The local impact and multiplier effect of universities in Lower Saxony on the labour market

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Abstract

This paper quantifies and compares the direct and indirect effects of labour demand generated by each university location in Lower Saxony. The results are classified in order to identify regional patterns. The applied method is based on three components: the importance, the dynamics and the interdependence of the university related labour market in relation to the other economic sectors. The importance of the university locations for their respective local economy and in comparison with each other is assessed by an indicator. The dynamic and change of the importance of the different university locations is shown using a shift-share analysis. Both measures can be applied for a classification and spatial clustering of different types of university locations. Additionally, input-output-based employment multipliers are estimated to display the interaction of the university locations with the local economy. The results can be summarised in the identification of three differing regions. The south-east of Lower Saxony is characterised by big, established, well integrated university locations with low dynamics. Adjacent, smaller university locations have difficulties to emerge of the shadows of the dominant locations. In the western part of Lower Saxony can be found small to big university locations with growing importance and continuous development potential. The university locations in the north east are small to medium sized and rather unimportant for the local as well as the total labour market.

JEL-Classification: I23, J48, R12, R15
Keywords: Regional Input-Output table, employment multiplier, spatial analysis, classification, (in)direct employment effects, universities

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1 Introduction

Universities make significant contributions to the labour market. By training and educating bachelor, master and doctoral students universities are crucial for the development of human capital. This favours the establishing of high-tech companies and advanced service providers in the need of highly qualified manpower (Romer, 1986, 1990, Lucas, 1988, Jaffe, 1989). Simultaneously, universities act as employer themselves by providing jobs for a huge number of scientific and non-scientific workers. Additional jobs are created by the fact that university employees and students consume and thus create demand for goods and services that would never have existed without the university. Overall, the supply and demand of labour induced by the university strengthen the economic situation in the region. Thus, the quantification of the significance and the economic value of universities for their respective region is of interest for local politicians as well as the universities themselves: it helps to legitimate public funds and the use of tax money, can be used as image campaign or supports reform or investment programmes.

There already exist a variety of different publications evaluating the economic importance – and especially the labour market effects – of universities in Germany. Only from the mid 1990ies until the second decade of this century were published a minimum of 17 studies for German universities such as the TU Ilmenau (Voigt, 1995), the University of Kassel (Blume and Fromm, 2000), the TU Berlin (Pavel, 2008) or the Heidelberg University (Glückler and König, 2011). Almost all studies focus on the demand side and use multipliers to estimate the significance for the labour market and the effect on regional income, consumption, labour demand and revenue (Leusing, 2007, p. 6). The indirect and induced effects originate from the expenses for personnel and materials, investments in plant and machinery or construction as well as the consumption expenditures of students and university personnel that trigger additional demand in the respective region. The university related demand results in additional income and the need for higher production and more labour input in other economic activities. Overall, this leads to an increase in local jobs. The methods generally applied for the calculation of the multipliers are the Keynesian multiplier analysis or the input-output analysis (ibid.).

However, the published studies are almost all single case studies with limited comparability (Blume and Fromm, 2000, p. 45f.): They focus on single or groups of universities (sometimes including additional research institutions), apply different definitions of the spatial dimensions and operate with different statistical and empirical methods. Thus, the comparison and classification of the single results is a complex task and seldom conducted.[1] The methods are also not designed for comparisons and classifications and therefore only partially suitable for a comparative ranking and spatial analysis of different university locations. To the knowledge of the author, there is no published study that analyses multiplying effects of universities in Lower Saxony.[2] Consequently, there are no results that can be directly used as reference values.

The aim of this study is to quantify the direct and indirect effects of each university location's labour demand within Lower Saxony and to compare and classify the different results in order to identify regional patterns. The focus on the labour market effects of university locations in their position as employer was chosen to yield solid, credible and comprehensible results.[3]

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[1] Exceptions are e. g. Bauer (1997), Blume and Fromm (2000).

[2] The city of Göttingen conducted an analysis that assesses the value of institutions related to science and research. It is mainly a descriptive analysis not considering any kinds of multipliers.

[3] Siegfried et al. (2007) recommend to concentrate on important aspects or fields of interest to address

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Standardized measurement procedures are necessary to allow a comparison of the significance of the different locations (Swenson, 2012, p. 1). The method at hand therefore combines standardised methods such as the RIOT based multiplier with other established instruments such as the indicator and the shift-share analysis. The results from the RIOT based multipliers can be used to compare the results for universities in other Federal States or countries. Additionally, the combination of the three different analysis tools offers the opportunity for spatial comparisons and classifications.

Section 2 gives a short introduction in the different university locations in Lower Saxony with focus on their function as employer. Section 3 presents the methodology for the estimation and classification procedure. Section 4 provides the results. Section 5 summarises the main findings and includes a short discussion.

2 Universities and their locations and employments in Lower Saxony

In 2016/17 there were a total of 30 different universities in 24 locations in Lower Saxony, comprising 14 public universities, seven public universities of applied sciences and nine private universities (MWK, 2017, StBA, 2017b)[4]. More than 195 thousand students were enrolled at this time. Their number varies greatly between the locations ranging from just 81 students at the University of Applied Sciences for Intercultural Theology Hermannsburg (FIT) in Herrmannsburg to 30723 students at the University of Göttingen.

The regional distribution, location and size of the universities is visualized in Figure 1. 24 out of 45 NUTS-3 regions in Lower Saxony have at least one university (indicated by the darker gray areas). The universities are not only situated in large cities but can also be found in small towns in rural areas. The size of the university locations given by the number of enrolled students is indicated by the size of the circles[5]. Most popular university locations with more than 20000 students are Hannover, Göttingen, Osnabrück and Braunschweig (LSN, 2017a).

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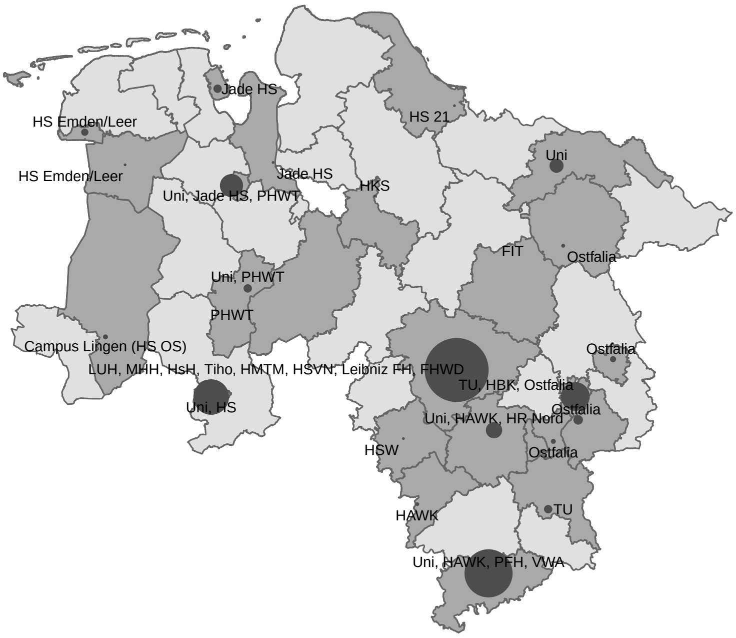
specific application areas and policy measures. Especially, correct multipliers, an adequate specification of the respective region / area, no double counting and a well-defined research framework are essential for the validity and credibility of the study results (ibid.). These guidelines are more easily met when narrowing down the object of investigation.

[4] In this text the term university refers to all kinds of universities – public, private and of applied sciences.

[5] The FIT for example is such a small university that the circle is not visible.

Figure 1: Size and location of the universities in Lower Saxony (2016/17)



Source: MWK (2017), LSN (2017a), own figure.

The universities are an important employer for Lower Saxony: a total number of 52856 persons were employed in 2015. The majority (54 %) worked as scientific employees in the fields of research and education. The remaining 46 % were employed in the non-scientific fields such as administration, maintenance, the technical department or similar.

The highest number of employees with 17840 persons[6] can be found in the universities located in Hannover, followed by those located in Göttingen with 13220 persons, Osnabrück with 4590 persons, Braunschweig with 4250 persons and Oldenburg with 4030 persons (see Figure 2). The other university locations are characterised by a number of personnel below average. However, the locations Hildesheim, Lüneburg and Clausthal still have a workforce consisting of more than 1000 persons. Wolfenbüttel, Vechta, Emden and Wilhelmshaven provide at least 600 jobs each. In the remaining university locations the number of employed persons decreases from 300 to less than 100 in Diepholz, Leer and Hermannsburg.

The below average number of employees does not necessarily involve a below average staff-student ratio (see dots in Figure 2). Beside the huge university locations Hannover and Göttingen especially the smaller locations Clausthal and Oldenburg show a high

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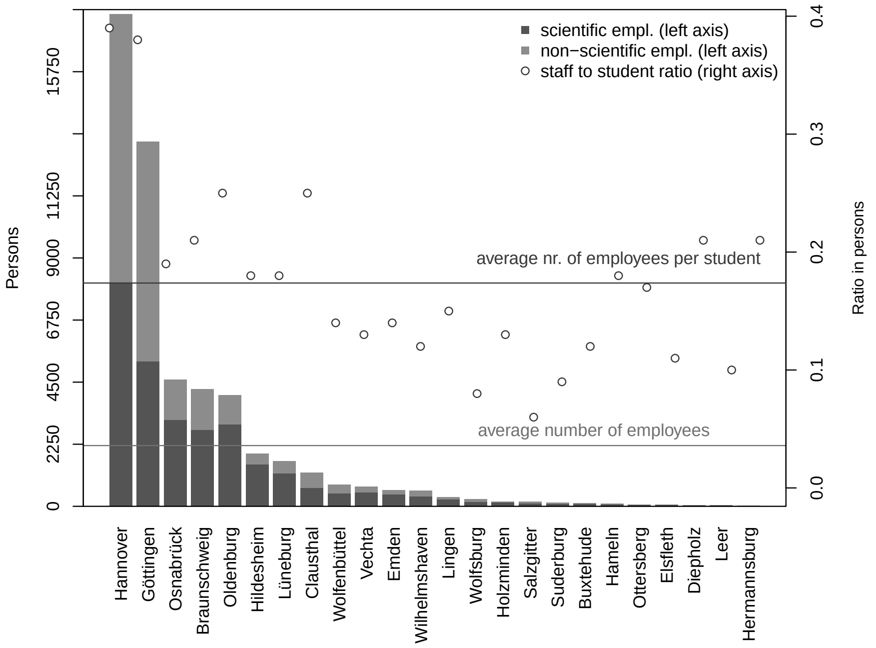
[6] The values were rounded to the nearest ten.

supervision-level with 0.25 and 0.25 university employees per student. The average staff to student ratio lies at 0.17.

Another striking feature is the different weighting of scientific and non-scientific employees at the different university locations, represented by the partition of the bars in light and dark grey in Figure 2. In Hermannsburg, Göttingen and Hannover, the number of non-scientific employees (coloured in light grey) outweighs that of scientific employees (coloured in dark grey): for each non-scientific employee there are only 0.5, 0.7 and 0.8 scientific ones. In average the ratio between scientific and non-scientific employees amounts to 2.8:1. The high deviation from average in Hannover and Göttingen can be explained by the fact that the university locations encompass university hospitals: The personnel responsible for medical care (especially nurses), administration, utilities management etc. are counted among the non-scientific employees and represent a considerable share of the hospital workforce (StBA, 2017c, Erläuterungen).[7] The highest number of scientific relative to non-scientific employees can be found in Holzminden, Leer and Diepholz with ratios of 6.7, 6.3 and 5.5. The first two locations are part of an alliance with other university locations and the administration with non-scientific employees is situated at the main location. More precisely, Holzminden belongs to the "University of Applied Sciences and Arts (HAWK)" with the main location in Hildesheim and Leer is part of "Hochschule Emden/Leer" with the main location in Emden.

Figure 2: Number of scientific and non-scientific university employees (without student assistants) and staff-student ratio (2015)



Source: StBA (2017b), own calculation and figure.

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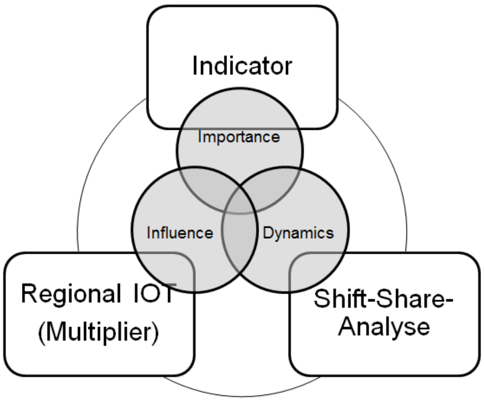
[7] University staff primarily working in the medical, dental or veterinary field are treated as scientific employees; the same is valid for professors or academics (StBA, 2017c, Erläuterungen).

3 Methodology for estimating and classifying the significance of university locations as employer

The size, location and employment structure of the different university locations already exhibit a broad spatial diversity. Assessing and ranking the significance of each university locations for the local labour market hence should take different characteristics into account. However, most existing studies and papers – as already mentioned in the introduction – focus on single cases and does not aim at comparing and classifying the results. Concentrating the approach solely on employment multiplier effects or descriptive analyses would not meet the various initial situations and developments at the different university locations in Lower Saxony. Nonetheless, the estimation approach provided by the existing studies can be used for the scientific problem at hand, but has to be extended.

Thus, the applied methodology shown in Figure 3 bases on a framework consisting on three major parts that each considers a different aspect related to the significance of university locations. More precisely, the methodological framework combines an indicator, a shift share analysis and an employment multiplier (based on a Regional Input-Output Table, RIOT). The indicator illustrates the importance and weight of the university sector in comparison to the regional labour market. The shift share analysis depicts the dynamics and provides the possibility to identify locations where the university sector is a growth sector. The employment multiplier shows the interdependencies of the university sector with other economic activities and gives an impression of its local influence. Taking the components together offers the opportunity for classification and spatial grouping.

Figure 3: Methodological framework



Source: Own figure.

The indicator representing the weight and importance of the university employments is estimated by the share of scientific and non-scientific personnel (up) in the local labour force (lf):

$$I_r = \frac{up_r}{lf_r} * 100, \forall r = 1, \ldots, 24 \tag{1}$$

I: Indicator
r: NUTS-3 region where the university location is located
up: number of employees at the university location (university personnel)
lf: labour force

The local labour market is defined as the NUTS-3 region r where the respective university is located. The university employees encompass the scientific and non-scientific personnel excluding the student assistants as provided by StBA (2017b). The local labour market consists of all employed and self-employed workers as reported in VGRdL (2017b). As the resulting indicator (share of university staff in local labour force) is a composition of two different data sources the resulting information should be interpreted with caution. It is supposed to give a first idea about the importance and the development of the university locations as employer.

The dynamic of each university-related labour market is analysed with a shift share analysis using the percentage point method. The average growth 2013–2015 of each local labour market is contrasted to the average development in Lower Saxony. This offers the possibility to identify university locations with strong or weak growing labour markets. The same has been done for the university-related employments. In detail, the calculation procedure is:

$$D_r^l = gr_r^l - gr_{LS}^l, \forall r = 1, \ldots, 24, \text{ and } l = 1, 2 \tag{2}$$

$$gr_r^l = \left[\left(\frac{emp_{r,t=2015}^l}{emp_{r,t=2013}^l} \right)^{0,5} - 1 \right] * 100 \tag{3}$$

$$gr_{LS}^l = \left[\left(\frac{emp_{LS,t=2015}^l}{emp_{LS,t=2013}^l} \right)^{0,5} - 1 \right] * 100 \tag{4}$$

D: Dynamics
r: NUTS-3 region where the university location is located
l: labour market, l = 1 for total labour market, l = 2 for university related labour market
gr: average annual growth rate
emp: number of employees

The influence of the university related labour market on other economic activities is analysed using an input-output based employment multiplier. The interdependencies between the university sector and other economic sectors have a multiplying effect on the labour market, i. e. changes in demand and production in the university sector trigger changes in total employment that are bigger than the initial effect due to intermediate demand and the related interconnectedness with other sectors.

The employment multiplier is derived from a regional input-output-table (RIOT) in combination with university-specific information.[8] The RIOT was constructed using the input-output-table (IOT) of the year 2013 for Germany (StBA, 2017e) and the CHARM-method as proposed in Kronenberg (2010), Kronenberg and Többen (2011), Többen and Kronenberg (2015). Additional information was implemented from different regional data

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[8] The use of employment multipliers from other studies was discarded, as they were calculated for other Federal States. According to Swenson (2012, p. 5) it is inappropriate to use multipliers from another state or from the nation, as the state-specific variance in the size and mix of the different industries is to high for similar multipliers.

sources (LSN, 2015a, 2015b, 2017b, VGRdL, 2017b). A detailed description about the construction of the RIOT is given in the Annex.

For the calculation of the employment multiplier em two different components – the physical labour input coefficient a^l and the (direct and indirect) employment effect ee – have to be estimated. The physical labour input coefficient represents the amount of labour emp (in number of employments) necessary for one production unit x. The employment effect shows the impact of one unit change in production on employment. Overall, the calculation procedure for the employment multiplier is as follows.

$$em_r = \frac{ee_r}{a_r^l}, \forall r = 1, \ldots, 24, \tag{5}$$

$$a_r^l = \frac{emp_r}{x_r} \tag{6}$$

$$\boldsymbol{ee} = \boldsymbol{a}^{\boldsymbol{l}'} * (\boldsymbol{I} - \boldsymbol{A})^{-1} \tag{7}$$

em:	employment multiplier
r:	NUTS-3 region where the university location is located
ee:	employment effect
a^l:	physical labour input coefficient
emp:	number of employees
x:	production
$(I - A)^{-1}$:	matrix of inverse input coefficients (of production)
I:	unity matrix
A:	matrix of input coefficients

For the estimation of university location specific employment multipliers university specific input coefficients are necessary. As such information is not publicly available, it has to be assumed that the input coefficients (of production) for education services remain unchanged for all university locations. However, due to this assumption the indirect effects stay the same for all university locations and take the value 0.000004 employees per one unit change in production. Differences originate solely from the direct employment effects given by the specific physical labour input coefficients.

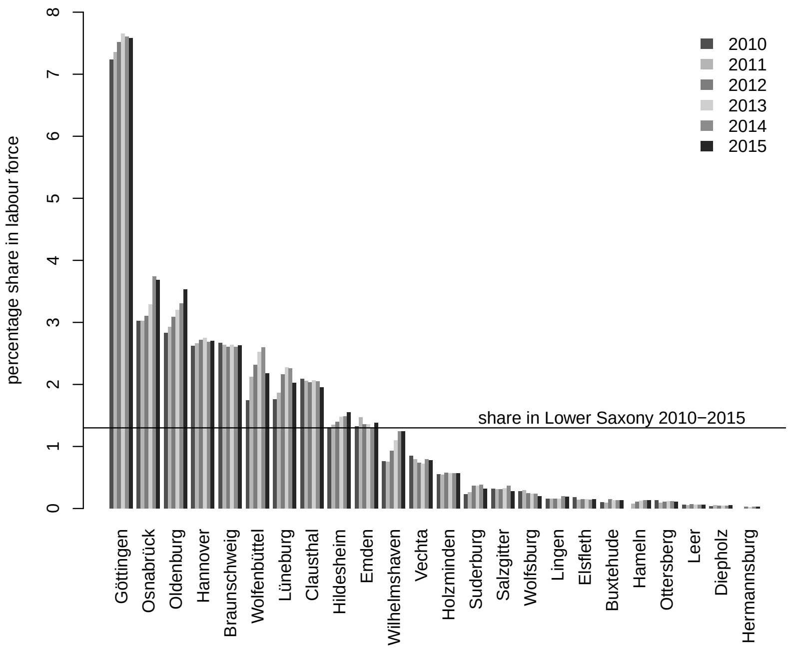
In detail, very little extra staff is needed to increase production by one unit at the university locations Hannover, Göttingen, Hermannsburg, Braunschweig and Clausthal: the physical labour input coefficients range between 0.000012 and 0.000015, which is lower or at most the same as for the total university sector in Lower Saxony (also 0.000015). The highest increase in labour demand can be observed for the locations Diepholz, Hameln and Ottersberg: 0.000028, 0.000029 and 0.000031 additional workers have to be employed for each increase in production.

Based on the calculation procedure of the employment multiplier given in Equation 5, the varying direct employment effects in combination with the constant indirect employment effects imply that the higher the physical labour input coefficient of the respective university location, the lower the multiplier.

4 Results

The weight and importance of the university employments represented by the share of scientific and non-scientific personnel in the local labour force is depicted in Figure 4. The indicator values vary considerably depending on the university location. In 2015, it ranges from 7.6 % in Göttingen to less than 1 % in the locations from Vechta to Hermannsburg. The overall share of scientific and non-scientific university employees in the labour force of Lower Saxony lies at 1.3 %. The first 10 university locations from Göttingen to Emden hence have a higher than average labour market share of university employees.

Figure 4: Importance of universities as employer for the local labour market measured by the share of university employees in labour force in the respective region (in %) for the years 2010–2015



Source: VGRdL (2017b), StBA (2017b), own calculation and figure.

In the university location and NUTS-3 region Göttingen more people are employed in the university sector than in the sector agriculture, forestry and fishing with a share of 1 % or the sector construction with a share of 4.3 %. Moreover, the sector public and other service activities including education is the most important one in that region providing over 40 % of the local jobs.[9] Having a more service oriented economic structure the university locations Osnabrück, Oldenburg, Hannover, Braunschweig, Clausthal and Wilhelmshaven show higher weights for the university sector than for the agricultural sector as well.

For the majority of the university locations the shares and results of 2015 were similar to those of the year 2010 with almost no variation in between. Exceptions are Osnabrück, Oldenburg, Wolfenbüttel and Wilhelmshaven. In the locations Osnabrück and Oldenburg the number of university employees relative to the total local labour market continually increased by 0.7 percentage points achieving a share of 3.7 % and 3.5 % respectively. In Wolfenbüttel the share of university-employed persons increased by 0.9 percentage points

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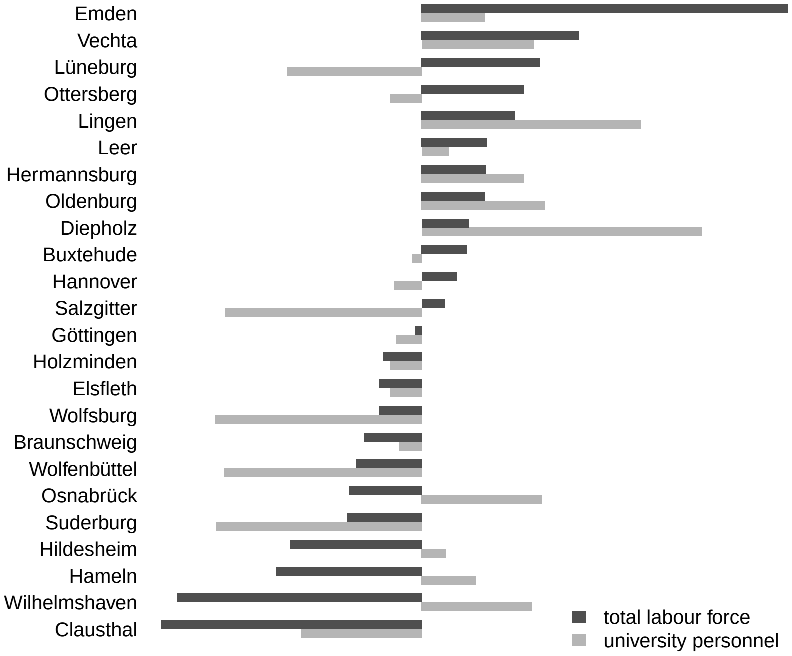
[9] In average this sector encompasses 32.7 % of total employment in Lower Saxony.

between 2010 and 2014 reaching 2.6 %. In 2015 the development came to a halt and the share dropped by -0.4 percentage points in 2015 eventually resulting in 2.2 %. In Wilhelmshaven the university as local employer gained slowly importance by growing 0.5 percentage points up to 1.2 % in 2015.

Figure 5 shows the dynamics for each university location. The dark grey bars represent the difference between the average annual growth in total employment of the university location and Lower Saxony for 2013–2015.[10] The light grey bars show the difference in university employment. Bars to the right indicate that the employment grows stronger in the respective university location than in Lower Saxony, whereas bars to the left display a weak growing labour market. If both bars (total and university-related employment) point in the same direction the university-related labour market has an intensifying effect on the labour market development. In case of opposite directions the university-related labour market can be regarded as having a balancing impact.

Figure 5: Dynamics of the regional labour markets in comparison to the total labour market in Lower Saxony



Note: The bars show the deviation of the regional average growth rates 2013–2015 from Lower Saxony's average growth rate for the total and the university related labour market in standardised values.

Source: VGRdL (2017b), StBA (2017b), own calculation and figure.

For the university locations Emden, Vechta, Lingen, Leer, Hermannsburg, Oldenburg and Diepholz the average annual increase in total employment 2013–2015 is higher than

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[10] The growth rates related to the university employees were a lot more volatile than that for the total labour market. For a better comparability the deviations given in percentage points have hence been standardised.

in average for Lower Saxony, so that these regions can be classified as dynamic. The characteristic is supported by the university sector that is growing above average as well. The locations Lüneburg, Ottersberg, Buxtehude, Hannover and Salzgitter also fall in the category of a dynamic region, but the university sector does not contribute to this characteristic, as its growth rates are below average. In Osnabrück, Hildesheim, Hameln and Wilhelmshaven the labour market grows weaker compared to Lower Saxony, but the university-related employments develop better. In these cases the universities as employer have a balancing impact and form an important growth sector for the local economy. No equalising effect can be found in the comparably weak growing university locations Göttingen, Holzminden, Elsfleth, Wolfsburg, Braunschweig, Wolfenbüttel, Suderburg and Clausthal: the number of total as well as university-related employments increases by only under-average growth rates.

Summarising, the university sector can be regarded as important growth sector for the local economy in Emden, Vechta, Lingen, Hermannsburg, Oldenburg, Diepholz, Osnabrück, Hameln and Wilhelmshaven displaying over-average growth rates. The contrary is valid for Lüneburg, Salzgitter, Wolfsburg, Wolfenbüttel, Suderburg, and Clausthal, i.e. the university sector plays a minor role in the local labour market development. A somewhat neutral status can be assigned to the locations Ottersberg, Buxtehude, Hannover, Göttingen, Holzminden, Elsfleth, Braunschweig, Leer and Hildesheim: their university-related employment growth corresponds more or less to the average level in Lower Saxony.

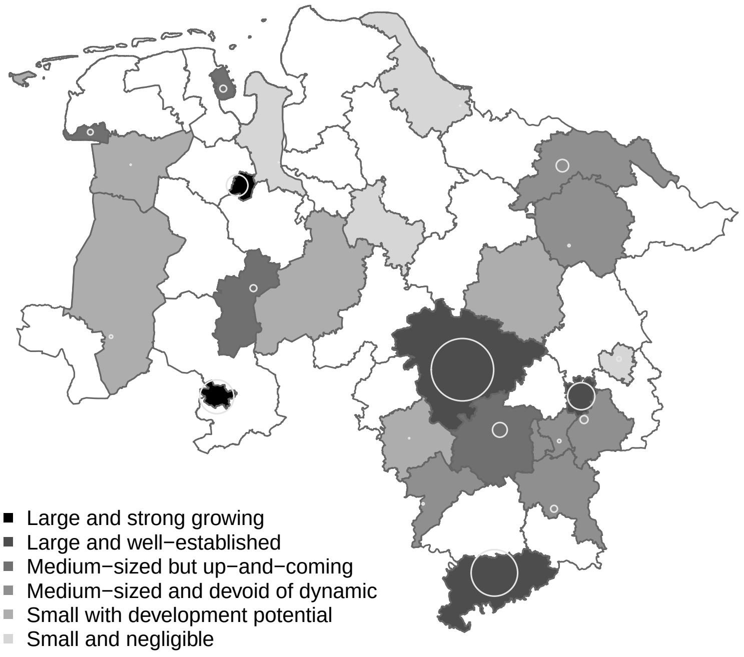
The results derived from the indicator and the shift-share analysis can be used to cluster the university locations in six different groups as given in Table 1. The regional distribution is visualised in Figure 6. While the south-east of Lower Saxony is characterised by the especially large and established university locations with slow growth, the western part has many locations showing high labour market dynamics. In the north-east can be mainly found university locations that are small to medium sized with a minor importance for their local labour market (related to share and growth).

Table 1: The classification of the university locations based on their labour market shares and dynamics

Large and strong growing university sector	**Large and well-established university sector**	**Medium-sized but up-and-coming university sector**	**Medium-sized university sector devoid of dynamic**	**Small university sector with development potential**	**Small and negligible university sector**
Oldenburg	Braunschweig	Emden	Clausthal	Diepholz	Buxtehude
Osnabrück	Göttingen	Hildesheim	Holzminden	Hameln	Elsfleth
	Hannover	Vechta	Lüneburg	Hermannsburg	Ottersberg
		Wilhelmshaven	Salzgitter	Leer	Wolfsburg
			Suderburg	Lingen	
			Wolfenbüttel		

Source: Own classification and table.

Figure 6: Regional distribution of the university locations according to their classification



Source: Own classification and figure.

The different employment multipliers are depicted in Figure 7. The horizontal line shows the average value of 1.24 for the total university sector in Lower Saxony. This means that one additional employee in higher education generates 0.24 additional employees in other economic sectors.[11].

A particularly high multiplicative effect achieve the university locations Hannover, Göttingen, Hermannsburg, Braunschweig and Clausthal. With values of 1.29 and 1.26, Hannover and Göttingen are doing better than or just as well as the sector education services. The locations Hermannsburg, Braunschweig and Clausthal reach multipliers of 1.25 and have a stronger impact on the labor market in Lower Saxony than the total university sector. Very little additional employment is generated by an increase in the university staff of Hamel and Ottersberg. With a value of 1.12, the employment multipliers are just half as high as that of the university sector.

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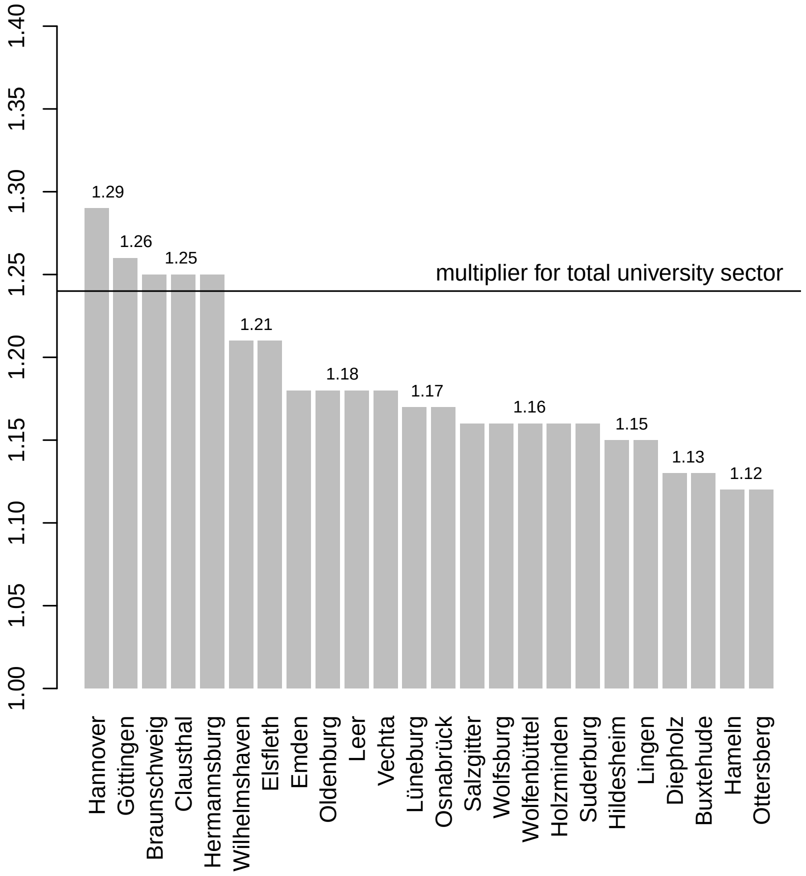
[11] Thus, the employment multiplier for the university sector is slightly lower than for the aggregate sector of education services (see Annex).

Figure 7: Employment multipliers of the university locations in Lower Saxony (2013)



Source: Own calculation and figure based on the RIOT for Lower Saxony[a]

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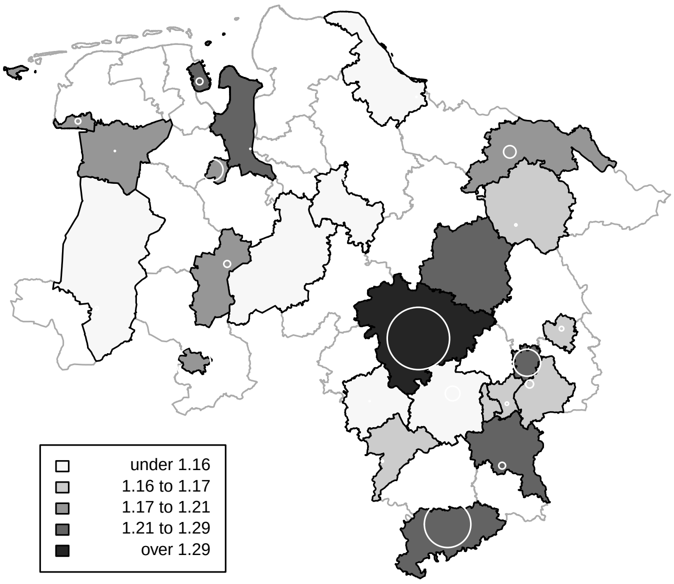
[a] For more details on the RIOT see the description in the Annex.

The spatial distribution of the employment multipliers given in Figure 8 reveals a north-south divide. Almost all of the high employment multipliers represented by the darker grey shaded regions can be found in the south-east of Lower Saxony. The north-east of Lower Saxony is characterized by rather very small multipliers. In the western area, in turn, an employment increase in the university sector display low to middle range effects.

Figure 8: Regional distribution of the university employment multipliers (2013)



Source: Own calculation and map based on the RIOT for Lower Saxony[a]

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[a] For more details on the RIOT see the description in the Annex.

5 Conclusion

This study combines the techniques indicator analysis, impact analysis and IO-analysis (multipliers) to show and compare the significance of university locations for their respective labour market and Lower Saxony. The results provide the opportunity to classify the university locations and to identify spatial specifics.

The south-east of Lower Saxony is characterised by big, established university locations with low dynamics. The university sector cannot be categorised as growth sector, but represents one important employment opportunity in the area. Furthermore, one additional employee unfolds the highest possible multiplier impact with 0.25 to 0.29 additional jobs in other economic sectors. However, the positive effects concentrate on the big locations. For the adjacent, smaller university locations it is difficult to emerge of the shadows of the dominant locations.

In the western part of Lower Saxony can be found small to big university locations where the university employments gain more and more importance. The dynamics of the university related labour market is high so that the university sector can be classified as growth sector. The labour input coefficients suggest potential for efficiency gains as the multipliers take only a low to middle range.

The university locations in the north east are small to medium sized and rather unimportant for the local as well as the total labour market. Growing slower than the respective university sector in Lower Saxony the university sector in this area is characterised by a low dynamic and hence does not represent a growth sector. Moreover, additional employment unfolds only a low impact with multipliers ranging from 1.12 to 1.17.

Nonetheless, these latter category of universities can also be of great importance to their region if the local labour market offers only few job opportunities and a weak economic environment. From an economic policy point of view, however, the results of the classification show that the founding of an university as a structural policy measure alone is not sufficient to sustainably support a structurally weak region. This requires a broad-based concept that integrates both university and local companies alike and provides a basis for the formation of a competence centre or cluster. The focus on courses that are rarely offered in Germany (e. g. foreign aid) as well as courses on a specific subject with a promising future (e. g. bio-economy) offers the opportunity to create a unique feature for the local university. Simultaneously, the provision of a good infrastructure and an environment that promote founding activities helps to attract new companies. Taken together, university and companies then can support each other by cooperating and building networks.

One critical remark regarding the assumption of equal input coefficients for all university locations that was necessary due to missing additional information: A specific input structure could change the indirect employment effects and hence the values of the multipliers. University locations that are more interconnected with the other economic sectors in their region would display a much larger employment multiplier. The necessary additional data can be only provided by the financial or controlling departments of each university i. e. the universities have to be willing to cooperate.

Another shortcoming of the presented methodology is that it focuses solely on the demand side. The positive effects of the output of universities, i. e. the generation of human capital by educating high-skilled workers as well as innovation and development by conducting research are not yet considered. In a next step, the classification procedure could hence be supplemented by indicators that focus on the supply side effects.

Overall, the proposed methodology offers the opportunity to perform a classification of the significance for each university location by considering location specific characteristics. Based on the results the distribution of public funds can be evaluated. Furthermore, if provides the possibility to identify fields of action for (educational) policies.

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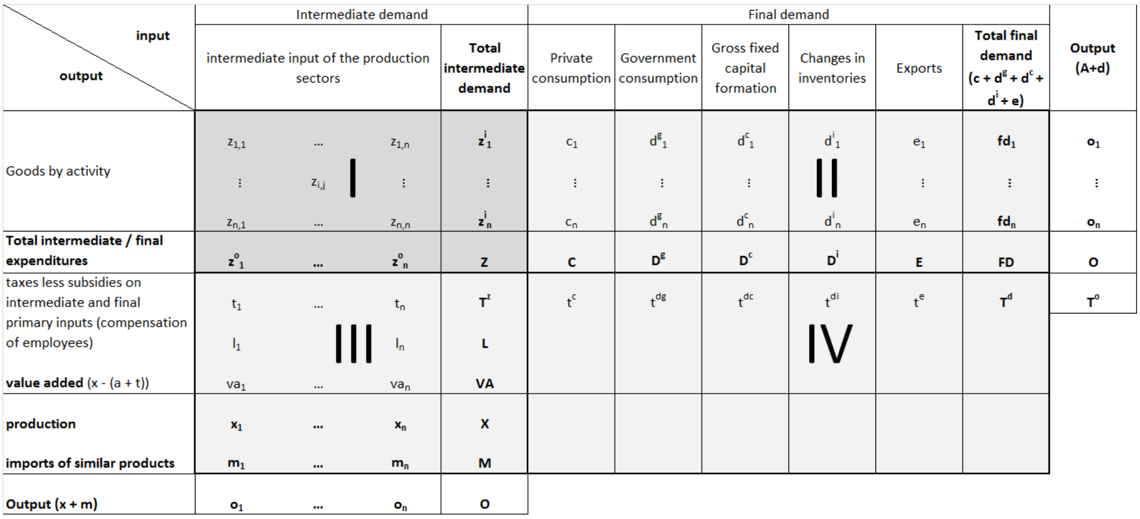
A Construction of the regional input-output-table for Lower Saxony

The objective is to build an input-output table on regional level for Lower Saxony that addresses the local interdependencies of universities with the economy and helps to understand and to quantify their economic impact on the region.[12]

The regional input output table (RIOT) for Lower Saxony is constructed following a non-survey approach as described in Kronenberg (2010), Kronenberg and Többen (2011), Schröder (2012) as well as Többen and Kronenberg (2015). It is a combination of two parts: the goods produced within Lower Saxony and the imported goods. The data basis consists of data provided by the Federal Statistical Office (StBA, 2009, 2017d, 2017e), the Statistical Office of Lower Saxony (LSN, 2015a, 2015b, 2017b) and the Working Group "Regional Accounts" (VGRdL, 2017a, 2017c, 2017d). As the level of detail of the Regional Accounts is lower than of the National Accounts the number of goods by activity and economic activities had to be reduced from 72 on national level to 20 on regional level.

The structure of the RIOT for Lower Saxony is depicted in Figure 9 and follows the regular composition according to ESVG 2010.[13] It consists of three main parts, the quadrants I - III: Quadrant I represents the interdependencies of branches showing the intermediate demand of goods. Quadrant II represents final demand, i.e. the structure of goods and services that are purchased by private households and the government, used for investment or exported. Quadrant III includes the transition from producers' to purchasers' prices and shows the structure of primary inputs such as the compensation of employees. In the following subsections the RIOT is described according to the structure of the Quadrants I to III. The transition from producers' to purchasers' prices is included in the description of intermediate demand and final demand. The methodology for the differentiation between the domestically produced and imported goods and services is explained as well.

Figure 9: Structure of the RIOT for Lower Saxony



input output	Intermediate demand				Final demand						Output (A+d)
	intermediate input of the production sectors			**Total intermediate demand**	Private consumption	Government consumption	Gross fixed capital formation	Changes in inventories	Exports	**Total final demand ($c + d^g + d^c + d^i + e$)**	
Goods by activity	$z_{1,1}$	…	$z_{1,n}$	z^i_1	c_1	d^g_1	d^c_1	d^i_1	e_1	fd_1	o_1
	⋮	$z_{i,j}$ I	⋮	⋮	⋮	⋮	⋮	II	⋮	⋮	⋮
	$z_{n,1}$	…	$z_{n,n}$	z^i_n	c_n	d^g_n	d^c_n	d^i_n	e_n	fd_n	o_n
Total intermediate / final expenditures	z^o_1	…	z^o_n	Z	C	D^g	D^c	D^i	E	FD	O
taxes less subsidies on intermediate and final	t_1	…	t_n	T^z	t^c	t^{dg}	t^{dc}	t^{di}	t^e	T^d	T^o
primary inputs (compensation of employees)	l_1	III	l_n	L				IV			
value added (x - (a + t))	va_1	…	va_n	VA							
production	x_1	…	x_n	X							
imports of similar products	m_1	…	m_n	M							
Output (x + m)	o_1	…	o_n	O							

Source: Own illustration based on StBA (2010, p.15).

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[12] The term universities equally encompasses universities and universities of applied sciences.

[13] For a detailed description of the structure of the national IOT see StBA (2010).

A.1 Intermediate demand in Lower Saxony (Quadrant I)

It is assumed that the production procedures in Lower Saxony equal that of Germany. The assumption can be legitimate by the fact that Lower Saxony is a big Federal State that represents in many aspects the average structure of Germany. Consequently, the way of production and hence the structure of intermediate demand is supposed to be similar between Lower Saxony and Germany. The input coefficients for Lower Saxony hence are assumed to be the same as for Germany ($a_{i,j}^{GE}$). Intermediate demand then can be calculated:

$$z_{ij}^{LS} = a_{ij}^{GE} * x_j^{LS} \tag{8}$$

$$a_{ij}^{GE} = \frac{z_{ij}^{GE}}{x_j^{DE}} \tag{9}$$

z_{ij}: demand of activity i for intermediate goods produced by activity j ($\forall i, j = 1, \ldots, 20$)
a_{ij}: input coefficient between activity i and j (($\forall i, j = 1, \ldots, 20$))
x_j: production of goods by activity j ($\forall j = 1, \ldots, 20$)

The production in Lower Saxony x^{LS} is known (LSN, 2017b) but classified by economic activities (WZ). It was transferred to the classification of goods by activity (CPA) using the structure given in the supply table for Germany (StBA, 2017e, Tab. 1.1):

$$x_{CPA}^{LS} = \sum_{WZ=1}^{WZ=20} (x_{WZ}^{LS} * v_{CPA,WZ}^{GE}) \tag{10}$$

$$v_{CPA,WZ}^{GE} = \frac{x_{CPA,WZ}^{GE}}{x_{WZ}^{GE}} \tag{11}$$

x_{CPA}: production classified by CPA (goods by activity) ($\forall CPA = 1, \ldots, 20$)
x_{WZ}: production classified by WZ (economic activity) (($\forall WZ = 1, \ldots, 20$))
$x_{CPA,WZ}$: production of good CPA produced by activity WZ ($\forall CPA, WZ = 1, \ldots, 20$)
$v_{CPA,WZ}$: weighing scheme for the reclassification of production ($\forall CPA, WZ = 1, \ldots, 20$)

The sum of the estimated intermediate inputs of Equation 8 used for the production of goods by activity j has to be equal to production less value added and taxes[14]:

$$z_j^{LS} = \sum_{i=1}^{i=20} z_{ij}^{LS} \overset{!}{=} x_j^{LS} - va_j^{LS} - t_j^{LS} \tag{12}$$

$$t_j^{LS} = (x_j^{LS} - va_j^{LS}) * \frac{t_j^{GE}}{(x_j^{GE} - va_j^{GE})} \tag{13}$$

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[14] The term taxes encompasses taxes less subsidies.

va_j: value added of goods by activity j ($\forall j = 1, \ldots, 20$)
t_j: taxes less subsidies of goods by activity j ($\forall j = 1, \ldots, 20$)

For Equation 12 to hold the estimated intermediate input z_{ij}^{LS} was scaled:

$$\widehat{z_{ij}}^{LS} = z_{ij}^{LS} * \frac{(x_j^{LS} - va_j^{LS} - t_j^{LS})}{z_j^{LS}} \tag{14}$$

The value added is known for Lower Saxony (VGRdL, 2017c) but again classified by economic activities. The reclassification was done using a similar procedure as for production (Equation 10 and Equation 11). However, the weighing scheme $w_{CPA,WZ}^{GE}$ slightly changed:

$$w_{CPA,WZ}^{GE} = v_{CPA,WZ}^{GE} * \frac{va_{CPA,WZ}^{GE}}{va_{WZ}^{GE}} \tag{15}$$

$va_{CPA,WZ}$: value added generated by activity WZ for product CPA ($\forall CPA, WZ = 1, \ldots, 20$)
va_{WZ}: value added classified by WZ (($\forall WZ = 1, \ldots, 20$))
$w_{CPA,WZ}$: weighing scheme for the reclassification of value added ($\forall CPA, WZ = 1, \ldots, 20$)

A.2 Final demand in Lower Saxony (Quadrant II)

Final demand consists of private consumption[15], government final consumption expenditure, gross fixed capital formation in machinery and equipment, gross fixed capital formation in construction, changes in inventories and exports.

Private consumption

Final private consumption expenditures in the RIOT are differentiated in three household types: students, university personnel and others. The necessary information originates from the Household Budget Survey (HBS) (LSN, 2015a, 2015b). There are four challenges: Firstly, the consumption expenditures in the HBS are structured by consumption purposes (COICOP) and has to be transferred to CPA. Secondly, the total sum of consumption expenditures does not equal total private consumption in the Regional Accounts (RA, VGRdL, 2017d). Thirdly, university personnel is no household type in the HBS and has to be constructed using social status. Fourthly, the consumption expenditures are given in purchasers' prices and have to be converted to producers' prices. The following steps were taken to derive the necessary information for private household consumption in the RIOT.

The total value of private consumption in the HBS is generally smaller than that of the NA and RA.[16] The IOT is balanced with the values of the National Accounts. The same rule applies for the RIOT, i. e. the aggregate values of the RIOT and the RA for

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[15] Private consumption encompasses consumption expenditures of private households as well as of non-profit institutions serving households (NPISHs).

[16] The reasons for the differences between HBS and NA/RA are (StBA, 2017f, p. 17): Households with a net income of more than 18000 Euro are underrepresented in the survey hand hence not included in the HBS due to data sensitivity; The HBS does not consider NPISHs; Retained earnings of self-employed are not (farmer) or only partially (other self-employed) accounted for in the HBS; Social security contributions of the employers are not included in the earned income; Income from rent and lease does not encompass depreciation; Goods and services that are only sporadic or rarely consumed or that are of a sensitive character (alcohol, tobacco, prostitution) are often underestimated in the HBS.

final consumption should be the same. Hence, the HBS values need to be harmonised with the NA values. This was done by:

$$\widehat{c}_{CP}^{HBS} = c_{CP}^{HBS} * \frac{C^{RA}}{\sum c_{CP}^{HBS}} \tag{16}$$

c_{CP}: consumption expenditures by consumption purpose CP ($\forall CP = 1, \ldots, 12$)
C^{RA}: total private consumption given in the Regional Accounts

The consumption pattern of each household type[17] stayed unaffected by the scaling:

$$\widehat{c}_{CP,h}^{HBS} = \widehat{c}_{CP}^{HBS} * \frac{c_{CP,h}^{HBS}}{c_{CP}^{HBS}} \tag{17}$$

$c_{CP,h}$: consumption expenditures by consumption purpose CP and household type h ($\forall CP = 1, \ldots, 12$ and $h = 1, \ldots, 7$)

The consumption expenditures by consumption purposes of the university personnel households was constructed considering their specific composition of white-collar employees and *Beamte*, the respective propensity to consume, the respective specific consumption pattern as well as the average household size. More precisely, the number of university personnel by social status "white-collar employee" and "*Beamte*" was derived from the Higher Education Statistics (LSN, 2017a). The number of households was calculated using the average household size of 1.98. Multiplying the calculated number of households with the consumption expenditures per household of the respective white-collar employee households as well as *Beamte* households and adding them up gives the specific consumption behaviour of the university personnel households:

$$\widehat{c}_{CP,up}^{HBS} = \widehat{c}_{CP}^{HBS} * \frac{c_{CP,up}^{HBS}}{c_{CP}^{HBS}} \tag{18}$$

$$c_{CP,up}^{HBS} = 1.98 * (n_e * c_{CP,e}^{HBS} + n_b * c_{CP,b}^{HBS}) \tag{19}$$

$c_{CP,up}$: consumption expenditures by consumption purpose CP and household type university personnel ($\forall CP = 1, \ldots, 12$)
n: number of persons of the university personnel with social status e (white collar employees) or b (*Beamte*)
$c_{CP,e}$: consumption expenditures by consumption purpose CP and household type white collar employees ($\forall CP = 1, \ldots, 12$)
$c_{CP,b}$: consumption expenditures by consumption purpose CP and household type *Beamte* ($\forall CP = 1, \ldots, 12$)

The consumption expenditures of the household types students, university personnel and others differentiated by consumption purposes (CP) then had to be transferred to the classification goods by activity (CPA). This was achieved using a transition matrix[18]:

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[17] The household types are differentiated by social status of the main income earner and consists of: students, other non-working households, self-employed, *Beamte* (civil servants), white-collar workers, blue-collar workers and unemployed.

[18] The transition matrix was constructed out of a consumption transition matrix for the year 2006 provided by the Statistical Office in combination with information from the National Accounts and own calculations. It is assumed that the relation between consumption purpose and goods by activity is the same for Germany and Lower Saxony.

$$\widehat{c}_{CPA,h} = \sum_{CP=1}^{12} \widehat{c}^{HBS}_{CP,h} * TM_{CPA,CP} \tag{20}$$

$c_{CPA,h}$: consumption expenditures by goods by activity (CPA) and household type ($\forall CPA = 1, \ldots, 20$ and $h = 1, \ldots, 3$)
$TM_{CPA,CP}$: transition matrix ($\forall CP = 1, \ldots, 12$ and $CPA = 1, \ldots, 20$)

Finally, the calculated consumption expenditures $\widehat{c}_{CPA,h}$ given in purchasers' prices p_{pu} had to be converted in producers' prices p_{pr}, that is the purchasers' prices minus trade margins (tm) and taxes on products (t) plus subsidies (s). The information of the transition from producer's to purchaser's prices from the National IOT is used for the RIOT.[19] It is assumed that the ratio of consumption by CPA between Germany and Lower Saxony also applies to the amount of trade margins, taxes and subsidies. Additionally, it is supposed that the distribution between the different household types (students, university personnel and others) does not change. Thus, consumption expenditures by CPA and in producers' prices $c^{p_{pr}}_{CPA,h}$ can be calculated:

$$\widehat{c}^{LS,p_{pr}}_{CPA} = \widehat{c}^{LS,p_{pu}}_{CPA} - \left(\frac{\sum_{h=1}^{3} \widehat{c}^{LS,p_{pu}}_{CPA,h}}{c^{GE,p_{pu}}_{CPA}} * (tm^{GE}_{CPA} + t^{GE}_{CPA} - s^{GE}_{CPA}) \right) \tag{21}$$

$$\widehat{c}^{LS,p_{pr}}_{CPA,h} = \widehat{c}^{LS,p_{pr}}_{CPA} * \frac{\widehat{c}^{LS,p_{pu}}_{CPA,h}}{\sum_{h=1}^{3} \widehat{c}^{LS,p_{pu}}_{CPA,h}} \tag{22}$$

$c^{p_{pr}}_{CPA}$: consumption expenditures by goods by activity (CPA) in producers' prices ($\forall CPA = 1, \ldots, 20$)
$c^{p_{pu}}_{CPA}$: consumption expenditures by CPA in purchasers' prices
tm_{CPA}: trade margins by CPA
t_{CPA}: taxes on goods by CPA
s_{CPA}: subsidies on goods by CPA

The result is a consumption matrix in producers' prices with 20 CPA in rows and 3 household types in columns.The total sum of consumption expenditures plus taxes minus subsidies on goods equals total private consumption as indicated in the RA.

Government final consumption expenditure

The total sum of government consumption D^g at purchasers' prices p_{pu} equals the value given in the RA (VGRdL, 2017d). For the transition from purchasers' to producers' prices the amount of taxes minus subsidies on goods for government consumption (t^{d_g}) has to be estimated. Again, it is assumed that the ratio between government consumption of Lower Saxony and Germany determines the amount of taxes minus subsidies in Lower Saxony. Additionally, the sum of taxes minus subsidies for intermediate and final demand has to comply with the total amount of taxes minus subsidies t^o provided by the RA (VGRdL, 2017c). As the values for intermediate demand (T^z) and private consumption (t^c) are given by definition of Equation 13 and Equation 21, the estimated values for government consumption (t^{d_g}) and gross fixed capital formation (t^{d_c}) has to be scaled on

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[19] The taxes on goods and services are the same for all Federal States as are the subsidies on products. The total amount can vary in each Federal States according to the economic structure and the output of the local industries.

the residual amount. The calculation procedure for taxes minus subsidies on government consumption is:

$$t^{d_g,LS} = \frac{D^{g,LS,p_{pu}}}{D^{g,GE,p_{pu}}} * (t^{d_g,GE}) \tag{23}$$

$$\widehat{t}^{d_g,LS} = t^{d_g,LS} * \frac{(t^{d_g,LS} + t^{d_c,LS})}{(T^{o,LS} - T^{z,LS} - t^{c,LS})} \tag{24}$$

t^{d_g}: taxes minus subsidies on products for government consumption
$D^{g,p_{pu}}$: total government final consumption expenditures in purchasers' prices
t^{d_c}: taxes minus subsidies on products for gross fixed capital formation
T^o: total sum of taxes minus subsidies on products
T^z: taxes minus subsidies on products for intermediate consumption
t^c: taxes minus subsidies on products for private consumption

Government consumption D^g at producers' prices p_{pr} then results from:

$$D^{g,LS,p_{pr}} = D^{g,LS,p_{pu}} - \widehat{t}^{d_g,LS} \tag{25}$$

$D^{g,p_{pr}}$: total government final consumption expenditures in producers' prices

Finally, the estimated total government consumption has to be break down to goods by activity. However, information about the distribution of total government consumption across the goods by activity in Lower Saxony is difficult to get. To keep things simple, the information of the National IOT is used. More precisely, is is assumed that the allocation of goods by activity in Lower Saxony equals that of Germany by applying the share of total government consumption expenditure in purchasers' prices of Lower Saxony in Germany to all categories of goods by activity. The sum of government consumption over CPA has to meet the estimated value of government consumption in producers' prices (Equation 25). In order to comply with the constraint the single CPA-values are scaled. Thus, the calculation procedure is as follows:

$$d^{g,LS}_{CPA} = \frac{D^{g,LS,p_{pu}}}{D^{g,GE,p_{pu}}} * (d^{g,GE}_{CPA}) \tag{26}$$

$$\sum_{CPA=1}^{20} d^{g,LS}_{CPA} \overset{!}{=} D^{g,LS,p_{pr}} \Rightarrow$$

$$\widehat{d}^{g,LS}_{CPA} = d^{g,LS}_{CPA} * \frac{\sum_{CPA=1}^{20} d^{g,LS}_{CPA}}{D^{g,LS,p_{pr}}} \tag{27}$$

d^g_{CPA}: government final consumption expenditures by CPA ($\forall CPA = 1, \ldots, 20$)

Gross fixed capital formation

The estimation procedure for gross fixed capital formation corresponds in most steps to that of government consumption. Below, differences will be explained in detail. For similar calculations it will be referred to the equations used for government consumption.

The total sum of gross fixed capital formation D^c at purchasers' prices p_{pu} equates to the value given in the RA (VGRdL, 2017d). The value is split in investment for plant and machinery $D^c_{j=1}$ as well as in construction $D^c_{j=2}$ respectively using the distribution of the National IOT:

$$D_j^{c,LS,p_{pu}} = \frac{D_j^{c,GE,p_{pu}}}{D^{c,GE,p_{pu}}} * D^{c,LS,p_{pu}} \tag{28}$$

$D_j^{c,p_{pu}}$: gross fixed capital formation in j ($\forall j = 1$ (plant and machinery), 2 (construction))
$D^{c,p_{pu}}$: total gross fixed capital formation

The values at producers' prices ($D_j^{c,LS,p_{pr}}$) were derived according to Equation 25 using the calculation of taxes minus subsidies as given in Equation 23 and Equation 24. The distribution of total gross fixed capital formation on CPA is estimated with Equation 26 and Equation 27.

Change in inventories

The RA provide no information about changes in inventories. In the national IOT and the NA the changes in inventories are used as means of adjustment for balancing the production and expenditure approach and are subject to severe revisions (Grömling, 2002, p. 1131). The interpretation of that value is hence limited (ibid.). Therefore, a simple approach with the Gross Domestic Product (GDP) as proxy was used for the RIOT. More precisely, the share of Lower Saxony's GDP in the national GDP was applied to the values of changes in inventories in the national IOT:

$$d_{CPA}^{i,LS} = \frac{GDP^{LS}}{GDP^{GE}} * d_{CPA}^{i,GE} \tag{29}$$

$$D^{i,LS} = \sum_{CPA=1}^{20} d_{CPA}^{i,LS} \tag{30}$$

d^i_{CPA}: changes in inventories by CPA ($\forall CPA = 1, \ldots, 20$)
D^i: total changes in inventories

Changes in inventories are not subject to taxes and subsidies. Thus, the total amount of changes in inventories at producers' prices is the same as at purchasers' prices:

$$D^{i,LS,p_{pr}} == D^{i,LS,p_{pu}}, \text{ with } t^{d_i} = 0 \tag{31}$$

$D^{i,p_{pr}}$: total changes in inventories at producers' prices
$D^{i,p_{pu}}$: total changes in inventories at purchasers' prices
t^{d_i}: taxes minus subsidies for changes in inventories

Exports

Exports in Lower Saxony encompass supplies within Germany to other Federal States as well as supplies outside of Germany to other countries. The estimation of exports considers cross-hauling as suggested in Kronenberg and Többen (2011, p. 11 f.) or Kronenberg (2010, p. 234-237). Cross-hauling is defined as the simultaneous importing and exporting of same products or commodities. By allowing cross-hauling, industries do not have to be solely import or export oriented. Cross-hauling (ch) is formally described by the difference between the trade volume (exports + imports) and the absolute value of the trade balance (exports - imports):

$$ch_{CPA} = e_{CPA} + i_{CPA} - |e_{CPA} - i_{CPA}| \tag{32}$$

ch_{CPA}: cross-hauling by CPA ($\forall CPA = 1, \ldots, 20$)
e_{CPA}: exports by CPA
i_{CPA}: imports by CPA

The cross-hauling shares (chs) give the amount of cross-hauling relative to the domestic use of a specific product:

$$chs_{CPA} = \frac{ch_{CPA}}{(x_{CPA} + z_{CPA} + (fd_{CPA} - e_{CPA}))} \tag{33}$$

chs_{CPA}: cross-hauling shares by CPA ($\forall CPA = 1, \ldots, 20$)
x_{CPA}: production by CPA
z_{CPA}: intermediate consumption by CPA
fd_{CPA}: final demand by CPA

The cross-hauling share is supposed to be product-specific and not location-specific. Thus, it can be assumed that the cross-hauling shares on national level derived from the national IOT are equally valid for Lower Saxony. Based on the national cross-hauling shares (chs^{GE}) cross-hauling for Lower Saxony can be estimated:

$$ch^{LS}_{CPA} = chs^{GE}_{CPA} * \left(x^{LS}_{CPA} + z^{LS}_{CPA} + c^{LS}_{CPA} + d^{g,LS}_{CPA} + d^{c,LS}_{CPA} + d^{i,LS}_{CPA} \right) \tag{34}$$

c_{CPA}: private consumption by CPA ($\forall CPA = 1, \ldots, 20$)
d^{g}_{CPA}: government consumption by CPA
d^{c}_{CPA}: gross fixed capital formation by CPA
d^{i}_{CPA}: change in inventories by CPA

Finally, exports and imports in Lower Saxony can be determined using the definition of Equation 32:

$$e^{LS}_{CPA} = \frac{ch^{LS}_{CPA} + \left| tb^{LS}_{CPA} \right| + tb^{LS}_{CPA}}{2} \tag{35}$$

$$i^{LS}_{CPA} = \frac{ch^{LS}_{CPA} + \left| tb^{LS}_{CPA} \right| - tb^{LS}_{CPA}}{2} \tag{36}$$

$$tb^{LS}_{CPA} = x^{LS}_{CPA} - z^{LS}_{CPA} - (c^{LS}_{CPA} + d^{g,LS}_{CPA} + d^{c,LS}_{CPA} + d^{i,LS}_{CPA}) \tag{37}$$

tb_{CPA}: trade balance by CPA ($\forall CPA = 1, \ldots, 20$)

The estimated values for exports and imports (e^{LS}_{CPA} and i^{LS}_{CPA}) are compared to values given by the trade statistics (StBA, 2017a). The estimated values should be larger than those of the trade statistics as they encompasses the trade with other Federal States within Germany as well as the trade with foreign countries outside of Germany. The trade statistics however only shows foreign trade with other countries, i. e. the trade of Lower Saxony outside Germany with other countries. The condition that the estimated values (e_{CPA}^{LS}, i_{CPA}^{LS}) are bigger than the values given by the trade statistics ($e_{CPA}^{f,LS}$, $i_{CPA}^{f,LS}$) does not hold for the CPA groups "products of agriculture, forestry and fishing", "mining and quarrying" and "electricity, gas, steam and air conditioning". For the first two CPA groups the estimated imports are lower than the imports from the trade statistics. In case of the last CPA group the estimated exports are too small. Thus, the estimated values has to be corrected. For the correction procedure as proposed by Kronenberg and Többen (2011, p. 13 f.) the values of the trade balance and the trade volume of Lower Saxony's domestic trade (with other Federal States) has to be estimated.

The value of the total trade balance tb_{CPA}^{LS} can assumed to be right as the input-output condition (total input = total output) holds (Kronenberg and Többen, 2011, p. 13). The trade balance for domestic trade with other Federal States then is the difference between the total trade balance and the foreign trade balance:

$$tb_{CPA}^{d,LS} = tb_{CPA}^{LS} - tb_{CPA}^{f,LS} \tag{38}$$

$$tb_{CPA}^{f,LS} = e_{CPA}^{f,LS} - i_{CPA}^{f,LS} \tag{39}$$

tb_{CPA}^{d}: trade balance for trade with other Federal States within Germany by CPA ($\forall CPA$, where $e_{CPA}^{LS} < e_{CPA}^{f,LS} \vee i_{CPA}^{LS} < i_{CPA}^{f,LS}$)

tb_{CPA}^{f}: trade balance for trade with other countries outside of Germany by CPA

The other component that has to be re-estimated to correct total exports and imports is the trade volume of Lower Saxony with the Federal States within Germany ($tv_{CPA}^{d,LS}$). The related equation is:

$$tv_{CPA}^{d,LS} = \left| tb_{CPA}^{d,LS} \right| - ch_{CPA}^{d,LS} \tag{40}$$

tv_{CPA}^{d}: trade volume with other Federal States within Germany by CPA ($\forall CPA$, where $e_{CPA}^{LS} < e_{CPA}^{f,LS} \vee i_{CPA}^{LS} < i_{CPA}^{f,LS}$)

ch_{CPA}^{d}: degree of cross hauling in domestic trade by CPA

As the amount of cross hauling between Lower Saxony and the other Federal States ($ch_{CPA}^{d,LS}$) is unknown, it is assumed that it equals the degree of cross hauling with foreign countries (Kronenberg and Többen, 2011, p. 13):

$$ch_{CPA}^{d,LS} = ch_{CPA}^{f,LS} = \left(e_{CPA}^{f,LS} - i_{CPA}^{f,LS} \right) - \left| tb_{CPA}^{f,LS} \right| \tag{41}$$

ch_{CPA}^{f}: degree of cross hauling in foreign trade by CPA ($\forall CPA$, where $e_{CPA}^{LS} < e_{CPA}^{f,LS} \vee i_{CPA}^{LS} < i_{CPA}^{f,LS}$)

Using the results of Equation 38 and Equation 40 in combination with Equation 35 and Equation 36 yields the regional exports and imports of Lower Saxony with the other Federal States $e_{CPA}^{d,LS}$ and $i_{CPA}^{d,LS}$:

$$e^{d,LS}_{CPA} = \frac{tv^{d,LS}_{CPA} + tb^{d,LS}_{CPA}}{2} \tag{42}$$

$$i^{d,LS}_{CPA} = \frac{tv^{d,LS}_{CPA} - tb^{d,LS}_{CPA}}{2} \tag{43}$$

e^{d}_{CPA}: exports in Federal States within Germany by CPA ($\forall CPA$, where $e^{LS}_{CPA} < e^{f,LS}_{CPA} \vee i^{LS}_{CPA} < i^{f,LS}_{CPA}$)
i^{d}_{CPA}: imports from Federal States within Germany by CPA ($\forall CPA$, where $e^{LS}_{CPA} < e^{f,LS}_{CPA} \vee i^{LS}_{CPA} < i^{f,LS}_{CPA}$)

The new total values of imports and exports for the respective CPA then are the sum of the domestic and foreign trade values resulting from Equation 42 and Equation 43 as well as from the trade statistics.

Finally, total exports in producers' prices is given by adding up the export values by CPA. The amount of taxes minus subsidies on exported goods on national level is extremely low.[20] For Lower Saxony it is hence assumed, that taxes minus subsidies are of zero value. Consequently, total exports in purchasers' prices equal total exports in producers' prices:

$$E^{LS,p_{pr}} = \sum_{CPA=1}^{20} e^{LS}_{CPA} = E^{LS,p_{pu}} \tag{44}$$

$E^{p_{pr}}$: total exports at producers' prices
$E^{p_{pu}}$: total exports at purchasers' prices

A.3 Primary inputs and imports in Lower Saxony (Quadrant III)

In this subsection the remaining parts of quadrant III – compensation of employees and imports of similar goods – are described. The estimation of taxes minus subsidies as well as the transition from producers' to purchasers' prices are explained in the previous subsections.[21]

Compensation of employees

Values for compensations of employees are available in the RA (VGRdL, 2017a). However, the information is classified by economic activities (WZ) and has to be transferred to CPA. Basically, a similar procedure as in Equation 10 or Equation 15 is applied:

$$l^{LS}_{CPA} = \sum_{WZ=1}^{20} (l^{LS}_{WZ} * w^{GE}_{CPA,WZ}) \tag{45}$$

$$w^{GE}_{CPA,WZ} = \frac{x^{GE}_{CPA,WZ}}{x^{GE}_{WZ}} * \frac{l^{GE}_{CPA,WZ}}{l^{GE}_{WZ}} \tag{46}$$

---

[20] In the 2013 national IOT the value of taxes minus subsidies for exports amounts to -2 million Euro, i. e. less than 0,001 % of total taxes minus subsidies and only 0,0002 % of exports at producers' prices.

[21] Albeit being per definition part of quadrant III, they were necessary for the calculation procedures of intermediate and final consumption. For the sake of higher clarity of the calculation process the description regarding taxes minus subsidies and the transition from producers' to purchasers' prices hence are added to the other subsections.

l_{CPA}: compensation of employees classified by CPA (goods by activity) ($\forall CPA = 1, \ldots, 20$)
l_{WZ}: compensation of employees classified by WZ (economic activity) (($\forall WZ = 1, \ldots, 20$))
$w_{CPA,WZ}$: weighing scheme for the reclassification of compensation of employees ($\forall CPA, WZ = 1, \ldots, 20$)
$x_{CPA,WZ}$: production of good CPA produced by activity WZ ($\forall CPA, WZ = 1, \ldots, 20$)
x_{WZ}: production classified by WZ ($\forall WZ = 1, \ldots, 20$)

Imports of similar goods

The amount of imported goods results from the CHARM method described in the calculation procedure for exports (p. 24ff.). More precisely, the value is generated by Equation 36.

A.4 Total output in Lower Saxony (domestic production and imports)

Total output can be calculated from the production as well as from the consumption side. Total output from the production side consists of the sum of products produced by each production sector and the sum of similar imported goods:

$$O = X + I = \sum_{j=1}^{20} \left(z_j^o + t_j + va_j + i_j \right) \tag{47}$$

O: total output

From the consumption side, total output is the sum of intermediate and final consumption:

$$O = Z + FD = \sum_{i=1}^{20} \left(z_i^i + c_i + d_i^g + d_i^c + d_i^i + e_i \right) \tag{48}$$

A.5 Subdivision of the RIOT into domestic production and imports

Multipliers are calculated using the information of solely domestically produced intermediate and final consumption. The RIOT hence has to be subdivided into two additional tables: domestic production and imports.

First estimation of imports for RIOT

A first approach for the import table of the RIOT of Lower Saxony ($\widehat{RIOT}^I$) is based on the import quotas given in the National IOT. More precisely, all intermediate inputs $z_{i,j}$ and all final demand components ($c_i, d_i^g, d_i^c, d_i^i, e_i$) are multiplied by the share of imported intermediate and final demand in total intermediate and final demand provided by the National IOT.

$$\widehat{RIOT}^I_{i,j} = RIOT_{i,j} * \frac{IQ_{i,j}}{100}, \forall i = 1, \ldots, 20, j = 1, \ldots, 29 \tag{49}$$

$$IQ_{i,j} = \frac{IOT_{i,j}^{GE}}{IOT_{i,j}^{I,GE}} * 100 \tag{50}$$

$RIOT^I$: Regional Input-Output-Table of imports
i: CAP
j: 1-20: input in production sector by CAP, 21-24: private consumption, 25: government final consumption expenditure, 26: gross fixed capital formation of plant and machinery, 27: gross fixed capital formation of construction, 28: changes in inventories, 29: exports
IQ: import quotas
IOT^I: National Input-Output-Table of imports

Regional Input-Output table for domestic production

The table for domestic production ($\widehat{RIOT}^D$) results from the difference between total and imported input-output values:

$$\widehat{RIOT}^D_{i,j} = RIOT_{i,j} - \widehat{RIOT}^I_{i,j}, \forall i = 1, \ldots, 20, j = 1, \ldots, 29 \tag{51}$$

$RIOT^D$: Regional Input-Output-Table of domestic production

One essential condition is that the equation of the Leontief-Inverse ($x = (I - A)^{-1} * fd$) has to hold with the estimated table for regional production $\widehat{RIOT}^D$. This means that inserting all estimated values in the Leontief-Inverse and solving for final demand must equal estimated final demand:

$$\widehat{RIOT}^D_{30} = \widehat{fd} \overset{!}{=} (I - A) * x = fd \tag{52}$$

$RIOT^D_{30}$: vector of total final demand of the RIOT for domestic production by CPA
I: identity matrix
A: matrix of input coefficients $a_{i,j} = z_{i,j}/x_j$, with $i, j = 1, \ldots, 20$
x: production vector

For Equation 52 to be true the estimated value of final demand $\widehat{fd}$ from the $\widehat{RIOT}^D$ has to be scaled to meet the Leontief condition. The new $RIOT^D$ then results from:

$$RIOT^D_{i,j} = \widehat{RIOT}^D_{i,j} * \frac{fd_i}{\widehat{fd_i}}, \forall i = 1, \ldots, 20, j = 21, \ldots, 29 \tag{53}$$

$$RIOT^D_{i,j} = \widehat{RIOT}^D_{i,j}, \forall i, j = 1, \ldots, 20$$

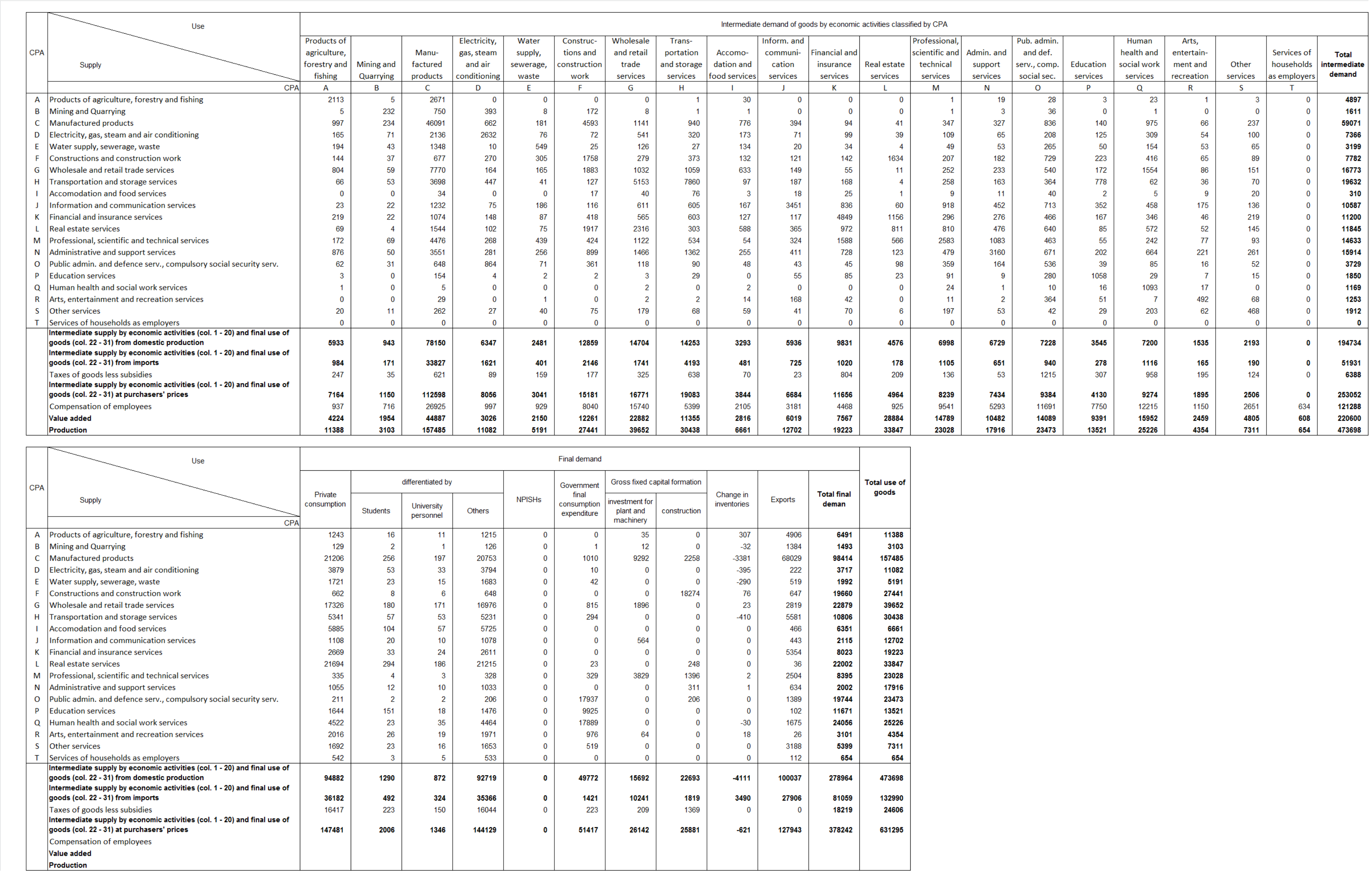
Regional Input-Output table for imports

Assuming that (1) the total RIOT for Lower Saxony is correctly estimated and (2) the table for domestic production within Lower Saxony is correct due to the Leontief-condition the final table for imports can be calculated subtracting the values of the table for domestic production from the values of the table for total production:

$$RIOT^I_{i,j} = RIOT_{i,j} - RIOT^D_{i,j}, \forall i = 1, \ldots, 20, j = 21, \ldots, 29 \tag{54}$$

The resulting tables for domestic production, imports as well as total values are depicted in Figure 10, Figure 11 and Figure 12.

Figure 10: Regional Input-Output Table for domestic production in Lower Saxony at producers' prices in million Euro (2013)

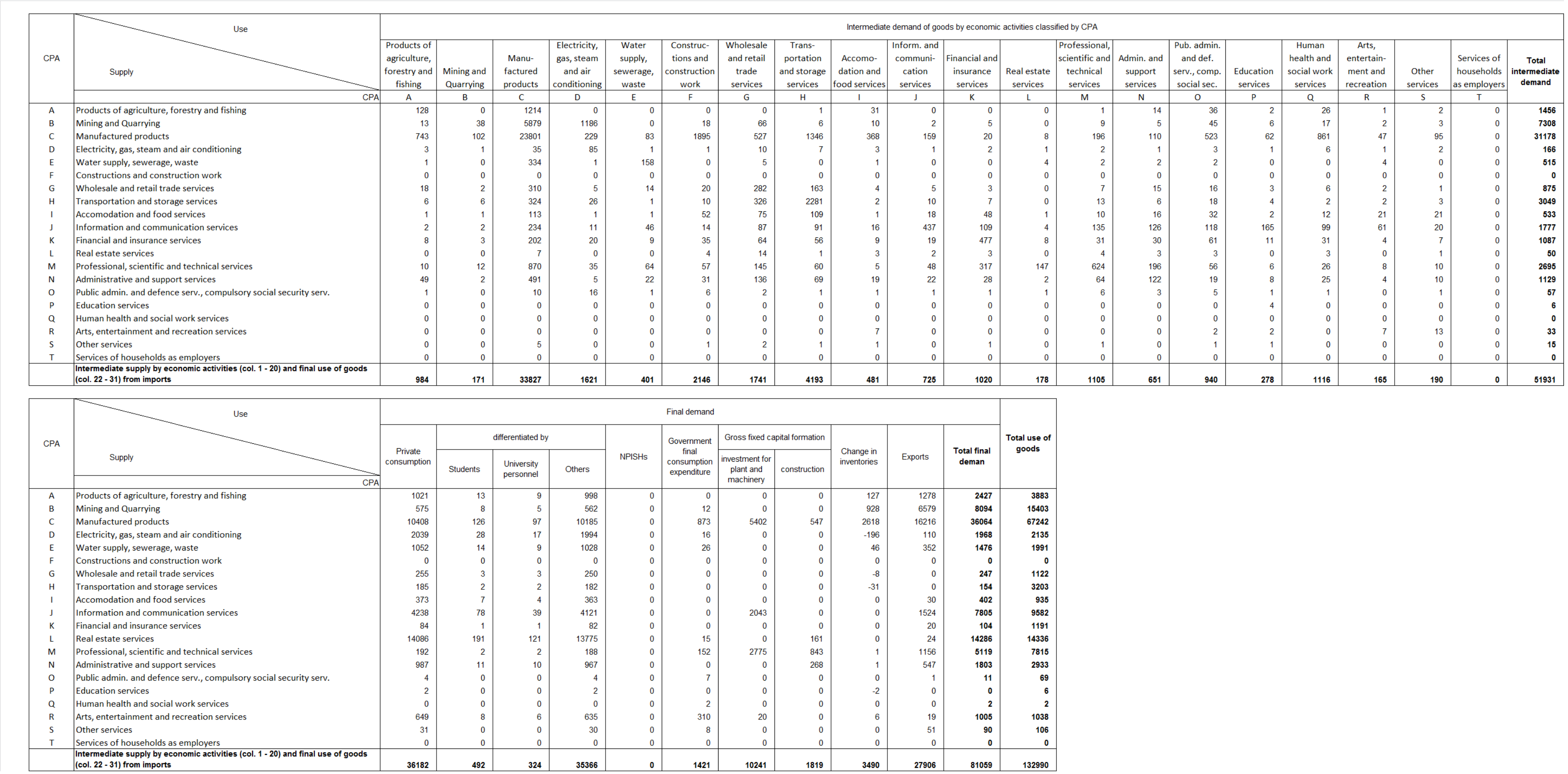


CPA	Use / Supply	Intermediate demand of goods by economic activities classified by CPA																				
		Products of agriculture, forestry and fishing	Mining and Quarrying	Manu-factured products	Electricity, gas, steam and air conditioning	Water supply, sewerage, waste	Construc-tions and construction work	Wholesale and retail trade services	Trans-portation and storage services	Accomo-dation and food services	Inform. and communi-cation services	Financial and insurance services	Real estate services	Professional, scientific and technical services	Admin. and support services	Pub. admin. and def. serv., comp. social sec.	Education services	Human health and social work services	Arts, entertain-ment and recreation	Other services	Services of households as employers	**Total intermediate demand**
	CPA	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	
A	Products of agriculture, forestry and fishing	2113	5	2671	0	0	0	0	1	30	0	0	0	1	19	28	3	23	1	3	0	**4897**
B	Mining and Quarrying	5	232	750	393	8	172	8	1	1	0	0	0	1	3	36	0	1	0	0	0	**1611**
C	Manufactured products	997	234	46091	662	181	4593	1141	940	776	394	94	41	347	327	836	140	975	66	237	0	**59071**
D	Electricity, gas, steam and air conditioning	165	71	2136	2632	76	72	541	320	173	71	99	39	109	65	208	125	309	54	100	0	**7366**
E	Water supply, sewerage, waste	194	43	1348	10	549	25	126	27	134	20	34	4	49	53	265	50	154	53	65	0	**3199**
F	Constructions and construction work	144	37	677	270	305	1758	279	373	132	121	142	1634	207	182	729	223	416	65	89	0	**7782**
G	Wholesale and retail trade services	804	59	7770	164	165	1883	1032	1059	633	149	55	11	252	233	540	172	1554	86	151	0	**16773**
H	Transportation and storage services	66	53	3698	447	41	127	5153	7860	97	187	168	4	258	163	364	778	62	36	70	0	**19632**
I	Accomodation and food services	0	0	34	0	0	17	40	76	3	18	25	1	9	11	40	2	5	9	20	0	**310**
J	Information and communication services	23	22	1232	75	186	116	611	605	167	3451	836	60	918	452	713	352	458	175	136	0	**10587**
K	Financial and insurance services	219	22	1074	148	87	418	565	603	127	117	4849	1156	296	276	466	167	346	46	219	0	**11200**
L	Real estate services	69	4	1544	102	75	1917	2316	303	588	365	972	811	810	476	640	85	572	52	145	0	**11845**
M	Professional, scientific and technical services	172	69	4476	268	439	424	1122	534	54	324	1588	566	2583	1083	463	55	242	77	93	0	**14633**
N	Administrative and support services	876	50	3551	281	256	899	1466	1362	255	411	728	123	479	3160	671	202	664	221	261	0	**15914**
O	Public admin. and defence serv., compulsory social security serv.	62	31	648	864	71	361	118	90	48	43	45	98	359	164	536	39	85	16	52	0	**3729**
P	Education services	3	0	154	4	2	2	3	29	0	55	85	23	91	9	280	1058	29	7	15	0	**1850**
Q	Human health and social work services	1	0	5	0	0	0	2	0	2	0	0	0	24	1	10	16	1093	17	0	0	**1169**
R	Arts, entertainment and recreation services	0	0	29	0	1	0	2	2	14	168	42	0	11	2	364	51	7	492	68	0	**1253**
S	Other services	20	11	262	27	40	75	179	68	59	41	70	6	197	53	42	29	203	62	468	0	**1912**
T	Services of households as employers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Intermediate supply by economic activities (col. 1 - 20) and final use of goods (col. 22 - 31) from domestic production	**5933**	**943**	**78150**	**6347**	**2481**	**12859**	**14704**	**14253**	**3293**	**5936**	**9831**	**4576**	**6998**	**6729**	**7228**	**3545**	**7200**	**1535**	**2193**	**0**	**194734**
	Intermediate supply by economic activities (col. 1 - 20) and final use of goods (col. 22 - 31) from imports	**984**	**171**	**33827**	**1621**	**401**	**2146**	**1741**	**4193**	**481**	**725**	**1020**	**178**	**1105**	**651**	**940**	**278**	**1116**	**165**	**190**	**0**	**51931**
	Taxes of goods less subsidies	247	35	621	89	159	177	325	638	70	23	804	209	136	53	1215	307	958	195	124	0	**6388**
	Intermediate supply by economic activities (col. 1 - 20) and final use of goods (col. 22 - 31) at purchasers' prices	**7164**	**1150**	**112598**	**8056**	**3041**	**15181**	**16771**	**19083**	**3844**	**6684**	**11656**	**4964**	**8239**	**7434**	**9384**	**4130**	**9274**	**1895**	**2506**	**0**	**253052**
	Compensation of employees	937	716	26925	997	929	8040	15740	5399	2105	3181	4468	925	9541	5293	11691	7750	12215	1150	2651	634	**121288**
	Value added	**4224**	**1954**	**44887**	**3026**	**2150**	**12261**	**22882**	**11355**	**2816**	**6019**	**7567**	**28884**	**14789**	**10482**	**14089**	**9391**	**15952**	**2459**	**4805**	**608**	**220600**
	Production	**11388**	**3103**	**157485**	**11082**	**5191**	**27441**	**39652**	**30438**	**6661**	**12702**	**19223**	**33847**	**23028**	**17916**	**23473**	**13521**	**25226**	**4354**	**7311**	**654**	**473698**

CPA	Use / Supply	Final demand											**Total use of goods**
			differentiated by					Gross fixed capital formation					
	CPA	Private consumption	Students	University personnel	Others	NPISHs	Government final consumption expenditure	investment for plant and machinery	construction	Change in inventories	Exports	**Total final deman**	
A	Products of agriculture, forestry and fishing	1243	16	11	1215	0	0	35	0	307	4906	**6491**	**11388**
B	Mining and Quarrying	129	2	1	126	0	1	12	0	-32	1384	**1493**	**3103**
C	Manufactured products	21206	256	197	20753	0	1010	9292	2258	-3381	68029	**98414**	**157485**
D	Electricity, gas, steam and air conditioning	3879	53	33	3794	0	10	0	0	-395	222	**3717**	**11082**
E	Water supply, sewerage, waste	1721	23	15	1683	0	42	0	0	-290	519	**1992**	**5191**
F	Constructions and construction work	662	8	6	648	0	0	0	18274	76	647	**19660**	**27441**
G	Wholesale and retail trade services	17326	180	171	16976	0	815	1896	0	23	2819	**22879**	**39652**
H	Transportation and storage services	5341	57	53	5231	0	294	0	0	-410	5581	**10806**	**30438**
I	Accomodation and food services	5885	104	57	5725	0	0	0	0	0	466	**6351**	**6661**
J	Information and communication services	1108	20	10	1078	0	0	564	0	0	443	**2115**	**12702**
K	Financial and insurance services	2669	33	24	2611	0	0	0	0	0	5354	**8023**	**19223**
L	Real estate services	21694	294	186	21215	0	23	0	248	0	36	**22002**	**33847**
M	Professional, scientific and technical services	335	4	3	328	0	329	3829	1396	2	2504	**8395**	**23028**
N	Administrative and support services	1055	12	10	1033	0	0	0	311	1	634	**2002**	**17916**
O	Public admin. and defence serv., compulsory social security serv.	211	2	2	206	0	17937	0	206	0	1389	**19744**	**23473**
P	Education services	1644	151	18	1476	0	9925	0	0	0	102	**11671**	**13521**
Q	Human health and social work services	4522	23	35	4464	0	17889	0	0	-30	1675	**24056**	**25226**
R	Arts, entertainment and recreation services	2016	26	19	1971	0	976	64	0	18	26	**3101**	**4354**
S	Other services	1692	23	16	1653	0	519	0	0	0	3188	**5399**	**7311**
T	Services of households as employers	542	3	5	533	0	0	0	0	0	112	**654**	**654**
	Intermediate supply by economic activities (col. 1 - 20) and final use of goods (col. 22 - 31) from domestic production	**94882**	**1290**	**872**	**92719**	**0**	**49772**	**15692**	**22693**	**-4111**	**100037**	**278964**	**473698**
	Intermediate supply by economic activities (col. 1 - 20) and final use of goods (col. 22 - 31) from imports	**36182**	**492**	**324**	**35366**	**0**	**1421**	**10241**	**1819**	**3490**	**27906**	**81059**	**132990**
	Taxes of goods less subsidies	16417	223	150	16044	0	223	209	1369	0	0	**18219**	**24606**
	Intermediate supply by economic activities (col. 1 - 20) and final use of goods (col. 22 - 31) at purchasers' prices	**147481**	**2006**	**1346**	**144129**	**0**	**51417**	**26142**	**25881**	**-621**	**127943**	**378242**	**631295**
	Compensation of employees												
	Value added												
	Production												

Source: Own calculations.

Figure 11: Regional Input-Output Table for imports in Lower Saxony at producers' prices in million Euro (2013)



CPA	Use Supply	Intermediate demand of goods by economic activities classified by CPA																				
		Products of agriculture, forestry and fishing	Mining and Quarrying	Manu-factured products	Electricity, gas, steam and air conditioning	Water supply, sewerage, waste	Construc-tions and construction work	Wholesale and retail trade services	Trans-portation and storage services	Accomo-dation and food services	Inform. and communi-cation services	Financial and insurance services	Real estate services	Professional, scientific and technical services	Admin. and support services	Pub. admin. and def. serv., comp. social sec.	Education services	Human health and social work services	Arts, entertain-ment and recreation	Other services	Services of households as employers	**Total intermediate demand**
	CPA	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	
A	Products of agriculture, forestry and fishing	128	0	1214	0	0	0	0	1	31	0	0	0	1	14	36	2	26	1	2	0	**1456**
B	Mining and Quarrying	13	38	5879	1186	0	18	66	6	10	2	5	0	9	5	45	6	17	2	3	0	**7308**
C	Manufactured products	743	102	23801	229	83	1895	527	1346	368	159	20	8	196	110	523	62	861	47	95	0	**31178**
D	Electricity, gas, steam and air conditioning	3	1	35	85	1	1	10	7	3	1	2	1	2	1	3	1	6	1	2	0	**166**
E	Water supply, sewerage, waste	1	0	334	1	158	0	5	0	1	0	0	4	2	2	2	0	0	4	0	0	**515**
F	Constructions and construction work	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
G	Wholesale and retail trade services	18	2	310	5	14	20	282	163	4	5	3	0	7	15	16	3	6	2	1	0	**875**
H	Transportation and storage services	6	6	324	26	1	10	326	2281	2	10	7	0	13	6	18	4	2	2	3	0	**3049**
I	Accomodation and food services	1	1	113	1	1	52	75	109	1	18	48	1	10	16	32	2	12	21	21	0	**533**
J	Information and communication services	2	2	234	11	46	14	87	91	16	437	109	4	135	126	118	165	99	61	20	0	**1777**
K	Financial and insurance services	8	3	202	20	9	35	64	56	9	19	477	8	31	30	61	11	31	4	7	0	**1087**
L	Real estate services	0	0	7	0	0	4	14	1	3	2	3	0	4	3	3	0	3	0	1	0	**50**
M	Professional, scientific and technical services	10	12	870	35	64	57	145	60	5	48	317	147	624	196	56	6	26	8	10	0	**2695**
N	Administrative and support services	49	2	491	5	22	31	136	69	19	22	28	2	64	122	19	8	25	4	10	0	**1129**
O	Public admin. and defence serv., compulsory social security serv.	1	0	10	16	1	6	2	1	1	1	1	1	6	3	5	1	1	0	1	0	**57**
P	Education services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	**6**
Q	Human health and social work services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
R	Arts, entertainment and recreation services	0	0	0	0	0	0	0	0	7	0	0	0	0	0	2	2	0	7	13	0	**33**
S	Other services	0	0	5	0	0	1	2	1	1	0	1	0	1	0	1	1	0	0	0	0	**15**
T	Services of households as employers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	Intermediate supply by economic activities (col. 1 - 20) and final use of goods (col. 22 - 31) from imports	**984**	**171**	**33827**	**1621**	**401**	**2146**	**1741**	**4193**	**481**	**725**	**1020**	**178**	**1105**	**651**	**940**	**278**	**1116**	**165**	**190**	**0**	**51931**

CPA	Use Supply	Final demand											**Total use of goods**
		Private consumption	differentiated by			NPISHs	Government final consumption expenditure	Gross fixed capital formation		Change in inventories	Exports	**Total final deman**	
	CPA		Students	University personnel	Others			investment for plant and machinery	construction				
A	Products of agriculture, forestry and fishing	1021	13	9	998	0	0	0	0	127	1278	**2427**	**3883**
B	Mining and Quarrying	575	8	5	562	0	12	0	0	928	6579	**8094**	**15403**
C	Manufactured products	10408	126	97	10185	0	873	5402	547	2618	16216	**36064**	**67242**
D	Electricity, gas, steam and air conditioning	2039	28	17	1994	0	16	0	0	-196	110	**1968**	**2135**
E	Water supply, sewerage, waste	1052	14	9	1028	0	26	0	0	46	352	**1476**	**1991**
F	Constructions and construction work	0	0	0	0	0	0	0	0	0	0	**0**	**0**
G	Wholesale and retail trade services	255	3	3	250	0	0	0	0	-8	0	**247**	**1122**
H	Transportation and storage services	185	2	2	182	0	0	0	0	-31	0	**154**	**3203**
I	Accomodation and food services	373	7	4	363	0	0	0	0	0	30	**402**	**935**
J	Information and communication services	4238	78	39	4121	0	0	2043	0	0	1524	**7805**	**9582**
K	Financial and insurance services	84	1	1	82	0	0	0	0	0	20	**104**	**1191**
L	Real estate services	14086	191	121	13775	0	15	0	161	0	24	**14286**	**14336**
M	Professional, scientific and technical services	192	2	2	188	0	152	2775	843	1	1156	**5119**	**7815**
N	Administrative and support services	987	11	10	967	0	0	0	268	1	547	**1803**	**2933**
O	Public admin. and defence serv., compulsory social security serv.	4	0	0	4	0	7	0	0	0	1	**11**	**69**
P	Education services	2	0	0	2	0	0	0	0	-2	0	**0**	**6**
Q	Human health and social work services	0	0	0	0	0	2	0	0	0	0	**2**	**2**
R	Arts, entertainment and recreation services	649	8	6	635	0	310	20	0	6	19	**1005**	**1038**
S	Other services	31	0	0	30	0	8	0	0	0	51	**90**	**106**
T	Services of households as employers	0	0	0	0	0	0	0	0	0	0	**0**	**0**
	Intermediate supply by economic activities (col. 1 - 20) and final use of goods (col. 22 - 31) from imports	**36182**	**492**	**324**	**35366**	**0**	**1421**	**10241**	**1819**	**3490**	**27906**	**81059**	**132990**

Source: Own calculations.

Figure 12: Regional Input-Output Table for domestic production and imports in Lower Saxony at producers' prices in million Euro (2013)

CPA	Use / Supply	Intermediate demand of goods by economic activities classified by CPA																				
		Products of agriculture, forestry and fishing	Mining and Quarrying	Manu-factured products	Electricity, gas, steam and air conditioning	Water supply, sewerage, waste	Construc-tions and construction work	Wholesale and retail trade services	Trans-portation and storage services	Accomo-dation and food services	Inform. and communi-cation services	Financial and insurance services	Real estate services	Professional, scientific and technical services	Admin. and support services	Pub. admin. and def. serv., comp. social sec.	Education services	Human health and social work services	Arts, entertain-ment and recreation	Other services	Services of households as employers	**Total intermediate demand**
	CPA	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	
A	Products of agriculture, forestry and fishing	2240	5	3884	0	0	0	0	2	61	0	0	0	2	33	64	5	49	3	5	0	6354
B	Mining and Quarrying	18	270	6629	1579	8	191	74	7	10	2	5	0	10	7	81	6	18	2	4	0	8919
C	Manufactured products	1740	337	69892	891	263	6488	1668	2286	1145	554	114	49	543	437	1358	202	1835	113	332	0	90249
D	Electricity, gas, steam and air conditioning	169	72	2171	2717	77	73	551	327	176	73	101	40	110	66	211	126	314	55	102	0	7532
E	Water supply, sewerage, waste	195	43	1682	11	707	25	130	27	135	20	34	7	51	55	267	50	155	56	65	0	3714
F	Constructions and construction work	144	37	677	270	305	1758	279	373	132	121	142	1634	207	182	729	223	416	65	89	0	7782
G	Wholesale and retail trade services	823	61	8080	169	179	1903	1314	1221	636	154	57	11	258	248	557	175	1560	88	152	0	17648
H	Transportation and storage services	72	59	4022	473	42	137	5479	10141	99	197	176	4	271	169	382	782	64	38	73	0	22681
I	Accomodation and food services	1	2	146	1	1	69	115	184	5	35	72	2	19	26	71	4	17	30	41	0	843
J	Information and communication services	24	25	1466	86	231	130	699	696	183	3887	945	64	1053	578	831	516	557	236	157	0	12364
K	Financial and insurance services	227	25	1276	168	97	453	629	659	136	136	5326	1164	326	307	527	177	377	50	226	0	12287
L	Real estate services	69	4	1551	102	75	1921	2330	304	591	367	974	811	814	478	643	85	574	52	145	0	11895
M	Professional, scientific and technical services	182	81	5345	303	503	481	1268	595	59	373	1905	713	3206	1279	519	61	268	85	103	0	17329
N	Administrative and support services	925	52	4042	287	277	930	1602	1431	274	433	756	125	543	3282	691	209	689	225	271	0	17044
O	Public admin. and defence serv., compulsory social security serv.	63	31	658	879	72	367	120	92	48	44	46	99	365	167	541	39	86	17	53	0	3787
P	Education services	3	0	154	4	2	2	3	29	0	56	85	23	92	9	280	1063	30	7	15	0	1855
Q	Human health and social work services	1	0	5	0	0	0	2	0	2	0	0	0	24	1	10	16	1093	17	0	0	1170
R	Arts, entertainment and recreation services	0	0	29	0	1	0	2	2	22	168	42	0	11	2	366	53	7	499	81	0	1286
S	Other services	20	11	267	27	40	76	181	69	60	41	71	6	198	53	43	30	204	62	468	0	1927
T	Services of households as employers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Intermediate supply by economic activities (col. 1 - 20) and final use of goods (col. 22 - 31)	6917	1114	111977	7967	2882	15004	16445	18445	3774	6661	10851	4754	8103	7380	8168	3823	8315	1700	2382	0	246665
	Taxes of goods less subsidies	247	35	621	89	159	177	325	638	70	23	804	209	136	53	1215	307	958	195	124	0	6388
	Intermediate supply by economic activities (col. 1 - 20) and final use of goods (col. 22 - 31) at purchasers' prices	7164	1150	112598	8056	3041	15181	16771	19083	3844	6684	11656	4964	8239	7434	9384	4130	9274	1895	2506	0	253052
	Compensation of employees	937	716	26925	997	929	8040	15740	5399	2105	3181	4468	925	9541	5293	11691	7750	12215	1150	2651	634	121288
	Value added	4224	1954	44887	3026	2150	12261	22882	11355	2816	6019	7567	28884	14789	10482	14089	9391	15952	2459	4805	608	220600
	Production	11388	3103	157485	11082	5191	27441	39652	30438	6661	12702	19223	33847	23028	17916	23473	13521	25226	4354	7311	654	473698
	Imports of similar goods	3883	15403	67242	2135	1991	0	1122	3203	935	9582	1191	14336	7815	2933	69	6	2	1038	106	0	132990
	Total supply	15271	18506	224727	13217	7182	27441	40775	33641	7596	22284	20414	48183	30843	20849	23542	13527	25228	5392	7417	654	606688

CPA	Use / Supply	Final demand											**Total use of goods**
		Private consumption	differentiated by			NPISHs	Government final consumption expenditure	Gross fixed capital formation		Change in inventories	Exports	**Total final deman**	
	CPA		Students	University personnel	Others			investment for plant and machinery	construction				
A	Products of agriculture, forestry and fishing	2264	30	21	2214	0	0	35	0	434	6184	8918	15271
B	Mining and Quarrying	704	10	6	688	0	13	12	0	896	7962	9587	18506
C	Manufactured products	31613	382	294	30938	0	1883	14694	2804	-762	84245	134478	224727
D	Electricity, gas, steam and air conditioning	5918	80	51	5787	0	26	0	0	-592	332	5685	13217
E	Water supply, sewerage, waste	2773	38	24	2712	0	68	0	0	-244	871	3468	7182
F	Constructions and construction work	662	8	6	648	0	0	0	18274	76	647	19660	27441
G	Wholesale and retail trade services	17581	182	174	17226	0	815	1896	0	16	2819	23127	40775
H	Transportation and storage services	5526	59	54	5412	0	294	0	0	-441	5581	10960	33641
I	Accomodation and food services	6258	110	60	6088	0	0	0	0	0	495	6753	7596
J	Information and communication services	5347	98	50	5199	0	0	2607	0	0	1967	9920	22284
K	Financial and insurance services	2753	34	25	2694	0	0	0	0	0	5374	8127	20414
L	Real estate services	35781	485	306	34990	0	39	0	409	0	60	36288	48183
M	Professional, scientific and technical services	527	6	5	515	0	481	6604	2240	3	3660	13514	30843
N	Administrative and support services	2042	23	20	2000	0	0	0	579	2	1181	3805	20849
O	Public admin. and defence serv., compulsory social security serv.	214	2	2	210	0	17945	0	206	0	1390	19755	23542
P	Education services	1646	151	18	1477	0	9925	0	0	-2	102	11672	13527
Q	Human health and social work services	4522	23	35	4464	0	17891	0	0	-30	1675	24058	25228
R	Arts, entertainment and recreation services	2666	34	25	2606	0	1287	85	0	23	45	4106	5392
S	Other services	1723	23	16	1684	0	528	0	0	0	3239	5489	7417
T	Services of households as employers	542	3	5	533	0	0	0	0	0	112	654	654
	Intermediate supply by economic activities (col. 1 - 20) and final use of goods (col. 22 - 31)	131063	1782	1196	128085	0	51193	25933	24512	-621	127943	360024	606688
	Taxes of goods less subsidies	16417	223	150	16044	0	223	209	1369	0	0	18219	24606
	Intermediate supply by economic activities (col. 1 - 20) and final use of goods (col. 22 - 31) at purchasers' prices	147481	2006	1346	144129	0	51417	26142	25881	-621	127943	378242	631295
	Compensation of employees												
	Value added												
	Production												
	Imports of similar goods												
	Total supply												

Source: Own calculations.