20th International Input-Output Conference

Bratislava, June 26 – 29, 2012

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On the tectonics[1] of the empirical basis of input-output analysis

Abstract

The theoretical concepts of input-output analysis are operationalised in a multi-step procedure in order to arrive at the parameters describing structural relationships. After the first steps supply and use matrices at purchasers' prices are compiled. The nature of these matrices is usually seen as belonging to the category of descriptive statistics. In the following step the use matrix has to be transformed into a matrix at basic prices in order to achieve homogeneity as regards valuation. On the basis of model assumption the information of supply and use tables at basic prices is then converted into technology matrices.

The paper concentrates on the different layers of valuation matrices which bridge between use matrices at purchasers' prices and use matrices at basic prices. It is shown that the "distance" between these two valuation concepts differs significantly in the various parts of the system and even across rows. The various layers (trade margins, transport margins, product taxes, product subsidies) are of quite distinct relevance by industries and products. Because the various layers are in a different way rooted in direct observations the "model content" and thus the cognitive character of the elements of an use matrix at basic prices are not equally distributed. As far as the sensitivity of the results with respect to the underlying modeling approaches are concerned the step from purchasers' prices to basic prices is probably not the most relevant one. Nevertheless it is an important step which deserves some attention.

The multifaceted tectonics of the use matrices are illustrated on the basis of Austrian data for 2007.

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[1] The metaphor "tectonics" in relation to the structure of a statistical system was coined by Alfred FRANZ (1994)

1. Introduction

Leontief defined input-output analysis “as a general methodological approach designed to reduce the steadily widening gap between factual observations and deductive theoretical reasoning” (LEONTIEF 1989, p. 3). Some authors argue that “Input-output analysis is based exclusively on magnitudes that are directly observable and that can be measured using the ordinary instruments for measurement in economics” (KURZ, SALVADORI 2006, p. 373).

In most cases input-output analysis is based on input-output tables fully integrated in the System of National Accounts. In the long sequence of steps which lead from the basic observation of some aspects of economic reality via economic statistics to the input-output table (s. BLACKBURN 1996, RICHTER 2002), information taken from the box labelled “facts” is combined with data taken from the box labelled “model results”[2].

In this sequence of steps supply and use tables can be seen as an important intermediate stage. They serve as a coordinating framework for economic statistics, both conceptually for ensuring the consistency of the definitions and classifications used and as an accounting framework for ensuring the numerical consistency of data drawn from different sources (SNA 1993[3], 15.3).

The SNA states that supply and use tables are **data-oriented in nature** (emphasis added) whereas the symmetric tables are always constructed from having made certain analytical assumptions (SNA 1993, 15.7). Most users familiar with the SNA will therefore suppose that supply and use tables consist of “facts” only or on data which at least “in principle” could be observed directly.

They are aware that these “statistical” supply and use tables provide the foundation from which the analytical input-output tables are constructed (SNA 1993, 15.7). They recognize that all the entries they find in symmetric input-output tables – using the terminology of Richard STONE - were taken from the box with the label "models".

The present paper shows that in order to arrive at the “statistical” supply and use tables a number of modeling steps which alter the cognitive character of the results are unavoidable. In this respect the emphasis is laid on the steps which lead from use tables at purchasers’ prices to use tables at basic prices.

To characterize supply and use tables as data-oriented in nature only holds – within some limitations – for the use tables at purchasers’ prices. Such tables may have strong ties to basic statistics, although a series of imputations, reconciliations and other national accounts requirements in fact usually entail considerable and varied compilation work on basic data to complete and balance the supply and use tables (SNA 1993, 15.122).

As discussed in more detail in RICHTER (1998) even some of the basic data is already the result of the combination of direct observations and hypotheses. Enterprises which consist of more than one establishment have to be partioned into separate establishments (SNA 1993, 15.13). Measuring the output by commodities for each of the establishment usually causes no major difficulties. Problems arise on the input side. All inputs of such units are at least “in

[2] Richard STONE made this important distinction in his Nobel prize speech (STONE 1986).

[3] EUROSTAT, IMF, OECD, UNITED NATIONS, WORLD BANK (1993)

principle” observable on the level of the enterprise. Some, but not all inputs may also be observable on the level of the establishment.

If the production programs of the different establishments belonging to one enterprise are quite distinct, the allocation of the "embodied material" (ARROW, HOFFENBERG 1959) or "direct material" (SEVALDSON 1970) can be based on technical knowhow. In most cases, however, the allocation of all non-specific inputs and overheads to establishments has to be based on some assumptions.

If the allocation is based on the consideration that the non-specific inputs are proportional to indicators like the total output of the establishments or the number of employees, this hypothesis corresponds to the industry technology assumption. If the allocation of non-specific inputs like costs for handling and transportation is done proportional to some specific output indicator (tons produced, for example) or the share of a specific product in the output-mix, this hypothesis is equivalent to the commodity technology hypothesis. Modeling procedures of this kind have to be and are used by many different people who have to fill in questionnaires.

For an “outsider” and perhaps also for the Statistical Office it is impossible to assess which hypotheses have already gone into the data generating process which resulted in the basic statistical data. The share of multi-establishment enterprises in the total population of units may give some broad indication of the order of magnitude of the problem

The analysis of the “model content” of the steps from a use table at purchasers’ prices to a use table at basic prices on the other hand can be based on solid information which is at least available for some countries. Starting from supply and use tables the entries at purchasers’ prices have to be decomposed into basic price, product taxes, product subsidies, and trade and transport margins. The decomposed parts then need to be reallocated in order to arrive at input-output tables at basic prices, the point of departure for estimating technology matrices.

The present empirical investigation is based on Austrian data for 2007. Statistics Austria (STATISTIK AUSTRIA 2011) publishes full sets of all the valuation matrices for margins, product taxes and product subsidies. Strictly speaking the results only describe the situation for Austria and the reference year 2007. On the other hand one can assume that the general findings are also valid for other reference years and at least for other industrialized countries.

In geology tectonics is concerned with the structures within the lithosphere of the earth. In analogy with geology it will be argued that the data, on which input-output analysis rests, is based on different layers of quite distinct cognitive character.

2. On the tectonics of use matrices by layers

2.1 Preliminary remarks

At the end of the entire compilation process the use table at purchasers' prices can be seen as the sum of the following matrices:

- Matrix of domestic production at basic prices,
- Matrix of imports,
- Matrix of trade margins,
- Matrix of transport margins,
- Matrix of taxes on products,
- Matrix of subsidies on products.

The process of arriving at a use matrix at basic prices usually starts from a use matrix at purchasers' prices. In order to transform the use table to basic prices, each element of the table must be decomposed. This can be seen as estimating similarly sized tables of the format products by uses, each of which contains all the items for one of the components.

In the present exercise no distinction is made between domestic production and imports. On the other hand the matrix of trade margins is split up into a matrix of wholesale trade margins and a matrix of retail trade margins. In the EUROSTAT Manual of Supply, Use and Input-Output Tables[4] (EUROSTAT 2008) the matrices of margins and of product taxes and product subsidies are called valuation matrices.

It deserves mentioning that the valuation matrices are not only necessary to arrive at use tables at basic prices. They are of analytical interest themselves and can serve as the empirical background of studies. One example is the investigation on the role of indirect taxes (e.g. BARDAZZI, GRASSINI, LANGOBARDI 1991), another example the assessment of the total content of transport costs in the various products (e.g. HEILING, RICHTER 2010).

After having estimated the valuation matrices the next step is to deduct the entries from each single entry in the use table at purchasers' prices and to reallocate the deducted margins, taxes and subsidies.

In the standard European classification of products CPA (EEC 1993) the wholesale trade margins are reallocated to

CPA 50 *Trade and repair services of motor vehicles etc*.

CPA 51 *Wholesale and comm. trade services, exclusive of motor vehicles*

The retail trade margins are reallocated to

CPA 50 *Trade and repair services of motor vehicles etc*.

CPA 52 *Retail trade services, repair services, except of motor vehicles*

[4] In the following text called Eurostat Manual

The transport margins are reallocated to

CPA 60 *Land transport and transport via pipeline services*

CPA 61 *Water transport services*

CPA 62 *Air transport services*

CPA 63 *Supporting transport services; travel agency services*

CPA 66 *Insurance and pension funding services*

The taxes on products are rerouted to a special row called ”Taxes on products”, the subsidies on product to a special row called “Subsidies on products”.

In a use table at basic prices the products CPA 50, 51, 52, 60, 61, 62, 63 and 66 have a very special cognitive character. The entries are the result of aggregation over (in principle) directly observable services such as repair services and margins, which are not directly observable. The entries serve as repositories for margins and in the tables at basic prices (as they are published by Statistical Offices) the “margin part” is not longer identifiable.

In the case of CPA 50 *Trade and repair services of motor vehicles etc*. for example the entries cover services such as repair services and margins. In the case of the transport services CPA 60 to CPA 63 the situation is even more complex[5]: The transport services for people pose no specific problems. They can be treated as any other input of services.

The costs for the transport of products however appear in two different ways: Either as inputs of the industries which purchase these services or as transport margins. The purchase of services as inputs can be directly observed as other service inputs. By definition these transport costs relate to the goods produced or traded. They can be identified in the use matrix at purchasers’ prices. This type of costs can be seen as “output related transport costs”.

On the other hand the transport margins contain transport costs paid separately by the purchasers and are included in the use of products at purchasers' prices but not in the basic prices of a manufacturers' output or in the trade margins of wholesale or retail traders. Transport margins cannot be directly observed and are not shown in the use matrix at purchasers’ prices. Transport costs appearing as margins can be considered as “input related transport costs”.

The same kind of transport service might appear in different parts of the use table at purchasers’ prices, only depending on the agreements in the contract behind the transaction. In the case that the transport is organized and paid by industry i and not invoiced separately the transport costs will be part of the production value of industry i and recorded as input of transport services of industry i. When the costs are invoiced separately or the transport is organized and paid by industry j the transport costs will be part of the input of the material product valued at purchasers’ prices of industry j. In the input structure at basic prices of industry j the transport costs – the sum of all input related transport costs – will appear in the column of industry j.

[5] For a more detailed discussion see RICHTER (2011)

The “output related transport costs” are more or less directly observable. The “input related costs” are not. Additional difficulties occur from the fact that “margins on top of margins” exist such as for example the services of forwarding agents and transport insurances on top of pure transportation costs.

Table 1[6] provides some information on the magnitudes involved. In order not to overload the presentation Table 1 does not include the services. In the last column of the presentation the ratio between supply at purchaser’s prices and supply at basic prices is added.

Table 1	Supply at purchasers' prices in relation to supply at basic prices						
	Supply at basic prices in Mio €	Wholesale trade margins in Mio €	Retail trade margins in Mio €	Transport margins in Mio €	Product taxes minus product subsidies in Mio €	**Supply at purchasers' prices in Mio €**	**Supply at purchasers' prices / Supply at basic prices**
Products by CPA							
01 Products of agriculture	**7 565**	871	950	196	242	**9 823**	**1,30**
02 Products of forestry	**3 398**	159	27	148	41	**3 773**	**1,11**
05 Fishes and products of fishes	**71**	10	20	0	7	**108**	**1,52**
10 Coal and lignite; peat	**395**	17	5	81	4	**503**	**1,27**
11 Crude petroleum, natural gas, metal ores	**7 187**	-	-	294	81	**7 562**	**1,05**
14 Other mining and quarrying products	**1 557**	84	9	322	14	**1 986**	**1,28**
15 Food products and beverages	**21 545**	2 452	3 331	202	1 943	**29 473**	**1,37**
16 Tobacco products	**510**	251	325	1	1 865	**2 952**	**5,78**
17 Textiles	**4 117**	604	768	43	398	**5 929**	**1,44**
18 Wearing apparel; furs	**3 973**	641	2 095	14	974	**7 698**	**1,94**
19 Leather and leather products	**2 060**	361	849	9	382	**3 661**	**1,78**
20 Wood and products of wood	**9 567**	989	286	129	227	**11 197**	**1,17**
21 Pulp, paper and paper products	**7 954**	774	190	124	128	**9 170**	**1,15**
22 Printed matter and recorded media	**7 291**	650	944	9	415	**9 310**	**1,28**
23 Coke, refined petroleum products	**8 246**	1 844	716	233	4 959	**15 999**	**1,94**
24 Chemicals, chemical products	**21 199**	3 832	1 610	183	1 104	**27 927**	**1,32**
25 Rubber and plastic products	**9 106**	1 063	334	51	198	**10 753**	**1,18**
26 Other non-metallic mineral products	**7 724**	914	243	219	154	**9 254**	**1,20**
27 Basic metals	**23 146**	1 360	2	287	25	**24 820**	**1,07**
28 Fabricated metal products	**17 142**	1 660	240	74	199	**19 316**	**1,13**
29 Machinery and equipment n.e.c.	**32 880**	3 506	593	168	439	**37 587**	**1,14**
30 Office machinery and computers	**2 841**	674	237	6	194	**3 954**	**1,39**
31 Electrical machinery and apparatus	**13 306**	784	258	38	155	**14 541**	**1,09**
32 Radio, TV and communication equipment	**8 778**	617	365	35	293	**10 089**	**1,15**
33 Med., precision, opt. instruments; watches, clocks	**6 202**	1 354	555	22	482	**8 616**	**1,39**
34 Motor vehicles, trailers and semi-trailers	**28 216**	1 656	712	123	1 177	**31 885**	**1,13**
35 Other transport equipment	**10 059**	37	110	9	164	**10 378**	**1,03**
36 Furniture; other manufactured goods n.e.c.	**8 764**	960	2 149	26	1 026	**12 925**	**1,47**

Source: Statistik Austria, Input-Output Tabelle 2007, own calculations

In 15 of the 28 selected product groups total supply at purchasers’ prices is at least 25% higher than total supply at basic prices. In the case of *Tobacco products* (CPA 16) supply at purchasers’ prices is almost six times the one at basic prices.

The relative importance differs considerably by type of margins and taxes on the one hand and by products on the other hand. Wholesale trade margins play a certain role for almost all products, with shares around 10%. High shares of retail trade margins (more than 20%) are concentrated on few product groups such as *Wearing apparel* (CPA 18), *Leather and leather products* (CPA 19) and *Furniture; other manufactured goods n.e.c*. (CPA 36). Remarkable retail trade margins (also in absolute terms) of more than 10% can also be observed for

[6] Table 1 corresponds to Table 4.13 of the EUROSTAT Manual (EUROSTAT 2008) showing the total supply at basic prices and the transformation into purchasers’ prices.

Products of agriculture (CPA 01) and *Food products and beverages* (CPA 15). A high share of transportation margins is only given for *Other mining and quarrying products* (CPA 14). The highest shares of product taxes are those on *Tobacco products* (CPA 16) and *Coke, refined petroleum products* (CPA 23).

The first conclusion that might be drawn from Table 1 is that the orders of magnitude are big enough to pay some attention to the problem. The second conclusion is that the shares of the different margins, taxes and subsidies are quite different by products. Therefore it seems necessary to go into some details and to add the "use dimension" which is not present in Table 1.

The following empirical part of the paper will concentrate on the different layers of valuation (use-side) matrices which bridge between valuation at purchasers' prices and valuation at basic prices. It will be shown that the "distance" between these two concepts differs significantly in the various parts of the system. The various layers (trade margins, transport margins, commodity taxes, commodity subsidies) are also of quite distinct relevance by industries and commodities. Because the various layers are in a different way rooted in direct observations the "model content" and thus the cognitive character of the elements of a use matrix at basic prices is not equally distributed.

2.2 Overall distance of the use table at basic prices from the use table at purchasers' prices

There are many options to describe the distance between these two tables and to arrive at some summary statistics. For the following presentations a very simple approach was chosen: The calculation of shares – element by element – and the calculation of arithmetic means and simple measures of distribution on the basis of these element-specific shares.

The calculations were carried out for intermediate demand and for final demand. All products referring to trade and transport services (CPA 50, 51, 52, 60, 61, 62, 63 and 66) were excluded from the computations.

Table 2	**Shares of the entries at basic prices in the corresponding entries at purchasers' prices excluding trade and transport services**						
	Intermediate				**Final demand**		
	All entries	**Tangible**	**Others**		**All entries**	**Tangible**	**Others**
Arithmetic mean	**0,889**	**0,811**	**0,984**		**0,886**	**0,838**	**0,975**
Standard deviation	**0,120**	**0,107**	**0,036**		**0,185**	**0,174**	**0,173**
Coefficient of variation	**0,134**	**0,132**	**0,037**		**0,209**	**0,207**	**0,177**
Source: Statistik Austria, Input-Output Tabelle 2007, own calculations							

As might be seen from Table 2 on the average the overall distance is only 11%, but there is a considerable variation around the mean. The distance for tangible products is considerably higher than the one for services ("Others") which are not subject to trade and transport margins. It is also remarkable that the coefficients of variation for the final demand part are much higher than the ones for the intermediate part of the table.

As regards the overall distance the empirical exercise suggests to distinguish four sub-quadrants:

- Intermediate deliveries – tangibles
- Intermediate deliveries – services
- Final demand – tangibles
- Final demand – services

Table 1 already showed that the shares of the different margins, taxes and subsidies are quite different by products. The following sub-chapters are devoted to the contribution of the various layers to the overall distance.

2.3 First layer: Wholesale trade margins

Talking about orders of magnitude the use side matrices of wholesale trade are the most relevant ones of all the valuation matrices. Their contribution to the overall distance between basic prices and purchasers' prices exceeds 50% both as regards intermediate deliveries and deliveries to final demand.

Table 3	**Shares of the wholesale trade margins in the corresponding entries at purchasers' prices excluding trade and transport services**						
	Intermediate				**Final demand**		
	All entries	**Tangible**	**Others**		**All entries**	**Tangible**	**Others**
Arithmetic mean	**0,070**	**0,129**	**0,000**		**0,058**	**0,091**	**0,000**
Standard deviation	**0,084**	**0,074**	**0,000**		**0,079**	**0,083**	**0,000**
Coefficient of variation	**1,203**	**0,579**			**1,360**	**0,911**	
Source: Statistik Austria, Input-Output Tabelle 2007, own calculations							

As might be seen from Table 3 the share of wholesale trade margins in purchasers' prices is quite high and around 13% for intermediate deliveries and 9% for deliveries to final demand. The variation around the mean is quite remarkable and ranges from shares of 0% to close to 30% in the case of intermediate deliveries of tangible goods. Since whole sale trade margins are only given for tangibles the coefficients of variation are much higher if calculated for all entries than in the case of the calculation for tangibles only.

Estimating use side matrices of trade margins is an arduous task. Not even the vector of trade margins by products (as shown in Table 2) is directly observable. What has a direct counterpart in the world of observable phenomena are trade margins by industry, the amount of trade margins produced by an industry being defined as the difference between the trading sales and the costs of goods purchased for resale adjusted by changes in stocks.

The fact that in particular whole sale trade margins are not only produced by the trade industries but also to a remarkable extent by other industries as a secondary activity makes the estimation process even more demanding. In 2007 in Austria about 14% of total wholesale trade margins were produced by units classified in manufacturing.

In principle use side trade margins can either be estimated in a bottom-up or in a top-down way. Even if some information on specific product margin ratios is available on which a bottom-up approach might be based it is unavoidable to estimate control totals of wholesale trade margins by products.

In its chapter 6.3 and in Figure 6.2 the EUROSTAT Manual (EUROSTAT 2008) describes in detail what might be seen as the standard approach of arriving at use side trade margins. The major steps are:

Starting from the supply side data the total trade margins **by industries** (usually available from sources like structural business statistics) needs to be transformed into data **by products**. In this transformation information on both the shares of the goods traded as well as the typical margin ratios of each product are needed. The shares of goods traded are sometimes available from trade turnover matrices, although the level of disaggregation of such matrices is often insufficient.

On the basis of trade turnover matrices, there are in principle two options to transform the data by industries to data by products: "We either can apply for each industry the average margin ratio of that specific industry to all the products traded or we can apply a specific product margin ratio to all trade turnover of that product irrespective of the industry. The first approach uses the idea of the industry technology and the second one that of the product technology" (EUROSTAT 2008, p. 177).

As soon as estimates of totals by products are available these totals have to be distributed along the row by users. For this purpose it would be necessary to have information on the distributive channels. In the standard case only for some elements and some users such empirical evidence is available. For all the other elements the distribution will have to rely on "plausible assumptions".

From this condensed description of the standard data generating process one can draw the following conclusions:

- The entries as they show up in tables of wholesale trade margins are also in principle only in exceptional cases "directly observable".
- They result from complex model calculations – some of them similar to the estimation of technology matrices from supply and use matrices.
- A considerable degree of uncertainty is involved in the estimation of margins by products as well as in the distribution among users.

The layer of wholesale trade margins is by far not as well rooted in observable economic phenomena as the use table at purchasers' prices.

2.4 Second layer: Retail trade margins

Table 4 shows that retail trade margins are not that relevant as whole sale trade margins as far as the overall order of magnitude is concerned. They are again limited to tangibles but – in contrast to whole sale trade margins – concentrated on deliveries to final demand.

The mean share of retail trade margins in general is considerable lower than the share of wholesale trade margins also with respect to deliveries to final demand; the coefficient of variation is much higher than in the case of wholesale trade margins.

Table 4	**Shares of the retail trade margins in the corresponding entries at purchasers' prices excluding trade and transport services**						
		Intermediate				**Final demand**	
	All entries	**Tangible**	**Others**		**All entries**	**Tangible**	**Others**
Arithmetic mean	**0,006**	**0,011**	**0,000**		**0,049**	**0,077**	**0,000**
Standard deviation	**0,020**	**0,025**	**0,000**		**0,104**	**0,121**	**0,000**
Coefficient of variation	**3,195**	**2,261**			**2,100**	**1,572**	
Source: Statistik Austria, Input-Output Tabelle 2007, own calculations							

In final demand the shares range from zero (such as for exports) to more than 30% for selected deliveries to Private consumption of households. In not less than nine product groups, such as *Textiles* (CPA 17), *Wearing apparel* (CPA 18), *Printed matter and recorded media* (CPA 22), just to mention a few, the shares exceed 30%

The method to estimate use side retail trade margins is more or less the same as in the case of whole sale trade margins. One difference which facilitates the compilation is that the retail trade margins are not to the same extent produced by other industries as a secondary activity. As regards the distribution of the margins by users the information situation is also better than for wholesale trade margins. The lower uncertainty about the distributive channel is one of the arguments why it is recommended to distinguish between wholesale and retail trade margins. It can be assumed that retail trade turnover is concentrated on certain types of buyers, on deliveries to private households and to small sized enterprises such as restaurants, small handicrafts. In this respect data on the size distribution of units in the various industries may help to allocate the margins.

Despite this somewhat more favourable information situation the general conclusions mentioned in the previous sub-chapter also hold for the layer of retail trade margins.

2.4 Third layer: Transport margins

As mentioned before the transport margins cover transport costs paid separately by the purchasers and which are included in the use of products at purchasers' prices but not in the basic prices of a manufacturers' output or in the trade margins of wholesale or retail traders.

Compared to the trade margins, the transport margins are of a much lower order of magnitude. Their share accounts for about 2% of the purchasers' price, the mean being almost the same for intermediate deliveries of tangibles as for deliveries to final demand.

Table 5	Shares of the transport margins in the corresponding entries at purchasers' prices excluding trade and transport services						
	Intermediate				Final demand		
	All entries	Tangible	Others		All entries	Tangible	Others
Arithmetic mean	0,010	0,019	0,000		0,012	0,019	0,000
Standard deviation	0,032	0,041	0,000		0,068	0,084	0,000
Coefficient of variation	3,137	2,217			5,466	4,337	
Source: Statistik Austria, Input-Output Tabelle 2007, own calculations							

The coefficients of variation are significantly higher than the ones calculated for trade margins. Especially in relative terms high transport margins are concentrated on a few products such as *Coal* (CPA 10) and *Mining and quarrying products* (CPA 14). Even for these products the relevance of transport margins is limited to few users of these products. As a consequence the table of transport margins shows many zero entries, on the other hand very high shares can be observed also in the case of very big transactions. One example of this kind is the input of crude oil in the refinery industry.

As described in Chapter 6.4 of the EUROSTAT Manual (EUROSTAT 2008) the calculation of the transport margins is a very complicated task, much more complex than the calculation of trade margins. The information situation usually is poor. To some extent the estimation of matrices by transport modes and the separate treatment of the services of forwarding agents and transport insurances might help to arrive at plausible results.

Despite the complexity of the situation of which the compilers are very well aware Statistical Offices like Statistics Austria are tempted to use rather simple methods to estimate transport margins (s. STATISTIK AUSTRIA 2010, Chapter 4.6.1.1.2), the main argument being that the relative importance of transport margins is rather limited.

Generally speaking the matrices of transport margins are based on a very weak database. The underlying information is much more instable over time than in the case of trade margins, in particular due the fact that the transport margins are based on the criterion of who pays for it.

As a consequence the layer of transport margins probably is the layer associated with the highest degree of uncertainty and the highest "model content". Descriptive petrology would classify such parts as soft rocks or even sediments.

2.5 Fourth layer: Taxes on products

According to the SNA 1993 and the ESA 1995 (EC 1996) three types of product taxes may be distinguished namely value-added-type taxes; taxes and duties on imports and taxes on products, except value added taxes and import taxes.

In use tables at purchasers' prices all taxes on the products have to be included, the exception being deductible taxes like value added tax on the products. For consumers and a number of industries there is no possibility to deduct value added tax. Under such circumstances value added tax has to be treated as a product tax.

Table 6	**Shares of the product taxes in the corresponding entries at purchasers' prices excluding trade and transport services**					
	Intermediate			**Final demand**		
	All entries	**Tangible**	**Others**	**All entries**	**Tangible**	**Others**
Arithmetic mean	**0,027**	**0,032**	**0,023**	**0,056**	**0,061**	**0,050**
Standard deviation	**0,061**	**0,075**	**0,045**	**0,109**	**0,095**	**0,126**
Coefficient of variation	**2,242**	**2,326**	**1,974**	**1,934**	**1,562**	**2,508**

Source: Statistik Austria, Input-Output Tabelle 2007, own calculations

The contribution of product taxes to the distance between purchasers' prices and basic prices is quite remarkable. In contrast to the margins both tangibles and services are affected. The relevance for final demand is more pronounced than for intermediate deliveries.

Again the variation is quite high. In the intermediate part most entries in the matrix of product taxes show values close to zero. The big entries are limited to very few products like *Refined petroleum products* (CPA 23), *Electrical energy, gas, steam and hot water* (CPA 40), *Insurance and pension funding services* (CPA 66) and to some extent to *Sewage and refuse disposal services* (CPA 90). On the other hand the intermediate part clearly shows the specific situation of industries[7] such as *Financial intermediation* (NACE 65), *Insurance and pension funding* (NACE 66), *Public administration and defence, compulsory social security* (NACE 75), *Education* (NACE 80), *Health and social work* (NACE 85) and *Activities of membership organizations* (NACE 91). Either all or the majority of units classified in these industries are not allowed to deduct value added tax.

In final demand generally speaking the tax burden is high the exception being exports because value added tax does not apply to exports. The share of product taxes in purchasers' value reaches 64,9% for tobacco products sold to households and 42,8% for refinery products delivered to private households.

[7] The classification by industries follows the European standard classification NACE Rev.1 (EEC 1990)

Estimating use side matrices for product taxes is by far not as complex as in the case of margins. The totals for the different product taxes can be derived from government revenues sources. In a second step they have to be adjusted to the concepts of national accounts. Minor problems and additional data requirement may arise from the fact that some taxes are collected in proportion to quantities, some in proportion to the value.

On the use side all the exceptions laid down in the respective tax legislation need to be taken into account. In particular for the industries exempted from value added tax, non-deductible value added tax needs be calculated both by industries and by products. This step has to be performed for intermediate consumption as well as for final demand, mainly capital formation.

Although also the compilation of product tax matrices includes some elements of estimation the results can be considered to belong to the category of solid rocks (in the terminology of descriptive petrology), especially compared to the margins.

2.6 Fifth layer: Subsidies on products

According national accounts standards subsidies on products are subsidies payable per unit of a good or service produced or imported. A subsidy on a product becomes payable when the good is produced, sold, or imported. The subsidy may be defined as a specific amount of money per unit of quantity of a good or service, or it may be calculated ad valorem as a specific percentage of the price per unit. A subsidy may also be calculated as the difference between a specified target price and the market price actually paid by the buyer.

Table 7	**Shares of the product subsidies in the corresponding entries at purchasers' prices excluding trade and transport services**						
	Intermediate				**Final demand**		
	All entries	**Tangible**	**Others**		**All entries**	**Tangible**	**Others**
Arithmetic mean	**-0,004**	**-0,001**	**-0,006**		**-0,007**	**-0,002**	**-0,013**
Standard deviation	**0,059**	**0,003**	**0,080**		**0,039**	**0,007**	**0,060**
Coefficient of variation	**-14,579**	**-2,593**	**-12,516**		**-6,046**	**-3,940**	**-4,528**
Source: Statistik Austria, Input-Output Tabelle 2007, own calculations							

As might be seen from Table 7, the shares of product subsidies in the entries at purchasers' prices are generally speaking rather low. They play an important role for some elements in final demand. They highest shares might be seen for *Land transport and transport via pipeline services* (CPA 60) provided to private and public consumers (more than 9%), *Water transport services* (CPA 61) for Private consumption of households and *Health and social work services* (CPA 85). In the case of health services delivered to Government consumption, the share almost reaches 30%. In the intermediate part products subsidies can be identified primarily for agricultural products, coal and for transport services.

The information situation for subsidies on products is similar to the one for taxes on products.

3. On the tectonics of use matrices by commodities

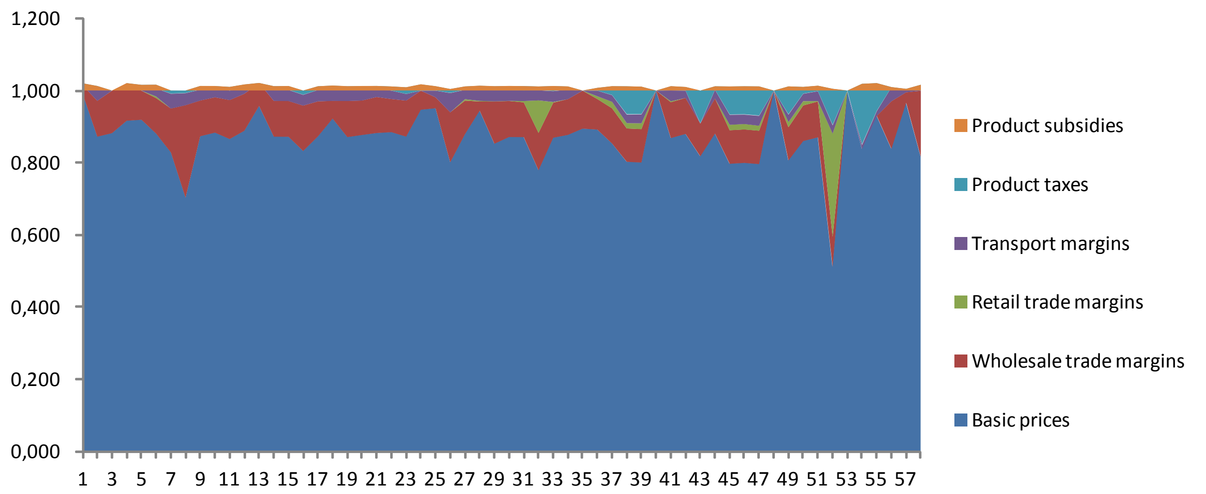
The distance between the use table at purchasers' prices and the use table at basic prices may be analysed along three dimensions: by layers, by industries and final demand categories and by products. The preceding pages provided some empirical evidence based on the input-output data set for Austria 2007 **by layers**. In the following paragraphs the tectonics of the data will be illustrated **by products**. This exercise will only be carried out for some selected products in order to demonstrate how different and multifaceted the situation is.

3.1 Products of agriculture (CPA 01)

Graph 1 shows the different size of the various layers in use of agricultural products both by intermediate users and in final demand. Total use of agricultural products at purchasers' prices was set to one.

It becomes immediately evident that the shares of the entries at basic prices (the goal of the decomposition of the entries at purchasers' prices) differ considerably across the row. What also can be seen is that the contributions of the various layers to this difference are by far not equally distributed. Whereas wholesale trade margins play a certain role for almost all the uses, retail trade margins are relevant only for the deliveries to hotels and restaurants and to Private consumption of households. Product taxes only show up for some industries (non-deductible value added tax) and for deliveries to domestic final demand.

Graph 1 **The situation by product groups: CPA 01 Products of agriculture**
Shares of the various layers in use at purchasers' prices



Source: Statistik Austria, Input-Output Tabelle 2007, own calculations

Table 8 summarizes the information on the product level by layers. In the same way as chosen for Tables 2 to 7 the table contains the arithmetic mean, the standard deviation and the coefficient of variation. The contribution of wholesale trade margins to the difference from basic prices to purchasers' prices is with almost 9% by far the most relevant one. The shares of transport margins and product taxes are of the same order of magnitude, the transport margins are however much more equally distributed across uses. The extremely high coefficient of variation for the retail trade margins is due to the fact that retail trade margins only affect to deliveries to restaurants and to private households and are zero for the majority of the entries in the row of the respective matrix.

Table 8 CPA 01 Products of agriculture — **Shares of the various layers in the corresponding entries at purchasers' prices**

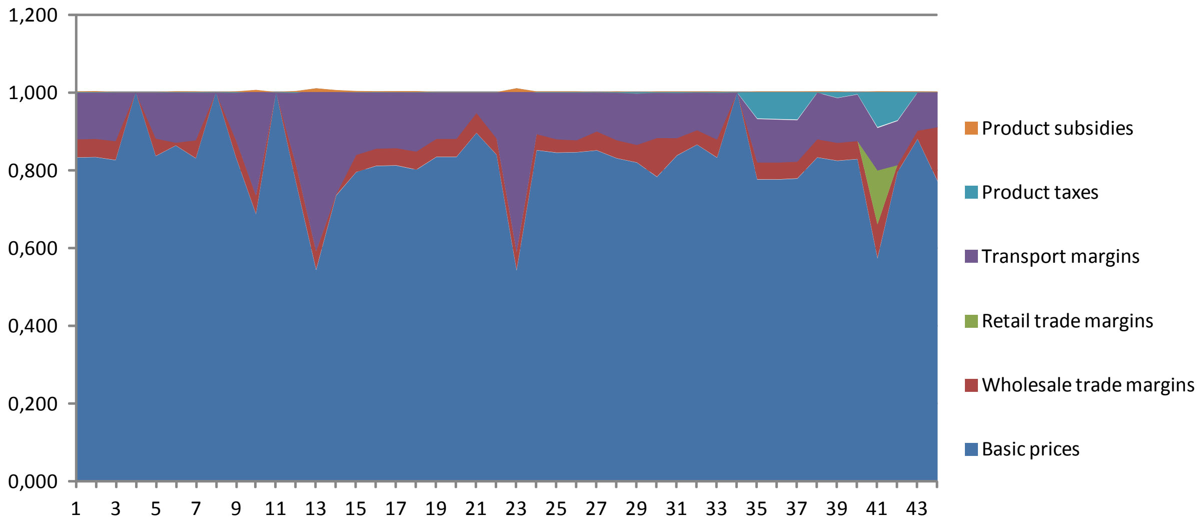
	Arithmetic mean	Standard deviation	Coefficient of variation
Basic prices	0,869	0,075	0,086
Wholesale trade margins	0,089	0,043	0,485
Retail trade margins	0,009	0,039	4,259
Transport margins	0,021	0,012	0,578
Product taxes	0,023	0,033	1,448
Product subsidies	-0,011	0,006	-0,530
Total	1,000	0,000	0,000

Source: Statistik Austria, Input-Output Tabelle 2007, own calculations

3.2 Products of other mining and quarrying (CPA 14)

Graph 2 shows a picture quite distinct from the one given in Graph 1. The distance from the entries at basic prices to the entries at purchasers' prices is more pronounced. The scenery is by far more mountainous. In particular the presence or absence of transport margins is responsible for the peaks and the deep valleys in landscape.

Graph 2 **The situation by product groups: CPA 14 Other mining and quarrying products**
Shares of the various layers in use at purchasers' prices



Source: Statistik Austria, Input-Output Tabelle 2007, own calculations

Table 9 complements the information included in Graph 2 by some numerical results. For this heavy product CPA 14 the contribution of transport margins to the difference from basic prices to purchasers' prices is with almost 13% the most important one. The second relevant layer covers the wholesale trade margins. Retail trade margins more or less only show up for Private consumption of households, which leads to the extremely high value of the coefficient of variation.

Table 9 CPA 14 Other mining and quarrying products — **Shares of the various layers in the corresponding entries at purchasers' prices**

	Arithmetic mean	Standard deviation	Coefficient of variation
Basic prices	0,816	0,096	0,117
Wholesale trade margins	0,043	0,025	0,573
Retail trade margins	0,003	0,021	6,557
Transport margins	0,129	0,081	0,631
Product taxes	0,011	0,024	2,266
Product subsidies	-0,002	0,002	-1,162
Total	1,000	0,000	0,000

Source: Statistik Austria, Input-Output Tabelle 2007, own calculations

3.3 Products of refined petroleum (CPA 23)

Graph 3 displays a scenery which is quite different from both the sceneries presented before. The distance from the entries at basic prices to the entries at purchasers' prices is even more pronounced than in Graph 2. The structure of the mountains shown seems to be quite similar from one end of the Graph to the other but there are some exceptions. The fact, that some industries such as in particular *Manufacture of chemicals and chemical products* (NACE 24), *Water transport* (NACE 61) and *Air transport* (NACE 62) are exempt from mineral oil tax can easily be seen from the graph. Some special regulations also exist for *Agriculture* (NACE 01).

Graph 3	The situation by product groups: CPA 23 Coke, refined petroleum products
	Shares of the various layers in use at purchasers' prices

Source: Statistik Austria, Input-Output Tabelle 2007, own calculations

Table 10 CPA 23 Coke, refined petroleum products — **Shares of the various layers in the corresponding entries at purchasers' prices**

	Arithmetic mean	Standard deviation	Coefficient of variation
Basic prices	0,510	0,102	0,201
Wholesale trade margins	0,142	0,030	0,213
Retail trade margins	0,019	0,012	0,630
Transport margins	0,017	0,003	0,196
Product taxes	0,313	0,094	0,300
Product subsidies	-0,001	0,000	-0,311
Total	1,000	0,000	0,000

Source: Statistik Austria, Input-Output Tabelle 2007, own calculations

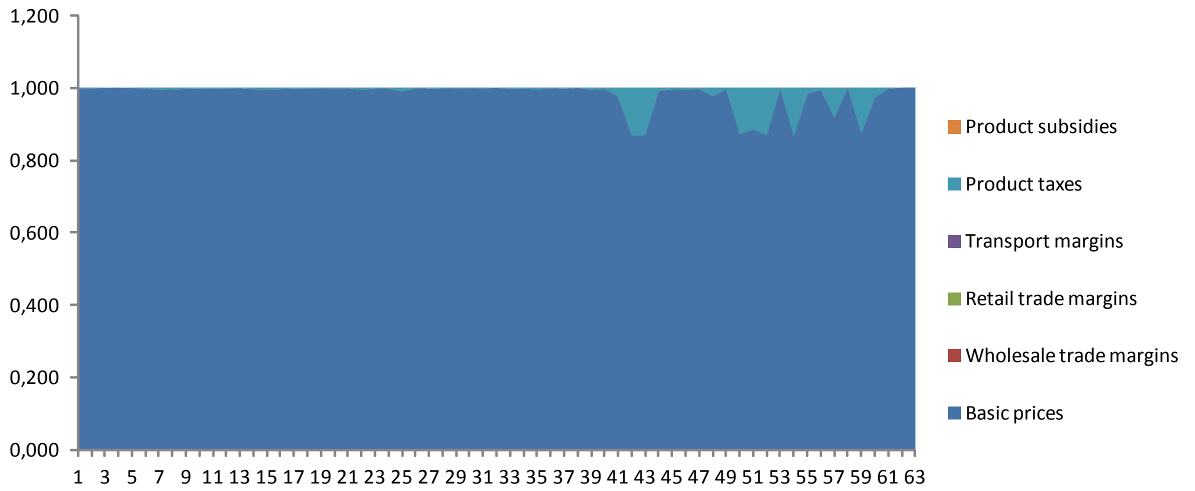
On the average the share of the use of refined petroleum products (coke plays a very minor role in Austria) at basic prices in the use at purchasers' prices is only about 50%. In the case of the use of petroleum products by private households the share is even below 40%!

Product taxes provide be far the biggest contribution to this remarkable distance. Wholesale trade margins are also quite remarkable. It is worthwhile mentioning that the coefficients of variation are rather of moderate size compared to the ones shown in Tables 8 and 9. The exceptions with respect to mineral oil tax which are to some extent responsible for the variation of the share of product taxes were already mentioned. The second factor which contributes to the relatively high variation in the case of product taxes can be ascribed to the fact that value added tax on top of mineral oil tax has only to be paid by some industries and by households.

3.4 Other business services (CPA 74)

The situation for typical services like business services is very different from the one of tangible products. The small distance between the use at basic prices to the use at purchasers' prices is nearly exclusively caused by product taxes, in this case value added tax.

Graph 4 The situation by product groups: CPA 74 Other business services
Shares of the various layers in use at purchasers' prices



Source: Statistik Austria, Input-Output Tabelle 2007, own calculations

Table 11 CPA 74 Other business services — **Shares of the various layers in the corresponding entries at purchasers' prices**

	Arithmetic mean	Standard deviation	Coefficient of variation
Basic prices	0,980	0,040	0,041
Wholesale trade margins	0,000	0,000	0,000
Retail trade margins	0,000	0,000	0,000
Transport margins	0,000	0,000	0,000
Product taxes	0,020	0,040	2,031
Product subsidies	0,000	0,000	-0,477
Total	1,000	0,000	0,000

Source: Statistik Austria, Input-Output Tabelle 2007, own calculations

4. Summary of the empirical findings

The empirical analysis of the tectonics of the Austrian use table revealed a number of characteristics of the use table at basic prices.

The distance of the various elements in the table at basic prices to the table at purchasers' prices is very different. The distance ranges from 0% to more than 60%.

The distance is lower for services compared to tangible products. The situation in the intermediate part of the use table is different from the situation in final demand.

The valuation matrices distinguished contribute in a very different extent to the distance between the valuation concepts. Significant differences exist by layers as well as by products and by industries. As a consequence the relation between these two matrices is a very complex one.

The various layers are in a very dissimilar way rooted in direct statistical observations. As a consequence the layers are characterized by a different degree of uncertainty and different "model content".

The pronounced differences in the distance to the underlying use table at purchasers' prices and the different element-specific shares of the layers result in implications for the cognitive character of the various elements of the use table at basic prices. In a simplified way one could argue: The bigger the difference and the higher the share of margins, the weaker the direct relationship to non-ambiguous information.

The last statement should not be seen as an argument to call the step from purchasers' prices to basic prices into question. On the contrary, the big differences in the distances between basic prices and purchasers' prices across the various product accounts underline the necessity to decompose purchasers' prices into components in order to arrive at a homogeneous valuation at basic prices.

Unavoidable the resulting use table at basic prices has the characteristics of a conglomerate consisting of some elements taken from the box of "facts" and many elements taken from the box labelled "models". The big box labelled "models" has a number of sub-divisions and the elements in the sub-boxes differ significantly with respect to their empirical foundation.

As already mentioned in the introduction the empirical material presented refers to the situation in Austria 2007 only. On the other hand one can assume that the general findings are also valid for other reference years and other industrialized countries. Similar exercises on the tectonics will probably yield similar general findings.

In some cases the picture will perhaps be less multifaceted. The complexity of the relationship between the two sets of use matrices cannot be interpreted as a deficiency of the Austrian data. It rather indicates the high empirical quality of the data set which was analyzed. It reflects the fact that the compilation was done on a very detailed level and that a lot of additional empirical material was used. It is evident from the analysis that simple (and very popular) assumptions like across-the-row distributions (allocations on a pro-rata basis) were only used in what might be called emergency cases.

5. Concluding remarks

The step from use tables at purchasers' prices to use tables at basic prices is associated with the necessity to rely on modeling because the required information such as margins by products in a breakdown by users cannot be directly observed.

The use table at basic prices has to be interpreted as a major step towards the conversion to an analytical input-output table. Intermediate and final uses calculated at basic prices are one step further removed from basic statistics and actual observations (EUROSTAT 2008, 11.2.1).

As has been shown in the empirical analysis this step leads to a rather inhomogeneous data set as far as the direct link to observations is concerned. Some elements are still close to the original data, some elements are quite far away. As a consequence the uncertainty differs from element to element.

Some users of input-output data who are not very familiar with the process of compiling the data might be surprised or even shocked by these findings. They should be aware that the step from purchasers' prices to basic prices is just one step in the long sequence of steps leading from basic observations to technology matrices.

As far as the sensitivity of the results with respect to the underlying modeling approaches are concerned it is probably not the most important step. The step from data on the enterprise level to data on the establishment level is probably at least as relevant, although it is (outside a Statistical Office) impossible to quantify the implications in a systematic way.

There is general agreement that the last step - the transformation of supply and use tables to symmetric input-output tables, to technology matrices - has to be based on technology assumptions and belongs to the category of "modeling". A large and well-known body of literature discusses the pros and cons of the various approaches.

There is also some evidence (e.g. RAINER, RICHTER 1992, PERTL, RICHTER 2009, STATISTIK AUSTRIA 2010) that the reliability of the results can be improved remarkably when some rearranging and adapting of the underlying supply and use table at basic prices is done before the transformation model is applied.

In the long sequence of steps which leads to technology matrices model assumptions are applied on top of data which already itself is based on (different) model assumptions. Any analysis based on the results of one of the intermediate steps or on the final technology matrix may to some extent mean nothing else than to reproduce what has already gone into the data generating process. The danger of "modeling on the basis of models" (see e.g. RICHTER 1994, HOLUB, TAPPEINER 1997) should be taken seriously.

The only way to avoid this danger is to pay much more attention to the data generating process and the nature of the data used. In this respect the situation has improved considerably in the last year.

On the one hand most of the standard textbooks still neglect the characteristics of the underlying data. They propagate the illusion that the underlying data is perfectly homogeneous and spread the view that to deal with "data problems" must be considered as a waste of time. This view is quite widespread among researchers because they suppose what is not present in textbooks is not worth dealing with.

On the other hand much more literature on the way input-output tables are compiled has become available. In this respect the EUROSTAT Manual of Supply, Use and Input-Output Tables (EUROSTAT 2008) must be considered as a milestone. It is easily accessible and nobody can argue that the compilation process must be considered as a black box.

In addition many Statistical Institutes publish detailed metadata on a regular basis. The description of the way the supply and use tables and the input-output tables are compiled in Austria (STATISTIK AUSTRIA 2010) can be seen as “best practice”. There is a growing awareness of the need to improve transparency, not only to get better insight into the compilation process but also to provide for a better and more transparent communication towards the users of statistical data (VAN DE VEN, VAN LEEUWEN 2004). Without access to metadata (both object data on the definitions and process data) it is impossible to use statistical data in a meaningful way.

Analysts have a much better chance now to avoid the critique formulated forty years ago "that in too many instances sophisticated statistical analysis is performed on a data set whose exact meaning and validity are unknown to the author" (LEONTIEF 1971, p 27).

The other lesson that might be learned from the available metadata is that the view that input-output analysis is (in principle) based exclusively on direct observations does not hold. The relationship between factual observations and the data base is not straightforward and rather complicated; on the other hand the sequence of steps can be understood and the nature of the modeling processes involved can be taken into account. To shed some light on the role of one of the major steps was the aim of this paper.

Input-ouput analysis has become an important tool for addressing many important economic problems. The statement by two pioneers of input-output analysis that “a science that purports to deal with the real world but that ignores its empirical and observational side is likely to appear a rather empty and unproductive discipline” (EVANS, HOFFENBERG 1955, p. 56) is still valid.

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