A DOUBLE-ENTRY METHOD FOR THE CONSTRUCTION OF BI-REGIONAL INPUT-OUTPUT TABLES*

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ABSTRACT. In The Netherlands, a strong tradition in the construction and updating of (inter)regional input-output tables has been built up. The paper gives a brief overview of this Dutch experience and discusses the features of the by now more or less standardized double-entry bi-regional construction method (DEBRIOT). This method systematically adds sales and export coefficients to the usual construction procedures. Thus, it introduces consistency checks at the cell level of the input-output table. Moreover, it offers a non-survey technique to estimate a regional domestic sales table that is crucial to the double-entry character of the method.

1. INTRODUCTION

The international exchange of information about experiences in regional input-output table construction is hampered in an *asymmetric* way. Most practioners outside English speaking countries are more or less acquainted with the experiences reported in English language professional journals, but few have an academic interest in publishing their own efforts in such journals, especially if English is not their mother language. Consequently, regional input-output table construction in several European countries and in Japan probably benefits from the experience in Anglo-Saxon countries (in The Netherlands this is certainly the case), but this does not happen the other way around.

This paper intends to remedy the asymmetry in the information exchange in the case of the Dutch experience in the construction of regional input-output tables. Through the cumulation of experience, the construction of the present generation of bi-regional tables has been more or less standardized. Where useful, we will illustrate the description of this double-entry construction method by means of the recently constructed table for the Province of Overijssel and the Rest of the Netherlands for 1986 (see Boomsma, Oosterhaven and van der Veen, 1991, for full details).

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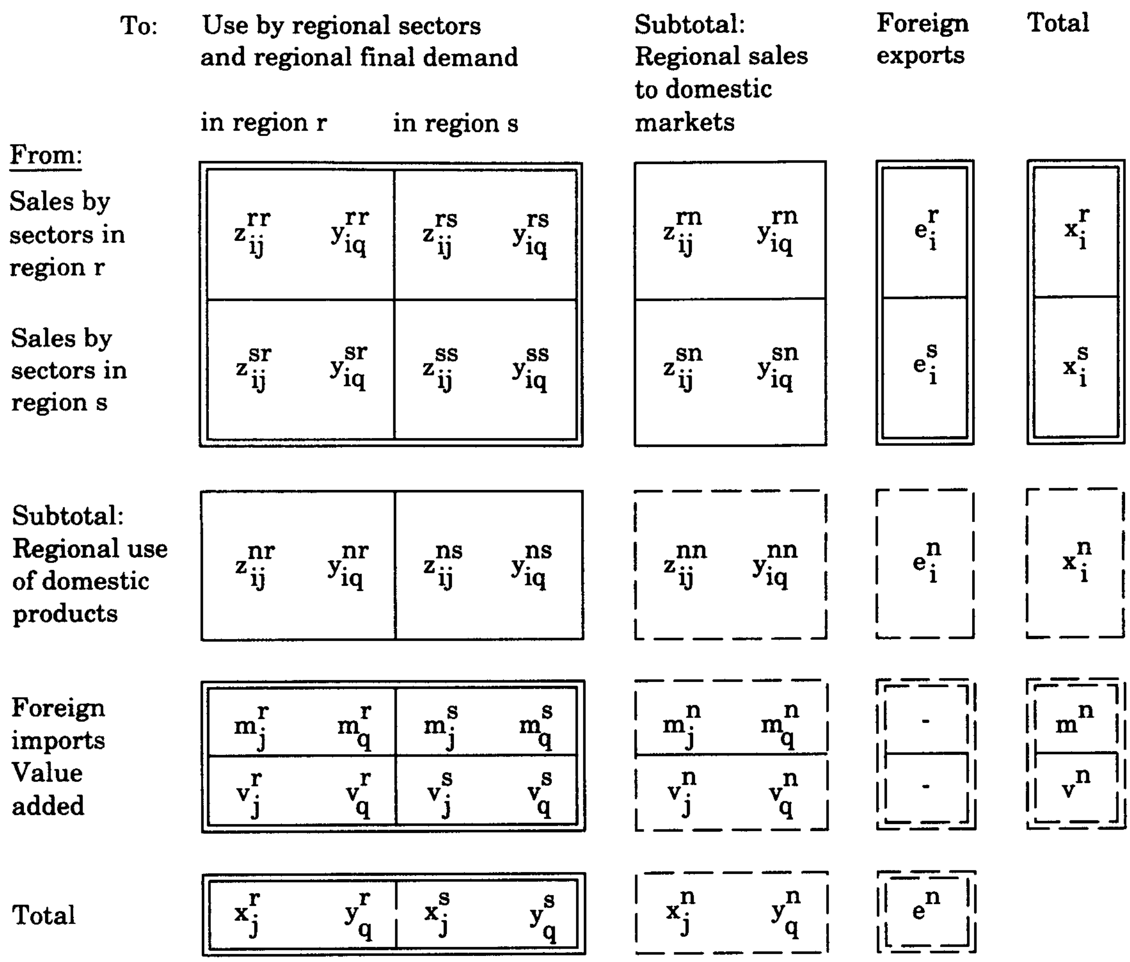
2. A BIRD'S EYE VIEW OF DUTCH REGIONAL INPUT-OUTPUT ANALYSIS

Oosterhaven (1980) gives an overview of the development of Dutch regional input-output analysis up to and including the 1970s. It is summarized as running "from regional tables with only limited information used for primarily descriptive purposes towards ideal interregional tables used for analytical purposes, such as estimates of economic impacts, experiments with programming models and building full forecasting models" (p. 12). Presently, about 70 so-called regional domestic-use tables and 50 (inter)regional input-output tables are available. Most of the latter tables have a hybrid, semi-survey character or they are updates of such tables. Here we will restrict ourselves to a brief discussion of the development in table construction in the 1980's using the accounting framework shown in Figure 1.

The lower right hand corner with its *broken* lines shows the information that is usually available in a national input-output table. The part of Figure 1 with the *double* lines shows the information that is contained in an ideal, Isard-type bi-regional input-output table for a country divided into a certain region r and the rest of the country s. The two sets of tables with *single* unbroken lines are important auxilary tables in the construction of both single-region and bi-regional input-output tables, as they show the two basic types of one-sidedly regionalized national input-output tables. The regional domestic *sales* tables for the regions r and s in the upper right-hand corner show the outcome of a breakdown of the national table only along its rows, whereas the regional domestic use or purchases tables for r and s in the lower left part of Figure 1 show a disaggregation of the national table only along its columns.

In The Netherlands, the 1980s started with a flurry of construction activities by several regional research institutes (for a detailed account, see Oosterhaven and Drewes, 1985). Most tables of this period are based on the regional domestic use tables of 1975 constructed by The Netherlands Central Bureau of Statistics (CBS, 1983). These CBS tables contain a complete breakdown of the national input-output table along its columns (including the foreign exports column) for the 11 Dutch provinces and the regions of Amsterdam, Rotterdam and the Hague (compare the lower left-hand tables in Figure 1).

As opposed to the Dutch tables constructed in the 1970s, the Dutch bi-regional tables of the 1980s are mainly based on surveys or export coefficients instead of the usual approach via (either survey or non-survey) import coefficients or regional purchase coefficients (in short, RPC's, Stevens and Trainer, 1980). Export data have been used in some early studies in the United States. They constitute an element of the sales-data-only aspect of the intersectoral flows approach introduced by Hansen and Tiebout (1963; also used by Lee, Lewis and Moore, 1971; and criticized by Clapp, 1977; and Giarratani, 1980). Moreover, Schaffer (1976) indicated how export and selected intermediate output data may be incorporated into the supply-demand pool (SDP) method to improve the reliability of this nonsurvey technique. In the last decade, however, most tables constructed in both the USA (see Richardson, 1985; Hastings and Latham III, 1990) and in Australia (see West, 1990), use information on imports to construct regional input-output



Legend

z_{ij}^{rs}: intermediate outputs from sector i in region r to sector j in region s

y_{iq}^{rs}: final outputs from i in r to final demand category q in region s

e_i^r : foreign exports of sector i in region r

x_i^r : total output of sector i in region r

m_q^s : foreign imports by final demand of category q in region s

v_q^s : value added of final demand of category q in region s

y_q^s : total final demand by category q in region s

m^n : total national foreign imports

FIGURE 1: Simplified Scheme of National and Bi-regional Input-output Data.

tables. This approach via imports is usually preferred for theoretical reasons (Isard and Langford, 1971, p. 116), but proves to produce unsatisfactory empirical results (see Isard and Langford, 1971, p. 121).

This turnabout in approach in The Netherlands was the outcome of earlier experiences that showed that firms, as a rule, are much better informed about the spatial destination of their sales than about the spatial origin of their purchases. This is especially the case if many different inputs are used and/or if the inputs are purchased through wholesale or retail channels. Firms are well informed about the origin of their inputs only when they deal with one or a few dominant inputs purchased directly from the producer of that input. On the sales side, however, firms may lack the necessary information on the spatial destination of their sales only when they primarily sell through wholesale firms.

But even with wholesale transactions, firms appear to be better informed about the spatial destination of their sales through wholesale than about the spatial origin of their purchases through wholesale firms. In the case of trade through retail firms the difference is even more evident. In the case of purchases via retail channels, firms have no idea where the producer of their inputs is located, whereas with sales, firms may almost be sure that the final customers are located in the same region as the retail store to which they sell.

As a consequence of this change in survey strategy, the need for more detailed information on the sectoral destination of intermediate and final output became apparent. In most Dutch construction cases this led to an explicit estimate of a domestic *sales* table (see Figure 1 for its need when trade data are restricted to regional exports).

This new approach of concentrating on row data became more or less standard, even in cases where only single-region tables were constructed. Besides the better coverage and the higher quality of export coefficients over import coefficients, there is an additional advantage of this approach to the construction of regional input-output tables. Through the construction of a regional (domestic) sales table, the *consistency checks* that result from the double-entry character of the input-output table can be used at the level of the individual *cells* of the table, whereas they operate only at the level of entire rows in the more traditional cases that only use domestic purchase tables and import coefficients or RPC's (which equal one minus the corresponding import coefficient).

When both approaches are combined (i.e., when import and export coefficients are used along with regional use tables and regional sales tables), a so-called reconciled dogleg table results in the case of a single region, while a reconciled bi-regional table results in the case of two regions (see Oosterhaven, 1984, for other members of the family of square single-region and multi-regional tables). In The Netherlands, due to the cost of their collection and the potential unreliability of domestic import data, such fully reconciled tables have not been constructed yet.

The second feature that makes Dutch regional input-output table construction different from the practice in most of the English speaking world is the almost total absence of the use of any kind of coefficient method, such as LQ, CIQ or SDP (see Miller and Blair, 1985, for a further discussion). All these methods implicitly maximize intra-regional transactions in one way or another. Consequently, all regional multipliers derived from such tables have a systematic *upward bias*, even when one claims that there is relatively little crosshauling (as West, 1990, p.108, does for Australia). In densely populated and highly urbanized countries, however, crosshauling is the rule; even more so when commuting across regional boundaries is important and type II multipliers are concerned (see Oosterhaven, 1981, Ch. 6).

With a combined LQ-CIQ method, the average over-estimation of the indirect part of the type I production multipliers for the Province of Drenthe for 1975, for example, amounted to as much as 77 percent (Oosterhaven and Drewes, 1985, p. 122). In our view, any expert who knows his region reasonably well may come up with better (i.e., at least not systematically biased) export or import coefficients as compared with the results of LQ and other coefficients. Alternatively, RSRI's RPC's might be used instead of LQ's (see Stevens, Treyz and Lahr, 1989). Consequently, the use of LQ and other *mechanical non-survey* methods is only defensible in a first explorative phase, but certainly not as a final rescue.

In this context, one other Dutch study is worth noting. In this study a really mixed survey/non-survey type of table resulted from a survey of four tourist-specific sectors in Drenthe. The RPC's that related to the tourist sectors' domestic inputs were also applied to the national domestic use coefficients that were assumed to hold for the other 18 sectors. A complete table resulted from putting the survey and non-survey columns into one single-region table. A comparison with the multipliers from the entirely semi-survey bi-regional table for Drenthe (FNEI, 1984), showed differences in the indirect part of the tourist sectors' multipliers of only 5-10 percent, whereas the differences in the direct parts of the 18 other multipliers ran between −50 and +65 percent, with outliers as large as +180, +280, and +510 percent (see Spijker, 1985).

We believe that these results show that both Bourque (1990) and Beemiller (1990) are right in their recent discussion in the *International Regional Science Review;* Bourque in his general rejection of RIMS's non-survey alternative for the Washington State input-output table, and Beemiller in his claim that combining direct information for the sectors of an impact study with a non-survey table produces sufficiently accurate estimates for most practical impact questions.

Finally, the 1980's showed a whole series of updates of the older 1975 tables to 1980 and 1986. Aside from the difference in construction method, the Dutch experience with updating the bi-regional tables may be of wider importance too. The somewhat higher initial cost of constructing bi-regional tables instead of single-region tables proves to pay off in the form of lower updating cost and a greater reliability of the updated tables. The cost appears to be lower because interregional trade is estimated as part of the updating procedure rather than needing to be estimated a priori, while the reliability is expected to be greater because national technological changes may easily be incorporated into the updated table (see Oosterhaven et al., 1986, for details).

3. THE DEBRIOT CONSTRUCTION METHOD

The double-entry construction method, to be described in this section, can be seen as the probable final product of the historical experience of Dutch table construction described above. All phases and steps in the DEBRIOT method are summarized in Table 1.

TABLE 1: The DEBRIOT Construction Method in Phases

PHASE I. *Adaptation of Given Data.*

(1) Confrontation of the national input-output table with regional (sectoral) totals.

(2) Estimation of lacking regional (household consumption) totals.

PHASE II. *Limited Regional Trade Survey.*

(3) Identification of relatively and absolutely large regional sectors and sectoral peculiarities (i.e., potentially inverse-important cells and wholesale trade).

(4) Selection of firms per sector and determination of questions to be asked per sector.

(5) Survey of firms and sector specialists and weighing of the regional trade data.

PHASE III. *Construction of the Regional Domestic Use Table.*

(6) Application of national technology coefficients to regional total use.

(7) Confrontation with available regional technology data.

(8) Estimation of missing (household consumption and private and public investments) "technology" data.

(9) Application of national foreign import coefficients per cell.

(10) Confrontation with regional foreign import data from the trade survey.

PHASE IV. *Construction of the Regional Domestic Sales Table.*

(11) Confrontation of official regional foreign export data with foreign export coefficients from the trade survey.

(12) Determination of the regional domestic sales coefficients as the weighted average of the domestic demand structure of the region and that of the rest of the country (row-wise).

(13) Application of regional domestic sales coefficients to regional total domestic sales.

PHASE V. *Construction of the Intra-Regional Transactions Table.*

(14) Determination per cell of maxima for intra-regional transactions and minima for regional domestic imports and regional domestic exports, and confrontation of these minima with data from the trade survey (consistency checks).

(15) Application of cell-specific domestic export coefficients to the domestic sales table and reduction of remaining cells from the maximum intra-regional transactions table to reach the trade survey's overall regional domestic export coefficients per sector.

(16) Plausibility verification of the preliminary regional domestic import coefficients and confrontation with the import coefficients available from the trade survey.

(17) Determination of the final intra-regional transactions table through selective collection of additional data and revision of earlier estimates.

PHASE VI. *Construction of the Bi-Regional Input-Output Table.*

(18) Calculation of the regional domestic exports table.

(19) Calculation of the regional domestic imports table.

(20) Calculation of the intra-regional transactions table for the rest of the country.

Its most important aspect is that it does not primarily proceed via purchase data but via information on the sectoral and spatial destination of the sales. Moreover, even when information on the spatial destination is not available, mechanical (coefficient) methods are not used, but rather expert opinions used. With these main features in mind, Table 1 is rather self-evident, at least as far as the main phases of the construction procedure are concerned. See also Figure 1.

The individual steps are presented in a logical order, in the sense that they follow the order in which data are subsequently used. The time sequence of each and every individual step, however, does not necessarily have to be followed. To limit the overall time spent to construct an input-output table in this way, it is advisable to start simultaneously with the steps 4-5 (the core of the trade survey) and the steps 6, 8 and 9 (the core of constructing the regional use table)[1].

Furthermore, it should be noted that Phase VI (i.e., completing the bi-regional aspect of the table) does not represent a necessary part of the construction process. When this last phase is deleted, one ends up with a single-region (dogleg type) input-output table. In the case of single-region studies such dogleg tables are just as valuable as bi-regional tables, as interregional feedbacks are mostly negligible. In The Netherlands for example, they added only 1-10 percent to the intra-regional indirect and induced income effects (Oosterhaven, 1981, pp. 51 and 98). Hence, the main advantage of full bi-regional tables over single-region tables lies in their ability to produce estimates of both regional and national impacts within a framework that consistently deals with both intra-regional impacts and interregional spillovers.

Phase I: The Preparation

The construction process presupposes the availability of a detailed national input-output table and detailed regional sectoral totals. In the Dutch case, a (confidential) national table can be used with 107 intermediate rows (both for domestic and for competitive foreign inputs), six primary cost rows, 104 intermediate columns, ten investment columns and four columns for other final demand[2]. Furthermore, (confidential) regional data for total production, total intermediate use, total value added subdivided into four components, and foreign exports are available for 94 sectors. For agriculture, total production and total exports are further disaggregated into nine subgroups.

Naturally, data for the region at hand (see x_i^r in Figure 1) and data for the rest of the country (x_i^s) do not always add to the corresponding national total (x_i^n). Hence, the first step in the construction of any regional input-output table (step 1 Table 1) requires a confrontation of corresponding regional and national data. It is clear that consistency is more easily checked and reached, but is also of greater importance, in a bi-regional context as compared to a single-region context.

Second, some regional totals may be lacking and need to be collected or estimated. In the Dutch case, only data on total regional household consumption are lacking and have to be estimated by means of secondary data. At the end of the prepatory phase, complete and consistent data for all regional totals need to be available (the double-lined edges of Figure 1) as well as a complete and consistent national table (the broken lined lower right-hand part of Figure 1).

[1] In the case of the Overijssel table this was in fact precisely what was done. The University of Twente (in Overijssel) conducted the trade survey, while the University of Groningen worked out the other phases of the construction process.

[2] As part of step 1, the household column in the Dutch table needs to be split into three separate columns: retail purchases by industries, expenditures by foreign tourists and expenditures by Dutch households. The last item needs to be separated from the others in order to derive a correct estimate of the regional household column in steps 2 and 8.

Phase II: The Estimation of Regional Trade Patterns

In principle, one export coefficient per sector for all exports to the rest of the country at hand (t_i^{rs}) would be sufficient to construct the entire double-lined table in Figure 1, that is, if both the regional domestic sales table and the regional domestic use table (the single lined auxilary tables in Figure 1) are available. This overall regional *domestic* export coefficient is defined as

$$t_i^{rs} = (z_{i\cdot}^{rs} + y_{i\cdot}^{rs})/(x_i^r - e_i^r) \tag{1}$$

where the dots indicate a summation over the sectoral destination index.

A survey estimate of (1), when available, might be applied directly to the regional *domestic sales* table to get an estimate of the regional domestic exports table

$$z_{ij}^{rs} = t_i^{rs} z_{ij}^{rn} \qquad y_{iq}^{rs} = t_i^{rs} y_{iq}^{rn} \tag{2}$$

The intra-regional transaction table and the domestic imports table are then derived by simple subtraction

$$z_{ij}^{rr} = z_{ij}^{rn} - z_{ij}^{rs} \qquad z_{ij}^{sr} = z_{ij}^{nr} - z_{ij}^{rr} \tag{3}$$

and analogously for y_{ij}^{rr} and y_{iq}^{sr}. In such a case, in fact, a full information multi-regional dogleg table would be the outcome and not a real interregional table (see Oosterhaven, 1984, for the precise differences).

Given its potential impact on sector multipliers, this level of information on trade should be considered too aggregate. Hence, it is necessary to collect separate export data for the household column and for the potentially inverse-important cells of the matrix[3]. The disaggegated national input-output table and the regional subsectoral totals provide the essential information on the absolute and relative importance of each regional sector and the probable absolute and relative importance of the intra-regional cells (step 3 in Table 1).

The selection of the firms to be interviewed will be influenced by the level of aggregation at which the table at hand may be used and published. In the Dutch case, strong confidentiality rules imply that the final table has to be aggregated to 36 sectors. By means of employment registers, individual companies could be selected in such a way that all dominant regional companies are present as well as a random selection from the smaller companies.

The subjects on which to gather data comprise at least the following items:

(i) total production,

(ii) total exports to the rest of the country and total foreign exports,

(iii) exports to specific sectors in the rest of the country (major cells, which are different for each sector),

and as far as the ultimate destination is unknown

[3] Here we have a typical "chicken or egg" problem. Without a regional table one cannot determine the inverse-important cells and without that information one cannot construct a decent regional table. Hence, we suggest use of the national table as second best information on inverse-importance.

(iv) sales through the wholesale sector in the region, and

(v) sales through wholesale in the rest of the country (in this case it is reasonable to assume that a national market is served, sales may then be distributed spatially according to the distribution of demand), and

(vi) imports from specific sectors in the rest of the country and from foreign countries (major cells, which are different for each sector).

Any further information is of course welcome, but complicates the survey and will negatively influence the response rate. Therefore, it is important to pre-select the potentially inverse-important cells *before* the interviews are made.

In view of the special position of the trade margins in standard input-output tables (see the above list of essential topics) it is advisable to oversample the regional wholesale sector in such a way that the major part of the region's industrial outputs that are sold through this sector is covered. The effort involved in this oversampling is justified as the survey's outcomes with regard to the spatial destination of the sales of the wholesale trade may be used twice

(i) to allocate the gross trade margin of the regional wholesale sector to its region of destination and

(ii) to allocate the sales of (mainly smaller) non-surveyed industrial firms to their region of destination.

The same oversampling strategy will also be useful for the transportation sector. The selection of firms and questions to be asked finishes step 4 (for further information see Boomsma, Oosterhaven and Van der Veen, 1991).

During the telephone interviews in the case of Overijssel, it appeared that some (major) companies were unwilling or unable to provide the requested information. To supplement the information from the survey, expert opinions were called upon. For agriculture, an important regional sector, frequent use was made of intermediate and advisory boards. With regard to sales to the household sector, estimates of export coefficients were augmented to include shopping across the provincial borders into Overijssel.

The ultimate survey-based export (and import) coefficients need to be calculated by weighting the individual firms' and experts' coefficients. Where possible (i.e., with the firms' information) total production can be used to derive appropriate weights. In other cases (i.e., with the opinions of the analysts, regional experts and sectoral experts) weights need to be guestimated—reflecting of course the analysts' own judgements of the relative importance and reliability of the information concerned. This finishes step 5.

Phase III: Estimation of Regional Technology and Regional Domestic Use Data

The third phase may well start before the second one. It begins with the application of national technology coefficients [between the square brackets in (4)] to regional total use data per sector ($x_j^r - v_j^r$). In this way, the total use of products from sector i by sector j in region r is estimated, irrespective of the location of sector i

$$z_{ij}^{\cdot r} = [z_{ij}^{\cdot n}/(x_j^n - v_j^n)]\,(x_j^r - v_j^r) \qquad (4)$$

where the dots indicate a summation over the spatial origin index (see also Figure 1) and therefore

$$z_{ij}^{\cdot n} = z_{ij}^{nn} + m_{ij}^{n} \tag{5}$$

In (5), the total use of domestic and foreign inputs of type i by the national sector j is defined. Between the square brackets in (4), technology coefficients are defined per unit of total use instead of per unit of total output. Thereby, (4) takes into account the fabrication effect mentioned by Round (1979). This finishes step 6.

In the case of Overijssel, the outcomes of (4) were compared with the confidential primary data from the national industrial census for seven regionally important subsectors. This was a rather labor intensive procedure as the industrial census data have to undergo several phases of adaptation, including the subdivision of multiregional companies with establishments in the region and the usual steps that transfer industrial census data into input-ouput data. The outcomes were disappointing in the sense that the amount of time involved (some weeks) only produced rather small differences. On the other hand, however, this result was encouraging as it showed that the national technology assumption produces a close approximation, even for subsectors that are specific for the region at hand.

The household sector in small regions such as Overijssel with only one million inhabitants is rather important. Hence, some weeks were spent to get the best possible estimate of the total amount of regional household consumption (in step 2) simultaneously with the estimate of the regional composition of household consumption expenditures (in step 8). To this aim, data from the national budget survey were weighted with the regional composition of household types, income deciles and urbanization grades. Next, the estimated regional budgets needed a painful adaptation in order to correspond with the input-output definitions and classifications—including the allocation of goods and services to sectors of production, the deduction of the V.A.T., and the deduction of the gross (wholesale and retail) trade margins to reach expenditures in producers' prices.

The same procedure has been applied to the budget survey's *national* outcomes. The differences that remain at the national level between input-ouput and adapted budget data then need to be applied to the regional consumption expenditure coefficients in order to reach final consistency between national and regional consumption data.

Finally, if necessary, regional totals and national technology coefficients need to be combined for other categories of final demand as well [Equation (4)]. In the Dutch case, this may be done separately for four types of public investment categories (buildings, civil engineering works, transport equipment, and metal products and machinery) and for six types of private investment categories (the above four plus dwellings and livestock). The Dutch public consumption column can be regionalized straightforwardly as it equals a column with zeros and a cell with the difference between total government production and total sales of government services, i.e., a cell "government to public consumption". This finishes step 8.

In step 9, national foreign import coefficients [between square brackets in (6)] need to be applied to the estimate of the regional technology table from steps 6-8.

$$z_{ij}^{nr} = z_{ij}^{\cdot r} - [m_{ij}^{n}/z_{ij}^{\cdot n}]\, z_{ij}^{\cdot r} \quad (6)$$

The result is a preliminary estimate of the domestic use or purchase table (the single-lined table in the bottom left part of Figure 1). For regional final demand an analogous formula applies.

The trade survey described in Phase II may produce region-specific foreign import coefficients that are different from the national coefficients used in (6). In that case a reconciliation (step 10) is needed. In the case of Overijssel, the trade survey produced only a few region-specific foreign import coefficients that proved to be very close to the CBS-national foreign import coefficients in (6). Hence, in the Overijssel case, the comparison in step 10 did not lead to changes in the outcomes of (6).

Phase IV: The Estimation of the Regional Domestic Sales Table

In the case of the foreign export coefficients, however, the Overijssel trade survey produced some coefficients that were considerably different from the region-specific foreign export coefficients of the CBS (i.e., step 11). In eight such cases the CBS-regional and CBS-national foreign export coefficients were precisely equal, which probably is caused by the lack of genuine regional data within the CBS. In these eight cases the survey coefficients were used. In five other cases the survey coefficients were considered sufficiently "hard" to be used instead of the CBS-data. With the rest of the subsectors the CBS-coefficients were used instead of the survey coefficients. After this comparison, total regional domestic sales per subsector may be calculated $(x_i^r - e_i^r)$.

In The Netherlands, Muller (1979) was the first to use domestic sales coefficients when constructing a non-survey table for the Rotterdam region. He assumed the row structure of the regional sales table (i.e., the rows with z^{rn} and y^{rn} in Figure 1) to be equal to the row structure of the national table. The first application of this approach in a semi-survey context (FNEI, 1984) showed that this assumption led to large inconsistencies in the case of services that are mainly oriented towards the regional market. Hence, in the case of services the row structure of regional demand (i.e., the rows with z^{nr} and y^{nr} in Figure 1) was used as an alternative.

Neither extreme is of course plausible. Instead of these extremes we propose to use an average of the demand structure of the region at hand and that of the rest of the country. These demand structures have to be weighted appropriately of course, namely by the means of the trade survey's overall regional *domestic* export coefficient defined in (1). Hence, the *non-survey* regional domestic sales coefficients may best be estimated as the weighted average of the demand structure of the rest of the country (z^{ns}) and the demand structure of the region at hand (z^{nr})

$$s_{ij}^{rn} = t_i^{rs} z_{ij}^{ns}/(z_{i\cdot}^{ns} + y_{i\cdot}^{ns}) + (1 - t_i^{ts}) z_{ij}^{nr}/(z_{i\cdot}^{nr} + y_{i\cdot}^{nr}) \quad (7)$$

This finishes step 12.

The application of the regional domestic sales coefficients to total domestic sales per regional subsector in step 13 is straightforward

(8) $$z_{ij}^{rn} = s_{ij}^{rn}(x_i^r - e_i^r)$$

This finishes the estimation of the second auxilary table, viz. the regional domestic sales table (the single-lined upper right-hand subtable in Figure 1).

Phase V: The Construction of the Intra-regional Transactions Table

In Phases III and IV the constraints for the construction of the intra-regional transaction table are now given at the level of the *individual* input-output *cells.* The smallest of the cell-values from the regional domestic purchases table and the regional domestic sales table determines the maximum for the intra-regional cells

(9) $$z_{ij}^{rr}(\max) = \min(z_{ij}^{nr}, z_{ij}^{rn})$$

and (9) in its turn determines the minima for the domestic export table and the domestic import table, respectively

(10) $$z_{ij}^{rs}(\min) = z_{ij}^{rn} - z_{ij}^{rr}(\max); \quad z_{ij}^{sr}(\min) = z_{ij}^{nr} - z_{ij}^{rr}(\max)$$

and analogously for regional domestic imports and exports of final outputs.

From (10) minimum domestic export and minimum domestic import coefficients may be derived straightforwardly. The comparison of these minimum values with the corresponding coefficients from the trade survey may show inconsistencies that have to be resolved in step 14.

In step 15, a distinction has to be made between transactions for which cell-specific export coefficients are available from the trade survey and those transactions for which no such specific information exists. First, the cell-specific domestic export coefficients from the trade survey (t_{ij}^{rs}) are applied to the domestic sales table

(11) $$z_{ij}^{rs}(\text{spec}) = t_{ij}^{rs} z_{ij}^{rn}$$

With (11), one simultaneously defines the corresponding cell-specific intra-regional transactions

(12) $$z_{ij}^{rr}(\text{spec}) = z_{ij}^{rn} - z_{ij}^{rs}(\text{spec})$$

Second, for the remaining, non-specific intra-regional cells, the empirical maximum for these cells, i.e. (9), is decreased proportionally[4] (by a factor h_i^r) until the domestic exports reach a level consistent with (1), the trade survey's overall domestic export coefficient per regional subsector. Consequently

(13) $$z_{ij}^{rr}(\text{non-s}) = (1 - h_i^r) z_{ij}^{rr}(\max)$$

The remaining, non-specific part of the regional domestic export table results simultaneously be adding the subtracted part of (13) to the minimum domestic

[4] When cell-specific survey information is absent, this coefficient can be labelled the *crosshauling coefficient* as it indicates the share in the maximally possible amount of intra-regional transactions that is almost literally crosshauled.

exports from (10)

$$z_{ij}^{rs}(\text{non-s}) = z_{ij}^{rs}(\text{min}) + h_i^r z_{ij}^{rr}(\text{max}) \tag{14}$$

Obviously, the procedure for exports about which we have cell-specific survey information [i.e., Equation (11)] is different from that for the other export-cells [i.e., Equation (14)].

Note that the domestic export coefficients that may be derived from (14) are endogenous. They will center around the trade survey's overall export coefficient in (1), but they may very well be different from it. When the minimum export in (10) is large, that is, if regional production is considerably above regional demand at the cell level, the corresponding (endogenous) export coefficient will be larger than the survey's average one, and that is precisely what we intend it to be. This outcome for the cells about which we have no specific survey information is the direct and desired result from choosing (13) instead of the older, more mechanical alternative of applying the domestic export coefficients directly to the domestic sales table (e.g., Muller, 1979; and FNEI, 1984).

In step 16, (12) and (13) are subtracted from the regional domestic use table derived in (6) in order to obtain a preliminary regional domestic import table from which corresponding endogenous domestic import coefficients may be derived.

$$c_{ij}^{sr} = (z_{ij}^{nr} - z_{ij}^{rr})/z_{ij}^{nr} \tag{15}$$

As opposed to the *row* trade (export) coefficients, as used above and defined in (1), (15) represents *column* trade (import) coefficients. The endogenous outcomes of (15) need of course to be compared with the exogenous information on domestic imports from the regional trade survey and from regional experts. Step 16 involves the reconciliation of these differences.

This final reconciliation, together with the earlier ones in steps 10 and 14, may require the collection of additional data before the preliminary intra-regional transactions table can be made final in step 17.

Phase VI: The Construction of the Bi-regional Input-Output Table

The last three steps only involve some simple calculations that are evident from Figure 1 [see also Equations (2) and (3)]. The subtable that contains the intra-regional intermediate and final output transactions *within* the rest of the country at hand is the last subtable to be calculated in step 20

$$z_{ij}^{ss} = z_{ij}^{nn} - z_{ij}^{rr} - z_{ij}^{rs} - z_{ij}^{sr} \tag{16}$$

and again an analogous formula applies for final outputs, y_{iq}^{ss}.

As most bi-regional input-output tables involve a region and the rest of the country, region r will be considerably smaller than region s. Consequently, the magnitude of the cells in (16) may be, for instance, as much as ten times as large as that of the other three subtables. Hence, the fact that all estimation errors from the subtables rr, rs, and sr accumulate in (16) does not imply that is it necessarily less accurate than the other subtables. On the contrary, its relative estimation errors might easily be smaller, provided that the estimation errors in the national table are smaller than those made in the regionalization process described in Phases

II-V. Finally, note that in such cases one finds a close resemblance between the input-output structure of the rest of the country (z^{ss}) and that of the national table (z^{nn}).

4. CONCLUSION

The construction of regional input-output tables in The Netherlands has gradually grown into what might be labelled the double-entry bi-regional construction method (DEBRIOT). The outcome is a typically hybrid table in the sense that survey information is supplemented with guestimates and assumptions about lacking data. The method, however, is different from the usual hybrid approaches reported in the English language literature. We claim that it presents a good and relatively cheap[5] alternative for the ready-made, non-survey tables produced in the United States. It differs from these approaches in two major aspects.

First, it systematically avoids the use of mechanical coefficient methods to estimate regional trade coefficients, whether these are column trade coefficients such as the RPC's or row trade coefficients such as our intra-regional sales coefficients, which might be labelled as RSC's[6]. In this way, we avoid the systematic upward bias in intra-regional transactions and in related multipliers, which is present in both the ready-made tables and in the hybrid tables that use such methods. We believe that any reasonably well informed regional expert should be able to make a better guestimate than LQ, CIQ, SDP or whatever other method that minimizes crosshauling, either explicitly or implicitly; but of course survey information remains superior to both.

Second, our method uses a different approach where it tackles the construction problem primarily from the output or sales side. It proposes [in step 12 in Table 1; compare Equation (7)] a new non-survey method to estimate a "regional domestic sales table" with a row (sales) structure that is a weighted average of the demand structure of the region at hand and that of the rest of the country. We believe this approach to have no systematic bias, although it of course remains a theoretical guestimate of the true empirical sales structure. Subsequently, our method proposes to concentrate on estimating RSC's instead of RPC's or, more precisely, to estimate primarily regional (domestic) export coefficients and only a few major regional (domestic) import coefficients.

There are two main reasons for the second deviation. First, Dutch experiences show that firms have more and better data on the spatial destination of their outputs than they have on the spatial origin of their imports. Second, in combination with the estimate of the "regional domestic sales table", information about domestic export cofficients leads to the possibility for consistency checks at the level of the individual cells (see Phase V in Table 1), contrary to the usual

[5] The Overijssel table was in fact constructed within half a year, using approximately nine months of labor. The total cost of the construction may be estimated at about Dfl. 150,000, which at the present exchange rate equals US $70,000.

[6] In non-survey tables both RPC's and RSC's are usually assumed to be uniform per industry of origin. Hence, both are applied uniformly across the rows of, respectively, the domestic purchases table and the domestic sales table.

practice[7]. As a consequence of this approach, we are now be able to differentiate the non-surveyed domestic export coefficients endogenously according to the strength of regional supply and demand at the cell level [Equation (14)].

Finally, the question arises of course whether or not the DEBRIOT procedure does not have some disadvantages too. Although it is a bit half-hearted, we believe its main fault to be its hybrid character as opposed to the full-survey alternative. In our view, however, a bi-regional table constructed with DEBRIOT will give at least a holistically accurate and a not systematically biased representation of the input-output structure of the region at hand.

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[7] In the ready-made models (Brucker et al., 1990, p. 122-3) consistency checks are practically absent and in the GRIT-procedure (West, 1990, p. 106) such checks are only possible at the aggregate level of total remaining final output.

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