On Regionalising Input/Output Tables - Experiences from Compiling Regional Supply and Use Tables in Finland[1]

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Abstract. Regional input-output tables form a consistent and well-founded method for regional analysis. However, there is an increasing interest to construct regional I/O tables using supply and use (S/U) framework. This paper discusses the compilation of regional I/O tables for Finland using S/U approach. In the paper the methods applied in the regionalisation of the Finnish national S/U tables are discussed. It is argued that the best method typically depends on the available data and the paper gives possible solutions for the regionalisation of different items of S/U tables. One of the most important of them is regional trade-flows. In one-region I/O tables regional trade-flows are usually determined by mathematical solutions. In estimating interregional trade flows into the Finnish multiregional system, however, a separate survey-based trade-flow data was utilized. This, we believe, is likely to give a more accurate and open picture of the inter-regional trade.

Keywords: regional input-output, supply and use tables, regional trade-flows

1. INTRODUCTION

Regional input-output tables have traditionally been constructed from national industry-by-industry or commodity-by-commodity I/O tables. However, there is an increasing interest to compile regional I/O tables using national supply and use (S/U) tables rather than national I/O tables as a reference. This seems to be the case especially for multiregional systems where the regional I/O tables are compiled simultaneously for more than one region. Such multiregional tables based on S/U approach have been constructed e.g. in the Netherlands (Rijksuniversiteit Groningen/Central Bureau voor de Statistiek 1999, Eding et al. 1998), Denmark (Madsen and Jensen-Butler 1999, 1998) and Canada (Siddiqi and Salem 1995).

The idea in supply and use approach is basically the same as that used in constructing I/O tables in national accounts.[3] In this approach the supply and use tables of industry-by-commodity dimension are first constructed and balanced, and I/O tables are then derived from these. At the regional level, a third dimension – region – is needed.

In 1997 Statistics Finland started a project to compile a multiregional I/O system in Finland describing the year 1995. These I/O tables were decided to be compiled using supply and use approach. Since the multiregional system should also be able to describe the regional trade-flows (domestic imports and exports), it was decided that a separate

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[3] See e.g. Eurostat (1996, ch. 9) for this framework at the national level.

trade-flow survey should be carried out in order to have empirical evidence on interregional trade.

In the present paper an overview of the Finnish multiregional S/U system is given. We first introduce the regional S/U framework with two balancing identities. In section 3 the classifications used in the Finnish system are introduced. The main emphasis of the paper is, however, in discussing the methods that were used in the compilation process.[4] These are discussed in section 4, where also the estimation of regional exports and imports into the S/U framework is examined in the Finnish system. Especially, we will discuss the use of the separate trade-flow data collected particularly for this purpose. In section 5 we will draw some conclusions of the approach.

2. A Framework of Multiregional Supply and Use Tables

Supply and use tables are a statistical system which, at a national level, describe the domestic production processes and the transactions in products of the national economy in great detail. These tables show the structure of the costs of production and income generated in the production process, the flow of goods and services produced within the national economy, and the flows of goods and services with the rest of the world (De March & Beutel, 1998). At the regional level such tables represent the analogous system for a region with an addition that they show also the flows of goods and services with the rest of the country. In a system of multiregional supply and use tables each region is represented as a part of the national economy.

Regional supply table describes, in a given year, the total supply of products in the region and where they originated. In a simplified regional supply table total supply can be separated into three origins (see table 1). $\mathbf{V}^r$ describes the production of commodity *c* (*c* = 1,...,k) by industry *j* (*j* = 1,...,m) resident in region *r*. This is often called a make matrix. Vector $\mathbf{M}^r$ on the right of the make matrix denotes the foreign imports of the commodities *c* to region *r*, while $\mathbf{T}^{\bullet r}$ represents imports of commodities *c* to region *r* from other regions of the country. Total supply of the commodity *c* in the region, $\mathbf{q}^r$, equals supply from resident producers plus imports from abroad and from other regions. The total output by industries in the region is $(\mathbf{g}')^r$.

Table 1. *Simplified Regional Supply Table.*

Region r	Industries	Abroad	Other regions	Total
Products	$\mathbf{V}^r$	$\mathbf{M}^r$	$\mathbf{T}^{\bullet r}$	$\mathbf{q}^r$
Total	$(\mathbf{g}')^r$			

Regional use table, on the other hand, describes the total use (demand) of commodities for the region used in different purposes in a given year. This total use can be separated into the following parts (see table 2). Matrix $\mathbf{U}^r$ describes the use of commodity *c* by industry *j* located in region *r* (intermediate consumption). Matrix $\mathbf{F}^r$ represents the use of commodities by final demand categories *f* (*f* = 1,...,t) in the region. Exports from the region are divided into exports of commodities abroad, $\mathbf{X}^r$, on the one hand, and exports of commodities to other regions in the country, $\mathbf{T}^{r\bullet}$, on the other. Total demand by commodities equals $\mathbf{q}^r$. Matrix $\mathbf{W}^r$ describes the use of primary inputs *h* (*h* = 1,...,p) by

[4] We will not go into details of describing the various data that were used in the compilation process. An overview of these can be found e.g. in Piispala (1998, 1999).

industries in the region (value-added). Total use of inputs (intermediary and primary) is given by vector $\mathbf{(g')}^{r}$.

Table 2. *Simplified Regional Use Table.*

Region r	Industries	Final Demand	Abroad	Other regions	Total
Products	$\mathbf{U}^{r}$	$\mathbf{F}^{r}$	$\mathbf{X}^{r}$	$\mathbf{T}^{r\bullet}$	$\mathbf{q}^{r}$
Primary Inputs	$\mathbf{W}^{r}$				
Total	$\mathbf{(g')}^{r}$				

A system of supply and use tables is balanced, meaning that the supply and the demand sides are equal. This equality is translated into two identities. First, the industry identity states that total regional output by industries equals total regional use of inputs by industries, or

(1) $\mathbf{V}^{r}{}_{j} = \mathbf{U}^{r}{}_{j} + \mathbf{W}^{r}{}_{j}.$

The second identity is the commodity identity. According to it, in a given region, total supply by commodities equals total use by commodities,[5] or

(2) $\mathbf{V}^{r}{}_{c} + \mathbf{M}^{r}{}_{c} + \mathbf{T}^{\bullet r}{}_{c} = \mathbf{U}^{r}{}_{c} + \mathbf{F}^{r}{}_{c} + \mathbf{X}^{r}{}_{c} + \mathbf{T}^{r\bullet}{}_{c}.$

These two identities guarantee that the system is balanced and consistent for each region. Since in a multiregional system these identities must hold for all regions simultaneously, the balancing of the whole system is a complicated task, as one may imagine.

3. CLASSIFICATIONS AND THE DETAIL OF COMPILATION

Multiregional S/U system is a three-dimensional system where classifications are needed for industries, commodities and regions. These classifications determine the level of detail at which the S/U tables are compiled.

In constructing regional S/U tables for Finland, the economy was divided into some 90 industries. This is the 'working level'. Industry classification was mainly based on TOL95, which is the Finnish version of the European NACE, Rev.1 industry classification.[6] The industries were formed mainly at the NACE 2-digit level, but in certain cases a more disaggregated level was chosen. All in all, the division of industries was largely dependent on the industry classification used in the national accounts and S/U tables at the national level. Both of these statistics use TOL95 as a basis for classification of industries.

[5] In fact, this equality requires that both tables have the same valuation, for example that they are valued in basic prices. If the supply table is valued at basic prices and the use table valued in purchasers' prices, then a matrix of trade and transportation margins and commodity taxes and subsidies by commodities must be added to the supply table or deduced from the use table to have similar valuation. In connection of commodity identity we assume the same valuation for both tables in what follows, unless otherwise mentioned.

[6] European classification of economic activities, NACE, is an acronym for *Nomenclature Générale des Activités Economiques dans les Communautés Européennes*. TOL95, on the other hand, is an acronym for *Toimialaluokitus 1995*.

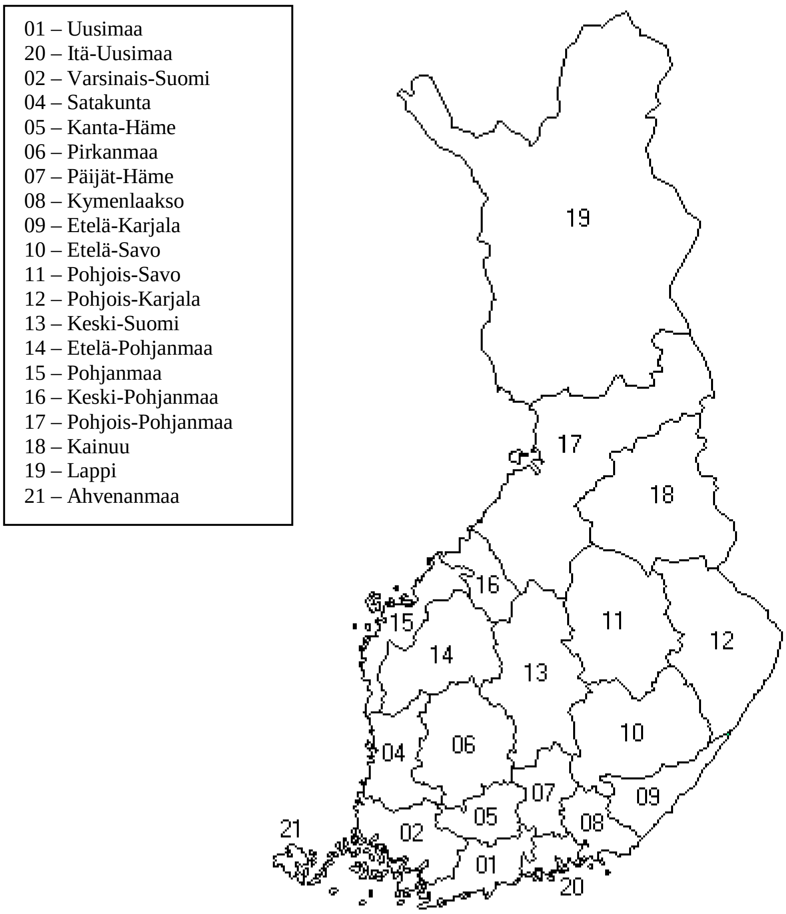
In the use table, final demand was divided into household consumption; consumption of NPISHs (non-profit institutions serving households); government consumption (separated to general government, local government, and social security funds); gross fixed capital formation; and changes in inventories. In the regional supply tables imports were divided into foreign and domestic imports. Likewise, each region's use table records both foreign and domestic exports, as well as value-added by industries.

The commodity classification follows closely CPA.[7] It is uniform with NACE, and thus with TOL95, up to 4-digit level. The commodity groups were formed typically at the 3-digit level of CPA, but some exceptions were made due to the industry classification used. All in all some 200 product-groups were used at a working level. Of course, not necessarily all commodities are produced domestically, but some are only imported to Finland.

Regional S/U tables were constructed at the level of 20 Finnish provinces (see Figure 1). These form the NUTS-3 level in Finland. All in all, the S/U tables were compiled at a very detailed level and they give an in-depth picture of the economic structures in all 20 Finnish provinces for the year 1995.

The tables are published with two different aggregation levels. The more aggregated version records S/U tables for all 20 regions at the level of 8 industries and 15 commodity groups. In a more detailed version, 37 industries and 44 commodity groups are available for each region.

Figure 1. *NUTS-3 Regions in Finland.*



[7] CPA stands for *Statistical Classification of Products by Activity in the European Community.*

4. METHODS FOR REGIONALISATION

4.1. Overview of the Compilation Process

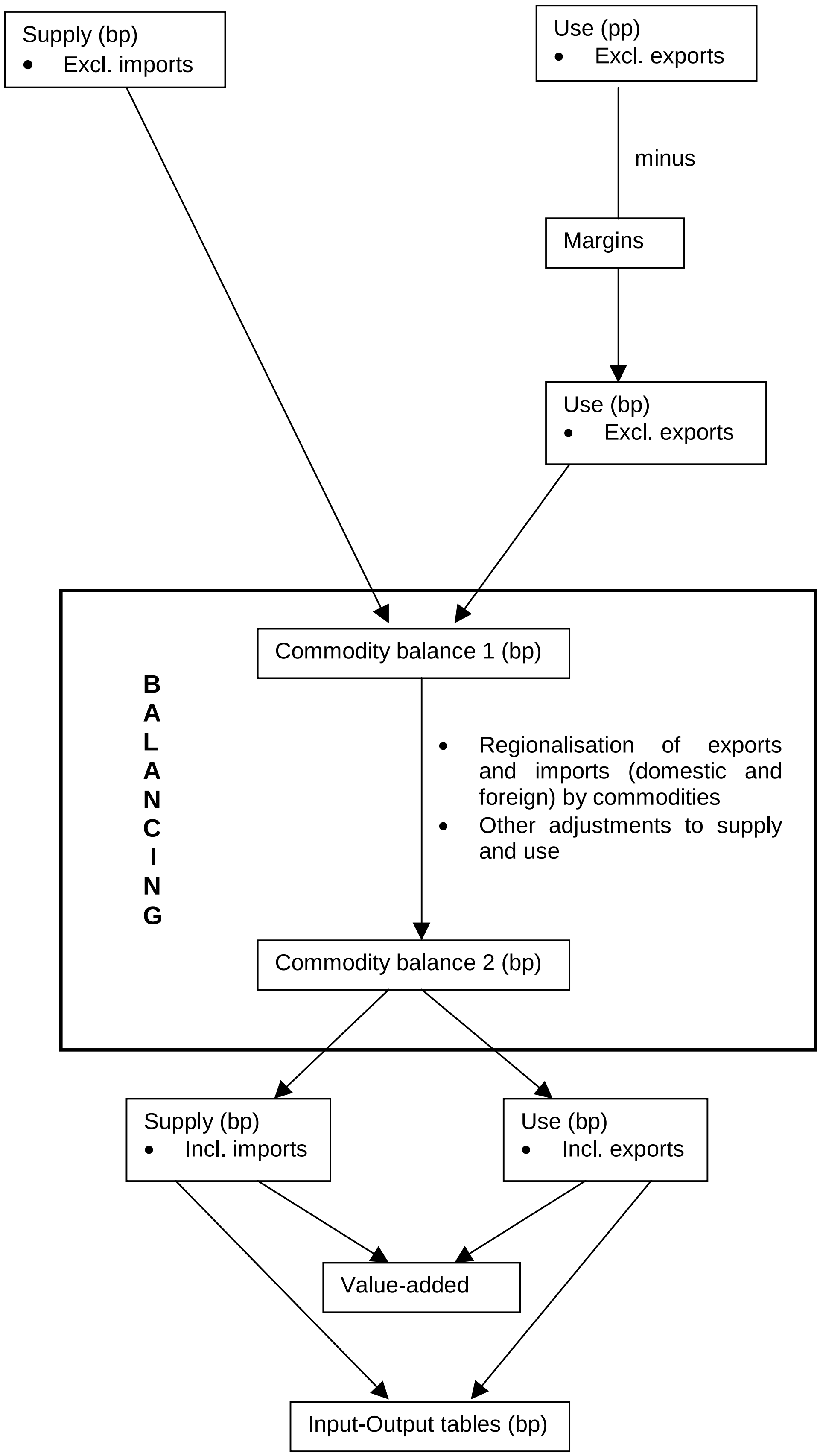
Figure 2 on the next page shows how the compilation of multiregional S/U tables was, in principle, carried out. The starting point was national make and intermediate use matrices (**V** and **U**) as well as national final demand matrix (**F**). These were regionalised at the industry level and final-demand category level. Since the regionalised make matrix was valued at basic prices and intermediate use and final demand matrices were valued at purchasers' prices, the next step was to regionalise the matrices of trade, transport and other margins and to assign these margins to different industries or final demand categories and commodities in use. At this stage, exports and imports (both domestic and foreign) were not yet regionalised.

Subtracting the matrix of margins from the use table (intermediate and final demand) valued at purchasers' prices yields a corresponding use table in basic prices. Since we now have both supply and use – except for exports and imports which were not yet regionalised – valued in same prices, the next step was to form commodity balances. These show the difference between total supply from resident industries ($\mathbf{V}^r$) and total use ($\mathbf{U}^r + \mathbf{F}^r$) by resident units for each commodity.

In the balancing process, foreign and domestic exports and imports by commodities are included in the commodity balance (see eq. (2)). For most of the commodities this was done so that we first estimated domestic and foreign exports (use side) as well as domestic imports (supply side) using primarily a separate trade-flow survey data. After that foreign imports were regionalised as a 'residual' so that the commodity identities hold. Since this survey-data does not contain information on trade-flows for all commodities, more non-survey-like methods were used for these, as will be discussed in section 4.4 of the paper. After these trade-flows were estimated for all commodities, this concluded the balancing process and the outcome was fully regionalised supply and use tables in basic prices for each 20 regions completed simultaneously.

The final step in the compilation process was to form industry-by-industry I/O tables using common methods and assumptions. This step is not, however, discussed in this paper.

Figure 2. *Compilation of multiregional I/O system in Finland. (bp=basic prices, pp=purchasers' prices)*



4.2. Methods for Regionalising Make, Intermediate Use and Final Consumption Matrices

The method to be used in regionalising national tables is mainly dependent on the data available. In some cases regional data is scarce and, therefore, the regionalisation might rely only on some indicator of regional activity. If, however, data at the regional level is more detailed, more sophisticated methods can be used, as well. This, of course, is likely to improve the quality of the tables and give more accurate picture of the regional industry structures.

In our case we were able to use detailed data in several instances. Therefore, the methods to regionalise national tables were also more advanced. In the following we describe the methods used in constructing regional S/U tables for Finland. These methods are divided into two which we call *simple* and *advanced* methods. The exposition deals with the regionalisation of intermediate use matrix **U** but can be generalized for other matrices as well. In our case, similar methods were used especially for make matrix **V** and final consumption matrix **F**.

First, let us denote u_{cj} an element of national intermediate use matrix, or simply use matrix, **U**. This element describes the use of commodity c by industry j expressed in monetary terms. Respective element for regional use table $\mathbf{U^r}$ is denoted as u^r_{cj} which describes the use of commodity c in industry j resident in region r.

The total use of inputs of industry j at the national table is then given by

(3) $$U_j = \sum_{c=1}^{k} u_{cj} .$$

Likewise, the total use of inputs of industry j at the regional level is

(4) $$U_j^r = \sum_{c=1}^{k} u_{cj}^r .$$

Total input use of industry j is also equal to the sum of input-use by regions, or

(5) $$U_j = \sum_{r=1}^{s} U_j^r = \sum_{r=1}^{s} \sum_{c=1}^{k} u_{cj}^r$$

using (4).

The problem in regionalising national intermediate use table is how we estimate each element u^r_{cj}. The regionalisation can be done either in the commodity dimension (row-wise) or in the industry dimension (columnwise) or both. The data available usually favors the industry dimension. This was the case also in Finland. However, in certain cases we had also commodity level data available, in which case this was used.

Simple or Indicator Method

The simplest way of deriving each u^r_{cj} is to assume that the input structures of industry j are similar in every region and correspond to national structure. In that case,

(6) $$\frac{u_{cj}^r}{U_j^r} = \frac{u_{cj}}{U_j} \; \forall \, r .$$

This implies that the share of input c is equal to total input use of industry j irrespective where the industry is located. This is seldom the case in reality, however, at least when the number of industries under regionalisation is small.

Equation (6) implies

$$(7)\qquad u_{cj}^{r} = \frac{u_{cj}}{U_{j}} \times U_{j}^{r}$$

and the problem is then how we get each U^r_j, the total input use of industry j in region r. This may be estimated using some indicator of economic activity to divide national input-use level of j into regions. This might be e.g. the salaries paid in industry j. In that case the indicator is defined as

$$(8)\qquad \varepsilon_{j}^{r} = \frac{e_{j}^{r}}{e_{j}}$$

or the share of wages in region r, e^r_j, to the wages paid at the national level in the corresponding industry, e_j. With this indicator of percentage number we can estimate regional input use in industry j as

$$(9)\qquad U_{j}^{r} = \varepsilon_{j}^{r} U_{j} \ .$$

However, as we are assuming national average input structures for each region, this same indicator can be applied directly to each element of use matrix

$$(10)\qquad u_{cj}^{r} = \frac{u_{cj}}{U_{j}} \times \varepsilon_{j}^{r} U_{j} = \varepsilon_{j}^{r} u_{cj}$$

using (7) and (9).[8]

In regionalising Finnish S/U tables this method was used only when the data did not permit other methods. These industries were typically only marginal.

Advanced Method

In an advanced method one regionalises each u^r_{cj} not starting from national levels, but starting from some micro-level data and only in the final step reaches national level. While the simple method is purely top-down, the advanced method is more of bottom-up nature.

For the advanced method one needs company/establishment level data with at least some information on the input structures of these units and their location. Let us assume that we have data available which records for each establishment its total use of inputs, and that the total input use is further divided into different inputs or input categories, like materials, services, rents etc. Let a^r_{uj} be the total input use of establishment u in industry j resident in region r. This input use is divided into commodities b^r_{ucj} so that

$$(11)\qquad a_{uj}^{r} = \sum_{c=1}^{k} b_{ucj}^{r} \ .$$

Summing this over each unit would result in input structures for each region and industry

$$(12)\qquad U_{j}^{r} = a_{j}^{r} = \sum_{c=1}^{k} b_{cj}^{r} = \sum_{c=1}^{k} u_{cj}^{r} \ .$$

[8] Jackson (1998) uses this method in regionalising the US S/U tables.

This would be a pure bottom-up method. However, since we are using national S/U tables as a reference, nothing quarantees that we end up with national levels when we sum (12) over regions. This is true since both total input levels *and* the level of each input must sum to national levels. Therefore, some sorts of adjustments are necessary. In our case we solved u^r_{cj} consistent with national table in three steps as discussed below.

Step 1. Total regional industry input use levels

In the first stage we regionalised total industry input use levels as

$$(13) \qquad U_j^r = \frac{a_j^r}{a_j} \times U_j$$

using national input-use levels as a reference. In (13) $a_j = \sum_{r=1}^{s} a_j^r$. Equation (13) is similar to (9) with (8) and actually we use an indicator method to get U^r_j in (13). However, now we have a more 'accurate' indicator in use. In the latter steps of the procedure, these regional levels were treated as fixed. By this we mean that these are the total input use levels for the relevant region and industry which are consistent with national totals.

Step 2. Regional industry input structures

From (13) we have now the total industry input use levels for each region. The next step is to divide these totals into different inputs, i.e. to determine the structure of intermediate consumption. This was calculated as

$$(14) \qquad \hat{u}_{cj}^r = \frac{b_{cj}^r}{b_{cj}} \times u_{cj} .$$

Again, for each input purchased by industry *j* in region *r*, its value is calculated using an 'accurate' indicator and the corresponding national level. Note that we use a hat (^) above *u* on the left-hand side. This is to denote it as an 'estimate' because when we sum each $\hat{u}_{cj}^r$ over commodities, we do not necessarily end up to U^r_j as calculated in (13).[9] Since we take the first-step regional industry input use levels as fixed, we must adjust each particular input estimate $\hat{u}_{cj}^r$. This is done using a RAS-like adjustment.

Step 3. RAS adjustment

In the RAS adjustment the estimates calculated with (14) are adjusted so that each regional industry input use level (U^r_j) from step 1 and national input use levels (u_{cj}) are met.[10] These estimates from (14) we call *first-round estimates* and denote as $(\hat{u}_{cj}^r)^1$. These are then modified with RAS to *n-round estimates*, where *n* is the number of RAS rounds.

To get the *second-round estimates* we first calculate two multipliers. The first we label $(\alpha^r_j)^1$ and it is calculated as

[9] Equation (14) quarantees that the national input use levels are met, however. Therefore, we have a contradiction only at the regional level.

[10] Note that U^r_js are consistent with, and add up to, national level U_j. Therefore, adjustments are done not only to meet regional levels of U^r_j but also national levels.

(15) $$(\alpha_j^r)^1 = \frac{U_j^r}{\sum_{c=1}^{k} (\hat{u}_{cj}^r)^1}$$

which shows how much the sum of first-round estimates deviate from the regional industry input use levels, one of our control totals. Typically $(\alpha^r_j)^1$s deviated from 1 and only seldom they were 1. This means that our first-round estimates are not final and some adjustments are needed.

Another multiplier shows how much the first-round estimates deviate from national input use levels, the other control total. This we label as $(\beta_{cj})^1$ and it is calculated as

(16) $$(\beta_{cj})^1 = \frac{u_{cj}}{\sum_{r=1}^{s} (\hat{u}_{cj}^r)^1} .$$

These were always 1, of course, as can be easily verified referring to (14).

Using these two multipliers and first-round estimates, the second-round estimates are calculated as

(17) $$(\hat{u}_{cj}^r)^2 = (\alpha_j^r)^1 \times (\beta_{cj})^1 \times (\hat{u}_{cj}^r)^1 .$$

When we now calculate the second-round multipliers corresponding to (15) and (16), i.e.

(18) $$(\alpha_j^r)^2 = \frac{U_j^r}{\sum_{c=1}^{k} (\hat{u}_{cj}^r)^2}$$

and

(19) $$(\beta_{cj})^2 = \frac{u_{cj}}{\sum_{r=1}^{s} (\hat{u}_{cj}^r)^2}$$

it should be noted that the α-multipliers are now 1 whereas the β-multipliers typically deviate from 1. This is because in the second round the first-round estimates $(\hat{u}_{cj}^r)^1$s were adjusted to be consistent with regional industry input use levels.[11]

The RAS step can be generalized so that the *n-round estimate* is equal to

(20) $$(\hat{u}_{cj}^r)^n = (\alpha_j^r)^{n-1} \times (\beta_{cj})^{n-1} \times (\hat{u}_{cj}^r)^{n-1} , n > 1$$

where

(21) $$(\alpha_j^r)^{n-1} = \frac{U_j^r}{\sum_{c=1}^{k} (\hat{u}_{cj}^r)^{n-1}}$$

and

[11] Every even-round αs equal 1, while every odd-round βs equal 1. Thus, every two rounds we adjust the previous-round estimates to national input use levels, and every other two rounds to regional industry input use levels.

(22) $$(\beta_{cj})^{n-1} = \frac{u_{cj}}{\sum_{r=1}^{s} (\hat{u}_{cj}^{r})^{n-1}} .$$

With this procedure the multipliers will eventually (as *n* increases) converge to 1 and so the first-round estimates will converge to certain levels. When both the multipliers equal one, both control totals $U^r{}_j$ and u_{cj} are met and the regionalised figures become fully consistent with national ones. This ends the RAS procedure.

Although the indicator method is straightforward to use and does not require detailed data, we propose using the advanced method whenever applicable. This is because in reality both the output and input structures of an industry are not likely to be similar across regions. Especially when the industry level of detail in national tables that are regionalised is small, the indicator method may lead to biased representations of industry structures. For example, in Finland in several industries the headquarters are concentrated in certain regions, especially in south of the country. The industry structures in those regions are certainly different compared to regions where only production units are located. For advanced method, however, one needs regional data at the commodity level for the industry. This may not be always available.

4.3. Margins

As figure 2 on page 6 shows, the regionalised national make matrix was valued at basic prices. On the other hand, the regionalised intermediate consumption and final demand matrices were valued at purchasers' prices. However, in order to fully exploit the commodity identity (2), it is important to have both supply and use valued similarly. This difference in valuation is recorded in different product margins and respective margin matrices. In particular, the purchasers' price of the commodity is equal to the basic price plus any margins (price components) that are included in the product as it passes from the producer to the user. These margins include trade margins, transportation margins, value-added tax, any other product taxes (incl. customs) and product subsidies. Then, for each input used in industry *j*, for instance, its value at basic prices is equal to

(23) $$(u_{cj})_{BP} = (u_{cj})_{PP} - \sum_{t=1}^{u} t_{cj}$$

where the last term on the RHS records the total amounts of different margins in this particular purpose.

In order to have the regionalised use table valued at basic prices, it is then necessary to subtract different margins from the purchasers'-prices valued use. Therefore, an identical equation for the regionalised use table at basic prices is

(24) $$(u_{cj}^{r})_{BP} = (u_{cj}^{r})_{PP} - \sum_{t=1}^{u} t_{cj}^{r}$$

where the $(u^r{}_{cj})_{PP}$ are calculated as shown in section 4.2.

The problem is now how different margins should be regionalised. In our case we resorted to a simple assumption that each margin in a particular purpose is divided into regions according to the region's share of the total use (at purchasers' prices) of that commodity in that purpose so that

(25) $$t_{cj}^{r} = \frac{(u_{cj}^{r})_{PP}}{(u_{cj})_{PP}} \times t_{cj} .$$

In this case, the regionalised use valued at basic prices (24) becomes

(26) $$(u_{cj}^r)_{BP} = (u_{cj}^r)_{PP} - \frac{(u_{cj}^r)_{PP}}{(u_{cj})_{PP}} \sum_{t=1}^{u} t_{cj} \ .$$

Expanding this results in

(27) $$(u_{cj}^r)_{BP} = \frac{(u_{cj}^r)_{PP}\left[(u_{cj})_{PP} - \sum t_{cj}\right]}{(u_{cj})_{PP}} = \frac{(u_{cj}^r)_{PP}}{(u_{cj})_{PP}} \times (u_{cj})_{BP}$$

which actually then implies that there are no disparities in the regions' shares in either valuation system. This, of course, is what we expect from assumption (25).

The assumption underlying (25) means that each margin is regionalised in this manner. It should be noted that this is a simplification of reality. In particular, transportation margins might differ considerably depending on where the commodity is used. If the commodity is consumed near where it was produced transportation margins are likely to be smaller compared to the case where the distance from the production site to the consuming site is long.[12] Also trade margins might differ between regions, depending among others on the intensity of rivalry.[13] On the other hand, tax rates (e.g. VAT) are more universal in any country, and regional disparities are not so evident.

4.4. Commodity Identity and the Estimation of Trade Flows

An important element in any regional I/O model is the inflows and outflows of goods and services. This is because regional I/O analysis typically concentrates on the consequences that some actions have in the region in question and how much of these consequences flow outside. Therefore, it is worth putting additional effort to estimating the trade-flows to the regional system.

In the regional S/U tables regional trade-flows are presented by commodities. These exports and imports appear only in the commodity identity (2), while in the industry identity (1) they do not show.

The commodity identity can be rewritten as

(28) $$\mathbf{V^r} - (\mathbf{U^r} + \mathbf{F^r}) = (\mathbf{X^r} + \mathbf{T^{r\bullet}}) - (\mathbf{M^r} + \mathbf{T^{\bullet r}})$$

where for the sake of simplifying presentation the sub-index *c* is dropped for the time-being. The terms in the LHS are the items that were by now regionalised, i.e. make table, intermediate use and final consumption. The terms in the RHS – regional exports and imports – are still unknown to us, and should be somehow estimated. There are basically two possibilities to calculate regional trade-flows to the system, non-survey and survey methods.

Since the data on regional trade flows is typically very scarce – at least at the commodity level – one must usually resort to non-survey techniques to model regional trade flows. Although foreign trade statistics record exports and imports typically at the commodity level, its regionalisation directly from these statistics is not possible since these exports and imports are recorded at nation's borders. The origin of exports and the final destination of imports are not necessarily available.

[12] The mode of transportation matters, as well.

[13] For example, it is quite common to see price rivalry amongst gas stations in certain regions of Finland every now and then. Other examples are easy to find, as well.

There are several non-survey methods to estimate regional trade flows, e.g. supply-demand pool and location quotients methods. Instead of presenting these in detail we only refer to literature (see e.g. Miller and Blair, 1985 ch. 9) on these. The common outcome of non-survey methods is, however, that no cross hauling is possible. This means that the region is either an exporter or an importer of a commodity, but cannot be both simultaneously. Therefore, these methods are considered to lead to underestimates of interregional trade (Harris and Liu 1998, Susiluoto 1996, 78-79).

As an example of a non-survey method in the S/U framework, Jackson (1998) uses a supply-demand pool method to estimate regional trade flows. In his study, foreign regional exports ($\mathbf{X^r}$) are first calculated and net imports ($\mathbf{N^r}$) are estimated using

(29) $$\mathbf{N^r} = (\mathbf{M^r} + \mathbf{T^{\bullet r}}) - \mathbf{T^{r\bullet}} = (\mathbf{U^r} + \mathbf{F^r} + \mathbf{X^r}) - \mathbf{V^r}.$$

If $\mathbf{N^r}$ is negative, this negative value is assigned to $\mathbf{T^{r\bullet}}$ and reversed in sign. Thus, the rationale behind this is that if the region has negative net imports of a commodity, then it must be an exporter of that commodity. But while the foreign exports are already determined, the remaining exports (i.e. negative net imports) must be exported to other regions in the country. In case that no additional information on regional trade-flows is available, the method fails to differentiate between foreign and rest-of-nation imports. Furthermore, no cross hauling takes place.

Survey methods are considered to be both time and money (resources) consuming. However, survey methods make it possible to have a more precise and realistic view of regional trade flows. In a survey method data relating to regional trade flows is used. For the Finnish multiregional I/O system a separate survey was carried out and the majority of trade flows were estimated using this data.

The Finnish Trade-Flow Survey and Estimations of Trade Flows into S/U Tables

The sample size of the survey was over 9600 establishments. These were asked the regional destination of their total sales, not separated by commodities, however.[14] All in all, 55 industries of the S/U system's total 90 were surveyed in this way. These industries were in manufacturing, construction and services. Thus, for instance agriculture and forestry, as well as certain service industries were not surveyed.

This data was supplemented with additional data – like goods transportation surveys, manufacturing statistics etc. – in the estimations. In the first phase, we estimated the foreign exports of industry j located in region r ($X^r{}_j$) and domestic exports of industry j from region r to region s ($T^{rs}{}_j$) for each region using the information available. Note that here $T^{rs}{}_j$ for all r and s ($r \neq s$) is the exports from r to s. Thus, an important aspect of our survey is that instead of estimating $\mathbf{T^{r\bullet}}$ as a column, $\mathbf{T^{r*}}$, (i.e. rest-of-nation exports) we estimated it as a matrix by regions, $\mathbf{T^{rs}}$, showing every region receiving exports from r. But, exports from r to s are imports of s from r. Thus, by knowing every origin-destination pair of domestic exports we actually know domestic imports, as well. Hence, the result of the estimations was estimates for foreign exports ($X^r{}_j$), domestic exports ($T^{rs}{}_j$) and domestic imports ($T^{sr}{}_j$) for each industry and region.[15]

When this data was exported into S/U framework, the industry-level results were first transformed into commodities based on certain assumptions. Namely, from the make tables we have the output by commodities for each industry and region. We assumed, however, that not necessarily all commodities that are produced by an industry are

[14] Thus, we did not receive information at the commodity level directly.

[15] See Statistics Finland (1999) for the main results and estimations of the data. Also, Kauppila (1999) describes the trade-flow survey in more detail.

exported. Secondly, we assumed that those commodities that are 'exportable', are exported in equal proportions.

To formalise this, v^r_{cj} describes the production of commodity *c* by industry *j* in region *r*. This we know from make table. Of this, according to our first assumption, only certain commodities may be exported. These we label as $\bar{v}^r_{cj}$. According to our second assumption, the foreign exports of commodity *c* produced by industry *j* in region *r* are

$$(30) \qquad X^r_{cj} = \frac{\bar{v}^r_{cj}}{\sum_{c=1}^{k} \bar{v}^r_{cj}} \times X^r_j$$

where $\sum_c \bar{v}^r_{cj}$ is the total output of 'exportable' commodities by industry *j* located in *r*. Then the total exports of commodity *c* from region *r* are

$$(31) \qquad X^r_c = \sum_{j=1}^{m} X^r_{cj} \, .$$

Total exports of commodity *c* must fulfil the condition where all regional exports add up to national level, i.e. $X_c = \sum_r X^r_c$.

Exports of commodity *c* to other regions in the country were calculated similarly so that exports of commodity *c* from region *r* to region *s* are

$$(32) \qquad T^{rs}_c = \sum_{j=1}^{m} T^{rs}_{cj}$$

where $T^{rs}_{cj} = \frac{\bar{v}^r_{cj}}{\sum_c \bar{v}^r_{cj}} \times T^{rs}_j$.

Total domestic exports of commodity *c* from region *r* are

$$(33) \qquad T^r_c = \sum_s T^{rs}_c \quad (s \neq r)$$

and total domestic imports of commodity *c* to region *s* are

$$(34) \qquad T^s_c = \sum_r T^{rs}_c \quad (s \neq r).$$

Thus, this data enabled us to calculate for each of these commodities their domestic exports and imports and foreign exports. Since we now know $\mathbf{X^r}$, $\mathbf{T^{r\bullet}}$ and $\mathbf{T^{\bullet r}}$ we have only $\mathbf{M^r}$ unknown in (28), so it can be estimated as a residual of

$$(35) \qquad \mathbf{M^r} = (\mathbf{U^r} + \mathbf{F^r} + \mathbf{X^r}) - \mathbf{V^r} + (\mathbf{T^{r\bullet}} - \mathbf{T^{\bullet r}}).$$

The advantages of our survey approach are as follows. First, we are able to estimate all four items of regional trade-flows. Second, a survey approach does not ignore cross hauling, but the region may simultaneously export and import any commodity. We strongly believe that these results are likely to give a more accurate and realistic view of the regional interdependencies.

Estimation of Trade-Flows for Other Commodities

The trade-flow survey covered majority of the commodities in our S/U tables meaning that for these we have accurate estimates concerning exports and imports. For other commodities, we used four different solutions.

I. Locally-demanded Commodities

For certain commodities (especially services) we made a very restrictive assumption that they are consumed only locally, i.e. no exports to or imports from other regions occur. Hence, all local production is assumed to be consumed locally. As an example of such commodities are hairdressing services and education services.

II. Supply-Demand Pool

A modification of supply-demand pool method was used e.g. to estimate the trade-flows of electricity. The method was as follows. For each region a balance

(36) $B^r_c = V^r_c - (U^r_c + F^r_c)$

shows the difference between local supply and local demand before exports and imports are taken into consideration. Using this balance information the national foreign exports (X_c) were first distributed among regions according to

(37) $$X_c^r = \frac{V_c^r + B_c^r}{\sum_r (V_c^r + B_c^r)} \times X_c \text{ where } B^r_c > 0.$$

Thus, foreign exports are affected by the magnitude of *positive* balance *and* the magnitude of supply. Hence, the larger is the positive balance or the larger is the local supply, the larger is the foreign exports.

In a similar manner the foreign imports were calculated, namely

(38) $$M_c^r = \frac{E_c^r + \left|B_c^r\right|}{\sum_r (E_c^r + \left|B_c^r\right|)} \times M_c \text{ where } B^r_c < 0$$

and $E^r_c = U^r_c + F^r_c$ or the local demand. Thus, the larger is the *absolute* negative balance or the larger is the local demand, the larger is the foreign imports.

Now that we have estimates for both foreign exports and foreign imports by regions, the new balance equation can be written as

(39) $$C_c^r = (V_c^r + M_c^r) - (U_c^r + F_c^r + X_c^r).$$

Thus, we have 'only' domestic exports and imports unknown. The problem is, of course, that we do not have any data concerning their magnitude. However, if we take commodity identity (28) as a rule and assume that all items in (39) have been correctly estimated, we may calculate the total (national) magnitude of interregional trade-flows to be

(40) $$T_c = \frac{\sum_r \left|C_r^c\right|}{2}$$

i.e. the sum of absolute magnitudes of balancing terms C^r_c divided by two. The reason why we divide this sum by two is the fact that the total interregional trade-flows contain both exports and imports. Otherwise we would double-count the magnitude of these trade-flows.

For the regionalisation of domestic exports the following variable was calculated

(41) $P^r{}_c = V^r{}_c - X^r{}_c$

which is the difference between local supply and foreign exports. This may be called *domestic export potential* since we assume that a region cannot export more than it produces. Therefore $P^r{}_c$ is the maximum amount of domestic exports. Using this variable and the variable for the second balance $C^r{}_c$ we regionalised domestic exports using

(42) $$T_c^{r\bullet} = \frac{P_c^r + C_c^r}{\sum_r (P_c^r + C_c^r)} \times T_c$$ s.t. $T^{r\bullet}{}_c \leq P^r{}_c$ and where $C^r{}_c > 0$.

Domestic imports may now be calculated as a residual.

This modification of supply-demand pool method makes it possible to estimate all four items of regional trade-flows (foreign exports and imports, domestic exports and imports) simultaneously. Also cross hauling is possible. These possibilities lie, of course, in the fact that it is not solely the balances that determine trade-flows, but also local supply and local demand are incorporated into the equations. Still, this method is based purely on assumptions and mathematical modeling, not on real empirical data.

III. Wood

Wood (a product of forestry) is an important natural resource in Finland and a great part of the export revenues as well as industrial output are based on the processing of this resource. Wood, or forestry, was not however in our survey. This is because the trade flows of wood are collected by another institute in Finland, namely Finnish Forest Research Institute (see Västilä and Peltola, 1997) and this data was obtained for the compilation of regional S/U tables. This data includes all regional trade flows of wood, namely foreign exports, foreign imports, domestic exports and domestic imports. With this data it was then easy to get the trade flows to S/U tables.

IV. Trade-flow survey on the origin of purchases

As mentioned in connection of the Finnish trade-flow survey, the main question related to where establishments sell their products (in total). In order to get some information concerning the trade flows of certain commodities (mainly certain services), we asked also where establishments buy e.g. their banking services, insurance services, post- and telecommunication services etc. That way we avoided sending the questionnaire to banks, for instance.

This data contained information on regional foreign imports and regional domestic imports. The problem is, however, that it is not solely the industries that use these commodities, but part is used in final demand, especially by households. Therefore, we made an assumption that local supplies cover all local *final* demand for these commodities. To sum, $M^r{}_c$ and $T^{\bullet r}{}_c$ are based partly on the survey data and partly on assumptions concerning the final demand.

After $M^r{}_c$ and $T^{\bullet r}{}_c$ were this way estimated, domestic and foreign exports were calculated using similar supply-demand pool modification as described above in II.

4.5. Value-added

To calculate the value-added for industry *j* in region *r* we used the industry identity (1). Thus, value-added was calculated as a difference between output and intermediate consumption.

5. CONCLUSIONS

In this paper the compilation of Finnish multiregional I/O system based on regionalised S/U tables were discussed. The paper examines, in particular, different methods that were used in regionalising national S/U tables, as well as in regionalising regional export and import flows.

While the typical top-down method based on some indicator of economic activity is widely used in regionalising national accounts, in our case more advanced methods to regionalise national S/U tables were used. Although perhaps more burdensome, these methods will certainly lead to more precise representations of regional economies. This is especially important in multiregional system where one of the tasks is to show these differences in order to make regional comparisons.

Another important piece of information in regional I/O and S/U tables is contained in the representation of regional trade-flows. As is argued elsewhere (Harris & Liu 1998, Susiluoto 1996) the non-survey methods tend to underestimate interregional trade, thus showing a region more 'closed' than it actually is. This is an important issue in I/O modeling and analyses since such models tend to underestimate the effects that outflow from the region. Although some non-survey and semi-survey solutions were used in our case, as well, still most of the trade flows were based on a specific trade-flow survey thus giving us an accurate data on regional exports and imports.

Finally, there are several benefits of constructing multiregional I/O tables based on S/U framework. This approach is widely used in national accounting offices compiling national I/O tables based on SNA93 or ESA95 framework. This framework is easily adapted to regional level, as well. Secondly, the information presented in S/U table is perhaps more informative than in I/O table. Thus S/U tables can be used for descriptive purposes, as well. This information is also "closer to the theories of production and consumption" (Madsen & Jensen-Butler 1999, 277). Thirdly, many other regional modeling systems, like SAM models and general equilibrium models need information as basically presented in S/U tables. Thus, this should benefit the construction of such models.

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