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Derivative Construction of Regional Input-Output-Tables under Limited Data Availability

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Contents

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Abstract

Input-output analysis is a powerful tool for regional economic studies, but its application is hindered by the fact that regional input-output tables are scarcely available, and their construction from survey data is prohibitively expensive. Nonsurvey methods are therefore used to derive regional tables from national IO-tables, but most of these tend to underestimate regional trade and overestimate regional multipliers. Some methods require an educated guess on the value of a parameter.

This paper presents a new nonsurvey method for the derivative construction of a regional input-output table. The method's advantages include minimal data requirements, a more sophisticated estimation of regional trade, and its independence from subjective educated guesses. The application of the method is illustrated with the construction of a regional input-output table for Hamburg.

Keywords

Input-output analysis, location quotient, regional trade, regional input-output analysis, nonsurvey methods

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I Introduction

Input-output analysis has seen a wide range of applications on many different economic topics. Nobel Laureate Wassily Leontief, who developed the theoretical foundations of input-output analysis, used it, for example, to uncover the *Leontief paradox* in the field of international trade, to examine the effects of military spending (or rather a reduction thereof), and to assess the environmental impacts of the economy [Leontief, 1986]. Currently, input-output approaches are commonly applied in research on regional economic issues like, for example, the effects of an airport on employment and income [Hujer & Kokot, 2001] or the emergence of geographical business clusters [Lublinksi, 2001].

The application of IO-analysis to regional issues requires the existence of a corresponding regional input-output table (henceforth RIOT). Unfortunately, such tables are usually not available, because their construction from scratch requires the collection of a huge amount of data, which is often prohibitively expensive [Hewings, 1985]. However, in most countries the national statistical office regularly publishes a national input-output table (henceforth NIOT) for the country as a whole. This table contains information which can be used to derive a RIOT by purely mathematical methods. Because these methods allow the construction of a RIOT without the need for actually performing a survey, they are called *nonsurvey methods*.

IO-analysis was first applied to regional issues in the middle of the twentieth century [Isard, 1951], generating demand for RIOTs. Accordingly, the first nonsurvey methods for RIOT construction were developed during the 1950s and 1960s, and by 1969 there was already enough variety among them to warrant a survey on nonsurvey techniques [Schaffer & Chu, 1969]. From the different *location quotient* (LQ) methods, the *simple location quotient* (SLQ) method appeared to be the most successful one [Morrison & Smith, 1974]. However, it was still criticized for systematically overestimating the size of regional multipliers [Richardson, 1985]. Addressing that criticism, some analysts developed more sophisticated methods [Round, 1978, Flegg et al., 1995, Gabriel, 2001].

However, the application of these methods may still face serious obstacles because they typically require information which is not easily available. This author, for example, attempted to retrieve data on regional gross outputs and total demand for Hamburg in order to apply the method presented by Gabriel, only to be informed by Statistikamt Nord that these data are not available. The lack of relevant data forces economists to use nonsurvey methods of doubtful reliability. For example, although Flegg and his co-authors warned that the SLQ method may "produce seriously misleading results", the analysts who were asked to predict the effects of the World Exhibition 2000 in Hanover applied exactly that method, arguing that "due to the poor regional data availability, there is currently no serious alternative" (author's translation) [Bredemeier et al., 1995]. Other researchers appear to have become frustrated with the idea of RIOT derivation in general, preferring to simply use the NIOT for regional analyses [Regionomica, 2005].

The aim of this paper is to improve the rather sad state of affairs by presenting a new, easy-to-use nonsurvey method with minimal data requirements, which enables researchers with limited resources for data collection to estimate a regional input-output table for any given region. The method requires a national input-output table for the country as a whole and sectorally disaggregated data on employment in the region. The application of the method is illustrated with the derivation of a RIOT for the city state of Hamburg from the German NIOT.

The paper contributes to the literature on applied IO-analysis by presenting in a very accessible way a new method for the derivative construction of a RIOT. This method provides an improvement over traditional nonsurvey methods insofar as it allows for cross-hauling of commodities. In comparison to the method by Gabriel, it provides the advantage of wider applicability because of minimal data requirements. Finally, the estimated RIOT is consistent with the general observation that regions trade relatively more than the nation as a whole, which eliminates the need to adjust regional multipliers by means of elaborate formulae, as in the FLQ method [Flegg et al., 1995], or by means of educated guesses on regional preference factors, as in Gabriel's method. Therefore, the results of the estimation do not depend on the subjective judgment of individual researchers.

II The National Input-Output Table for Germany

Table 1 shows Germany's NIOT for the year 2002. The original table published by the Federal Statistical Office presents disaggregated data for 71 different industries, six primary input categories, and six final demand categories. In order to facilitate a simple illustration of the regionalisation process, the original table has been aggregated to 12 industries, two primary input categories (domestic primary inputs and imports) and two final demand categories (domestic use and exports). Table 2 shows the shorthand notation of the 12 industries as well as their full description.

NIOT Germany 2002		Deliveries to													Final demand			Total output
€ million		AB	C	D	E	F	G	H	I	J	K	L	MNOP	total	domestic	exports	total	
Deliveries from	AB	7,178	39	33,418	0	0	12	779	53	6	589	881	663	43,618	20,705	5,257	25,962	69,580
	C	474	2,085	31,502	6,400	1,521	387	123	42	77	108	489	422	43,630	4,869	1,847	6,716	50,346
	D	10,471	2,359	581,978	6,031	57,602	17,524	12,275	16,904	1,896	11,798	10,833	24,621	754,292	426,353	614,120	1,040,473	1,794,765
	E	882	734	18,106	8,920	227	3,008	1,156	1,868	621	1,374	1,017	3,749	41,662	27,688	4,092	31,780	73,442
	F	271	201	3,874	1,060	8,204	1,271	568	1,738	742	18,729	2,236	4,676	43,570	161,094	104	161,198	204,768
	G	2,808	588	61,559	1,977	10,244	17,075	3,700	6,736	479	2,248	2,344	8,194	117,952	220,586	37,589	258,175	376,127
	H	13	32	1,932	38	299	1,199	185	1,696	1,321	809	1,228	1,136	9,888	56,377	3,722	60,099	69,987
	I	316	779	36,645	1,418	1,828	38,297	1,026	72,513	4,477	4,227	3,988	6,926	172,440	67,428	29,604	97,032	269,472
	J	1,015	143	11,235	844	3,629	5,685	1,341	4,151	50,401	25,663	6,009	6,177	116,293	66,815	19,107	85,922	202,215
	K	4,844	1,717	123,643	6,623	25,085	49,640	8,252	23,139	41,832	104,985	12,843	30,157	432,760	264,309	27,005	291,314	724,074
	L	111	105	2,750	3,468	939	482	192	376	197	2,304	1,872	1,224	14,020	158,910	1,234	160,144	174,164
	MNOP	1,110	350	12,391	528	1,232	4,863	2,044	2,395	1,761	16,700	3,852	35,236	82,462	382,378	1,239	383,617	466,079
	total	29,493	9,132	919,033	37,307	110,810	139,443	31,641	131,611	103,810	189,534	47,592	123,181					
Domestic primary inputs		22,724	5,823	401,011	32,072	91,052	233,300	32,875	111,213	87,974	503,059	125,598	338,341					
Production value		52,217	14,955	1,320,044	69,379	201,862	372,743	64,516	242,824	191,784	692,593	173,190	461,522					
Imports of similar goods		17,363	35,391	474,721	4,063	2,906	3,384	5,471	26,648	10,431	31,481	974	4,557					
Total output		69,580	50,346	1,794,765	73,442	204,768	376,127	69,987	269,472	202,215	724,074	174,164	466,079					

Source: Federal Statistical Office and author's calculations

Table 1: National Input-Output Table for Germany

It is important to realize the meaning of the row titled “imports of similar goods” in Table 1. There are two methods of entering imports in an IO-table: *direct* or *indirect* allocation [Office of the Government Statistician, 2004]. In the German NIOT, imports are entered indirectly. This means that imports of certain goods are treated as if they were imported by the respective industry. For example, the domestic production of the manufacturing industry (industry D) amounted to 1,320,044 million Euros, and imports of manufacturing goods amounted to 474,721 million Euros. A large amount of these imports was of course delivered directly to the other industries, but in the NIOT they are treated as if they were imported by the domestic manufacturing industry, where they were then added to the domestic production of manufacturing goods (yielding a grand total of 1,794,765 million Euros) and finally delivered to the other industries and to final demand.

Industry	WZ 2003 code
Agriculture, hunting, forestry, fishing	AB
Mining and quarrying	C
Manufacturing	D
Electricity, gas and w ater supply	E
Construction	F
Wholesale and retail trade; repair of motor vehicle, motorcycles and personal and household goods	G
Hotels and restaurant	H
Transport, storage and communication	I
Financial intermediation	J
Real estate, renting and business activities	K
Public administration and defence; compulsory social security	L
Other services	MNOP

Source: Federal Statistical Office [Statistisches Bundesamt, 2002]

Table 2: Classification of industries according to WZ 2003 standard

This treatment of import figures provides a great advantage for the purpose of RIOT derivation. In a NIOT with direct allocation, imported goods are assigned to the industry which actually receives them. If the NIOT in Table 1 were of the direct form, we would interpret the import row as stating, for example, that the manufacturing industry imported 474,721 million Euros worth of all kinds of goods. Thus, we could not know, for example, how much output from the construction industry was used by the manufacturing industry, because a part of those construction services would be somewhere in the import figure, and only the part which was purchased from the domestic construction industry would show up in the intermediate transactions matrix.

III Derivation of the Regional Input-Output Table

III.1 Regional Intermediate Transactions and Primary Inputs

We know the national output of each industry as well as the technological input coefficients from the NIOT. If we assume that the region applies the same production technology as the nation as a whole, we can derive the regional production of each industry as well as the regional intermediate transactions between industries. All that is required is a way of scaling the regional inputs and outputs of an industry relative to the national inputs and outputs of that industry. In principle, different indicators may be used, for example production value, gross value added, or employment, all of which are equally valid if the assumption of equal technology is fulfilled. In practice, labour income by industry may be the best indicator of the regional output structure, because if the wage rate reflects productivity differentials, labour income “corrects” for these differentials [Lahr, 2001]. In this paper, however, we use regional employment figures, because these are usually the most easily available figures.

Industry	Employees (thousands)		Share HH/ GER
	HH	GER	
AB	5.3	444.0	0.012
C	0.6	115.0	0.005
D	126.2	7,089.0	0.018
E	6.7	256.0	0.026
F	40.6	2,043.0	0.020
G	168.7	5,707.0	0.030
H	45.7	1,360.0	0.034
I	93.5	1,975.0	0.047
J	56.9	1,136.0	0.050
K	203.2	4,302.0	0.047
L	61.7	2,784.0	0.022
MNOP	233.8	7,882.0	0.030
Total	1,042.9	35,093.0	0.030

Source: Federal Statistical Office; Statistikamt Nord

Table 3: Employees per industry in Hamburg and Germany (2002)

Table 3 shows employment[1] figures for the 12 industries in Hamburg and Germany, as well as Hamburg's share in the national total. In the last row, we can see that Hamburg's share in total national employment amounted to three percent. Thus, those industries in Hamburg which account for more (less) than three percent of regional employment are relatively large (small). As could be expected from a metropolitan region, the primary sector (industries AB and C) and the secondary sector (industries D through F) are relatively underrepresented in Hamburg, whereas the tertiary sector (all remaining industries) is relatively overrepresented in Hamburg.

Under the assumption of a similar production technology, we can easily derive the regional intermediate transactions and primary inputs by multiplying the corresponding entries in some industry's column in the NIOT by that industry's share in national employment. The result of this computation is shown in Table 4. This table contains a full intermediate transactions matrix, the first quadrant of an IO-table, and estimates

[1] The number of employees subject to social insurance contribution

of domestic primary inputs and production value. In order to complete the RIOT, we now require estimates of imports and final demand.

€ million		Inputs to AB	C	D	E	F	G	H	I	J	K	K	MNOP	total
Intermediate deliveries from	AB	86	0	595	0	0	0	26	3	0	28	20	20	777
	C	6	11	561	168	30	11	4	2	4	5	11	13	825
	D	125	12	10,361	158	1,145	518	412	800	95	557	240	730	15,154
	E	11	4	322	233	5	89	39	88	31	65	23	111	1,021
	F	3	1	69	28	163	38	19	82	37	885	50	139	1,513
	G	34	3	1,096	52	204	505	124	319	24	106	52	243	2,761
	H	0	0	34	1	6	35	6	80	66	38	27	34	329
	I	4	4	652	37	36	1,132	34	3,433	224	200	88	205	6,051
	J	12	1	200	22	72	168	45	197	2,524	1,212	133	183	4,770
	K	58	9	2,201	173	499	1,467	277	1,095	2,095	4,959	285	895	14,013
	L	1	1	49	91	19	14	6	18	10	109	41	36	395
	MNOP	13	2	221	14	24	144	69	113	88	789	85	1,045	2,607
	total	352	48	16,361	976	2,202	4,122	1,063	6,231	5,200	8,952	1,055	3,654	50,216
Domestic primary inputs		271	30	7,139	839	1,809	6,896	1,105	5,265	4,406	23,761	2,784	10,036	64,343
Production value		623	78	23,500	1,816	4,012	11,018	2,168	11,496	9,606	32,714	3,838	13,690	114,559
Imports														
Total output														

Source: Derived from Tables 1 and 3

Table 4: Estimated regional intermediate transactions and production

III.2 Regional Final Demand

Before we can attempt to estimate a region's imports and exports, we need some estimate of that region's domestic final demand. By "domestic" final demand we mean those portions of final demand that are used within the boundaries of the region, like consumption, investment, change in inventories, etc. Effectively, domestic final demand means final demand excluding exports.

If no data on domestic final demand are easily available, there are various ways of estimating it. The simplest method is to assume that regional domestic final demand is proportional to national domestic final demand, where the factor of proportion could be, for instance, the number of inhabitants, the number of employees, or the region's share in GDP. More sophisticated methods may account for differences in demography, because the consumption patterns of old people tend to differ from those of young people, and people in densely populated urban areas consume different goods than people in sparsely populated rural areas. Especially in very large countries, it may also make sense to account for differences in climate, since people in Alaska are likely to consume different goods than people in Florida.

Many other regional differences may be incorporated in the estimation of regional domestic final demand. At this point, however, our intention is not to actually produce an accurate estimate of final demand, but to illustrate the method of RIOT derivation as simply as possible. Therefore we assume that regional domestic final demand is simply proportional to its national pendant, and the factor of proportion is the region's share in total national employment, in Hamburg's case three percent. Table 5 reports our estimate of regional domestic final demand in Hamburg.

	National final demand excl. exports (€ million)	Regional final demand excl. exports (€ million)
AB	20,705	615
C	4,869	145
D	426,353	12,670
E	27,688	823
F	161,094	4,787
G	220,586	6,555
H	56,377	1,675
I	67,428	2,004
J	66,815	1,986
K	264,309	7,855
L	158,910	4,723
MNOP	382,378	11,364
Total	1,857,512	55,202

Source: Federal Statistical Office and author's calculations

Table 5: Estimation of regional final demand excl. exports

III.3 Regional Imports and Exports

The most difficult part in the derivation of a RIOT is certainly the estimation of regional imports and exports. In our view, this requires first to ask the question why regions engage in trade at all. There are, of course, many reasons, but in the end they can be summarized in two key observations: Firstly, a region's production of a certain commodity may be higher (lower) than the regional demand for that commodity. In this case, trade in the form of exports (imports) balances regional supply and demand. Secondly, one of the basic assumption of theoretical input-output economics, that of each industry producing a homogeneous output, does not hold in reality, especially not if we are dealing with highly aggregated IO-tables of only 12 industries. If the manufacturing industry's output is not homogeneous, Hamburg may wish to import manufacturing goods from other regions and export other manufacturing goods in return, a phenomenon known as *intraindustry trade* or *cross-hauling*.

Unfortunately, data on interregional trade is very rarely available, so it is impossible to observe the extent of cross-hauling in each industry. Therefore, we propose a simple procedure to estimate the amount of cross-hauling. In order to this, we will need to know the regional trade *volume* including cross-hauling and the regional trade *balance*:

(1) $$TVOL = E + I$$

(2) $$TBAL = E - M$$

Equations (1) and (2) state that the trade volume *TVOL* is defined as the sum of exports *E* and imports *M*, whereas the trade balance *TBAL* is defined as the difference between the two.

Solving (2) for *M*, substituting that into (1) and solving for *M* yields:

$$(3) \qquad M = (TVOL - TBAL) / 2$$

In a similar fashion, we find the following expression for *E*:

$$(4) \qquad E = (TVOL + TBAL) / 2$$

Also, note that the trade balance must be equal to the difference between regional production *X* and regional consumption *C*. We already have an estimate of *X*; it is labelled ‘production value’ in Table 4. Regional consumption is the sum of intermediate deliveries and final demand excluding exports. For these we also have estimates; total intermediate deliveries of each commodity are contained in the last column of Table 4, and final demand excluding exports is contained in Table 5. Thus, we can use our estimates of *X* and *C* in order to estimate *TBAL*. Equations (3) and (4) show that in order to compute estimates for *M* and *E*, all we need now is an estimate of *TVOL*.

As we have argued above, the regional trade volume can be expressed as the sum of balancing trade and cross-hauling trade:

$$(5) \qquad TVOL = |TBAL| + CH$$

CH stands for cross-hauling. Note that the trade balance, which is defined as exports minus imports, may be negative. Therefore, the absolute value of *TBAL* appears in equation (5).

Unfortunately we have no data on *CH*. However, as we have argued above, cross-hauling will occur only if an industry’s output is to some extent heterogeneous. The higher the heterogeneity of an industry’s output, the higher the amount of cross-hauling that can be expected. We assume the following mathematical relationship:

$$(6) \qquad CH = \varepsilon(X + C)$$

In word, we assume that the amount of cross-hauling depends on ε, a measure of heterogeneity, regional production X, and regional consumption *C*.

To understand the logic that underlies equation (6), let us consider the extreme case in which an industry produces a perfectly homogeneous commodity, an assumption which underlies the theoretical foundation of input-output economics. In this case, we have $\varepsilon = 0$, so $CH = 0$. According to (5), the trade volume is then equal to the absolute value of the trade balance. In other words, a region engages in trade only to balance domestic supply and demand, and once this balance is established, no further trade occurs.

In reality, however, most industries produce a heterogeneous output, and the heterogeneity of an industry becomes more pronounced at higher aggregation levels. At a 12-industry-aggregation, the output of each industry may be very heterogeneous. The problem is now to estimate the extent of this heterogeneity. Fortunately, the data contained in the NIOT allow us to do this. In order to perform the estimation, we first substitute (6) into (5):

$$\text{(7)} \qquad TVOL = |TBAL| + \varepsilon(X + C)$$

Solving this for ε yields:

$$\text{(8)} \qquad \varepsilon = \frac{TVOL - |TBAL|}{X + C}$$

Next, we substitute the information from the NIOT, as displayed in Table 1, into (8). The trade volume can be derived by adding imports and exports, as can the trade balance by subtracting imports from exports. National production is found in the row labelled “production value”, and national consumption is found by adding domestic intermediate deliveries and domestic final demand excluding exports. The results of the calculations are reported in Table 6. Industries with a high value of ε produce a relatively heterogeneous output. This is the case, notably, for the manufacturing industry. Therefore, regions will wish to trade manufacturing goods even if their domestic production is equal to domestic consumption. Industries such as construction and other services, on the other hand, appear to produce a relatively homogeneous output, so we can expect that regions will trade in these “commodities” only to balance their regional supply and demand.

€ million	Production	Interm. deliveries	Final demand	Trade balance	Imports	Exports	Trade volume	ε
AB	52,217	43,618	20,705	-12,106	17,363	5,257	22,620	0.090
C	14,955	43,630	4,869	-33,544	35,391	1,847	37,238	0.058
D	1,320,044	754,292	426,353	139,399	474,721	614,120	1,088,841	0.380
E	69,379	41,662	27,688	29	4,063	4,092	8,155	0.059
F	201,862	43,570	161,094	-2,802	2,906	104	3,010	0.001
G	372,743	117,952	220,586	34,205	3,384	37,589	40,973	0.010
H	64,516	9,888	56,377	-1,749	5,471	3,722	9,193	0.057
I	242,824	172,440	67,428	2,956	26,648	29,604	56,252	0.110
J	191,784	116,293	66,815	8,676	10,431	19,107	29,538	0.056
K	692,593	432,760	264,309	-4,476	31,481	27,005	58,486	0.039
L	173,190	14,020	158,910	260	974	1,234	2,208	0.006
MNOP	461,522	82,462	382,378	-3,318	4,557	1,239	5,796	0.003
Total	3,857,629	1,872,587	1,857,512	127,530	617,390	744,920	1,362,310	

Source: Derived from Table 1

Table 6: Estimation of Industry Heterogeneity

Substituting the estimates for ε from Table 6, along with the regional estimates of *X* and *C* from Tables 4 and 5, into (7) yields an estimate of the regional volume of trade for each commodity. The regional estimates of *TVOL* and *TBAL* can then be used in equations (3) and (4) to estimate *M* and *E*. The results of these calculations are reported in Table 7.

Industry	Production (€ million)	Interm. deliveries (€ million)	Final demand (€ million)	Trade balance (€ million)	ε	Trade volume (€ million)	Imports (€ million)	Exports (€ million)	TVOL reg. / TVOL nat.
AB	623	777	615	-769	0.090	951	860	91	0.04
C	78	825	145	-892	0.058	953	922	30	0.03
D	23,500	15,154	12,670	-4,324	0.380	23,811	14,068	9,743	0.02
E	1,816	1,021	823	-28	0.059	242	135	107	0.03
F	4,012	1,513	4,787	-2,289	0.001	2,294	2,292	3	0.76
G	11,018	2,761	6,555	1,702	0.010	1,895	97	1,799	0.05
H	2,168	329	1,675	164	0.057	401	119	282	0.04
I	11,496	6,051	2,004	3,441	0.110	5,600	1,079	4,520	0.10
J	9,606	4,770	1,986	2,851	0.056	3,761	455	3,306	0.13
K	32,714	14,013	7,855	10,846	0.039	12,967	1,061	11,907	0.22
L	3,838	395	4,723	-1,279	0.006	1,330	1,305	25	0.60
MNOP	13,690	2,607	11,364	-281	0.003	355	318	37	0.06
Total	114,559	50,216	55,202	9,141		54,560	22,710	31,851	0.04

Source: author's calculations

Table 7: Estimated regional trade figures

III.4 Completion of the Regional Input-Output Table

In order to complete the RIOT, we augment Table 4 with estimates of domestic final demand from Table 5 and estimates for imports and exports from Table 7. Adding regional production values and imports yields total output, which is entered in the last row of Table 8. In order to check the consistency of our estimates, we add the intermediate deliveries and final demand along each row and find that the row sums are equal to the column sums. Thus, in Table 8 we have a complete estimated RIOT for Hamburg.

RIOT Hamburg 2002 € million		Deliveries to													Final demand			Total output
		AB	C	D	E	F	G	H	I	J	K	L	MNOP	total	domestic	exports	total	
Deliveries from	AB	86	0	595	0	0	0	26	3	0	28	20	20	777	615	91	706	1,483
	C	6	11	561	168	30	11	4	2	4	5	11	13	825	145	30	175	1,000
	D	125	12	10,361	158	1,145	518	412	800	95	557	240	730	15,154	12,670	9,743	22,414	37,567
	E	11	4	322	233	5	89	39	88	31	65	23	111	1,021	823	107	930	1,951
	F	3	1	69	28	163	38	19	82	37	885	50	139	1,513	4,787	3	4,790	6,303
	G	34	3	1,096	52	204	505	124	319	24	106	52	243	2,761	6,555	1,799	8,354	11,115
	H	0	0	34	1	6	35	6	80	66	38	27	34	329	1,675	282	1,958	2,287
	I	4	4	652	37	36	1,132	34	3,433	224	200	88	205	6,051	2,004	4,520	6,524	12,575
	J	12	1	200	22	72	168	45	197	2,524	1,212	133	183	4,770	1,986	3,306	5,292	10,061
	K	58	9	2,201	173	499	1,467	277	1,095	2,095	4,959	285	895	14,013	7,855	11,907	19,761	33,775
	L	1	1	49	91	19	14	6	18	10	109	41	36	395	4,723	25	4,748	5,143
	MNOP	13	2	221	14	24	144	69	113	88	789	85	1,045	2,607	11,364	37	11,401	14,008
	total	352	48	16,361	976	2,202	4,122	1,063	6,231	5,200	8,952	1,055	3,654	50,216	55,202	31,851	87,052	137,268
Domestic primary inputs		271	30	7,139	839	1,809	6,896	1,105	5,265	4,406	23,761	2,784	10,036	64,343				
Production value		623	78	23,500	1,816	4,012	11,018	2,168	11,496	9,606	32,714	3,838	13,690	114,559				
Imports of similar goods		860	922	14,068	135	2,292	97	119	1,079	455	1,061	1,305	318	279,333				
Total output		1,483	1,000	37,567	1,951	6,303	11,115	2,287	12,575	10,061	33,775	5,143	14,008	137,268				

Source: author’s calculations

Table 8: Regional Input-Output Table for Hamburg

IV Discussion

The most frequent use of input-output analysis lies in the estimation of a change in final demand, possibly due to a new investment project, on the total output of the different industries, from which effects on employment and total production can be derived. The direct effect of a change in demand for some industry's output generates indirect effects, which raise the output of other industries. The indirect effect also amplifies the direct effect on the originally affected industry, which gives rise to a *multiplier effect*. The size of these multiplier effects can be determined from the *Leontief Inverse* of an IO-table. Since these multiplier effects arise from the intermediate transactions between sectors, they are likely to be smaller at a regional level than at a national level, because at a regional level a larger share of intermediate demand spills over into other regions via interregional trade. Therefore, a derived RIOT should result in lower estimates of these multiplier effects.

Because of this, any reliable method of RIOT derivation must incorporate a proper treatment of imports and exports, and the estimates which results from that. Let us therefore take some time to examine our estimated trade figures for Hamburg. According to Table 7, we estimate that Hamburg imports 860 Million Euros worth of agriculture and fishing products (sector AB) and exports 91 Million Euros, leaving it with a trade deficit of 769 Million Euros. Thus, Hamburg is a net importer of agriculture and fishing products, which is not surprising for a metropolitan region. What is more interesting to observe is that our calculations indicate that Hamburg, despite having a negative trade balance of 4,324 Million Euros in manufacturing, still exported 9,473 Million Euros of manufacturing goods, which made it necessary to import a whopping 14,068 Million Euros of manufacturing goods.

These estimates suggest that a lot of cross-hauling is going on in the manufacturing industry. This kind of trade is completely ignored by traditional LQ methods, which assume that imports occur only if the regional industry's production is too small to satisfy regional demand, and exports occur only if the regional industry's production exceeds regional demand. Because of this assumption, the traditional methods tend to underestimate the regional volume of trade. Harrigan and his co-authors, for example, compared the estimates of several nonsurvey techniques of the intermediate imports to Scotland from the rest of the UK with actual survey data, and found that the SLQ method underestimated the actual figure by almost 80 percent. Other LQ-based methods fared slightly better, but were still off the mark by roughly fifty or more percent [Harrigan et al., 1981].

The underestimation of regional trade in turn causes an overestimation of regional multipliers [Flegg et al., 1995]. This is problematic because impact analyses based on such nonsurvey methods tend to be too optimistic about the income and employment effects of demand impulses. In fact, "the major problem affecting the LQ method is the overstatement of multipliers, which arises from the fact that conventional location quotients do not take sufficient account of interregional trade" [Tohmo, 2004]. Since the new method presented in this paper takes account of interindustry trade, which both LQ and pool methods neglect, the bias should be considerably reduced. Under the assumptions of the SLQ method, we would have estimated that Hamburg imported 4,324 Million Euros of manufacturing goods (Table 7), but with our new method that estimate more than triples to 14,068 Million Euros (Table 8). Total imports, using the LQ method, would be estimated by adding all the negative entries in the trade balance column of Table 7, which would amount to 9,093 Million Euros. With the new method, by contrast, the estimated total imports amount to 22,710 Million Euros (Table 7). Thus, the underestimation of imports, a serious problem of LQ methods, is considerably reduced by the new method.

In order to compare the multiplier effects at the national level with those at the regional level, the Leontief inverse matrices of both the NIOT and the RIOT are computed. The sum of each column in a Leontief inverse matrix yields the multiplier effect of that column's industry. These numbers are reported in Table 9.

	National	Regional
AB	1.731	1.368
C	1.294	1.071
D	1.915	1.709
E	1.829	1.759
F	1.950	1.563
G	1.615	1.600
H	1.769	1.741
I	1.864	1.856
J	1.857	1.855
K	1.413	1.401
L	1.460	1.327
MNOP	1.427	1.402
Total	20.122	18.653

Source: author's calculations

Table 9: Industry multiplier effects at the national and regional levels

Table 9 shows that if, for example, national final demand for mining commodities (the output of industry C) rises by one Euro, one would expect the total output of the German economy to increase by 1.29 Euros. However, if the demand for mining commodities in Hamburg rises by one Euro, we would expect the total output of Hamburg's economy to rise by only 1.07 Euros. The reason for this is that if national demand for mining goods rises, chances are that some of that demand can be satisfied, for instance, by the coal mines of North Rhine-Westphalia or the salines of Thuringia and Lower Saxony. Hamburg, however, has no mining industry to speak of; most of the additional demand will simply be imported, causing not much in the way of indirect effects on the other industries.

Furthermore, we can see from Table 9 that the regional multipliers for every single industry are smaller than their counterparts at the national level, although the difference is in some cases very small. For example, there is virtually no difference between the national and regional multipliers of financial intermediation (industry J). The largest differences arise in the industries which belong to the primary and secondary sectors, which is intuitively plausible, because a metropolitan area like Hamburg can be expected to meet most of its primary and secondary sector demands by imports. The bottom row of Table 9 displays the sum of the 12 industries' individual multipliers. It states that if final demand for each commodity rises by one Euro, which amounts to a total increase of 12 Euros, this causes an increase in total output by 20.12 Euros in Germany, and by 18.65 Euros in Hamburg. Thus, the total multiplier is 1.67 for Germany as a whole and 1.55 for the city state of Hamburg. This is consistent with the claim that regional multipliers must be lower than national ones, because regions, being small, tend to trade relatively more than countries, being large.

V Conclusion

In this paper, we have presented a new, easy-to-use nonsurvey method for the derivative construction of regional input-output tables. Although we believe that the method produces more accurate results than traditional methods, it may still be subject to the criticism of nonsurvey methods in general. Certainly, one cannot expect a nonsurvey method like the one presented above to yield a complete accurate picture of a regional economy, given its astonishingly low data requirements.

However, as Lothar Hübl argued in a foreword to a book by Olaf Hübler on nonsurvey methods, the variety of methods ranging from pure nonsurvey methods via hybrid methods to survey methods can be seen as a menu, from which we can choose, depending on our research goal, between higher precision and lower implementation cost [Hübler, 1979]. Also, in developing countries data availability is generally low, which is why Geoffrey Hewings argues that "nonsurvey and semisurvey techniques […] appear to hold considerable potential in these countries [Hewings, 1985]. Furthermore, since hybrid approaches are based on the preliminary results of nonsurvey methods, "it is critical to use the best non-survey methods possible" [Lahr, 1993]. Therefore, it certainly makes sense to further improve the accuracy of nonsurvey methods, and we hope to have made a small contribution toward this goal.

With the new method presented in this paper, researchers are able to derive regional input-output tables even under very limited data availability. All that is required is a national input-output table and some regional data to indicate the size of each regional industry relative to its national counterpart. Ideally, labour income should be used, because it corrects to a certain extent for productivity differentials [Lahr, 2001]. If such data is not available, employment figures may be used as well, although the accuracy of the resulting IO-table may suffer.

Compared to the traditional nonsurvey methods, the new method offers several advantages. First of all, because of its minimal data requirements it can be applied to any region for which sectorally disaggregated employment figures are available. Secondly, the tendency of traditional LQ and pool methods to underestimate the volume of regional trade, which causes an overestimation of regional multipliers, is meliorated, because cross-hauling is accounted for. Thirdly, the propensity for cross-hauling, which is assumed to depend on the heterogeneity of an industry's output, is estimated from the national input-output table. We consider this an advantage, because it replaces a subjective educated guess on regional 'preference factors', as required by Gabriel's method, with an objective estimate based on actual data.

The new method, being easy and simple, offers a huge scope for extensions. One might, for example, introduce a parameter to account for productivity differences, which are known to exist even within a national economy, for example between West and East Germany. Furthermore, since the accuracy of the method depends on the accuracy of the final demand estimate, one should use a very good estimate. The approach taken in this paper, simply scaling down national final demand, is workable but crude. However, if the funds for a hybrid approach are available, it nearly always makes sense to collect survey data from the household sector [West, 1990]. Therefore, it may be a good idea to first perform the household sector survey and use the resulting data to get a good estimate of regional final demand.

Finally, if one believes that the new method still underestimates regional trade, one may introduce a correction factor into the formulae, but this would again require an educated guess on the size of that correction factor. The next logical step, however, will be to test the new method empirically by comparing its results to those of other nonsurvey methods and to RIOTs constructed from survey data.

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