Data based uncertainty in regional input-output analysis – Some model calculations about the importance of agriculture in the "Alte Land"

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Abstract:
This paper aims to evaluate and demonstrate the impacts of different baseline national tables and data base uncertainty in regional input-output analysis. As a top-down-technique - as Lenzen 2003 describes it - input-output analysis in Germany is an important economic method in analysing the regional impacts of large infrastructure investments like airports (Prognos 1998; Bergmann et al. 2002) or exhibitions like EXPO 2000 (Althues/Maier 2002).

In GTAP or other models input-output tables –based on national accounting information - are the core data base of the Social Accounting Matrices (SAM), in which capture income und expense flows between institutions supplement to existing national information (more details in Reinert/Roland-Holst 1997; 96).

Based on these national statistics regional input-output tables can be derived from the regional share of workers (Althues/Maier 2002) or production values in different sectors (Bergmann et al. 2002, Klauer 1999). Second step in the process to compile a regional table is to implement the MODOP method (Stäglin 1972). It is recommended in this process always to use the most recent and geographically nearest available input-output table. This recommendation will be analysed in this paper as well as the impact of data uncertainty on the resulting impact calculations.

However national accounts contain certain failures, which Pacca (2003) divides in four categories: data uncertainties, temporal constraints, Economic boundaries and methodological constraints.

Chosen to analyze in this article have been data-based uncertainties: the effects of different larger-scale input-output tables and the effects of different import dependency of a region (being expressed in the proportion of intermediate inputs in the study region divided by the sum of intermediate imports).

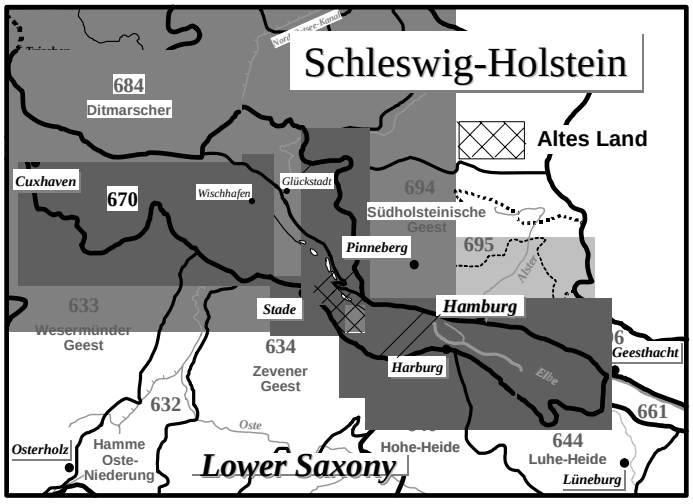
The results in relation to specific national tables show that there is no basis in this case for the recommendation to always use the latest available input-output table nor to use the nearest available geographic table.

The results further show that even small changes of the rate of import dependency expressed in working places show that a linear variation do has impacts above average effects. For this reason it is recommended for future regional input-output analyses to share not only information about the importance of a sector for the labour market but also to inform its variance.

1 Introduction

According to recent agricultural statistics in Germany the importance of agriculture within the national labour market is decreasing since 1952 and currently is under 2% in Germany (BMLEV 2005). However, in some regions, such as East Germany with its declining economy and in rural areas the agricultural sector remained one of the most important regional employers (see Klauer 1999). Target of this article is the illustration of the economic importance of the agricultural sector in the region "Altes Land", a peri-urban area near Hamburg in Germany, and to show how marginal changes of the import factors influence the employment importance of this sector for the region.

Figure 1 location of the „Alte Land" in Germany



Source: Bergmann et al. 2006; Map made by Ursula Stratmann (2003)

This importance will be described in terms of economic data, which will exclude cultural aspects (more information about this can be found in Bergmann et al. 2002) and the tourist valuation of

the region (more information about this can be found in Huch 1997). As the region is quite near to the metropolis of Hamburg and due to the special quality of soils and climate, the region is famous for its concentration on apple production (Stamer 1995). This region is quite favourably situated as regards transportation to the mayor markets, the major disadvantage is that numerous infrastructure measures compete for the land being used by agricultural holdings, like the enlargement of the local EADS (European Aeronautic Defence and Space Company) plant (cf. Bergmann et al 2002 or Prognos 1998).

In the political decision making process input-output analysis is often used to calculate the most popular key figure, i.e. the labour market importance of a specific sector, as this seems to be easier to understand than making a more complicated cost-benefit analysis (Bergmann 2006).

However, the compilation of regional input-output tables grounded on primary data is only rarely undertaken nowadays as it is time- and cost-consuming. For this reason some methods like MODAM or RAS have been developed (cf. Stäglin 1972 and 1973), using national input-output tables and then to derive the regional input-output table. However, this derivation for itself has two different uncertainties:

- The assumed linearity between national and regional economic structure must not be given,
- Through the delayed publishing of national input-output tables, factor relations within single sectors can be changed to a quite big extent (and so the answer to actual political or economical questions might be incorrect).

For this inquiry only a part of the “Alte Land” was chosen, as exact figures about the production values are available only for this part. As a base year 1999 was chosen as it was at the time of the calculations it was the latest year for which governmental figures about production values as well as national input-output tables were available.

The “Alte Land” is the second largest producing apple region in Germany and the largest in North-Eastern Europe. As specialised crop standard gross margins are lying over 7,500 Euros per ha (Landwirtschaftskammer Hannover (1999).

The turnover statistics for the year 1999 for the Alte Land show that the agricultural sector was responsible for a total turnover of 38 million Euro. In order to derive a regional input-output table the turnover statistics are the data base and will be taken as production value in the region. The

agricultural sector in the region employed 220 persons making social insurance contribution in 1999.

Table 1 Production value and jobs being subject to social insurance contribution in the „Alte Land“ (Lower Saxony)

	Production value in 1.000 Euro (1999)	**Jobs by sector (1999)**
Agriculture	38.589	220
Energy	5.754	0
Industry	99.686	363
Construction	65.125	321
Trade	650.254	564
Transport sector	209.499	624
Credit	46.700	45
Services	64.932	694
State	52.590	140
Sum	**1.233.129**	**2.971**

Source: Niedersächssiches Landesamt für Statistik- Umsatzsteuerstatistik (2000); Arbeitsamt Stade 1999

As Table 1 shows, the turnover (here called production value) of agriculture in the importance is second smallest of the different sectors and only responsible for ~3% of all in the region The sector is responsible for more than 7% of all employment. Therefore in employment figures the sector has twice as high importance for the region as in output units in Euro. However, these employment figures underestimate the local importance of agriculture for the labour market as there are more than 1,000 farms in the region and conservatively estimated there must be at least another 1,000 self-employed farmers in the region who do not appear in the official labour market statistics (cf. Bergmann et al. 2002; Tiemann 2000).

The region is threatened by new highways, upgrading of the river “Elbe”, new industrial plants and new house building areas. All these are likely to reduce apple production in the region. All this threat together lower the number of hectares available for apple production so much that it is feared that the critical mass for cost advantages of this concentrated apple area will be destroyed. This development seems to be likely in the next 30 years as plans exist to use this highly profitable area as land bank dedicated to urban infrastructure measures (vergl. Bergmann et al. 2002; Tiemann 2000).

2 Methods

The input-output analysis is based on national accounting and according to Lenzen (2000) isan economic top-down technique, with which sector-specific monetary flows can be used to describe the complexity of modern national economies.

Although in Germany there is large demand for regionalised input-output tables (respectively analyses), there are only a few tables based on primary data (Krengel 1969; Lehbert 1981 or Münzenmaier 1988). As the collection of primary data for regional input-output-data is cost and time consuming, apart from sample surveys, Stäglin (1972 and 1973) developed MODOP.

The MODOP method gathers from national input-output tables the values and relations in regional input-output tables (more information can be found in Bergmann et. al. 2002; Pfähler et al. 1997 or Gabriel 2003). This method however has two different sources of errors:

- in order to derive the tables it is presumed that the national input relations are similar to the regional input relations. As the study area can be a extreme urban or a extreme rural area, the assumption that the regional factor relations can be derived linearly from the national factor relations may well be wrong.
- As a basic principle the MODOP method recommends that there is the highest possible correspondence between locality and time, so that for all analyses the most recent input-output table must be used. As those tables are only published every two or three years this is one of the most important sources of failure.

Input-output analysis is based on a proposal by Leontief (cf. Fleissner et al. 1993, Krengel 1969 oder Pfähler et al. 1997). Mathematically it can be described by the following formula:

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

with M = matrix of the multipliers

I = unitary matrix

A = Input-output table (first quadrant)

For this work, as no regional regional table was available, a regional input-output table had to be derived from existing data. Only data was available about the production value of the different sectors in the region,therefore a method being used by Klauer 1999 was adapted. This method assumes that it is possible to assign the relation of base-line input-output tables data linear in the study areas input-output table. Then this data can be adapted to fit the conformity rule of intermediate regional inputs use and regional demand vectors with the MODOP method.

The MODOP method can best be described as a method of double proportionality (Schintke 1973) as it uses row- and column-wise adaptation of given values to produce a central matrix.
Mathematically this method can be described in the following way:
In a first step the coefficients of the baseline input-output table are multiplied with a coefficient of correction:

$$a(i,j) = x_{ij}^{0} \sqrt{\frac{z_i^*}{z_i^0} * \frac{v_j^*}{v_j^0}}$$

formula (1)

where

a(i;j) = coefficients of the base line matrix, x = correction coefficient,

z = intermediate demand vector; v = regional intermediate input vector

The correction coefficient is the geometric median of the relation of the input structure a(i,j) and a factor calculated as the geometric median of the output structure.
The second step of this method is that the elements of the central matrix a(i,j) are corrected until the sum of the rows and the columns are equals alternately. This iteration process is being done in a first step row wise and in a second step column wise, with the following formulas:

$$a(i,j) = a(i,j) * \frac{z_i^*}{z_i^{2m}}$$

formula (2) for m=0,1,2,...n

$$a(i,j) = a(i,j) * \frac{v_i^*}{v_i^{2m-1}}$$

formula (3) for m = 1,2,3,...n

If the precedent condition is fulfilled the iteration process is terminated. Stäglin (1972) shows that if the run is long enough, the termination condition will be fulfilled.

3 Derivation of intermediate demand and the regional factor vector

To construct a regional input-output table, it is necessary to know the intermediate demand vector as well as the intermediate regional input use vector. The latter can be calculated by subtracting the regional gross value added from the regional production value (cf. Table 1). In a regional context unlike in national input-output table all imports come from the rest of the world or the rest of the federal republic of Germany (FRG), however some (or most) of the inputs can also be originated from other regions in the same state. For this calculation it has been assumed that the

relation of imported inputs to the production values is the same in the region as on a national scale. The data base for these calculations was the regional production value tax statistics of the villages Jork and Lühe in the "Alte Land". The gross value added in the region has been calculated, that the relation between Gross Value Added (GVA) and production value in Germany and the study area equals (cf. Klauer 1999). As a condition of consistency the sum of the regional intermediate demand and the intermediate regional input use had to be equal. For this reason the lasting surpluses have been added up uniformly on the different sectors.

The calculated key figures to be used in the MODOP method to calculate a regional input-output table for the study area were therefore:

Table 2 economic key figures in the study area in Euro in 1999

	Input			Output			
	Production value	**Gross value added**	**Intermediate Regional inputs**	**Regional output demand**	**Household demand**	**Final demand**	**Total regional utilisation**
Agriculture	38.589	19.597	18.992	10.282	348	-16.938*	38.589
Energy	5.754	3.075	2.679	16.998	2.428	-18.461*	5.754
Manufacturing	99.686	37.883	61.803	118.705	6.510	325.355	99.686
Construction	65.125	32.428	32.697	9.623	61	47.949	65.125
Trade	650.254	439.224	211.030	23.160	3.412	136.710	650.254
Transport sector	209.499	118.881	90.618	32.719	3.725	160.384	209.499
Credit	46.700	9.188	37.512	29.851	1.636	26.607	46.700
Services	64.932	41.712	23.220	113.089	1.349	174.327	64.932
State	52.590	24.921	27.669	20.599	2.689	22.168	52.590
Sum	**1.233.129**	**726.909**	**506.220**	**375.026**	**22.160**	**858.103**	**1.233.129**

Source: own calculations

* - Negative figures in the column "final demand" indicate that the production of agricultural goods as well as energy production in the region is not enough to supply the region and for that reason we find here another component of the imports of the region.

Based on these results four different base-line input-output tables have been chosen to calculate regional input-output table and to compare the results. These base-line input-output tables have been:

- a national German input-output table from 1999 ("base 1999") (Statistisches Bundesamt (2003);
- a national German input-output table from 1994 ("variant 1994") (Statistisches Bundesamt (2000)
- a national German input-output table from 1990 ("variant 1990") (Statistisches Bundesamt (2000)

- an input-output table for Hamburg from 1990 (“Hamburg 1990”) (Pfähler et al. 1997)

As an example the most recent input-output table from 1999 is portrayed here. The results of the other calculations can be obtained by request to the author.

Table 3 Input-Output table for the „Alte Land in T € estimated by MODOP method – base 1999

	Agri-culture	**Energy**	**Indus-try**	**Construc tion**	**Trade**	**Transport**	**Credit**	**Services**	**State**	regional output demand	households	State	Changes of stocks	Exports (Rest of the World)	Exports (FRG)	Sum	Final demand
Agriculture	796	2	4.036	0	123	1.123	31	62	36	6.210	6.210	2.281	0	830	1.033	34.445	4.144
Energy	496	228	2.779	625	3.099	4.089	397	1.217	94	13.023	13.023	7.410	0	56	398	-2.110	7.864
Industry	3.316	199	27.668	16.058	18.313	21.224	813	688	564	88.842	88.842	46.602	0	25.396	86.401	-58.713	158.399
Construction	98	39	250	757	1.503	1.550	345	117	85	4.745	4.745	946	0	53.038	41	11.099	54.026
Trade	439	19	1.351	1.140	8.795	3.467	77	64	85	15.436	15.436	46.347	0	3.168	5.989	594.749	55.505
Transport	87	13	667	261	2.986	12.381	634	112	71	17.213	17.213	28.926	737	749	6.752	172.335	37.164
Credit	33	6	87	124	825	1.680	17.518	128	16	20.416	20.416	9.323	0	0	462	36.915	9.785
Services	753	133	3.800	4.228	25.596	9.983	8.241	2.789	363	55.885	55.885	54.120	2.242	8.239	3.309	-2.977	67.909
State	11.421	2.494	15.320	8.499	104.818	46.993	11.275	12.030	8.921	221.770	221.770	195.954	2.979	91.476	104.385	-342.204	394.794
Intermediate regional inputs	17.440	3.133	55.958	31.692	166.057	102.489	39.330	17.207	10.236	443.540	443.540	391.908	5.958	182.952	208.770	443.540	789.589
Imports	7.262	310	17.671	4.322	85.545	11.388	2.070	906	5.273	134.745							
Gross value added	13.887	2.311	26.057	29.112	398.652	95.622	5.300	46.820	37.082	443.540							
Production value	38.589	5.754	99.686	65.125	650.254	209.499	46.700	64.932	52.590	1.233.129							

Source: Own calculation

The variation of the imported inputs as a proportion of all used inputs in the region has been made in the following way:

Table 4 import factors and their variation

	import factors (percentages)
Agriculture	29,4 as base-line variation from 0 to 100
Energy	9%
Manufacturing	24 %
Construction	12 %
Trade	34%
Transport sector	10 %
Credit	5%
Services	5%
State	34%

Source: Own assumptions and calculations

What these import factors say is that eg. in agriculture 70,6% of the factors are imported from other regions. In the case of the energy sector 91% of all the products of this sector are imported from other regions.

4 Results and discussion

4.1 Derivation based on different years and geographic area

The importance of the agricultural sector in the region (including direct as well as indirect effects) is quite high. Agriculture accounts for nearly (depending on the baseline tables) 10% of all social insurance paying jobs in the region. However, as written in the preceding sections, this concentration point of pomiculture in Germany may erode in the following years. Due to large infrastructure projects in the region, the point will soon be reached when the existing comparative cost advantages of this singular concentrationt will be lost.

Table 5 comparison of different labour market importance of agriculture in the "Alte Land" in insurance paying jobs.

	Base 1999	Variant 1994	Variant 1990	Hamburg 1990
Agriculture	220	220	220	220
Energy	0	0	0	0
Manufacturing	18	32	25	34
Construction	1	3	0	3
Trade	0	2	0	1
Transport	0	1	8	2
Credit	0	1	0	0
Services	12	29	32	19
State	41	8	10	2
Sum	**294**	**295**	**296**	**282**

Source: Own calculations

The results in Table 5 show that surprisingly the transportation sector is only affected sparsely by agriculture. This is due to the fact that the large transportation enterprises have their main location outside the region. Another explanation is that deriving the tables from national or Hamburg region tables leads to an underestimation of the linkages between pomiculture and the transportation sector.

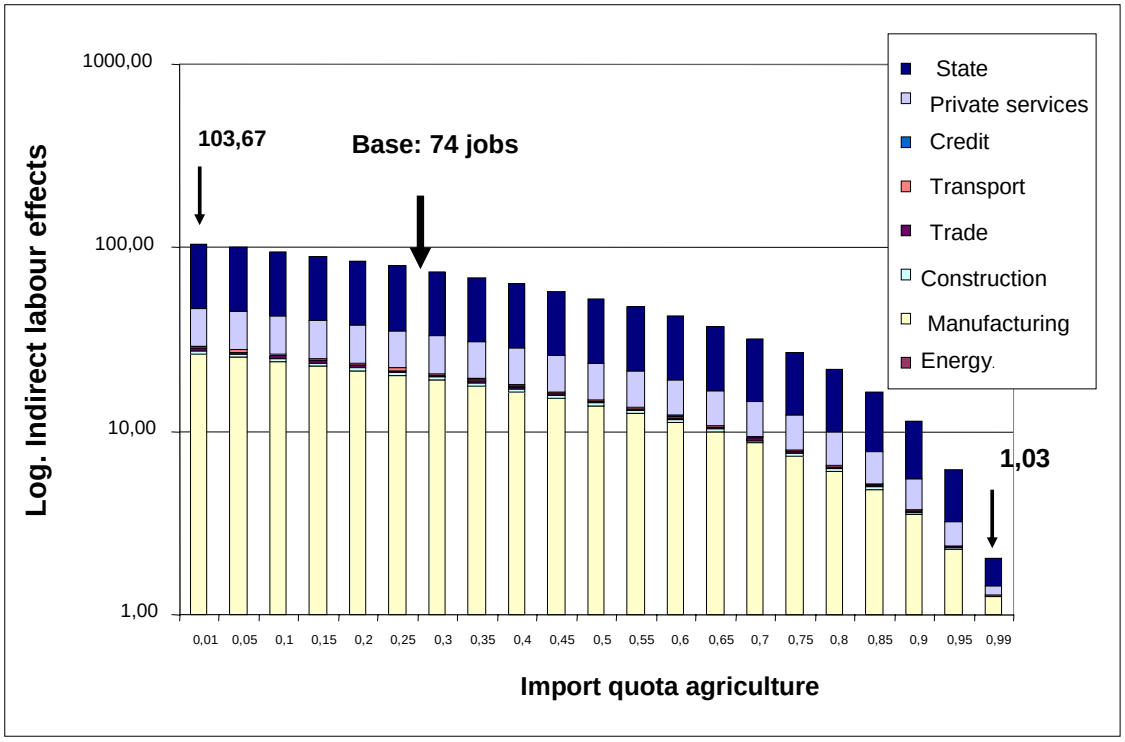
While the first three columns in their summation show little differences, there is a difference with the Hamburg 1990 table. This difference can be explained as generally in urban areas the linkages between local agriculture and other local economic sectors is low. The distribution of jobs indirectly linked to agriculture over all results shows that there are three sectors being highly linked to agriculture: manufacturing, services and state. While the estimate for the cases national 1999 and 1990 look very similar (apart from the high importance of state in 1999), there is quite similarity between national 1994 and Hamburg 1990. This unexpected result seems to be due to changes which have taken place in the national economy in the first years of the reunification and therefore explicable.

By using national input-output tables for estimating of the labour market importance of agriculture is higher than by using a geographical nearer but more urbanised table. Therefore in this case both parts of the recommendation that the geographical nearest and the latest available input-output table shall be used, can not be supported.

4.2 Variation of import factors

The result of the variation of the agricultural import factor is interesting. While it might be assumed that in a model in which most relations are linear the result must have a linear trend, it was not. Marginal changes of the import factors by 1% resulted in changes above or higher than 1 % and were just in one case (import factor 50%) equal to 1. Although the difference from 1 is only small, the resulting curve is concave rather than linear. In Figure 2 the y-axis has been recalculated as a logarithmic presentation of the resulting jobs.

Figure 2 Labour market importance of agriculture (only indirect effects) dependant on the import factor



Source: own calculations

The result shown in Figure 2 can be described in the following way. If all intermediate regional inputs needed for the agricultural production were purchased in the region, 103 jobs in the region would indirectly depend on this sector. If nearly no inputs are purchased within the region the indirect effect of agriculture will be just 1 job indirectly being provided. However in a band between ~80% and 20% purchases in the region, the direct effect of agriculture onto the regional labour market stays stable at above around 50 jobs.

In concluding these calculations shows that marginal changes or failure in the determination of import factors will have above average influence either positive or negative on the resulting labour market importance of a sector.

5 Conclusions

Agriculture in the chosen study area "Altes Land" – Northern Germany - is of high importance for the regional labour market. By including only direct and indirect effects of a marginal change in production values it was calculated that at least 10% of jobs in the region depend on apple production. Therefore it is concluded that, with major threats from large-scale land-using projects in the region, a further reallocation of land will be hurtful to the local labour market with its highly skilled employees in agriculture.

Using MODOP method it could be shown that the difference between rather old and more timely baseline tables is quite small. In contrast, if another geographically near area with an urban-based economy is chosen as the baseline table, there are quite high differences in the resulting importance of agriculture for the labour market, especially as the service sector in urban areas has only a small relation to the local agriculture. For this reason, assuming an urban baseline input-output table for a peri-urban area seems to be inappropriate.

The model calculations varying the import factor for the region show, that the importance of agriculture for the regional labour market naturally is increasing as more inputs are purchased from the region. However, it has been shown that marginal changes do not have linear effects but that these effects are above average. The resulting curve is likely to be concave rather than linear. For this reason, it is recommended that future regional input-output-analyses to share information about the importance of a sector for the labour market but also provide information about the effects of variations.

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