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Schwärzler, Marion Cornelia and Kronenberg, Tobias

WifOR Darmstadt, Bochum University of Applied Sciences

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Basic Results of the Multiregional Health Account for Germany

Validation of Indirect Effects of the Health Economy

Marion Cornelia Schwärzler¹, Tobias Kronenberg²

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Abstract: The Multiregional Health Account is a methodological enhancement of the National Health Account and adds a subnational regional dimension to the latter. Both satellite accounts aim to quantify the contribution of the German health economy in terms of gross value added, employment and trade. Moreover, since they are based on supply and use tables and thus input-output tables of the national accounting system, both models allow input-output analysis for a more thorough evaluation of the national and multiregional health economy. The challenge addressed in this paper consists in questioning the reliability of the results from multiregional input-output analysis based on the Multiregional Health Account. This is necessary due to the circumstance that no official multiregional input-output tables are available for German federal states and we elaborated a new methodology to derive multiregional tables on our own. Hence, we conduct input-output analysis to evaluate the performance of the multiregional input-output table in modeling intra- and interregional interdependencies. We find that the model succeeds in reproducing certain regional characteristics.

JEL Classification: C67, E01, I15, R11, R15

Key words: Input-output analysis, regionalization, satellite account, health economy, Germany, supply and use tables, SUT-RAS

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¹ WifOR, Darmstadt

² Bochum University of Applied Sciences

1 Introduction

The main database for the subsequent described input-output analysis is the Multiregional Health Account (MRHA), which is a methodological enhancement of the National Health Account (NHA). The latter was developed over years commissioned by the Federal Ministry for Economic Affairs and Energy (Henke et al., 2010; Ostwald et al., 2014; BMWi, 2015, 2016, 2017a; Schneider, et al., 2016; Schwärzler & Legler, 2016). The high heterogeneity of categories of the health economy observed during these research activities and from first attempts for an equivalent database on the subnational level (Ostwald et al., 2014, 2015a, 2015b, 2015c; Ostwald & Schwärzler, 2015; Ranscht, 2009; AG GGRdL, 2016; Schneider, 2013, 2014; BASYS & GÖZ, 2012) led to this research in the field of the multiregional health economy.

Hence, we pursued to apply the same methodology to compile this satellite account on health, which has been elaborated at the national level, also for the multiregional level for the sake of consistency in methodological terms and results (Schwärzler & Kronenberg, 2017a, 2017b). The main challenge, however, consists in the circumstance that the main database for the compilation, official supply and use tables of the national accounting system, are not available for German federal states. Hence, we developed a new methodology to compile multiregional supply and use tables for this purpose (Schwärzler & Kronenberg, 2017b).

Subsequent processing into a satellite account favors analyses regarding the reliability of the approach, since it enables focusing on specific characteristics. We want to point out here that the methodology of the NHA and therefore the MRHA refers to a product-specific approach. The ratio behind this is that we want to quantify the economic contribution of all health care products and services irrespective of questions regarding responsibility in financial terms and the producing industry. Consequently, the direct effects of the health economy in terms of i.e. GVA already refer to modelled information, since only industry-specific information but no product-specific information is available for German federal states in this context. This is the rationale behind an already conducted assessment of direct effects of the MRHA (Schwärzler & Kronenberg, 2017c) in order to challenge result calculated (BWMi 2017b).

Hence, this paper on the assessment of indirect effects of the multiregional health economy is already the second step of the validation procedure, since the assessment on direct effects found that the model succeeds in reproducing certain characteristics of the health economy not only for one year but also in a time series (Schwärzler & Kronenberg, 2017c). Indirect effects are derived from conducting input-output analysis. It captures the complex interdependencies of the economy. Therefore, it is challenging to conduct a reliable validation without having a survey-based multiregional input-output table at hand. This is the rationale for focusing on the main beneficiaries of effects among federal states and industries in this paper in order to assess the reliability of the approach in the context of intra- and interregional dependencies. The results refer to 2011, since the latest and for the compilation necessary generic supply and use tables at the national level available to us correspond to that year.

The remainder of this paper is structured as follows. Section **Fehler! Verweisquelle konnte nicht gefunden werden.** initiates the results with a general assessment of interregional interdependencies. Subsequently, we focus on indirect output effects of five specific categories of the health economy, which is medication manufacturing, medical products manufacturing, in- and outpatient treatment, organic food supply and health tourism. Section 3 summarizes and concludes.

2 Indirect output effects of selected categories of the health economy

In this section, we evaluate indirect output effects of the health economy by conducting input-output analysis based on the standard static open model. In order to facilitate an assessment regarding the reasonability of the results, we aim to identify specific characteristics of intra- and interregional contributors in contrast to just name most important beneficiaries of indirect effects in the following subsections.

Indirect effects highly depend on the amount of interregional trade. A high proportion of interregional imports implies lower indirect effects in the federal state of concern, while it results in higher indirect effects for the interregional exporting federal states. The same applies vice versa. For this reason we refer to the following tables, which focus on overall interdependencies of German federal states. They depict modelled direct intra- and interregional dependencies in absolute and relative terms according to the domestic use table.

Table 1: Direct overall interdependencies of German federal states in M. €, 2011²

	BW	BY	BE	BB	HB	HH	HE	MV	NI	NW	RP	SL	SN	ST	SH	TH
BW	532,759	53,219	10,126	6,121	2,537	9,780	25,676	2,921	25,451	70,600	10,947	3,196	9,717	5,803	7,196	5,130
BY	51,946	636,125	12,659	7,737	3,161	12,181	32,131	3,703	31,933	87,839	13,884	3,955	12,337	7,361	9,074	6,499
BE	8,348	10,735	111,673	1,249	529	2,138	5,453	616	5,029	13,848	2,226	620	1,927	1,150	1,510	1,002
BB	6,035	7,893	1,609	69,417	392	1,576	3,951	476	3,851	10,621	1,715	474	1,504	908	1,147	788
HB	1,962	2,446	443	272	39,486	433	1,176	128	1,202	3,122	483	146	429	254	319	228
HH	4,995	6,296	1,324	748	339	127,051	3,244	358	2,976	8,205	1,325	374	1,164	688	887	592
HE	18,512	23,948	4,909	2,898	1,237	4,874	269,312	1,386	11,445	32,016	5,142	1,425	4,486	2,674	3,405	2,315
MV	4,040	5,285	1,047	660	260	1,032	2,626	45,209	2,592	6,919	1,137	310	1,005	609	773	532
NI	25,045	32,103	6,149	3,789	1,549	5,997	15,767	1,808	313,645	41,971	6,731	1,895	5,871	3,533	4,450	3,121
NW	60,917	79,010	15,915	9,504	3,965	15,642	39,472	4,544	37,776	763,080	16,906	4,798	14,782	8,814	11,235	7,669
RP	12,477	16,307	3,257	1,980	796	3,183	8,116	949	7,848	22,100	150,371	971	3,062	1,849	2,312	1,611
SL	2,879	3,671	709	435	179	688	1,811	203	1,785	5,099	768	44,863	683	405	509	360
SN	12,079	15,543	3,017	1,826	737	2,923	7,621	875	7,439	20,688	3,276	931	125,719	1,704	2,155	1,501
ST	5,778	7,639	1,514	948	371	1,514	3,856	444	3,702	10,503	1,704	456	1,426	69,304	1,107	758
SH	7,954	10,322	2,043	1,265	515	2,051	5,116	608	4,975	13,574	2,193	606	1,926	1,166	91,643	1,010
TH	5,938	7,754	1,516	931	370	1,474	3,845	445	3,733	10,514	1,676	465	1,435	869	1,098	62,949

Source: own calculations.

Table 2: Direct overall interdependencies of German federal states in percentage shares, 2011

	BW	BY	BE	BB	HB	HH	HE	MV	NI	NW	RP	SL	SN	ST	SH	TH
BW	0.68	0.07	0.01	0.01	0.00	0.01	0.03	0.00	0.03	0.09	0.01	0.00	0.01	0.01	0.01	0.01
BY	0.06	0.68	0.01	0.01	0.00	0.01	0.03	0.00	0.03	0.09	0.01	0.00	0.01	0.01	0.01	0.01
BE	0.05	0.06	0.66	0.01	0.00	0.01	0.03	0.00	0.03	0.08	0.01	0.00	0.01	0.01	0.01	0.01
BB	0.05	0.07	0.01	0.62	0.00	0.01	0.04	0.00	0.03	0.09	0.02	0.00	0.01	0.01	0.01	0.01
HB	0.04	0.05	0.01	0.01	0.75	0.01	0.02	0.00	0.02	0.06	0.01	0.00	0.01	0.00	0.01	0.00
HH	0.03	0.04	0.01	0.00	0.00	0.79	0.02	0.00	0.02	0.05	0.01	0.00	0.01	0.00	0.01	0.00
HE	0.05	0.06	0.01	0.01	0.00	0.01	0.69	0.00	0.03	0.08	0.01	0.00	0.01	0.01	0.01	0.01
MV	0.05	0.07	0.01	0.01	0.00	0.01	0.04	0.61	0.04	0.09	0.02	0.00	0.01	0.01	0.01	0.01
NI	0.05	0.07	0.01	0.01	0.00	0.01	0.03	0.00	0.66	0.09	0.01	0.00	0.01	0.01	0.01	0.01
NW	0.06	0.07	0.01	0.01	0.00	0.01	0.04	0.00	0.03	0.70	0.02	0.00	0.01	0.01	0.01	0.01
RP	0.05	0.07	0.01	0.01	0.00	0.01	0.03	0.00	0.03	0.09	0.63	0.00	0.01	0.01	0.01	0.01
SL	0.04	0.06	0.01	0.01	0.00	0.01	0.03	0.00	0.03	0.08	0.01	0.69	0.01	0.01	0.01	0.01
SN	0.06	0.07	0.01	0.01	0.00	0.01	0.04	0.00	0.04	0.10	0.02	0.00	0.60	0.01	0.01	0.01
ST	0.05	0.07	0.01	0.01	0.00	0.01	0.03	0.00	0.03	0.09	0.02	0.00	0.01	0.62	0.01	0.01
SH	0.05	0.07	0.01	0.01	0.00	0.01	0.03	0.00	0.03	0.09	0.01	0.00	0.01	0.01	0.62	0.01
TH	0.06	0.07	0.01	0.01	0.00	0.01	0.04	0.00	0.04	0.10	0.02	0.00	0.01	0.01	0.01	0.60

Source: own calculations.

² BW = Baden-Württemberg, BY = Bavaria, BE = Berlin, BB = Brandenburg, HB = Bremen, HH = Hamburg, HE = Hesse, MV = Mecklenburg-Western Pomerania, NI = Lower Saxony, NW = North Rhine Westphalia, RP = Rhineland Palatinate, SL = Saarland, SN = Saxony, ST = Saxony-Anhalt, SH = Schleswig-Holstein, TH = Thuringia

The diagonal elements reveal intraregional trade flows, while off-diagonal elements provide information on the interregional export and import of the overall economy. Each row of Table 2 sums up to 100 percent since every single cell represents the percentage share of output it obtains from the supplying federal state. We provide this information over here in order to facilitate an initial assessment of interregional dependencies and to challenge these results with different models in the context of multiregional supply and use tables of German federal states.

In order to conduct input-output analysis, we calculated a multiregional input-output table from the compiled satellite account comprising of multiregional supply and use tables. We applied the commodity technology in this case for the sake of consistency with the official input-output table of Germany (Destatis, 2010), according to (Miller & Blair, 2009)

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

with Z corresponding to the final entries of the input-output table, V and U referring to the supply and use table and \hat{x} representing the diagonal matrix of product-specific total output. We take into account resulting negative values in the input-output table. Schwärzler & Kronenberg (2016) provide a detailed description on the procedure.

The resulting multiregional input-output table exhibits interdependencies of the 16 federal states for non-health and health-related categories. Non-health categories refer to the 63 industries of the official national supply and use tables, of which output and intermediate use of health-related products were subtracted. Categories of health refer to the established definition provided in Schwärzler & Kronenberg (2016), but can be further differentiated for the sake of enabling certain analyses. This implies that the results provided in the following subsections cannot be directly compared to official ones, since we conduct our calculations based on a health-input-output table with categories deviating from known CPA/NACE categories.

Indirect output effects are calculated according to the Leontief inverse (Miller & Blair, 2009):

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

where x corresponds to output and A to the technology matrix, the entries of the latter defined by

$$a_{ij} = \frac{z_{ij}}{x_j}$$

where z_{ij} refers to direct input of product i to industry j .

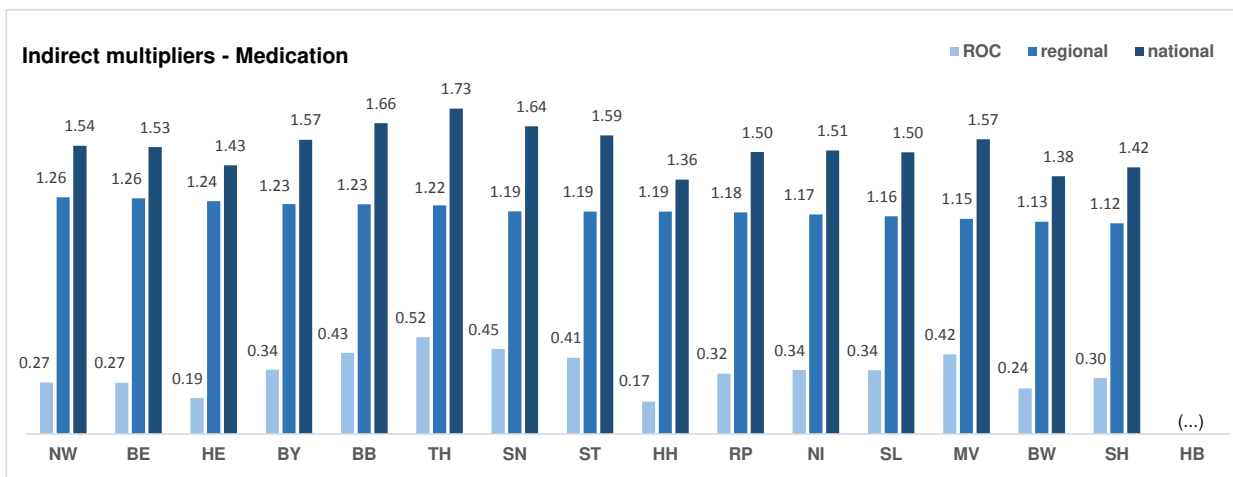
2.1 Indirect effects of medication manufacturing in German federal states in 2011

In this subsection, we evaluate the indirect output effects from medication manufacturing. The national multiplier from the NHA is 1.48, which can be obtained from Figure 2. This category is closest to pharmaceutical products (CPA 21) in terms of its composition of products. Official data shows a multiplier of 1.38 for this category (Destatis, 2015).

As in most cases, North Rhine-Westphalia shows the highest regional multiplier among federal states. This is reasonable since North Rhine-Westphalia is the biggest federal state of Germany in terms of GDP and exhibits a corresponding high diversification of economic activities. In general, industries affected by indirect

effects are different regarding the initial impulse. However, some industries show a general high influence, which is energy in the case of North Rhine-Westphalia. This is reasonable, since this federal state supplies one third of overall German energy output (MKULNV, 2014). In the special case of medication manufacturing, which is the focus of this subsection, an above-average amount of indirect effects also arises from wholesale trade of medication and manufacturing of chemical products. Especially the last fact is not surprising, since the chemical industry of North Rhine-Westphalia generates about one third of overall German sales in this context and looks back at a long and successful history in a close relationship to the coal and steel industry in earlier days (Chemieatlas, 2017).

Figure 1: Indirect output multipliers of medication manufacturing, 2011



(...) output value too low for reasonable interpretation

Source: own calculations.

It is quite different in the case of Berlin, which exhibits an indirect regional multiplier of the same amount. This is very special for this city state, since it shows considerably lower multipliers in the context of other categories. Hence, manufacturing of medication is a special case for Berlin. In particular, this is caused by high indirect effects in public administration, consulting services for health facilities and medication manufacturing itself. The first fact is reasonable, since Berlin is the capital city of Germany and consequently shows above-average activities in public administration. Moreover, nine out of the ten leading auditing and tax consultancy companies of Germany (Lünendonk, 2016) have branches in Berlin. A close cooperation between pharmaceutical industries and health facilities hence explain resulting effects on related consulting services (Health Capital, 2014). Moreover, the high effect on medication manufacturing is reasonable due to the existence of a cluster and accordingly a strong collaboration in this area (idibem).

Hesse shows the third highest regional indirect output multiplier in this case. Due to its strong economy, this is no extraordinary special case. Air transport services contribute to a significantly above-average amount to this characteristic, compared to the other federal states. This is supported by the airport company Fraport AG itself, according to which a vast majority of chemical and pharmaceutical companies could not exist without their closeness to the airport (Fraport AG, 2017a). This is mostly due to 7,000 m² of space for ground handling operations exclusively for pharmaceutical products (Fraport AG, 2017b).

In addition, financial services are a main promoter of indirect effects. This is again reasonable, since the city Frankfurt in Hesse is the most important financial center in Germany due to an agglomeration of important players, the European Central bank, the German Central Bank and the German Stock Exchange among them (IAB, 2013). Since manufacturing of medication is of above-average importance for the economy in Hesse, it is plausible that there is an above-average indirect output effect on this category as well. The low rest-of-country (ROC) multiplier of Hesse is remarkable, since it indicates a relatively low dependency on other federal states in the case of medication manufacturing.

From Figure 1 we can also obtain the highest national multiplier for Thuringia, promoted by an accompanying high ROC multiplier. This circumstance mostly derives from an above-average dependency concerning chemical products and wholesale trade of medication manufacturing in this federal state.

Figure 2: Indirect output multipliers of medication manufacturing, 2011

1.48	BW	BY	BE	BB	HB	HH	HE	MV	NI	NW	RP	SL	SN	ST	SH	TH
BW	1.13	0.04	0.01	0.01	0.00	0.01	0.03	0.00	0.02	0.07	0.01	0.00	0.01	0.01	0.01	0.00
BY	0.05	1.23	0.02	0.01	0.00	0.02	0.05	0.00	0.03	0.11	0.02	0.00	0.01	0.01	0.01	0.01
BE	0.03	0.05	1.26	0.01	0.00	0.01	0.04	0.00	0.02	0.07	0.01	0.00	0.01	0.00	0.01	0.00
BB	0.05	0.07	0.02	1.23	0.00	0.02	0.04	0.00	0.04	0.12	0.02	0.00	0.02	0.01	0.01	0.01
HB	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
HH	0.02	0.03	0.01	0.00	0.00	1.19	0.02	0.00	0.01	0.05	0.01	0.00	0.01	0.00	0.00	0.00
HE	0.03	0.04	0.01	0.00	0.00	0.01	1.24	0.00	0.02	0.06	0.01	0.00	0.01	0.00	0.00	0.00
MV	0.05	0.07	0.02	0.01	0.00	0.02	0.05	1.15	0.03	0.11	0.02	0.00	0.01	0.01	0.01	0.01
NI	0.04	0.06	0.02	0.01	0.00	0.02	0.05	0.00	1.17	0.10	0.02	0.00	0.01	0.01	0.01	0.01
NW	0.04	0.06	0.02	0.01	0.00	0.02	0.05	0.00	0.03	1.26	0.02	0.00	0.01	0.01	0.01	0.01
RP	0.04	0.05	0.02	0.01	0.00	0.01	0.04	0.00	0.02	0.09	1.18	0.00	0.01	0.01	0.01	0.01
SL	0.04	0.06	0.01	0.01	0.00	0.01	0.04	0.00	0.03	0.09	0.01	1.16	0.01	0.01	0.01	0.01
SN	0.05	0.07	0.02	0.01	0.00	0.02	0.06	0.00	0.03	0.12	0.02	0.00	1.19	0.01	0.01	0.01
ST	0.05	0.07	0.02	0.01	0.00	0.02	0.05	0.00	0.03	0.11	0.02	0.00	0.01	1.19	0.01	0.01
SH	0.04	0.05	0.01	0.01	0.00	0.01	0.04	0.00	0.02	0.08	0.01	0.00	0.01	0.01	1.12	0.00
TH	0.06	0.08	0.02	0.01	0.00	0.02	0.06	0.00	0.04	0.14	0.03	0.00	0.02	0.01	0.01	1.22

■ national multiplier ■ top 5 regional indirect output multipliers | (...) output value too low for reasonable interpretation

Source: own calculations.

We do not want to focus on multipliers exclusively, since it ignores the relative importance of absolute indirect effects for the economy in consideration. Hence, we calculated the share of absolute indirect effects, shown in Figure 3, on the corresponding overall output of the economy in consideration. We highlight calculated above-average values in order to combine information of absolute values and corresponding relevance.

A high relevance of regional indirect effects from own output is indicated by a red frame in Figure 3, pointing towards Baden-Württemberg, Hesse, North Rhine-Westphalia Rhineland-Palatinate and Saxony-Anhalt in this case. This is mostly due to the above-average relevance of medication manufacturing in these federal states. The only exception to this circumstance is North Rhine-Westphalia. However, it is the corresponding high regional multiplier, which results in an above-average relevance of regional indirect effects in North Rhine-Westphalia.

Figure 3: Indirect output effects of medication manufacturing, 2011

	BW	BY	BE	BB	HB	HH	HE	MV	NI	NW	RP	SL	SN	ST	SH	TH
BW	996	334	85	43	21	85	243	18	158	536	89	20	69	40	47	34
BY	128	617	50	21	10	46	141	9	79	294	48	10	36	21	23	17
BE	23	31	173	3	2	8	27	2	13	50	8	2	6	3	4	3
BB	23	33	7	100	2	8	19	2	16	51	9	2	7	4	5	4
HB	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
HH	6	8	3	1	0	53	7	0	4	13	2	0	2	1	1	1
HE	178	243	73	28	14	63	1,670	12	108	396	63	14	49	27	32	23
MV	4	5	1	1	0	1	4	11	2	8	1	0	1	1	1	0
NI	52	73	20	9	4	19	57	4	214	123	20	4	15	9	10	7
NW	214	294	86	35	17	76	242	15	131	1,298	79	17	59	33	39	28
RP	62	86	25	10	5	22	71	4	38	143	293	5	17	10	11	8
SL	2	3	1	0	0	1	2	0	2	5	1	10	1	0	1	0
SN	38	53	16	6	3	14	43	3	23	88	14	3	133	6	7	5
ST	56	78	22	9	4	20	63	4	35	130	21	4	16	219	10	7
SH	24	33	10	4	2	9	28	2	15	54	8	2	7	4	85	3
TH	20	29	7	4	2	7	19	2	13	49	9	2	6	4	4	75

indicating direct relationship
 top 5 most affected regions by indirect effects from own output
 top 3 most affected regions by indirect effects from federal state in y-axis

(...) output value too low for reasonable interpretation

Source: own calculations.

A high relevance of regional indirect output effects from output of other federal states is indicated by a blue filling in Figure 3. Accordingly, the overall economies of Berlin, Hamburg, Hesse and North Rhine-Westphalia profit the most from medication manufacturing in other federal states. Berlin profits in an extraordinary way from high indirect effects contributed by public administration, while Hamburg benefits in terms of refined petroleum products due to their high importance for this federal state (Statistik Nord, 2016) and the fact that respective refineries are at the start of industrial value-added chains (MWV, 2015). Large indirect effects arise in medication manufacturing in Hesse, while wholesale trade and manufacturing of chemical products in North Rhine-Westphalia profit in an extraordinary way from medication manufacturing in other federal states.

2.2 Indirect effects of medical products manufacturing in German federal states in 2011

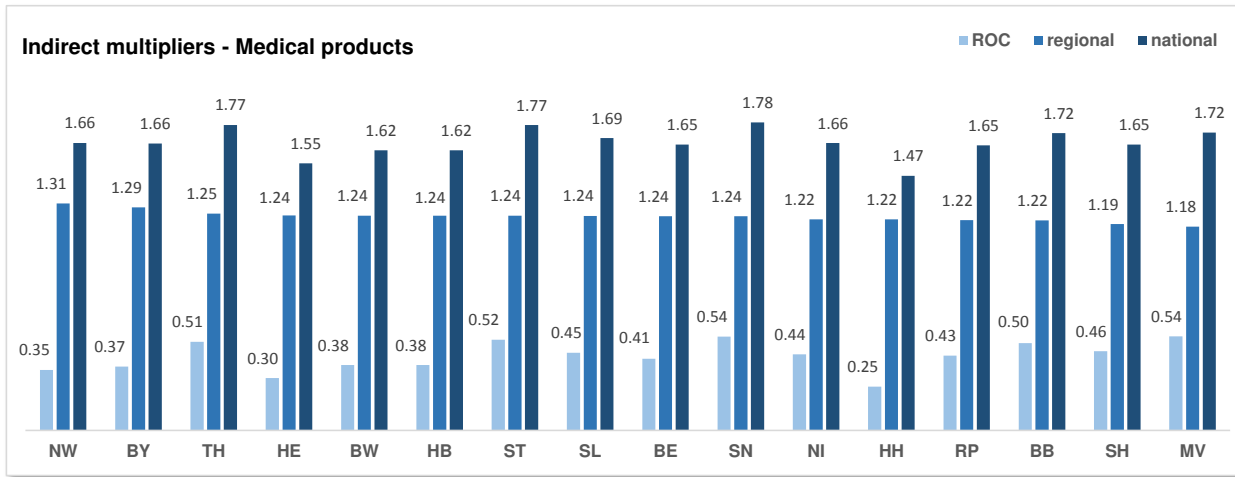
The category of medical products refers to products mostly from CPA 26 and CPA 31-32, which is 'Computer, electronic and optical products' and 'Manufacture of furniture; other manufacturing'. The national indirect output multiplier of medical products manufacturing is 1.65. The corresponding multipliers from related CPAs are 1.62 and 1.66 according to official data (Destatis, 2015).

In the case of medical products manufacturing, North Rhine-Westphalia again exhibits the highest regional indirect output multiplier among federal states. Next to chemical products, wholesale trade and energy, manufacturing of basic metals and fabricated metal products profit from this activity in North Rhine-Westphalia. This is reasonable, since North Rhine-Westphalia supplies about 38 percent of overall German steel and employs about 56 percent of corresponding employees. (MWEIMH NRW et al., 2015).

The previous paragraph already indicates certain differences between medication and medical products. In the following, we will obtain the high diversification of medical products even more when we look at the

characteristics of indirect effects. Hence, it is useful to recall the product range of this category involving large medical equipment, wheelchairs, visual aids, human medicine instruments and dental products among other things.

Figure 4: Indirect output multipliers of medical products manufacturing, 2011



Source: own calculations.

Hence, manufacturing of medical products causes indirect effects on a highly differentiated product range, especially such as computer, electronic and optical products in Bavaria and products of wood, cork, rubber, plastic and fabricated metal in Thuringia. Moreover, it shows a strong reciprocal relationship, since it causes again high indirect effects on medical products in Bavaria, Thuringia and Baden-Württemberg. The latter federal state is especially interesting in this case, since it shows relatively low regional multipliers in general due to a strong international orientation. However, large indirect effects in computer, machinery, electronic and optical products cause this significant high regional multiplier in Baden-Württemberg. Reality supports the depicted high effects on the regional economy, since activities in that field nearly cover the overall product range of medical products and are characterized by close collaborations with practice-oriented research facilities (BW-I, 2015).

Figure 5: Indirect output multipliers of medical products manufacturing, 2011

	BW	BY	BE	BB	HB	HH	HE	MV	NI	NW	RP	SL	SN	ST	SH	TH
1.65	1.24	0.08	0.01	0.01	0.00	0.02	0.04	0.00	0.03	0.11	0.02	0.00	0.01	0.01	0.01	0.01
BW	1.24	0.08	0.01	0.01	0.00	0.02	0.04	0.00	0.03	0.11	0.02	0.00	0.01	0.01	0.01	0.01
BY	0.06	1.29	0.02	0.01	0.00	0.02	0.04	0.00	0.03	0.12	0.02	0.00	0.02	0.01	0.01	0.01
BE	0.06	0.08	1.24	0.01	0.00	0.02	0.04	0.00	0.03	0.11	0.02	0.00	0.01	0.01	0.01	0.01
BB	0.07	0.09	0.02	1.22	0.00	0.02	0.05	0.00	0.04	0.13	0.02	0.01	0.02	0.01	0.01	0.01
HB	0.04	0.06	0.01	0.01	1.20	0.01	0.03	0.00	0.03	0.09	0.01	0.00	0.01	0.01	0.01	0.01
HH	0.04	0.05	0.01	0.00	0.00	1.22	0.03	0.00	0.02	0.07	0.01	0.00	0.01	0.00	0.01	0.00
HE	0.04	0.06	0.01	0.01	0.00	0.01	1.24	0.00	0.03	0.09	0.01	0.00	0.01	0.01	0.01	0.01
MV	0.07	0.10	0.02	0.01	0.00	0.02	0.05	1.18	0.04	0.14	0.02	0.01	0.02	0.01	0.01	0.01
NI	0.06	0.09	0.02	0.01	0.00	0.02	0.05	0.00	1.22	0.12	0.02	0.01	0.02	0.01	0.01	0.01
NW	0.06	0.09	0.02	0.01	0.00	0.02	0.05	0.00	0.04	1.31	0.02	0.01	0.02	0.01	0.01	0.01
RP	0.06	0.08	0.02	0.01	0.00	0.02	0.04	0.00	0.03	0.12	1.22	0.00	0.02	0.01	0.01	0.01
SL	0.06	0.08	0.01	0.01	0.00	0.02	0.04	0.00	0.03	0.12	0.02	1.24	0.02	0.01	0.01	0.01
SN	0.08	0.10	0.02	0.01	0.00	0.02	0.05	0.00	0.04	0.15	0.02	0.01	1.24	0.01	0.01	0.01
ST	0.07	0.10	0.02	0.01	0.00	0.02	0.05	0.00	0.04	0.14	0.02	0.01	0.02	1.24	0.01	0.01
SH	0.06	0.09	0.02	0.01	0.00	0.02	0.05	0.00	0.04	0.12	0.02	0.01	0.02	0.01	1.19	0.01
TH	0.07	0.10	0.02	0.01	0.00	0.02	0.05	0.00	0.04	0.14	0.02	0.01	0.02	0.01	0.01	1.25

■ national multiplier ■ top 5 regional indirect output multipliers | (...) output value too low for reasonable interpretation

Source: own calculations.

The highest ROC multipliers from manufacturing medical products occur in Saxony and Mecklenburg-Western Pomerania. The first is highly dependent on metal products and electrical equipment from North Rhine-Westphalia, next to medical products from Bavaria. Mecklenburg-Western Pomerania also exhibits a high dependence on medical products from Bavaria, next to extraordinary high indirect output effects in rental and leasing services in North Rhine-Westphalia.

The five most affected regions by absolute indirect output effects from own supply are Baden-Württemberg, Bavaria, Hamburg, Schleswig-Holstein and Thuringia. All show above average relevance of medical products for the economies in consideration.

Figure 6: Indirect output effects of medical products manufacturing, 2011

	BW	BY	BE	BB	HB	HH	HE	MV	NI	NW	RP	SL	SN	ST	SH	TH
BW	1,244	414	74	44	21	79	211	20	168	580	87	25	76	45	51	43
BY	435	2,088	108	64	30	116	308	29	246	840	127	36	110	66	75	63
BE	58	80	239	8	4	15	43	4	32	109	16	5	14	8	10	8
BB	29	40	7	93	2	8	21	2	17	58	9	2	8	5	5	4
HB	6	9	2	1	29	2	4	0	4	12	2	1	2	1	1	1
HH	45	63	12	6	3	276	32	3	24	82	12	3	11	6	8	6
HE	106	147	28	16	7	30	579	7	60	204	31	8	27	16	18	15
MV	22	31	6	3	1	6	16	52	12	40	6	2	5	3	4	3
NI	89	122	22	13	6	24	64	6	310	171	26	7	22	13	15	13
NW	279	383	70	42	19	76	201	19	158	1,389	83	23	71	42	48	41
RP	48	67	13	7	3	14	37	3	28	96	179	4	12	7	9	7
SL	14	20	4	2	1	4	10	1	8	28	4	57	4	2	2	2
SN	64	88	16	9	4	17	45	4	35	125	19	5	204	9	11	9
ST	28	39	7	4	2	8	21	2	16	55	9	2	7	97	5	4
SH	70	97	17	10	5	19	50	5	39	134	20	6	17	10	216	10
TH	45	63	11	7	3	12	32	3	26	89	14	4	11	7	8	166

indicating direct relationship
 top 5 most affected regions by indirect effects from own output
 top 3 most affected regions by indirect effects from federal state in y-axis

Source: own calculations.

The federal states Bavaria, Hesse, North Rhine-Westphalia and Thuringia profit the most from indirect effects caused by medical products manufactured in other federal states. Referring industries are computer, electronic, optical and medical products in Bavaria, financial and airport transport services in Hesse, basic metal in North Rhine-Westphalia and medical, rubber, plastic, fabricated metal and wood products in Thuringia. Especially the last federal state shows specifics in this category, since it does not reveal the same economic diversification as the other named regions. However, medical products are indeed a special field in Thuringia, due to clusters consisting of innovative companies and research facilities (Thüringen innovativ, 2006). Moreover, the demonstrated high relevance of Bavaria is not surprising in this context, since activities in this area are perceived as extraordinary important drivers for innovation and economic growth. Moreover, they generate significant effects for supplier industries in this federal state (Forum MedTech Pharma e.V., 2015).

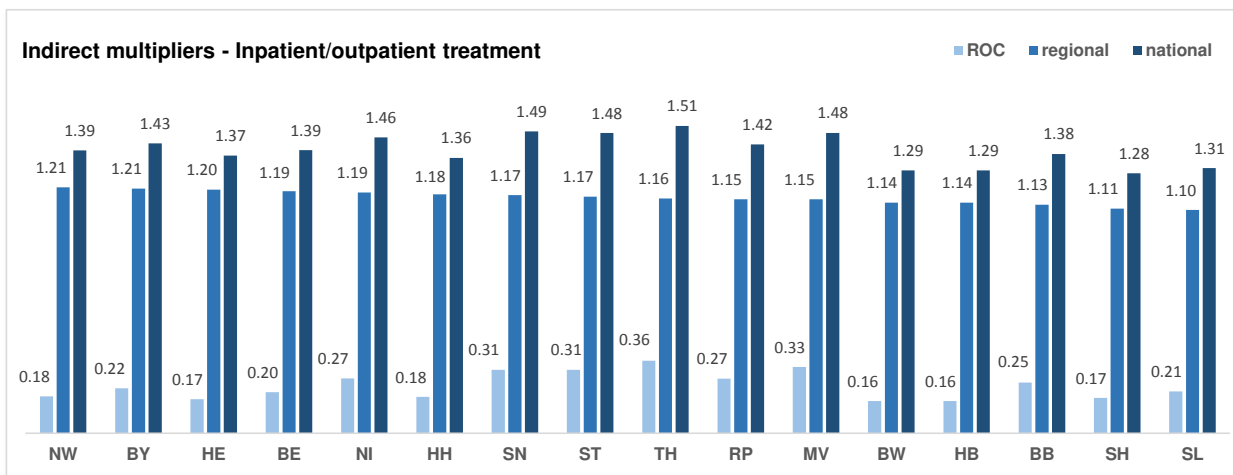
2.3 Indirect effects of in- and outpatient treatment in German federal states in 2011

The closest related category of inpatient and outpatient treatment corresponds to 'Human health services' (CPA 86). Official data exhibits an indirect output multiplier of 1.40 for this category (Destatis, 2015). The

national multiplier of inpatient and outpatient treatment according to the NHA is 1.41, which can be obtained from Figure 8.

The highest regional indirect output multiplier from inpatient and outpatient treatment occurs in North Rhine-Westphalia. Among others, already described general contributing industries, an extraordinary amount of indirect output effects emerge in retail trade with medical products, related collaborating health service facilities and wholesale trade with medical products and medication.

Figure 7: Indirect output multipliers of inpatient and outpatient treatment, 2011



Source: own calculations.

In Bavaria, manufacturing, related health service facilities and trade services of medical products are in an extraordinary way responsible for the high regional indirect output multiplier. Medication manufacturing and health care facilities contribute largely to the high regional multiplier in Hesse.

Figure 8: Indirect output multipliers of inpatient and outpatient treatment, 2011

1.41	BW	BY	BE	BB	HB	HH	HE	MV	NI	NW	RP	SL	SN	ST	SH	TH
BW	1.14	0.03	0.01	0.00	0.00	0.01	0.02	0.00	0.01	0.05	0.01	0.00	0.01	0.00	0.00	0.00
BY	0.03	1.21	0.01	0.01	0.00	0.01	0.03	0.00	0.02	0.07	0.01	0.00	0.01	0.01	0.01	0.00
BE	0.03	0.04	1.19	0.00	0.00	0.01	0.02	0.00	0.02	0.05	0.01	0.00	0.01	0.00	0.01	0.00
BB	0.03	0.04	0.01	1.13	0.00	0.01	0.03	0.00	0.02	0.07	0.01	0.00	0.01	0.00	0.01	0.00
HB	0.02	0.03	0.01	0.00	1.11	0.01	0.02	0.00	0.01	0.05	0.01	0.00	0.01	0.00	0.00	0.00
HH	0.02	0.03	0.01	0.00	0.00	1.18	0.02	0.00	0.01	0.05	0.01	0.00	0.01	0.00	0.00	0.00
HE	0.02	0.03	0.01	0.00	0.00	0.01	1.20	0.00	0.01	0.05	0.01	0.00	0.01	0.00	0.00	0.00
MV	0.04	0.06	0.01	0.01	0.00	0.01	0.04	1.15	0.03	0.08	0.01	0.00	0.01	0.01	0.01	0.01
NI	0.04	0.05	0.01	0.01	0.00	0.01	0.03	0.00	1.19	0.08	0.01	0.00	0.01	0.01	0.01	0.00
NW	0.03	0.04	0.01	0.00	0.00	0.01	0.03	0.00	0.02	1.21	0.01	0.00	0.01	0.00	0.01	0.00
RP	0.04	0.05	0.01	0.01	0.00	0.01	0.03	0.00	0.02	0.07	1.15	0.00	0.01	0.01	0.01	0.00
SL	0.03	0.04	0.01	0.00	0.00	0.01	0.02	0.00	0.02	0.05	0.01	1.10	0.01	0.00	0.01	0.00
SN	0.04	0.06	0.01	0.01	0.00	0.01	0.04	0.00	0.03	0.08	0.01	0.00	1.17	0.01	0.01	0.01
ST	0.04	0.06	0.01	0.01	0.00	0.01	0.04	0.00	0.03	0.08	0.01	0.00	0.01	1.17	0.01	0.00
SH	0.02	0.03	0.01	0.00	0.00	0.01	0.02	0.00	0.01	0.05	0.01	0.00	0.01	0.00	1.11	0.00
TH	0.05	0.06	0.02	0.01	0.00	0.01	0.04	0.00	0.03	0.09	0.01	0.00	0.01	0.01	0.01	1.16

■ national multiplier ■ top 5 regional indirect output multipliers (...) output value too low for reasonable interpretation

Source: own calculations.

Thuringia is most dependent on the rest of the country when it comes to indirect output effects, indicated by the highest ROC multiplier. Unlike manufacturing industries, supply of inpatient and outpatient health care does not require specific intermediate consumption in regard of the federal state in consideration.

Hence, the composition of national indirect output effects of inpatient and outpatient service does not vary among federal state to a great amount. The ROC multiplier behaves similarly for the same reason. Therefore, we cannot distinguish any specific characteristic for Thuringia. The most driving forces however, but not exclusively for Thuringia, are supply of energy, food products, imputed rents including owner-occupied dwellings and construction of health care facilities.

The top five most affected regions by indirect effects from own output are Berlin, Mecklenburg-Western Pomerania, North Rhine-Westphalia, Saxony and Thuringia. All these regions show an above-average importance of inpatient and outpatient treatment for their economy.

Figure 9: Indirect output effects of inpatient and outpatient treatment, 2011

	BW	BY	BE	BB	HB	HH	HE	MV	NI	NW	RP	SL	SN	ST	SH	TH
BW	3,765	889	215	97	43	179	555	51	399	1,288	184	49	165	95	126	79
BY	1,182	7,085	392	178	79	327	1,015	93	732	2,358	337	89	302	174	230	145
BE	263	363	1,879	39	17	72	231	20	160	528	74	20	66	38	50	32
BB	166	229	55	639	11	45	144	13	102	333	47	12	42	24	32	20
HB	47	65	16	7	222	13	41	4	29	95	13	4	12	7	9	6
HH	135	186	46	20	9	1,008	117	11	83	269	38	10	34	20	26	16
HE	382	525	128	57	26	107	3,186	30	235	763	109	29	97	56	74	47
MV	171	237	57	26	11	47	148	620	106	342	48	13	44	25	33	21
NI	777	1,074	258	116	51	213	673	61	3,843	1,556	221	58	198	115	152	95
NW	1,557	2,144	519	233	106	432	1,349	122	960	10,500	440	117	396	228	302	189
RP	344	475	115	51	22	94	300	27	212	691	1,477	26	87	50	67	42
SL	72	99	24	11	5	20	62	6	44	144	20	270	18	11	14	9
SN	407	561	134	61	27	110	351	32	251	817	116	31	1,712	60	79	50
ST	223	308	74	33	15	60	193	17	138	448	64	17	57	907	43	27
SH	163	224	54	24	11	45	140	13	101	325	46	12	42	24	756	20
TH	249	345	82	37	16	67	216	19	154	501	71	19	63	37	48	842

indicating direct relationship
 top 5 most affected regions by indirect effects from own output
 top 3 most affected regions by indirect effects from federal state in y-axis

Source: own calculations.

Economies of Bavaria, Berlin, Hesse and North Rhine-Westphalia are most affected by indirect output effects from inpatient and outpatient treatment in other federal states. This is reasonable, since all these federal states exhibit extraordinary characteristics in certain activities regarding manufacturing and trade services of medical products and medication. In Bavaria this applies to medical products, while it is medication in the case of Berlin and Hesse. In North Rhine-Westphalia, wholesale of both, medication and medical products, profit in an above-average way from inpatient and outpatient treatment of other federal states.

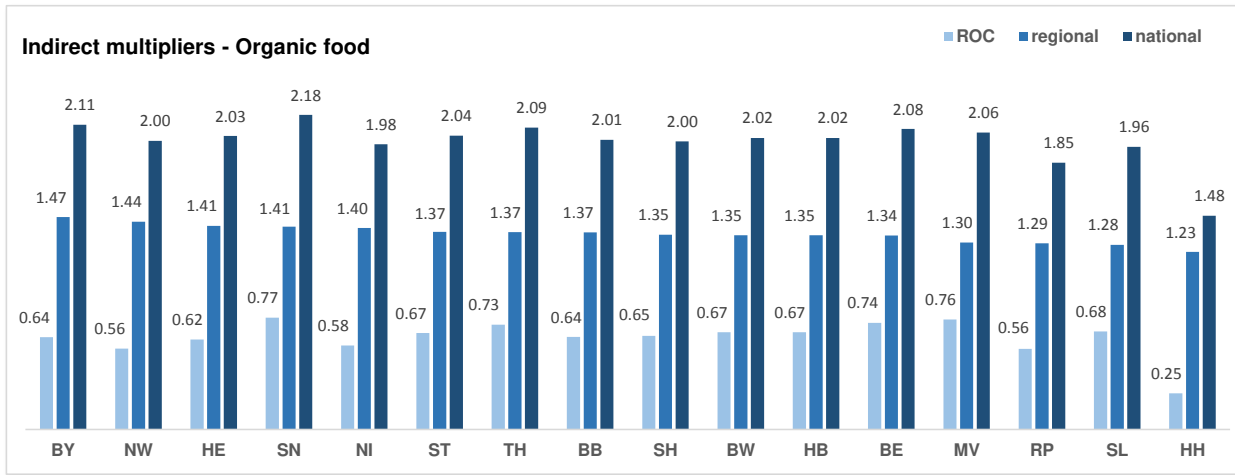
2.4 Indirect effects of organic food supply in German federal states in 2011

Organic food supply consists of selected categories of ‘Products of agriculture, hunting and related services’ (CPA 01) and ‘Food products, beverages and tobacco products’ (CPA 10-12). Corresponding indirect output multipliers from official data are 1.86 and 1.11 (Destatis, 2015). The national multiplier of organic food supply according to the NHA can be obtained from Figure 11, referring to 1.99.

In this subsection, we focus on indirect output effects from organic food supply of German federal states in 2011. We chose this category, since it provides another and quite different area compared to what has

been evaluated in this section so far. Moreover, evidence shows that domestic effects from agri-food production are high even for industrialized countries (Semerák et al., 2010). Hence, we find it interesting to take a closer look at this often underestimated part of the economy in the present multiregional context.

Figure 10: Indirect output multipliers of organic food supply, 2011



Source: own calculations.

The highest regional indirect output multiplier can be observed in Bavaria, showing specific characteristics regarding high amounts of indirect output in products of agriculture, food and machinery. This is not surprising, since Bavaria exhibits the highest absolute area of both, agricultural land and organic farming (i.m.a, 2013). The growing relevance of machinery in agriculture favors the production of corresponding products. In addition to a general high importance of machinery in Bavaria, important manufacturers of harvesting machines are based in this federal state, Fendt® (AGCO GmbH, 2017) and CLAAS KGaA mbH (CLAAS KGaA mbH, 2017) among them.

Figure 11: Indirect output multipliers of organic food supply, 2011

1.99	BW	BY	BE	BB	HB	HH	HE	MV	NI	NW	RP	SL	SN	ST	SH	TH
BW	1.35	0.14	0.02	0.02	0.01	0.03	0.07	0.01	0.08	0.18	0.03	0.01	0.03	0.02	0.03	0.02
BY	0.09	1.47	0.02	0.02	0.01	0.03	0.07	0.01	0.08	0.18	0.03	0.01	0.03	0.02	0.03	0.02
BE	0.09	0.14	1.34	0.02	0.01	0.03	0.06	0.01	0.08	0.17	0.03	0.01	0.03	0.02	0.03	0.02
BB	0.08	0.12	0.02	1.37	0.01	0.03	0.06	0.01	0.07	0.16	0.03	0.01	0.02	0.01	0.02	0.01
HB	0.04	0.06	0.01	0.01	1.21	0.01	0.03	0.00	0.03	0.07	0.01	0.00	0.01	0.01	0.01	0.01
HH	0.03	0.05	0.01	0.01	0.00	1.23	0.02	0.00	0.03	0.06	0.01	0.00	0.01	0.01	0.01	0.01
HE	0.08	0.12	0.02	0.02	0.01	0.03	1.41	0.01	0.07	0.16	0.03	0.01	0.03	0.02	0.02	0.01
MV	0.09	0.14	0.02	0.02	0.01	0.03	0.07	1.30	0.08	0.18	0.03	0.01	0.03	0.02	0.03	0.02
NI	0.08	0.11	0.02	0.02	0.01	0.03	0.06	0.01	1.40	0.16	0.03	0.01	0.02	0.01	0.02	0.01
NW	0.09	0.13	0.02	0.02	0.01	0.03	0.06	0.01	0.08	1.44	0.03	0.01	0.03	0.02	0.02	0.01
RP	0.07	0.10	0.02	0.02	0.01	0.02	0.05	0.01	0.06	0.14	1.29	0.01	0.02	0.01	0.02	0.01
SL	0.08	0.12	0.02	0.02	0.01	0.03	0.06	0.01	0.07	0.16	0.03	1.28	0.03	0.02	0.02	0.01
SN	0.09	0.14	0.02	0.02	0.01	0.03	0.07	0.01	0.09	0.19	0.03	0.01	1.41	0.02	0.03	0.02
ST	0.08	0.12	0.02	0.02	0.01	0.03	0.06	0.01	0.07	0.16	0.03	0.01	0.03	1.37	0.02	0.01
SH	0.08	0.12	0.02	0.02	0.01	0.03	0.06	0.01	0.06	0.16	0.03	0.01	0.02	0.01	1.35	0.01
TH	0.09	0.13	0.02	0.02	0.01	0.03	0.06	0.01	0.08	0.18	0.03	0.01	0.03	0.02	0.02	1.37

■ national multiplier ■ top 5 regional indirect output multipliers | (...) output value too low for reasonable interpretation

Source: own calculations.

North Rhine-Westphalia, second in the ranking of regional indirect output multipliers, shows no characteristics exclusively specific to organic food supply. In fact, the general high contribution of energy and wholesale trade are the usual industries, which show above-average relevance compared to other federal states.

In the case of Hesse, rental and leasing services next to advertising and market research activities show extraordinary high contributions in this special case. The latter fact may seem surprising at first but becomes reasonable when considering the rising attention and efforts to market especially organic food (Agrifood, 2012).

Saxony exhibits the highest ROC multiplier. This circumstance is very interesting, since this federal state also shows a reasonable high regional multiplier. Supply of organic food is above-average characterized by high indirect effects on agriculture over there. This circumstance is supported by Semerák et al., (2010), who find a high importance of indirect effect from agri-food production especially for remote regions. This explanation is supported by the fact of Saxony being among the five German federal states with the lowest GDP per capita in 2011 (VGRdL, 2016). However, Saxony is still by far the biggest federal state among these five in terms of GDP. Moreover, organic food supply is characterized by food processing rather than agricultural production in Saxony, which in turn favors above-average indirect effects in regional agricultural production. Therefore, we find that the high regional multiplier is reasonable, in addition to the high ROC multiplier, which is caused by the relative weakness of the economy in consideration.

Indirect effects from own output are of highest importance for the economies of Bavaria, Brandenburg, Mecklenburg-Western Pomerania, Lower-Saxony and Schleswig-Holstein, which all show reasonable above-average relevance of organic food supply.

Figure 12: Indirect output effects of organic food supply, 2011

	BW	BY	BE	BB	HB	HH	HE	MV	NI	NW	RP	SL	SN	ST	SH	TH
BW	799	316	52	51	17	66	150	18	186	412	70	16	68	41	58	36
BY	239	1,230	61	57	19	77	174	21	211	479	82	19	77	47	66	40
BE	14	22	53	4	1	4	10	1	13	27	4	1	5	3	4	3
BB	30	44	8	140	2	10	22	3	25	60	10	2	9	6	8	5
HB	4	6	1	1	20	1	3	0	3	7	1	0	1	1	1	1
HH	7	12	2	2	1	57	5	1	7	15	2	1	3	1	2	1
HE	56	85	14	13	5	18	287	5	50	111	19	4	18	11	15	10
MV	54	82	14	13	4	17	39	176	48	107	18	4	18	11	15	9
NI	142	207	36	31	11	47	105	12	727	287	50	11	43	27	37	22
NW	156	236	40	37	13	50	114	14	138	794	53	12	50	30	43	26
RP	57	85	15	13	5	18	42	5	49	114	238	4	18	11	15	9
SL	7	11	2	2	1	2	5	1	6	14	2	24	2	1	2	1
SN	36	55	9	9	3	11	26	3	32	72	12	3	154	7	10	6
ST	18	27	5	4	1	6	13	2	16	36	6	1	6	83	5	3
SH	53	75	14	11	4	18	39	4	42	107	19	4	15	10	228	8
TH	17	25	4	4	1	5	12	1	15	34	6	1	5	3	5	71

indicating direct relationship
 top 5 most affected regions by indirect effects from own output
 top 3 most affected regions by indirect effects from federal state in y-axis

Source: own calculations.

Impacts of output from other federal states are of above average relevance for the economies of Brandenburg, Lower-Saxony and Schleswig-Holstein. Products from agriculture prove to be a major characteristic, since they show a reasonable above-average share of indirect effects in all three federal states. Moreover, refined petroleum products and energy exhibit high shares of indirect effects in Brandenburg, initiated by

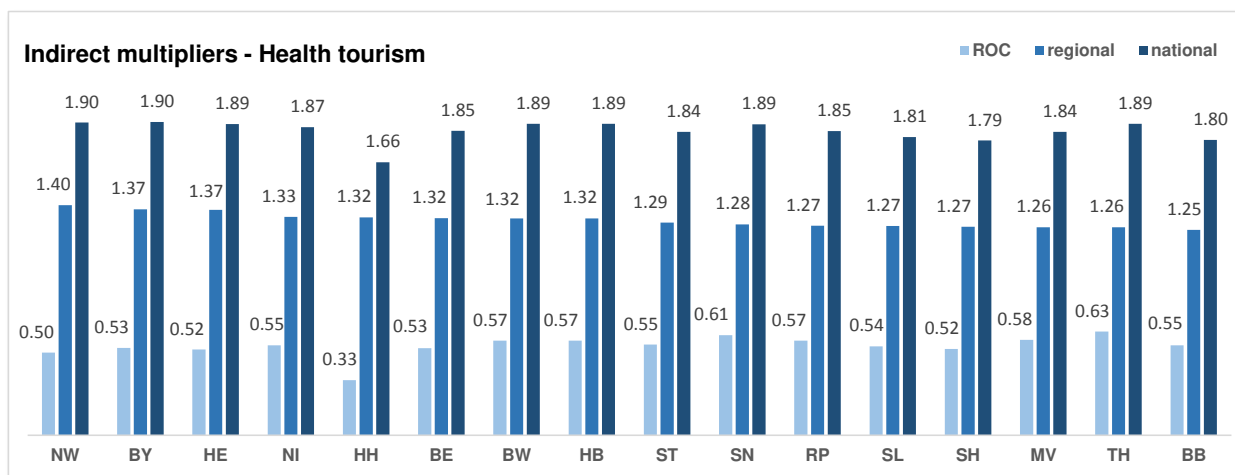
organic food production in other federal states. This is reasonable, since a significant proportion of electricity generated in Brandenburg is determined for export into other federal states (Amt für Statistik Berlin-Brandenburg, 2017) and petroleum products is the second main source of energy supply in Brandenburg (MWE, 2012). In Lower-Saxony, an extraordinary high share of indirect effects emerge in the area of food products manufacturing. The latter federal state becomes less important in the case of organic food production in Schleswig-Holstein. In this case, the nearby Hanseatic City Hamburg exhibits a higher relevance of indirect effects with above-average shares from refined petroleum products and warehousing, induced by organic food supply in Schleswig-Holstein.

2.5 Indirect effects of health tourism in German federal states in 2011

The satellite account category of health tourism is strongly related to ‘Accommodation and food services’ (CPA 55-56). Official data exhibits an indirect output multiplier of 1.77 for this category (Destatis, 2015). The NHA multiplier of health tourism, shown in Figure 14, is 1.87.

North Rhine-Westphalia, Bavaria and Hesse exhibit the highest regional indirect output multipliers from health tourism. In the case of the first, health services and travel agencies are above-average contributors to regional indirect effects, next to the known federal-specific industries of energy supply and wholesale.

Figure 13: Indirect output multipliers of health tourism, 2011



Source: own calculations.

Characteristics of health tourism become even more obvious when taking a closer look at Bavaria, with having real estate service including imputed rents of owner-occupied dwellings and health services as above-average contributors to regional indirect output effects from health tourism. Hesse exhibits extraordinary effects in areas such as travel agencies and air transport services, next to wholesale and financial services.

The general influence of travel agencies, health services and air transport services seem obvious in this case, since those categories exhibit a direct relevance for health tourism. North Rhine-Westphalia and Hesse show an above-average density of travel agencies (DRV, 2017), while again, North Rhine-Westphalia and Bavaria are two among the three federal states profiting the most from tourism in the context of treatment (H-BRS, 2016). The relevance of air transport services in Hesse is obviously reasonable due to

the largest airport of Germany in terms of passenger volume is based in Frankfurt (Destatis, 2016). A relative high contribution of real estate service including imputed rents of owner-occupied dwellings in Bavaria is argued with the highest price per square meter for land ready for construction in this federal state in 2011, city states excluded (Destatis, 2017).

Figure 14: Indirect output multipliers of health tourism, 2011

1.87	BW	BY	BE	BB	HB	HH	HE	MV	NI	NW	RP	SL	SN	ST	SH	TH
BW	1.32	0.12	0.02	0.01	0.01	0.03	0.06	0.01	0.06	0.16	0.03	0.01	0.02	0.01	0.02	0.01
BY	0.08	1.37	0.02	0.01	0.01	0.03	0.06	0.01	0.06	0.15	0.02	0.01	0.02	0.01	0.02	0.01
BE	0.07	0.10	1.32	0.01	0.01	0.02	0.05	0.01	0.05	0.13	0.02	0.01	0.02	0.01	0.02	0.01
BB	0.07	0.10	0.02	1.25	0.01	0.02	0.05	0.01	0.05	0.13	0.02	0.01	0.02	0.01	0.02	0.01
HB	0.05	0.08	0.02	0.01	1.30	0.02	0.05	0.00	0.04	0.11	0.02	0.00	0.02	0.01	0.01	0.01
HH	0.04	0.06	0.01	0.01	0.00	1.32	0.04	0.00	0.03	0.08	0.01	0.00	0.01	0.01	0.01	0.01
HE	0.07	0.10	0.02	0.01	0.01	0.03	1.37	0.01	0.05	0.14	0.02	0.01	0.02	0.01	0.02	0.01
MV	0.07	0.10	0.02	0.01	0.01	0.02	0.05	1.26	0.06	0.14	0.02	0.01	0.02	0.01	0.02	0.01
NI	0.07	0.11	0.02	0.01	0.01	0.03	0.06	0.01	1.33	0.14	0.02	0.01	0.02	0.01	0.02	0.01
NW	0.08	0.12	0.03	0.01	0.01	0.03	0.06	0.01	0.06	1.40	0.03	0.01	0.02	0.01	0.02	0.01
RP	0.07	0.11	0.02	0.01	0.01	0.03	0.06	0.01	0.05	0.14	1.27	0.01	0.02	0.01	0.02	0.01
SL	0.07	0.10	0.02	0.01	0.01	0.02	0.05	0.01	0.05	0.13	0.02	1.27	0.02	0.01	0.01	0.01
SN	0.08	0.11	0.02	0.01	0.01	0.03	0.06	0.01	0.06	0.15	0.02	0.01	1.28	0.01	0.02	0.01
ST	0.07	0.10	0.02	0.01	0.01	0.02	0.05	0.01	0.05	0.14	0.02	0.01	0.02	1.29	0.02	0.01
SH	0.07	0.09	0.02	0.01	0.01	0.02	0.05	0.01	0.05	0.13	0.02	0.01	0.02	0.01	1.27	0.01
TH	0.08	0.11	0.02	0.01	0.01	0.03	0.06	0.01	0.06	0.15	0.02	0.01	0.02	0.01	0.02	1.26

■ national multiplier ■ top 5 regional indirect output multipliers (...) output value too low for reasonable interpretation

Source: own calculations.

Again, Thuringia shows the highest ROC multiplier in the case of health tourism. This is caused by general interregional interdependencies of travel agencies, real estate services including imputed rents for owner-occupied dwellings and food products, without revealing any characteristics exclusively applying in the case of Thuringia.

Figure 15: Indirect output effects of health tourism, 2011

	BW	BY	BE	BB	HB	HH	HE	MV	NI	NW	RP	SL	SN	ST	SH	TH
BW	366	132	29	16	8	32	72	9	69	180	29	8	27	16	21	13
BY	153	727	47	26	14	53	119	15	115	300	48	13	44	27	35	22
BE	17	24	79	3	1	6	13	2	12	32	5	1	5	3	4	2
BB	8	11	2	28	1	3	6	1	6	15	2	1	2	1	2	1
HB	1	2	0	0	8	1	1	0	1	3	0	0	0	0	0	0
HH	6	9	2	1	1	48	5	1	5	13	2	1	2	1	1	1
HE	61	88	19	10	6	22	321	6	46	120	19	5	18	10	14	8
MV	41	58	12	7	3	14	31	150	31	79	13	3	12	7	10	6
NI	82	118	26	14	8	29	65	8	364	161	26	7	24	14	18	11
NW	115	167	37	19	11	41	92	11	86	572	36	9	33	20	25	16
RP	24	35	7	4	2	8	19	2	18	47	90	2	7	4	5	3
SL	2	3	1	0	0	1	2	0	2	4	1	9	1	0	0	0
SN	13	19	4	2	1	5	11	1	10	26	4	1	49	2	3	2
ST	6	9	2	1	1	2	5	1	5	12	2	1	2	26	1	1
SH	59	84	18	10	5	20	45	6	44	114	19	5	17	11	238	8
TH	11	15	3	2	1	4	8	1	8	21	3	1	3	2	2	36

■ indicating direct relationship ■ top 5 most affected regions by indirect effects from own output

■ top 3 most affected regions by indirect effects from federal state in y-axis

Source: own calculations.

Regional indirect output effects from health tourism have the highest impact on the economies of Bavaria, Hesse, Mecklenburg-Western Pomerania, Lower-Saxony and Schleswig-Holstein. All federal state show

above-average relevance of health tourism for their economies with outstanding importance in Schleswig-Holstein and Mecklenburg-Western Pomerania.

Output of health tourism leads to indirect effects outside of the supplying federal states. The economies of Berlin, Hamburg, Hesse and North Rhine-Westphalia are above-average affected by these effects. The industries shaping these characteristics in particular are legal, accounting and management consulting services in the context of Berlin, refined petroleum products in Hamburg, financial services in Hesse and wholesale trade in North Rhine-Westphalia. Moreover, all these federal states show an above-average contribution of travel agencies to regional indirect effects. Apart from this characteristic, benefiting areas of the economies in consideration are specific for the federal states in concern rather than health tourism.

3 Concluding remarks

In this paper, we presented selected results from multiregional input-output analysis based on the compiled MRHA. We focused on the reliability of results in order to provide a foundation on a subsequent application of the model to answer a specific question of political relevance.

We proceeded accordingly in order to conclude upon the performance of the algorithm in the context of intra- and interregional dependencies. Unfortunately, no secondary data is available for this case, since generic multiregional supply and use table are not available for German federal states. Consequently, it is challenging to evaluate the accuracy of results, since input-output analysis aims at capturing inter-industry relationships in terms of a finite geometric series. This implies that input-output analysis captures economic correlations, which are normally unconceivable from pure knowledge of reality. Therefore, we decided to focus on various categories of health when we conducted and assayed results from input-output analysis. We are able to derive explanations from reality for obtained results in all considered cases. This does not only apply to the level of multipliers calculated, but also for the industry-specific characteristics of federal states revealed.

From this paper and the assessment of direct effects of the health economy (Schwartzler & Kronenberg, 2017c) we conclude that the developed model shows reasonable results in the context of 'holistic accuracy' (Jensen, 1980). This means the model provides results, which manage to picture a macroeconomic overview of the health economy in German federal states.

Next steps involve the application of the model in a political framework, in order to found certain decisions on macroeconomic and interregional relationships in the context of the health economy. To be concrete, we will address the challenge of lagging investments in German hospitals, which is caused by an underfinancing of responsible federal states. (Schwartzler & Kronenberg, 2017d)

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