax + f \quad (4)$$

If we want to calculate the amount of output x necessary to supply a specific amount of final demand f , we solve equation (4) for x and receive the Leontief inverse multiplied by f

$$x = (I - A)^{-1} f = Lf \quad (5)$$

This procedure is special since it calculates round-by-round effects. In the first round, output of one product requires a certain amount of inputs. Those inputs have to be produced themselves, which leads to the second round of effects. Adding all rounds of effects results in a single number from an entire series, caused by economic interdependencies.

Table 1 exhibits exemplary results of direct and indirect effects from patient treatment. Since we only want to focus on effects in the rest of the country, diagonal elements are blanked.⁵ The resulting distribution is applied on the given amount of the fund to define each federal state’s contribution. The underlying argument is that federal states, which profit from patient treatment in the rest of the country should also be made responsible for investments necessary over there in order to keep up needs-based health care supply.

Table 1: Exemplary results of the allocation mechanism.

	R1	R2	R3	R4	Σ	%
R1	...	3	1	4	8	9%
R2	10	...	23	15	48	52%
R3	13	9	...	3	25	27%
R4	5	2	5	...	12	13%
					93	100%

Source: own illustration.

When we define each federal state’s tax contribution to the fund, we will focus on results in terms of GVA. Reason for this approach is a similar challenge in the Federal Financial Equalization System. As mentioned, the latter aims to distribute unequally generated taxes among federal states to ensure the latter are capable to fulfill their duties. Before it gets to the point of re-distributing taxes, however, generated taxes in overall

⁵ We provide arguments for this approach in subsection 5.2.

Germany have to be allocated to their 'rightful' owner, which is currently carried out according to the principle of local origin. This becomes tricky when it comes to multiregional companies or employees, who commute over borders of federal states. Special adjustment rules come into action in such situations, which are, however, heavily discussed in the current design of the Federal Financial Equalization System. Consequently, Lenk & Glinka (2015) derive the advantages of allocating taxes according to GVA generated in federal states, due to advancements in transparency and allocation with respect to economic power. Hence, we focus on direct and indirect effects from patient treatment in the rest of the country in terms of GVA in order to define each federal state's contribution to the earmarked fund for hospital investments.

Table 2: Categories of the health economy referring to 'patient treatment'.

Core area of health economy	 Medication	▶ e.g. pharmaceutical products
	 Medical products	▶ e.g. medical technology products
	 Retail trade services of the core area	▶ e.g. pharmacy
	 Health insurance	▶ e.g. public and private health insurance
	 Services of inpatient facilities	▶ e.g. hospitals
	 Services of outpatient facilities	▶ e.g. dentists
	 Wholesale trade services of the core area	▶ e.g. wholesale trade services for medication

Source: own illustration based on BMWI (2017a).

We define 'patient treatment' as public and private expenditures on health according to the health expenditure survey. This corresponds to the categories of the health economy shown in the Table 2.⁶ In the following analysis, we define three categories: Medication, medical products and inpatient/outpatient treatment including administration, where the latter refers to 'health insurance' depicted in Table 2. Retail trade and wholesale trade is separately assigned to the corresponding products, which is medication and medical products.

Correspondingly, our main foundation for this calculation, the MRHA, incorporates these categories of health, which were obtained from matching compiled multiregional supply and use tables with regional health expenditures. Hence, in technical terms, we calculate direct and indirect input-output effects from current household and government consumption of categories of the health economy shown in Table 2, based on the standard static open model

At this point we introduced background and challenges of lagging investments in hospitals, described existing strategies and our proposed approach and explained foundations of the empirical framework. On the basis of this, we show and discuss results in the next section.

⁶ These categories only refer to the 'core area' of the health economy. All categories of the health economy – including the 'extended area' of the health economy - are depicted in Schwärzler & Kronenberg (2016).

5 Results and discussion

This section focusses on the results from input-output analysis. Based thereon, we compile the theoretical fund size for hospital investments in a specific federal state according to direct and indirect GVA generated by patient treatment in the rest of Germany. Subsection 5.1 describes the results and subsection 5.2 discusses further implications.

5.1 Results

In our understanding, the economic constitution of the health economy plays a decisive role to supply needs-based health care in hospitals. Yet, the health economy does not operate individually within each federal state, but depends on products and services from other federal states, i.e. the “rest of the country”. Hence, this interdependency implies that certain federal states profit from patient treatment in the rest of the country. This, however, contradicts the dualistic financing of hospitals, according to which investments have to be financed by the responsible federal states exclusively.

Therefore, we pursue the discussion on a compensation mechanism, which is derived from interregional dependencies of the health economy. Direct and indirect GVA generated in federal states due to the treatment of patients in the rest of the country is the main directive to define contributions to the fund. We suggest that federal states, which profit above average from patient treatment in the rest of the country, are obligated to make a greater contribution to the earmarked fund.

The overall amount of this fund corresponds to 5.85 Bn. € for 2015, which is derived from investment allocation assessments (DKG, 2017). We refer to 2015, since it represents the most recent data base of federal states’ actual investments. We are aware of occurring inaccuracies when applying this amount to modelled interregional interdependencies based on data from 2011. Since it is our primary objective to bring the underlying mechanisms into the reader’s attention, we ignore occurring inaccuracies in the following.

Table 3 exhibits the results from input-output analysis. Summed up over all federal states, we obtain an overall amount of around 48 Bn. € GVA from patient treatment in the rest of the country. We derive individual payments to the fund according to the contribution of each federal state to this amount, indicated by the red frame in Table 3.

This amount comprises of different categories, which is medication, medical products and inpatient/outpatient treatment including administration. The latter provides the majority of GVA effects generated, while the first exhibits the highest effects in terms of GVA generated per 100 € spent on this kind of treatment. This is comprehensible, since health products experience trade between federal states and are therefore responsible for a high degree of interdependencies among federal states for each Euro spent in the rest of the country. Inpatient and outpatient treatment is not part of interregional trade, since this service always takes place at the supplying federal state. This causes GVA generated per 100 € spent on inpatient and outpatient treatment in the rest of the country to be of a lower amount compared to health products. However, inpatient/outpatient treatment and administration represent the biggest contributor to the overall health

economy, which makes this part nonetheless powerful in its absolute importance. Its corresponding inter-regional dependencies come along with necessary inputs like medication and medical products for inpatient and outpatient treatment, but also with energy and food among others.

Table 3: Direct & indirect GVA effects from patient treatment in the rest of country.

	Medication			Medical products			Inpatient/outpatient treatment & administration			Σ patient treatment			Regional economy
	[M. € GVA]	[share]	[€ GVA per 100 € exp.]	[M. € GVA]	[share]	[€ GVA per 100 € exp.]	[M. € GVA]	[share]	[€ GVA per 100 € exp.]	[M. € GVA]	[share]	[€ GVA per 100 € exp.]	[share]
BW	3,012	17.2%	8.40	930	18.0%	7.11	3,394	13.4%	1.73	7,335	15.3%	2.99	15.0%
BY	1,472	8.4%	4.21	1,050	20.3%	8.18	4,180	16.5%	2.21	6,702	14.0%	2.82	17.7%
BE	1,729	9.9%	4.43	149	2.9%	1.04	1,313	5.2%	0.61	3,191	6.7%	1.19	4.0%
BB	363	2.1%	0.92	74	1.4%	0.51	501	2.0%	0.23	937	2.0%	0.34	2.1%
HB	108	0.6%	0.27	57	1.1%	0.38	248	1.0%	0.11	412	0.9%	0.15	1.0%
HH	525	3.0%	1.33	228	4.4%	1.56	1,023	4.0%	0.47	1,777	3.7%	0.65	3.6%
HE	3,989	22.8%	10.55	472	9.1%	3.39	3,100	12.2%	1.49	7,562	15.8%	2.91	8.7%
MV	74	0.4%	0.19	36	0.7%	0.25	275	1.1%	0.12	386	0.8%	0.14	1.3%
NI	661	3.8%	1.82	397	7.7%	2.96	1,959	7.7%	0.96	3,017	6.3%	1.19	8.7%
NW	2,937	16.8%	9.12	1,115	21.5%	9.37	5,612	22.2%	3.23	9,664	20.1%	4.43	21.8%
RP	1,361	7.8%	3.50	155	3.0%	1.08	1,006	4.0%	0.47	2,522	5.3%	0.94	4.4%
SL	124	0.7%	0.31	52	1.0%	0.35	280	1.1%	0.13	456	0.9%	0.16	1.2%
SN	248	1.4%	0.64	120	2.3%	0.84	845	3.3%	0.39	1,213	2.5%	0.45	3.7%
ST	244	1.4%	0.62	63	1.2%	0.43	487	1.9%	0.22	794	1.7%	0.29	1.9%
SH	429	2.5%	1.09	198	3.8%	1.36	693	2.7%	0.32	1,320	2.8%	0.49	2.8%
TH	196	1.1%	0.50	77	1.5%	0.52	406	1.6%	0.19	679	1.4%	0.25	1.9%
Σ	17,471	100%	2.85	5,173	100%	2.29	25,322	100%	0.75	47,967	100%	1.14	100%

Source: own calculations.

By comparing the contribution of each federal state with its share on the overall national economy in terms of GVA, we observe an above or below average advantage from patient treatment in the rest of the country. For example, the federal states Baden-Württemberg, Berlin, Hesse and Rhineland-Palatinate profit above average when patients in the rest of the country are treated with medication, since their corresponding GVA share is higher than their share on the national economy. This is legitimate due to large companies operating over there. The companies Sanofi-Aventis Deutschland GmbH and Merck KGaA characterize Hesse as a federal state with strong focus on medication manufacturing (Schwartzler & Kronenberg, 2017b). Berlin exhibits emphases in R&D in medication especially due to activities of Bayer HealthCare AG, Berlin-Chemie AG and Pfizer Deutschland GmbH. An established cluster in this field and close cooperation between the pharmaceutical industry and health facilities intensify Berlin's activities in corresponding R&D. Boehringer Ingelheim GmbH has high impact on medication supply in Baden-Württemberg and Rhineland-Palatinate. Supply of medication goes in hand with several other indirect effects in these federal states (Schwartzler & Kronenberg, 2017b).

Bavaria and Baden-Württemberg profit from expenditures on medical products in the rest of Germany. Activities in this field have extraordinary importance in these federal states (Forum MedTech Pharma e.V., 2015; BW-I, 2015) and exhibit essential interindustry and interregional effects (Schwartzler & Kronenberg, 2017b). Both federal states show accompanying regional effects from computer, electronic and optical products next to a strong relationship to machinery in Baden-Württemberg.

As already mentioned, inpatient and outpatient treatment are themselves not subject to interregional trade. However, an essential share of their input does, such as medication, medical products or further services

and products related with daily business. This implies high effects for Berlin, Hesse and North Rhine-Westphalia due to their supply of medication. Moreover, high effects arise in administration in Berlin due its characteristic as capital of Germany and in financial activities in Hesse, due to the city of Frankfurt hosting several important players such as the European Central bank, the German Central Bank and the German Stock Exchange among them (Schwärzler & Kronenberg, 2017b; IAB, 2013). In addition, North Rhine-Westphalia profits from inpatient and outpatient treatment in terms of energy supply, since it provides about a third of overall German energy output. Hamburg benefits from a wide range in related services, such as trade and warehousing next to insurance, legal, accounting, rental and leasing services.

Summing up all direct and indirect GVA effects from patient treatment in the rest of Germany results in the already mentioned amount of around 48 Bn. €. The more a federal states profits from this effect, the more it should be obligated to contribute to the earmarked fund. When we contrast this share with the regional contribution to the national economy, we obtain above average effects for Baden-Württemberg, Berlin, Hamburg, Hesse and Rhineland-Palatinate, as can be obtained from Table 3. In the following subsection we will apply this allocation to the necessary amount for hospital investments and discuss the results.

5.2 Discussion

In the previous subsection, we have derived each federal state's contribution to the earmarked fund for hospital investments. The rationale behind is that federal states should contribute a higher amount to the fund if they profit from patient treatment in the rest of the country in an extraordinary way. This subsection concentrates on further implications of this adjustment scheme. Hence, we conduct another input-output analysis, which focusses on the direct and indirect GVA effects, which arise from current investments in hospitals. We proceed accordingly in order to examine the subsequent step of establishing a fund for investments, which is direct and indirect GVA effects from investments in hospitals.

One essential point is that federal states do not only profit from patient treatment in the rest of the country, but also from investments taken over there. Hence, federal states should indeed be willing to support additional investments in the rest of the country. Even more, as can be depicted from column one and column two of Table 4, returns in terms of GVA generated per 100 € expenditure on investments in the rest of the country exceed those from patient treatment.

Column three depicts the derived relative contributions from subsection 5.1 applied to the overall amount of hospital investments necessary in 2015 according to DKG (2017). When we contrast these numbers with actual federal states' investments depicted in column four, it results in the current implementation rate, shown in column five. The only federal state with accordingly sufficient participation is Mecklenburg-Western Pomerania. Not surprisingly, the five federal states, Baden-Württemberg, Berlin, Hamburg, Hesse and Rhineland-Palatinate, which are supposed to compensate other federal states for their investments in accordance to our calculations, particularly lag behind others in their current participation.

At this point, we want to bring the reader's attention back to the positive effects from hospital investments according to the second input-output analysis conducted. Column six of Table 4 depicts the absolute amount of each federal state's current direct and indirect GVA generated by hospital investments in overall

Germany. Therefore, we calculate the current gap arising between current expenditures on investments and GVA generated due to investments taken. It follows, that from an overall investment amount of 2,794 M. € in 2015 (DKG, 2017) direct and indirect GVA arises in federal states to the amount of 2,035 M. €. In consideration of this significant amount we suggest to provide more room for a discussion regarding the upsides of investment financing of hospitals in the current political debate.

Table 4: Relationship of patient treatment and hospital investments.

	C1	C2	C3	C4	C5	C6	C7
	Effects from patient treatment in ROC	Effects from investments in ROC	Calculated contribution to fund [2015]	Current investments [2015]*	Implementation rate	Effects from investments	Current gap
					(C4/C3)		(C4-C6)
	[€GVA per 100 € expenditure]	[€GVA per 100 € investments]	[M. €contribution]	[M. €]	%	[M. €GVA]	[M. €]
BW	2.99	7.00	895	437	49	289	148
BY	2.82	9.64	817	500	61	387	113
BE	1.19	2.11	389	96	25	86	10
BB	0.34	0.98	114	83	72	46	36
HB	0.15	0.44	50	39	77	21	18
HH	0.65	1.17	217	91	42	48	43
HE	2.91	4.88	922	242	26	198	44
MV	0.14	0.67	47	53	112	33	20
NI	1.19	3.97	368	276	75	173	102
NW	4.43	10.39	1,179	515	44	381	134
RP	0.94	2.00	308	120	39	83	37
SL	0.16	0.51	56	29	51	21	8
SN	0.45	2.94	148	131	89	118	13
ST	0.29	1.09	97	39	40	40	-1
SH	0.49	1.12	161	94	59	50	45
TH	0.25	1.58	83	50	60	60	-10
Σ	1.14	2.96	5,850	2,794	48	2,035	759

Source: own calculations, *DKG (2017).

Next to the additional GVA effects just described, we want to turn to some aspects of more technical nature in the following. There may arise a question on why we refer to GVA effects generated by patient treatment in the rest of the country exclusively in order to calculate individual contributions of federal states, instead of adding effects from treatment in the own federal state.

First, the provided framework is supposed to make involved players aware of the importance and advantages of interregional dependencies for the economy. We believe that if we promote this awareness, it will lead to a higher willingness for any sort of compensation mechanism. Second, we do not intend to interfere with regional policy, which means corresponding decisions regarding general regional health care supply should not impact on the federal state's contribution to the fund. Otherwise, we think, this could affect federal states' incentives to supply needs-based health care in yet unknown directions.

In addition, one may question whether this compensation mechanism impacts on the federal state's strategic decision regarding their export activities. Federal states would indeed reduce their contribution to the compensation mechanism if they substitute their sales to the rest of the country by international sales.

However, companies operate to maximize their profit and therefore look for possibilities all over the world to sale their products. Hence, there is no reason to substitute sales if there is a possibility to increase sales. In addition, federal states probably will not interfere with certain incentives for companies due to additional domestic effects accompanied with interregional trade.

6 Concluding remarks

This work and the underlying model, the MRHA, focus on the economic effects of the health economy in German federal states. Clearly, the perspective on health care as an economic contributor can be criticized. In this perception, the patient is no longer the focus of respective analyses. Related analyses even suggest advantages for the health economy if there is an increased need for patient treatment.

From a scientific view, however, it is beneficial to have additional explanatory factors available for certain analyses. Moreover, supply of health care results in financing responsibilities, hence it is legitimate to pursue the approach of “economizing of health”. The macroeconomic framework provides the opportunity to evaluate financing of the health care system in a different picture and puts an alternative light on e.g. investment decisions, with in turn pursue effects on demographic impacts, life expectancy and the degree of pain and suffering of patients.

Both the NHA and the MRHA are macroeconomic models for the German health economy. However, over the years we recognized that the first lacks a certain necessary degree of differentiation. This is the reason we developed the MRHA. It exhibits important regional characteristics and reveals interregional and inter-industry dependencies. Due to its existence we are able to address the current political challenge of lacking investments in German hospitals. This is one example for the close connection between expenses of the health system and its economic contribution at the same time, since federal states are obligated to finance hospital investments from tax revenues.

Due to the circumstance that budgets of federal states influence the amount of hospital investments taken, we developed a financial equalization scheme based on modelled interdependencies of federal states caused by patient treatment in the rest of the country. One advantage of this model is a high degree of transparency in the context of the equalization scheme. Another advantage is that the model demonstrates further effects from actual investments. We hence argue that this model has the potential to impact on current policy decisions. This is especially important in the context of the inadequacies of two related policy decisions, which is the future design of the Federal Financial Equalization System and the current adjustments in the Hospital Financing Act to cope with lagging investments.

Clear limitations of the approach is the modelled multiregional input-output table, due to its non-availability from statistical offices. Our work to compile the MRHA contributes to existing scientific research in this field, since it incorporates new approaches and exhibits realistic findings in this and a previous paper (Schwärzler & Kronenberg, 2017b). In an overall perspective, we believe it is worth considering to use multiregional tables in the context of financial equalization schemes of federal states in general, since they incorporate actual information on interregional dependencies. However, there is clearly a relatively high effort of such a scientific-based approach associated therewith, since it would require an ongoing monitoring based on a regular updating of the multiregional input-output model.

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