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COMPILATION OF A PRODUCT-BY-PRODUCT INPUT-OUTPUT TABLE FOR ESTONIA

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Abstract

One of the most frequently discussed methods for compiling product-by-product input-output table is the method based on product technology assumption, recommended by European System of Accounts 1995, ESA 1995. This paper deals with the Estonian experience in the derivation of such a kind of input-output table. In practice, the application of the product technology assumption leads frequently to negative, although often minimal, flows in the transformed input-output matrix, the adjustment of which is quite time and effort consuming.

The paper presents the results of a product-by-product input-output table compilation based on the product technology assumption. In this study, two different approaches are used. The first one is the Clopper Almon's algorithm that avoids negative entries when compiling input-output tables; while the other input-output matrix is calculated with the standard product technology method and contains a certain number of negative values. These two tables are compared and the largest negatives which appeared in the second transformed input-output matrix are analysed.

Introduction

One of the most frequently discussed methods for compiling product-by-product input-output tables is the method based on product technology assumption. Recommended by the ESA 1995, this approach has been examined by many experts as well as producers of official statistics who have pointed out its advantages and drawbacks.

A quite wide and heterogeneous literature on this issue is available. A very good overview on the past research can be found in Guo *et al.* (2002). Among the opponents to the product technology assumption we can mention Thage (2002), who considered an industry-by-industry table based on the assumption of a fixed product sales structure (market share assumption) the only one worthy to be compiled, and de Mesnard (2004), who described the make-use model in terms of economic circuit. Recently, Svensson and Widell (2004) have proposed their method for calculating a symmetric input-output table (SIOT) that solves the problem of negative coefficients.

Some years ago, in a study performed for Eurostat, the Dutch Statistical Office tested the so-called standard method of calculation of the symmetric input-output tables and compared it with Almon's algorithm in order to get a general method for deriving SIOTs for the statistical institutes of the Member States (see Vollebregt, 2001).

In the Netherlands, both algorithms were implemented in Visual Basic. When applying Almon's algorithm, we used PTP software prepared by Almon, written in C++. The results of each run were examined with the help of several diagnostic files produced by this software. The complete description of these useful tools is presented in Almon (2000 and 2003).

This paper does not aim to convince anyone nor indicate "the only and the right" way to derive a symmetric input-output table. Our intention was to test these two alternative methods on Estonian Supply and Use tables for 2000, and to verify the results we obtained by using these different approaches.

The paper is divided into three chapters. The first one describes the official product-to-product table prepared by the Estonian National Statistical Office. In the second chapter, the results of the application of Almon's algorithm are illustrated. Finally, the third chapter provides a brief comparison of these two methods, followed by conclusions.

1. Background information on the compilation of Supply and Use Tables for Estonia

The first Supply and Use tables (SUTs) and the symmetric input-output table according to the ESA 95 were compiled and published for 1997 (Dedegkajeva, 2002). Starting from the accounting year 2000, Statistical Office of Estonia (SOE) now produces Supply and Use tables regularly on an annual basis. The SUTs for 2000 and 2001 are available and will be published as integrated parts of the National Accounts in 2006. SIOTs will be calculated on a multi-year basis. To satisfy our users' requirements, we intend to calculate both product-by-product and industry-by-industry input-output tables.

To test calculations of input-output tables, we utilized the benchmark Supply and Use tables for 2000. In Estonia, most data for the compilation of Supply and Use tables are obtained from statistical surveys conducted by SOE and other administrative sources. The statistical units used for the calculation of SUTs are enterprises; in Estonia statistical surveys (e.g. Structural Business Statistics, agricultural and other surveys) collect information on both turnover and input costs at the enterprise level.

SUTs are available at both purchasers' and basic prices. For input-output purposes, the Use table valued at basic price was used. In the Estonian SUTs, in total 201 industries are broken down by institutional sectors and by types of producer. The consolidated number of industries is 97. On the product side, 415 product groups are distinguished. To obtain the square format, the Supply and Use tables were aggregated to the level of 85 products and 85 industries.

1.1 Amount of secondary production

It is known that the major problem of the compilation of SIOT is the existence of secondary production.

Table 1.1 illustrates the total output value by industry with distinction made between primary and secondary outputs. In 2000, the estimated output value of the whole economy was 224242,7 million EEK[1] (sector 86). The total value of secondary production amounted to 18541,1 million EEK, i.e. 8,3% of the total production. Hence, in 2000, the industries' primary output was 91,7% of the total output.

As can be seen from Table 1.1, in 2000, almost all industries had some kind of secondary production. For nearly half of them (precisely 42 industries out of a total of 85), the share of secondary output was higher than average (8,3%) calculated for total output. Nearly 13 industries had a very large proportion of secondary output – more than 20% of total industry output.

Table 1.1 – Primary and secondary output by industry grouped by relative size of secondary output in 2000, million EEK.

Sector number	Industry code	Industry output	Industry primary output	% of total industry output	Industry secondary output	% of total industry output
1	2	3=4+6	4	5=4/3	6	7=6/3
46	D.37	128,3	16,6	12,9%	111,7	87,1%
43	D.35	1 201,4	724,1	60,3%	477,3	39,7%
57	H.551	1 303,3	810,9	62,2%	492,4	37,8%
3	B.05	914,4	598,8	65,5%	315,6	34,5%
52	G.50	2 449,5	1 692,5	69,1%	757,1	30,9%
41	D.33	1 209,3	857,2	70,9%	352,0	29,1%
18	D.1589	428,5	323,6	75,5%	104,9	24,5%
37	D.29	1 679,9	1 272,3	75,7%	407,6	24,3%
14	D.156	158,1	120,8	76,4%	37,3	23,6%
70	J.65	4 018,9	3 103,8	77,2%	915,1	22,8%
34	D.269	1 791,6	1 404,0	78,4%	387,6	21,6%
36	D.28	4 453,9	3 498,6	78,6%	955,3	21,4%
11	D.153	250,3	197,5	78,9%	52,8	21,1%
20	D.1596	918,4	739,1	80,5%	179,3	19,5%
44	D.361	3 422,4	2 779,0	81,2%	643,4	18,8%
39	D.31	3 029,6	2 510,1	82,9%	519,5	17,1%
30	D.23	552,6	463,4	83,9%	89,2	16,1%
25	D.19	1 027,3	865,4	84,2%	161,9	15,8%
55	G.52	7 899,5	6 661,4	84,3%	1 238,1	15,7%
8	C.14	285,4	241,2	84,5%	44,2	15,5%
64	I.61	3 839,7	3 279,7	85,4%	559,9	14,6%
47	E.401	4 271,4	3 667,0	85,9%	604,4	14,1%
38	D.30	285,6	247,2	86,5%	38,4	13,5%
59	I.601	2 077,0	1 821,4	87,7%	255,7	12,3%
49	E.403	1 475,1	1 294,8	87,8%	180,3	12,2%
15	D.157	271,2	238,8	88,1%	32,4	11,9%
61	I.60211	193,4	171,1	88,5%	22,3	11,5%
13	D.155	2 744,6	2 428,2	88,5%	316,4	11,5%
74	K.71	454,3	402,0	88,5%	52,3	11,5%

[1] EEK = Estonian *kroon*.

Sector number	Industry code	Industry output	Industry primary output	% of total industry output	Industry secondary output	% of total industry output
1	2	3=4+6	4	5=4/3	6	7=6/3
2	A.02	3 974,2	3 525,6	88,7%	448,6	11,3%
53	G.502	898,1	796,8	88,7%	101,3	11,3%
1	A.01	6 187,6	5 503,3	88,9%	684,3	11,1%
21	D.1598	466,3	414,9	89,0%	51,4	11,0%
82	O.91	690,2	615,8	89,2%	74,3	10,8%
54	G.51	11 186,4	9 994,7	89,3%	1 191,7	10,7%
4	C.10	433,7	388,6	89,6%	45,1	10,4%
75	K.72	1 281,1	1 150,7	89,8%	130,4	10,2%
45	D.362	534,2	480,0	89,9%	54,2	10,1%
16	D.1581	1 229,5	1 107,3	90,1%	122,1	9,9%
33	D.261	681,0	615,5	90,4%	65,4	9,6%
32	D.25	1 742,3	1 578,0	90,6%	164,3	9,4%
17	D.1584	367,3	335,2	91,3%	32,1	8,7%
86	**Total**	**224 242,7**	**205 701,6**	**91,7%**	**18 541,1**	**8,3%**
29	D.222	1 429,3	1 316,2	92,1%	113,0	7,9%
63	I.6024	5 532,9	5 127,4	92,7%	405,6	7,3%
66	I.631	5 863,3	5 471,4	93,3%	391,9	6,7%
26	D.20	8 125,1	7 598,0	93,5%	527,1	6,5%
24	D.18	4 093,2	3 832,9	93,6%	260,3	6,4%
42	D.34	941,1	881,9	93,7%	59,2	6,3%
60	I.602	1 199,6	1 125,8	93,8%	73,8	6,2%
33	D.261	681,0	615,5	94,0%	65,4	6,0%
19	D.1591	442,1	415,4	94,1%	26,7	5,9%
31	D.24	2 634,8	2 480,7	95,4%	154,2	4,6%
23	D.17	3 593,8	3 428,6	95,6%	165,2	4,4%
67	I.633	448,2	428,7	95,7%	19,5	4,3%
58	H.553	2 161,5	2 069,1	95,8%	92,3	4,2%
77	K.74	7 549,9	7 232,2	95,8%	317,7	4,2%
78	L.75	9 310,7	8 920,1	95,8%	390,5	4,2%
51	F.45	15 294,6	14 658,0	95,8%	636,5	4,2%
56	G.527	212,3	203,4	96,1%	8,8	3,9%
65	I.62	1 024,0	983,9	96,2%	40,1	3,8%
27	D.21	920,6	885,8	96,4%	34,8	3,6%
28	D.221	1 397,7	1 347,7	96,8%	50,0	3,2%
83	O.92	3 141,6	3 040,3	96,8%	101,3	3,2%
10	D.152	1 750,7	1 694,5	96,8%	56,2	3,2%
79	M.80	6 557,6	6 349,2	97,2%	208,4	2,8%
76	K.73	414,5	402,9	97,3%	11,6	2,7%
50	E.41	810,3	788,3	97,4%	21,9	2,6%
9	D.151	1 605,6	1 564,1	97,4%	41,5	2,6%
80	N.85	4 568,2	4 451,0	97,5%	117,2	2,5%
81	O.90	707,5	689,9	97,6%	17,6	2,4%
71	J.66	739,3	721,2	97,9%	18,1	2,1%
73	K.70	13 155,6	12 875,7	98,2%	279,9	1,8%
69	I.64	6 014,8	5 906,5	98,6%	108,3	1,4%
40	D.32	16 723,6	16 494,4	98,7%	229,2	1,3%
84	O.93	1 263,3	1 246,9	98,9%	16,4	1,1%
5	C.11	1 346,6	1 331,3	99,0%	15,3	1,0%
12	D.154	183,9	182,0	99,1%	1,9	0,9%

Sector number	Industry code	Industry output	Industry primary output	% of total industry output	Industry secondary output	% of total industry output
1	2	3=4+6	4	5=4/3	6	7=6/3
72	J.67	384,0	380,4	99,4%	3,6	0,6%
68	I.634	8 762,2	8 709,4	99,5%	52,8	0,5%
48	E.402	950,9	945,6	99,5%	5,2	0,5%
35	D.27	90,3	89,8	99,9%	0,5	0,1%
62	I.6022	453,9	453,6	100,0%	0,3	0,0%
85	P.95	37,2	37,2	100,0%	-	-
6	C.12	-	-	-	-	-
7	C.13	-	-	-	-	-
22	D.16	-	-	-	-	-

The output value by product with distinction between primary and secondary output for the product groups is presented in Table 1.2.

As can be observed from this table, almost all products were produced by primary industries as well as by non-characteristic industries. For example, wholesale and retail distribution margins and renting services were produced as the secondary product by almost all of the industries. In 2000, five products (i.e. sectors 20, 61, 78, 82, 85)[2] were produced only as primary products. In three product groups (sectors 35, 74 and 72) out of a total of 85, more than half of production took place outside the characteristic industry.

Table 1.2 – Product output by relative size of product secondary output in 2000, million EEK

Sector number	Product code	Product output	Product primary output	% of total product output	Product secondary output	% of total product output
1	2	3=4+6	4	5=4/3	6	7=6/3
35	1.D.27	480,5	89,8	18,7%	390,7	81,3%
74	1.K.71	1 110,6	402,0	36,2%	708,6	63,8%
72	1.J.67	911,9	380,4	41,7%	531,5	58,3%
37	1.D.29	2 180,1	1 272,3	58,4%	907,8	41,6%
53	1.G.502	1 277,8	796,8	62,4%	481,0	37,6%
45	1.D.362	673,8	480,0	71,2%	193,8	28,8%
9	1.D.151	2 172,5	1 564,1	72,0%	608,4	28,0%
58	1.H.553	2 855,7	2 069,1	72,5%	786,6	27,5%
49	1.E.403	1 775,3	1 294,8	72,9%	480,5	27,1%
41	1.D.33	1 149,7	857,2	74,6%	292,4	25,4%
46	1.D.37	22,1	16,6	75,0%	5,5	25,0%
8	1.C.14	311,1	241,2	77,5%	69,8	22,5%
18	1.D.1589	405,5	323,6	79,8%	81,9	20,2%
30	1.D.23	568,2	463,4	81,5%	104,8	18,5%

[2] The complete list of sectors' codes (industries as well as products) can be found in Appendix 2.

Sector number	Product code	Product output	Product primary output	% of total product output	Product secondary output	% of total product output
54	1.G.51	12 235,2	9 994,7	81,7%	2 240,5	18,3%
19	1.D.1591	504,2	415,4	82,4%	88,8	17,6%
36	1.D.28	4 235,1	3 498,6	82,6%	736,5	17,4%
56	1.G.527	239,0	203,4	85,1%	35,6	14,9%
10	1.D.152	1 986,3	1 694,5	85,3%	291,8	14,7%
14	1.D.156	141,4	120,8	85,4%	20,7	14,6%
55	1.G.52	7 795,6	6 661,4	85,5%	1 134,2	14,5%
11	1.D.153	229,7	197,5	86,0%	32,2	14,0%
21	1.D.1598	481,3	414,9	86,2%	66,5	13,8%
52	1.G.50	1 962,8	1 692,5	86,2%	270,4	13,8%
63	1.I.6024	5 816,3	5 127,4	88,2%	688,9	11,8%
15	1.D.157	269,6	238,8	88,6%	30,8	11,4%
75	1.K.72	1 289,3	1 150,7	89,3%	138,6	10,7%
12	1.D.154	203,6	182,0	89,4%	21,6	10,6%
77	1.K.74	8 082,1	7 232,2	89,5%	850,0	10,5%
32	1.D.25	1 761,8	1 578,0	89,6%	183,8	10,4%
73	1.K.70	14 232,3	12 875,7	90,5%	1 356,6	9,5%
66	1.I.631	6 044,9	5 471,4	90,5%	573,5	9,5%
81	1.O.90	759,7	689,9	90,8%	69,7	9,2%
57	1.H.551	891,4	810,9	91,0%	80,5	9,0%
42	1.D.34	966,6	881,9	91,2%	84,8	8,8%
39	1.D.31	2 747,2	2 510,1	91,4%	237,1	8,6%
86	**Total**	**224 245,7**	**205 701,6**	**91,7%**	**18 544,1**	**8,3%**
23	1.D.17	3 702,4	3 428,6	92,6%	273,8	7,4%
27	1.D.21	955,2	885,8	92,7%	69,4	7,3%
26	1.D.20	8 183,5	7 598,0	92,8%	585,5	7,2%
44	1.D.361	2 983,1	2 779,0	93,2%	204,1	6,8%
34	1.D.269	1 503,7	1 404,0	93,4%	99,7	6,6%
67	1.I.633	454,4	428,7	94,3%	25,7	5,7%
51	1.F.45	15 505,5	14 658,0	94,5%	847,5	5,5%
28	1.D.221	1 423,9	1 347,7	94,7%	76,2	5,3%
24	1.D.18	4 031,4	3 832,9	95,1%	198,5	4,9%
43	1.D.35	761,0	724,1	95,2%	36,9	4,8%
48	1.E.402	985,7	945,6	95,9%	40,1	4,1%
38	1.D.30	257,0	247,2	96,2%	9,9	3,8%
16	1.D.1581	1 150,0	1 107,3	96,3%	42,7	3,7%
68	1.I.634	9 025,8	8 709,4	96,5%	316,4	3,5%
17	1.D.1584	347,2	335,2	96,5%	12,0	3,5%
60	1.I.602	1 165,4	1 125,8	96,6%	39,6	3,4%
50	1.E.41	815,1	788,3	96,7%	26,8	3,3%
25	1.D.19	892,1	865,4	97,0%	26,6	3,0%
4	1.C.103	400,4	388,6	97,0%	11,9	3,0%
2	1.A.02	3 620,1	3 525,6	97,4%	94,5	2,6%
5	1.C.11	1 366,7	1 331,3	97,4%	35,4	2,6%
47	1.E.401	3 755,9	3 667,0	97,6%	88,9	2,4%
31	1.D.24	2 537,6	2 480,7	97,8%	56,9	2,2%
33	1.D.261	628,6	615,5	97,9%	13,0	2,1%
84	1.O.93	1 271,4	1 246,9	98,1%	24,5	1,9%
29	1.D.222	1 337,4	1 316,2	98,4%	21,1	1,6%
79	1.M.80	6 437,6	6 349,2	98,6%	88,4	1,4%

Sector number	Product code	Product output	Product primary output	% of total product output	Product secondary output	% of total product output
83	1.O.92	3 080,3	3 040,3	98,7%	40,0	1,3%
1	1.A.01	5 557,8	5 503,3	99,0%	54,5	1,0%
70	1.J.65	3 133,1	3 103,8	99,1%	29,3	0,9%
76	1.K.73	406,5	402,9	99,1%	3,5	0,9%
40	1.D.32	16 610,9	16 494,4	99,3%	116,5	0,7%
71	1.J.66	726,1	721,2	99,3%	4,9	0,7%
65	1.I.62	988,7	983,9	99,5%	4,9	0,5%
69	1.I.64	5 933,9	5 906,5	99,5%	27,4	0,5%
13	1.D.155	2 439,3	2 428,2	99,5%	11,1	0,5%
3	1.B.05	601,1	598,8	99,6%	2,3	0,4%
62	1.I.6022	455,2	453,6	99,6%	1,6	0,4%
80	1.N.85	4 455,6	4 451,0	99,9%	4,6	0,1%
59	1.I.601	1 822,1	1 821,4	100,0%	0,7	0,0%
64	1.I.61	3 280,1	3 279,7	100,0%	0,4	0,0%
20	1.D.1596	739,1	739,1	100,0%	0,0	0,0%
61	1.I.6021	171,1	171,1	100,0%	0,0	0,0%
78	1.L.75	8 920,1	8 920,1	100,0%	0,0	0,0%
82	1.O.91	615,8	615,8	100,0%	0,0	0,0%
85	1.P.95	37,2	37,2	100,0%	0,0	0,0%
6	1.C.12	-	-	-	-	-
7	1.C.13	-	-	-	-	-
22	1.D.16	-	-	-	-	-

1.2 Derivation of SIOT by applying the "standard" approach

The Symmetric input-output table is calculated in accordance with the "standard" method proposed by Eurostat. Calculation procedures are described in detail in the Eurostat Input-Output Table Manual (see ESA 1995 Input-Output Draft Manual, 2002, pp. 239-241).

In practice, the application of the product technology assumption leads to negative flows in the transformed intermediate use and value added matrices. The reasons for these negatives might be different, but in most cases they are caused by errors in the original Supply and Use tables, heterogeneity in data and classifications, as well as when the product technology assumption appears incorrect and therefore can lead to negatives (vertically integrated production processes and existence of by-products).

The first results of the transformation of the SUTs into a SIOT are illustrated in Table 1.3. The number of positive elements in the transformed intermediate part of the Use Table *Z* was 5283 (73,1% of total). The number of negatives accounted for were 1942, i.e. 26,9% of the elements in the transformed intermediate part of the Use table.

As can be observed from the table, the total number of negative elements in the transformed SIOT accounted for 1946, of which the number of negatives in transformed intermediate use and value added matrices were 1942 and 4 respectively. The share of negative elements was large—26,3% of the elements of our matrix.

Table 1.3 – Statistics about the first version of the SIOT

	Number of cells	As % of total
Positive elements	5283	73,1
Negative elements, total	1942	26,9
– 0-1	178	24,6
– 1-2	66	0,9
– 2-10	76	1,1
– 10-20	8	0,1
– 20-30	3	0,0
– 30 +	11	0,2
Total	7 225	100,0

Table 1.4 reports the results on the transformation of the Supply and Use table into a SIOT by value. As emerges from this table, the negatives in the transformed SIOT (in the value added part as well as in the intermediate part of the table) amounted to 1401,1 million EEK, equal to 0,6% of the total production. The amount of negative values in intermediate use matrix *Z* was 1322,9 million EEK, i.e. 1,0% of the total value of intermediate consumption. Negatives that appeared in the transformed value added part of *K* were equal to1,5 million EEK or 0,1% of the total value added.

Table 1.4 – The results of the transformation of SUT into SIOT by number of elements and in value (millions of EEK)

	Number of elements	Value, million EEK
Negative elements in transformed intermediate part of Use table *Z*	1942	1322,9
Intermediate part of Use table *U*	7225	129563,6
Share %	26,9	1,0
Negative elements in transformed value added part of Use table *K*	4	1,5
Value added part of Use table *Y*	170	94679,2
Share %	2,4	0,1
Total negative elements	1946	1401,1
Total production	7395	224242,8
Share %	26,3	0,6

Table 1.5 illustrates the results of the transformed intermediate Use Matrix *Z* in more detail. Here, the negative elements are classified by absolute size. The first two groups contain the largest negative elements (with absolute value each between 30-50, 50-100 million EEK). As can be seen from the table, there was just 11 such elements with a total amount of 528,2 million EEK. Their share accounted for 40% of total negative value.

The next three groups (rows 3, 4 and 5 of Table 1.5) represent medium size negative elements with values between 30-20, 20-10, 10-2 million EEK. The number of such size elements was 87 accounting for 40,8% of the total negative value.

Considering the small size negative elements (rows 6, 7 of Table 1.5), their number was quite large (1844) if compared to the number of the largest negative elements. But the total value was small: 19,3 million EEK or 19,3% of the total negative value. The number of positive elements was 5283, or 73,1% of the total number.

Table 1.5 – Additional facts regarding the transformation of SUT into SIOT

	Elements in transformed intermediate part of the Use table ***Z***	Number of elements	% of total negative elements	% of total elements	Value, million EEK	%
1	$-100 < z_{ij} \leq -50$	3	0,2	0,0	220,5	16,7
2	$-50 < z_{ij} \leq -30$	8	0,4	0,1	307,7	23,3
3	$-30 < z_{ij} \leq -20$	3	0,2	0,0	81,5	6,2
4	$-20 < z_{ij} \leq -10$	8	0,4	0,1	122,7	9,3
5	$-10 < z_{ij} \leq -2$	76	3,9	1,1	334,8	25,3
6	$-2 < z_{ij} \leq -1$	66	3,4	0,9	98,4	7,4
7	$-1 < z_{ij} \leq 0$	1 778	91,6	24,6	157,3	11,9
	Total negative elements	1 942	100,0	26,9	1 322,9	100
	Positive elements	5 283		73,1		
	Total elements in Z	7 225		100,0		

2. Application of Almon's algorithm

The problem of the negative coefficients associated with the application of traditional product technology will never trouble a user of Almon's algorithm, because there will not be any negative entries in the resulting product-to-product table. Therefore, it can give the impression that the computation of the matrix is fully automatic—just a question of a few seconds needed to run the program. It should be noted that this impression is absolutely erroneous.

Hereafter, we are going to illustrate our experience in applying Almon's method and his software to Supply and Use tables for 2000. We will explain, even briefly, what kind of corrections we had to make to the original data, how much time it took, etc. The following considerations are based upon the analyses of two PTP output files, the first called ***Problems***. Like the negative coefficients produced when performing the standard product-technology assumption, useful in detecting coexisting technologies and/or aggregation problems, the Problems file carries out the same task showing the most relevant inconsistencies between the data and the product-technology assumption (Almon, 2003). In the second file, called ***Stats***, different statistics on the transformation processes are reported.

2.1 Corrections to the Original tables

The first application of Almon's algorithm on the original Supply and Use tables issued by the National Statistical Office of Estonia allowed us to discover the most evident inconsistencies between the data and the product-technology assumption.

The first product-by-product table was then carefully examined and, on the basis of the indications in the ***Problems*** file representing the most urgent adjustments to make, manual corrections were effectuated. The principle is that, with step-by-step adjustments, added one or two at a time, a good product-by-product matrix can be calculated.

As widely recognized, in the real world, a pure product-by-product matrix does not exist; so, for some kinds of products, industry-technology should be, certainly, the only acceptable solution. In some other cases, there could be products where the choice of the technology (industry or product) is left merely to the good sense of the statistician working on these data. On the other hand, it should be remembered that in the standard approach the manual adjustments cannot also be avoided.

There are two alternative ways to modify the original tables when using the PTP software and, as stated by Almon (2003), "*which way to us is to some extent a matter of aesthetics*". However, as affirmed by Almon, *the "move" option transfers the inputs from the column in the Use matrix to the column, i.e. industry where this product represents a characteristic output, when the "sell" option converts the secondary production in the Make matrix into a primary sale in the Use matrix*.

Here a brief description of three of the largest discrepancies is given.

1. **Meat and meat products produced in agriculture**. Let us take, for example, the case of sausages and salami produced by some firms engaged, mainly, in agriculture, cattle, and pig-breeding industries which also have establishments where foodstuffs are produced and prepared as a secondary activity. We believe that a transfer to the industry producing principally meat products should be more appropriate, as far as the input structure of those two types of goods is considered. These products were moved into the industry where they represent a characteristic product. This change permitted this item to be removed from those most significant problems listed.
2. **Fish and fishing products produced in the fishing sector**. The characteristic product of the fishing industry represents about two-thirds of its output, and the fish and fish products amount to the remaining third. Probably these products are canned fish prepared directly on the ships. However, it seems more appropriate to move these fish products and their inputs to the characteristic industry.
3. **Basic metals produced in the machinery and equipment industry**. In fact, according to the Supply table, a number of industries produce basic metals and the characteristic industry provides only for 18,7 per cent of the total output of basic metals. The principal producers of basic metals are the industry producing metal products and that which recovers secondary raw materials. To solve this problem more than one correction was needed. The adjustments concerned metal products, recovered secondary raw materials and medical and optical instruments. After several iterations, the problem of metals disappeared.

2.2 Problems with diagonal elements

The PTP software offers an optional tool permitting one to deal with problems arising from the diagonal elements of the input-output table. In particular, the *[Diag]* option allows the removal of a fraction from the original Use matrix, obtained by the multiplication of the diagonal elements of the original Use matrix and the specified coefficient, between 0 and 1. A detailed description of this tool can be found in Almon (2003).

We made several attempts using different coefficients to study their effects on the resulting product-to-product matrix, with particular attention to the improvements of its diagonal elements.

When using the original Supply and Use table without any specification of the *Diag* coefficient, six items with some problems linked to diagonals of the product-to-product matrix were evidenced. Subsequently, the coefficient was introduced and runs were made increasing the coefficient (incremented by 0,1 each time).

The results of different runs have made clear that an increase in *Diag* option leads, generally, to an improvement of the problematic values on the diagonal as well as on some other elements out of the diagonal. Some sectors, however, as can be seen from Table 2.1, appeared unaffected by variations in coefficient thus indicating that the very nature of the problem was related to other factors.

Table 2.1 – Overview of problems with the diagonal elements of the symmetric table, extracted from the *Problems* file

	Diagonal Problems	Sectors
Diag = 0	6	3,9,77,39,45,35
Diag = 0,1	6	3,9,77,39,45,35
Diag = 0,2	7	3,9,77,39,45,35,59
Diag = 0,3	7	3,9,77,39,35,45,59
Diag = 0,4	6	3,9,77,39,59,35
Diag = 0,5	4	3,9,59,39
Diag = 0,6	3	3,9,59
Diag = 0,7	3	3,9,59
Diag = 0,8	4	3,52,9,59
Diag = 0,9	3	3,52,59

From the above table, it can be observed that one of the most persistent problems concerned fishing products[3] (No.3), meat and meat products (No.9), and railway transportation services (No.59). These problems disappeared from the list when some secondary products were reallocated to sectors where they are produced as characteristic products—a procedure that will be discussed below.

If we do not take into account these three above-mentioned products and consider only some other problems which appeared, it might be observed that a quite satisfactory result was obtained when the coefficient was set equal to 0,6. Another little improvement was achieved

[3] For the complete list of items with code descriptions, see Appendix.

by increasing the coefficient to 0,7. After that point, an additional increase would cause new troubles.

2.3 Iterations and Convergence process

On average, the iterative process converged for the product-by-product matrix's rows in six iterations. Eleven rows out of 85 needed more than 10 iterations to converge. The largest number of iterations necessary for a row was 18 (wholesale trade services), followed by real estate services with 16 iterations and business services with 14 iterations.

Table 2.2 – Statistics on convergence

Iterations	Number of rows
1	8
2	5
3	12
4	16
5	11
6	8
7	6
8	3
9	5
10	4
11	1
12	2
13	1
14	1
15	0
16	1
17	0
18	1
Average	**6**

A sufficient condition for the convergence of the matrix is that at least half of the production for each product group takes place in the primary industry for the considered product group. As reported by Vollebregt (2001), the algorithm converges even if less than half of the production of a product comes from its main producer. In fact, we could observe that in three cases where this condition was not satisfied, the convergence was however attained, but extra iterations were required.

Table 2.3 – Products with less than half main producer production

Item number	Product	% of product output produced by main producer	Number of iterations for convergence
35	Basic metals	18,7%	11
72	Auxiliary financial services	41,7%	10
74	Renting services of movables	36,3%	10

If we consider the number of so so-called stops (i.e., cells to scale down), we can see that, on average, they were quite few. The maximum number reached was for metal products (213), followed by basic metals with 130 stops. In all the other rows the number of stops was less than 70 (see Table 2.4 for the complete description).

Table 2.4 – Other useful indicators on the program run

Stops Interval	Number of rows
0	2
1 – 10	25
11 – 20	16
21 – 30	9
31 – 40	9
41 – 50	8
51 – 100	14
101 – 200	1
200 +	1
Average	**28**

2.4 Differences between Use and NewUse tables

After effectuating several elaborations that led to a slightly different Use table, the comparison was made between the original Use matrix and the so-called NewUse, a table fully coherent with the computed product-by-product table.

The latter is computed as

$$NewUse = \mathrm{Re}\,cipe * Make$$

The Use matrix has, clearly, only positive entries, so this table cannot be compared with that of the negative entries of the standard calculation method. However, the number of cells that have been modified could be considered an acceptable indicator of the validity of the original data.

Table 2.5 – Comparative Results obtained from Use and NewUse tables

Difference	Number of cells	% of Total
No difference	837	11,58%
0-1	6099	84,42%
1-2	128	1,77%
2-3	45	0,62%
3-4	24	0,33%
4-5	22	0,30%
5-6	14	0,19%
6-7	7	0,10%
7-8	1	0,01%
8-9	2	0,03%
9-10	4	0,06%
10-20	20	0,28%
20-30	12	0,17%
30-40	4	0,06%
40+	6	0,08%
TOTAL	7225	100,00%

The evidence from Table 2.5 indicates that there were no difference in 11,6 per cent of the cells and the differences were mostly insignificant (from 0 to 1 million EEK).

It was observed that only 6 cells out of a total of 7225 (0,08%) were affected by really consistent adjustments. Here, the largest one was related to meat and meat products produced by agricultural sector and the second one concerned fish products of fishing sector.

3. Comparison of methods

We were interested to check if these two different ways of calculation of input-output table would reveal the same kind of problems. For the standard approach, we used as indicators the negative elements of the first version of the table, for the Almon's method the problematical elements were obtained from the ***Problems*** file produced by the PTP software.

Table 3.1 – List of the largest negatives appearing in transformed matrix Z using the Standard method, compared with the respective cells obtained when applying Almon's algorithm

	Row	Column	ESA value	PTP value
1)	D.151	A.01	-90,56	9,63
2)	K.74	J.65	-72,05	26,75
3)	D.27	D.33	-57,93	0,00
4)	B.05	B.05	-47,66	0,10
5)	D.27	D.37	-42,57	7,46
6)	D.31	D.28	-40,29	0,00
7)	D.34	G.50	-38,92	42,22
8)	D.23	E.401	-37,83	0,00
9)	K.70	I.61	-34,43	0,00
10)	D.27	G.51	-33,96	0,00
11)	I.61	I.6024	-32,09	0,00
12)	D.27	A.01	-29,71	0,00
13)	D.152	B.05	-29,26	1,16
14)	D.362	D.361	-22,51	0,00
15)	I.631	G.52	-19,45	0,00
16)	I.61	I.631	-18,88	0,00
17)	D.32	D.29	-17,09	0,00
18)	D.28	B.05	-15,39	1,85
19)	D.154	B.05	-13,73	0,00
20)	D.24	D.1596	-12,91	0,00
21)	A.01	D.25	-12,64	0,00
22)	A.02	E.401	-12,56	0,00
Total			-732,4	89,17

As can be observed from Table 3.1 above, the largest negative concerned meat products (code D.151, for the complete list of code descriptions, see Appendix 1) produced in agriculture. This problem has been illustrated several times and here it can only be emphasized that this was the first substantial adjustment made to the original data (we solved the problem with PTP by transferring these products to their characteristic industry).

The fourth item, denoted by code B.05, represents a diagonal element, already discussed above. Nonetheless, it seems useful to repeat that this was the second most problematic element indicated in the ***Problems*** file with the very first run, i.e. before any specification of diagonal and adjustment to the original matrix was effectuated.

In Appendix 2 the complete list of the 30 most problematic elements has been copied exactly from the ***Problems*** file. It can easily be verified that the greatest part of the largest negatives associated with traditional computation methods are listed in Almon's PTP output file also referred to as ***Problems***.

4. Conclusions

In this paper we described two alternative ways to compute an input-output table. We used the Estonian Supply and Use tables for 2000, distinguishing 85 products and industries.

In that Eurostat requires the Member countries to deliver every five years a product-by-product table, without indicating a preferred algorithm for its calculation, each National Statistical Office can decide what method to adopt.

In Estonia, Table 1997, the very first one, was derived using the traditional product-technology method. Here we compared this method with Almon's version of product-technology assumption, searching for similarities and differences between these two different approaches.

As expected, the standard calculation method forced us to correct manually the negative coefficients, some of them quite large. It is well-known that the major problem of this method concerns the high number of quite small negative elements of the matrix. In fact, our results were similar.

On the other hand, the application of Almon's algorithm obviously will never produce a negative entry in the input-output table, but in this case we were obliged to make corrections to the original data when, without a doubt, the assumption of product-technology failed.

We searched for overlapping problems by comparing the largest negatives and the problems evidenced by Almon's software; and, we had to recognize that problematic elements evidenced by the application of Almon's method were substantially similar to those of the standard calculation method. Finally, there was not any important difference between the final input-output tables derived using different approaches. As a result, we can conclude that the Almon's method can certainly be integrated with that which the Estonian Statistical Office is using.

* * *

References

Almon, C., (2000), "Product-to-Product Tables via Product-Technology with No Negative Flows", Economic Systems Research, Vol. 12, No. 1, pp. 27-43.

Almon, C., (2003), "PTP – An Implementation of the Inforum Product-to-Product Algorithm".

Dedegkajeva, I., (2002), "The Derivation of Symmetric Input-Output Tables for Estonia", paper presented at 14th International Conference on Input-Output Techniques , Montreal, Canada.

de Mesnard, L., (2004), "Understanding the Shortcomings of Commodity-based Technology in Input-Output Models: an Economic-circuit Approach", Journal of Regional Science, Vol.44, No. 1, pp. 125-141.

Eurostat, (1996), *"European System of accounts ESA 1995"*, Luxembourg, Office for Official Publications of the European Communities

Eurostat (2002) *"Eurostat Input-Output Manual"*, first draft, Luxembourg

Guo, J., Lawson, A.M., Planting, M.A., (2002), "From Make-Use to Symmetric IO Tables: An Assessment of Alternative Technology Assumptions", paper presented at 14th International Conference on Input-Output Techniques , Montreal, Canada.

Svensson, L., Widell, L.M., (2004), "Estimation of Commodity-by-Commodity IO-Matrices", Örebro University, ESI Working Paper Series, No. 14.

Thage, B., (2002), "Symmetric Input-Output Tables and Quality Standards for Official Statistics", paper presented at 14th International Conference on Input-Output Techniques, Montreal, Canada.

Vollebregt, M., (2001), "Different Ways to Derive Homogeneous Input-Output Tables", Statistics Netherlands.

APPENDIX 1

Products in the Estonian Supply and Use tables

1	A.01	Products of agriculture, hunting services
2	A.02	Products of forestry
3	B.05	Products of fishing
4	C.103	Peat
5	C.11	Crude petroleum and natural gas
6	C.12	Uranium and thorium ores
7	C.13	Metal ores
8	C.14	Other mining and quarrying products
9	D.151	Meat and meat products
10	D.152	Fish and fish products
11	D.153	Potato, fruit and vegetable products and juices
12	D.154	Animal and vegetable oils and fats
13	D.155	Dairy products
14	D.156	Grain mill products, starches and starch products
15	D.157	Prepared animal feeds
16	D.1581	Bread, pastry goods and cakes, sugar
17	D.1584	Cocoa; chocolate and sugar confectionery
18	D.1589	Vinegar, yeasts and other food products
19	D.1591	Alcoholic beverages
20	D.1596	Beer
21	D.1598	Mineral waters and soft drinks
2	D.16	Tobacco products
23	D.17	Textiles
24	D.18	Wearing apparel; furs
25	D.19	Leather and leather products
26	D.20	Wood and wood products
27	D.21	Pulp, paper products
28	D.221	Books, newspapers and other printed matter and recorded media
29	D.222	Printing services and services related to printing
30	D.23	Coke, refined petroleum products
31	D.24	Chemical products
32	D.25	Rubber and plastic products
33	D.261	Glass products
34	D.269	Other non-metallic mineral products
35	D.27	Basic metals
36	D.28	Metal products
37	D.29	Machinery and equipment
38	D.30	Office machinery and computers
39	D.31	Electrical machinery and apparatus
40	D.32	Radio, TV, communication equipment
41	D.33	Medical, optical instruments
42	D.34	Motor vehicles, trailers and semi-trailers
43	D.35	Other transport equipment
44	D.361	Furniture
45	D.362	Other manufactured goods
46	D.37	Recovered secondary raw materials
47	E.401	Electricity
48	E.402	Gas

49	E.403	Steam and hot water
50	E.41	Water
51	F.45	Construction work
52	G.50	Trade of motor vehicles
53	G.502	Repair and maintenance of motor vehicles and motorcycles
54	G.51	Wholesale trade services
55	G.52	Retail trade services
56	G.527	Repair of personal and household goods
57	H.551	Hotel services
58	H.553	Restaurant services
59	I.601	Railway transportation services
60	I.602	Other land passenger transportation services
61	I.6021	Tramway transportation
62	I.6022	Taxi services
63	I.6024	Freight land transportation
64	I.61	Water transport services
65	I.62	Air transport services
66	I.631	Transport supporting services
67	I.633	Travel agency services
68	I.634	Transport agency services
69	I.64	Post and telecommunications services
70	J.65	Monetary intermediation services
71	J.66	Insurance services
72	J.67	Auxiliary financial services
73	K.70	Real estate services
74	K.71	Renting services of movables
75	K.72	Computer and related services
76	K.73	Research and development services
77	K.74	Business services
78	L.75	Public administration and defence services
79	M.80	Education services
80	N.85	Health and social services
81	O.90	Sewage and refuse disposal services, sanitation and similar services
82	O.91	Membership organization services
83	O.92	Cultural, sporting services
84	O.93	Other services
85	P.95	Private households with employed persons

APPENDIX 2

Problems in absolute amount sorted by size encountered in the PTP's first run

The first number reports the column sum of absolute differences (CSAD) between Use and NewUse table, the second one indicates the column number followed by the item that individuates this industry, i.e. its "title". Follows the row number, and then come the biggest difference and the description of the type of the product.

CSAD	Col Title = Industry	Max difference Row = Product	
117.7	1 Products of agriculture	9	68.7 Meat and meat products
114.6	3 Products of fishing	3	40.6 Products of fishing
110.9	10 Fish and fish products	3	40.6 Products of fishing
91.8	37 Machinery and equipment	35	61.1 Basic metals
85.9	9 Meat and meat products	9	68.1 Meat and meat products
76.3	36 Metal products	39	30.4 Electrical machinery &Equipm.
69.4	55 Retail trade services	73	26.1 Real estate services
69.4	54 Wholesale trade services	66	18.3 Transport supporting services
61.2	70 Monetary intermed. serv.	77	39.6 Business services
60.9	51 Construction work	26	17.3 Wood and wood products
56.3	47 Electricity	30	28.0 Coke, refined petroleum prod.
55.7	66 Transport supporting serv.	64	16.5 Water transport services
54.8	49 Steam and hot water	30	28.0 Coke, refined petroleum prod.
54.7	64 Water transport services	73	31.1 Real estate services
49.0	68 Transport agency serv.	64	44.3 Water transport services
48.7	63 Freight land transport	64	27.4 Water transport services
47.2	41 Medical, optical instrum	35	33.3 Basic metals
40.0	52 Trade of motor vehicles	42	22.1 Motor vehicles, trailers
36.4	77 Business services	77	12.6 Business services
36.1	39 Electrical machinery,Equip	39	22.9 Electrical machinery &Equipm.
35.6	53 Repair of motorvehicles	42	22.9 Motor vehicles, trailers
32.6	45 Other manufactured goods	45	24.1 Other manufactured goods
32.0	46 Recovered second. raw mat	35	11.8 Basic metals
29.8	44 Furniture	45	15.6 Other manufactured goods
29.0	35 Basic metals	35	19.2 Basic metals
28.5	72 Auxiliary financial serv	77	22.4 Business services
26.8	74 Renting serv of movables	77	4.6 Business services
21.1	73 Real estate services	26	5.1 Wood and wood products
20.8	58 Restaurant services	11	3.4 Potato, fruit and vegetables
20.7	26 Wood and wood products	44	5.5 Furniture