# INDONESIA'S INTER-REGIONAL INPUT-OUTPUT MODEL: A NEW HYBRID PROCEDURE FOR AN ISLAND ECONOMY



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**Abstract**
*Tulisan ini menggagas sebuah prosedur hibrida baru dalam penyusunan model input-output antardaerah pada suatu perekonomian kepulauan, dengan mengacu kepada kasus khusus Indonesia. Prosedur ini, disebut GIRIOT, merupakan kombinasi dan modifikasi dari prosedur GRIT II dan GRIT III; prosedur hibrida yang dirancang untuk perekonomian maju di negara benua. Dua prosedur hibrida dalam penyusunan model input-output antardaerah akan ditelaah. Kemudian, empat pertimbangan dasar dari prosedur hibrida baru akan dikemukakan, sebelum prosedur yang diusulkan dibahas; tahap demi tahap. Menggunakan data Indonesia, dua model input-output antardaerah kemudian dihasilkan. Pengujian validitas model menunjukkan bahwa prosedur yang digagas menghasilkan model input-output antardaerah yang dalam batas tertentu mencerminkan karakteristik perekonomian kepulauan Indonesia.*

**Key words** : inter-regional input-output, hybrid procedure, island economy

## 1. INTRODUCTION

Inability of national or single-region input-output to model the spatial aspects of an economy is a major limitation, especially in an island economy like Indonesia. Richardson (1972) strongly recommended the development of inter-regional input-output models. He contended that these models would validate the use of regional input-output studies as general equilibrium models.

Regional policy in developing countries is determined and often executed at the national level. Input-output analysis should be inter-regional in design if it is to be relevant for measuring the spatial distribution of these policies (Oosterhaven, 1981). The development of the inter-regional input-output model enabled the regional analyst to incorporate spatial interdependence into empirical analysis. This is an important contribution to analytical methods. While the general spatial implications of an event, action or policy might not seem important, many economic impact and forecasting studies would improve significantly if spatial implications were provided in detail (West, Morison & Jensen, 1982; West et al., 1989).

Many analysts, including Richardson (1972), Polenske (1969; 1995), Miller and Blair (1985), Freeman, Alperovich and Weksler (1985), Ngo, Jazayeri and Richardson (1986), West, Morison and Jensen (1982); West et al. (1989), Hulu, Hewings and Azis (1992) and Dewhurst (1994), argued that inter-regional models have significant advantages and uses compared to the single-region model. Firstly, an operational inter-regional model provides consistency checks on its data. For instance, total inter-regional imports must equal total inter-regional exports. Secondly, aided by acceptable recently developed methods,

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the data requirements of inter-regional models are not disproportionately heavy, particularly if a government collects some of the necessary information as part of its normal statistical service. Thirdly, inter-regional models have a wider application than the single region model because they can be used to compare and contrast the various regions that comprise the table. They can also represent the differential effects of an action or policy on each region. West, Morison & Jensen (1982) and West et al. (1989) provided a good example of how the regional economic effects of the migration of population and industry can be represented in more meaningful detail if the compensating effects from the migration for all regions can be studied.

Polenske (1969) listed the following potential uses of an inter-regional input-output model: studies of shifts in the location of industrial activity and employment; estimations of regional and industrial differences in production techniques; the establishment of regional accounts; regional impact studies; regional economic development programs; transportation planning; and civil defence planning. Richardson (1972) identified more specific applications of inter-regional input-output models. These included calculating the effects on different regions of changes in central government; evaluating the effects of inter-regional shifts in industrial location; measuring and forecasting export markets for a region; estimating the effects of freight rate changes on regional production and trade; calculating spill-over effects for poorer regions of expanded development in rich regions; and providing inter-regional feedback.

A further advantage of inter-regional models is that they can be used to compare the effect on the whole economy of increases in demand for the output of one region with the effect of increases in demand for the output of a different region. A government, for instance, can affect the spatial allocation of final demand. It could use this comparative aspects the inter-regional model to the growth of the economy as a whole (Dewhurst, 1994). If employment data are available, the model could be used to estimate the employment effects of such stimuli on the economy. If the government then increased its demand for a product, the inter-regional model could not only measure the number of jobs created and their location, but also provide a measure of the relative costs of creating jobs using different sectoral and spatial patterns of increased demand.

For a developing country like Indonesia, the need for spatial analysis appears to be increasing (Hulu & Hewings, 1993) because national development process is very often accompanied by a sharp increase in the disparities in welfare across regions (Williamson, 1965). The identification of optimum development strategies must include consideration of location. Attempts to reduce welfare disparities are often hampered by substantial inter-regional leakages because regional economies in developing countries are very open. Without a reliable accounting system, it is difficult to make informed judgments about appropriate project selection. It is also difficult to monitor projects and provide ex-post evaluation. One very important aspect of the model development process for Indonesia has been the provision of a strong link between national and regional systems through an inter-regional input-output model (Hulu & Hewings, 1993).

Empirically, the major problem in the development of inter-regional input-output models for Indonesia is that not all provincial statistical offices have constructed and published single-region input-output tables, due to data limitations. Even if single-region input-output tables were available for all provinces, data on inter-regional flows among provinces are not readily available. Their unavailability creates another problem.

Developing appropriate methods for constructing inter-regional input-output tables for Indonesia would contribute greatly to progress in regional economics. These tables would be used to analyse the spatial structure of the country's island economy. The keys must be accuracy and simplicity in regard to the availability of data.

The objective of this paper is to develop a new hybrid procedure for the construction of inter-regional input-output tables of an economy with special reference to Indonesia. In Section 2, two hybrid procedures for the construction of inter-regional input output tables will critically be reviewed. In Section 3, four basic considerations of the new hybrid procedure will be stressed before the procedure is fully described. Using Indonesian data of 1990, two inter-regional input-output tables were empirically constructed and be discussed in Section 4. This includes discussion on regional definitions and sectoral classification, data and their sources and model validation. Finally in Section 5, some notes regarding the problems and prospects of this new hybrid procedure are provided.

## 2. PREVIOUS INTER-REGIONAL HYBRID PROCEDURES

The principle of using hybrid techniques to construct regional input-output tables is widely accepted, therefore, there is no reason for this technique to be less appropriate for constructing inter-regional input-output tables (West, 1990). At least two hybrid procedures have been so far developed for constructing inter-regional input-output tables. One method developed at the University of Queensland (West, Morison & Jensen, 1982; 1983; West et al., 1989) is called GRIT III. The other technique, developed by Boomsma and Oosterhaven (1992), is called DEBRIOT, an acronym for Double Entry Bi-Regional Input-output Tables.

## 2.1. The GRIT III Procedure

The central focus of GRIT III is the derivation of the trade matrices which are estimated initially from the exports vectors of the single-region tables and later balanced with the estimates of inter-regional imports. The procedure of GRIT III consists of four phases and twelve steps (see Table 1). Phase I provides for the selection of the regional tables that are appropriate for inclusion in the inter-regional table. It also insures the accounting conformity of these tables. Phase II identifies the significant inter-regional trade flow. Special attention is paid to ensuring the accuracy of those cells of the table that are expected to contribute significantly to the inter-regional multipliers. Superior data, if available, are directly inserted in this phase. Phase III estimates those cells for which superior data are not available. These cells are generally the less significant cells of the table. Their estimation uses more formal and arbitrary methods. Zero cells are identified where the single-region tables show that no trade occurs or is presumed to occur. Non-zero cells are estimated by employing various allocation methods, such as gravity model allocation processes. Phase IV provides for the preparation of the final version of the inter-regional table. This phase requires close observation of the regional trade balance and a professional overview of the tables consistency. This phase also makes provision for the calculation of the inverses and multipliers for the inter-regional tables. For the system of regions where single-region tables have been constructed for each region, the GRIT III procedure seems promising because it is designed for the derivation of an inter-regional table, given the existence of appropriate single-region tables. When single-region tables have not been constructed a procedure that combines GRIT II and GRIT III procedures must be developed. For Indonesia, a new procedure is required since the single-region tables are not available for all regions. A further complication is that the single-region tables that are available are not uniform in sectoral classification. As well, they are constructed on different base-years.

Table 1.
**The GRIT III methodological sequence**

| | |
|---|---|
| **Phase I.** | **Selection and adjustment of regional tables** |
| Step 1. | Determination of the inter-regional set |
| Step 2. | Adjustments for accounting uniformity |
| **Phase II.** | **Identification of significant trade flows** |
| Step 3. | Identification of significant regional trade components |
| Step 4. | Identification of significant inter-regional trade components |
| Step 5. | Insertion superior data |
| **Phase III.** | **Estimation of remaining trade flows** |
| Step 6. | Identification of zero cells |
| Step 7. | Allocation methods |
| Step 8. | Preparation of preliminary inter-regional table |
| **Phase IV.** | **Derivation of final tables and multipliers** |
| Step 9. | Ensuring the regional trade balance |
| Step 10. | Consistency checks |
| Step 11. | Analysis of sensitivity and coefficient significance |
| Step 12. | Derivation of inverses and multipliers for final transaction tables |

Source : West, Morison & Jensen, 1982; 1983; West et al, 1989.

## 2.2. The DEBRIOT Procedure

The DEBRIOT model developed for the Netherlands can also be employed for constructing single-region tables. The procedure consists of twenty steps in six phases. All phases and steps in the DEBRIOT procedure are summarised in Table 2.

This method differs from the usual hybrid approach in two major aspects. First, it avoids the use of mechanical calculation to estimate the regional trade coefficients. Second, it tackles the construction problem from the output or sales side. It then proposes a new non-survey method to estimate a regional domestic sales table which is believed to have no systematic bias. Rather than concentrating on the construction of regional purchase coefficients the method focuses on estimating regional sales coefficients. The main reason for the different focus is that firms in the Netherlands have more and better data on the spatial destination of their outputs than they have on the spatial origin of their imports.

The main weakness of this technique is that it can only deal with a two-region model.

Neither GRIT III nor DEBRIOT are appropriate for constructing inter-regional input-output tables for Indonesia because Indonesia has more than two regions and has insufficient and inconsistently composed single-region tables.. This is because the GRIT III was designed for the derivation of inter-regional tables given the existence of the appropriate single-region tables. DEBRIOT can deal only with two regions since it was designed for constructing two-region input-output tables. To construct a hybrid many-region input-output table where no single-region tables are available, GRIT II and GRIT III procedures should be combined and some modifications on the procedure are required.

Table 2.
**The DEBRIOT construction method**

| | |
|---|---|
| **Phase I.** | **Adaptation of given data** |
| Step 1. | Confrontation of the national input-output table with regional(sectoral) totals |
| Step 2. | Estimation of lacking regional (household consumption) totals |
| **Phase II.** | **Limited regional trade survey** |
| Step 3. | Identification of relatively and absolutely large regional sectors |
| Step 4. | Selection of firms per sectors and determination of question to be asked |
| Step 5. | Survey of firms and sector specialists and weighting of the regional trade data |
| **Phase III** | **Construction of the regional domestic use table** |
| Step 6. | Application of national technology coefficients to regional total use |
| Step 7. | Confrontation with available regional technology data |
| Step 8. | Estimation of missing "technology" data (household consumption, etc) |
| Step 9. | Application of national foreign import coefficients per cell |
| Step 10. | Confrontation with regional foreign import data from the trade survey |
| **Phase IV** | **Construction of the regional domestic sales table** |
| Step 11. | Confrontation of official regional foreign export data with foreign export coefficient from survey |
| Step 12. | Determination of the regional domestic sales coefficients |
| Step 13. | Application of regional domestic sales coefficients to regional total domestic sales |
| **Phase V** | **Construction of the intra-regional transaction table** |
| Step 14. | Determination per cell of maxima for intra-regional transactions and minima for regional domestic imports and regional domestic exports and confrontation these minima with data from the survey |
| Step 15. | Application of cell-specific domestic export coefficients to the domestic sales table and reduction of remaining cells from the maximum intra-regional transaction table to reach the trade survey's overall regional domestic export coefficients per sectors |
| Step 16. | Plausibility verification of the preliminary regional domestic import coefficients and confrontation with the import coefficients available from the trade survey |
| Step 17. | Determination of the final intra-regional transaction table through selective collection of additional data and revision of earlier estimate |
| **Phase VI** | **Construction of the bi-regional input-output table** |
| Step 18. | Calculation of the regional domestic exports table |
| Step 19. | Calculation of the regional domestic imports table |
| Step 20. | Calculation of the intra-regional transaction table for the rest of the country |

Source : Boomsma and Oosterhaven, 1992

## 3. THE GIRIOT PROCEDURE

### 3.1. Four Basic Considerations

The GIRIOT procedure developed in this paper was designed to conform with four important considerations. The first consideration was that the procedure be applicable to the construction of either single-region input-output tables or inter-regional input-output tables. A combination of GRIT II and GRIT III procedures was judged appropriate since the combination of the procedures will provide a facility in which either the single-region or the many-region input-output tables can be constructed. To generate an inter-regional table, the complete GIRIOT procedure should be followed but only certain procedures need to be followed for the generation of single-region tables. Some modifications of GRIT II and GRIT III were required to satisfy the first and the following considerations.

The second consideration was that the non-survey techniques employed in the procedure be able to provide the most accurate initial estimates so that the cells or sectors that do not receive superior data are as accurate possible. For this purpose, the procedure had to ensure three important factors: (1) that the difference in regional technology could be taken into account; (2) that more accurate techniques could be employed to estimate the intra-regional input coefficients; and (3) that more appropriate techniques could be provided to estimate the inter-regional input coefficients for a developing country's island economy.

The third consideration was that superior data could be inserted at any stage of the table construction. This characteristic is important since it is anticipated that superior data could be available at any level of disaggregation, from highly disaggregated to highly aggregated and in any form, in coefficients or in flows.

The fourth consideration was that the procedure be open to professional judgment. Conforming with this final consideration is very important for ensuring that, first, the procedure produces a model that represents the structure of the economy being studied, and second, that the results, in the form of multipliers, represent reality within acceptable professional norms.

### 3.2. The Procedure

The proposed procedure is a modification as well as a combination of GRIT II and GRIT III procedures (West, Wilkinson & Jensen, 1980; West, Morison & Jensen, 1982; West et al.,1989). The GIRIOT procedure consists of three stages, seven phases and twenty four-steps (Table 3).

Stage I : Estimation of regional technical coefficients, consists of two phases: Phase 1, Derivation of national technical coefficients; and Phase 2, Adjustment for regional technology. Stage II: Estimation of regional input coefficients, consists of two phases: Phase 3, Estimation of intra-regional input coefficients; and Phase 4, Estimation of inter-regional input coefficients. Stage III: Derivation of transaction tables, consists of three phases: Phase 5, Derivation of initial transaction tables; Phase 6, Sectoral aggregation; and Phase 7, Derivation of final transaction tables.

#### 3.2.1. Estimation of Regional Technical Coefficients

This first stage provides an estimation of regional technical coefficients. As stated earlier this stage consists of two phases: Phase 1, Derivation of national technical coefficients; and Phase 2, Adjustment for regional technology.

**Phase 1: Derivation of National Technical Coefficients.** The national technical coefficients are derived from the national input-output table in which imports are allocated indirectly and at producer prices (Step 1). In case the national tables are only available with direct allocation of imports, the national tables must be adjusted by "adding-back" the national imports to derive the national technical coefficients from the national input coefficients, in the same way as in GRIT (see Jensen, Mandeville & Karunaratne, 1979).

Step 2 converts the national transaction flows into coefficients by dividing the flows by total input (${}^{n}X_{ij}/{}^{n}X_{j}$), so that :

$${}^{n}a_{ij} = ({}^{n}X_{ij}/{}^{n}X_{j}) \quad \text{for } i, j = 1,2,\ldots\ldots n \qquad (1)$$

where ${}^{n}a_{ij}$ is the national technical coefficient, ${}^{n}X_{ij}$ is the amount of industry *i* that is used by industry *j* at national level, and ${}^{n}X_{j}$ is national total input of industry *j*.

Step 3 provides an option for updating the national regional technical coefficients to reflect price and technological changes.

**Phase 2: Adjustment for Regional Technology.** Regional technology might be similar to or different from its at national counterpart, therefore, Phase 2, Adjustment for regional technology, provides an adjustment for regional technology differences. Step 4 provides a procedure for adjusting for regional technical differences. Several techniques are available. However, data are only available for regional gross output (${}^{r}X_{i}$), which are the same as total regional input (${}^{r}X_{j}$), and regional value-added (${}^{r}V_{j}$).

Table 3.
**Hybrid procedures for generating inter-regional input-output tables (GIRIOT) for a developing country's island economy**

| | |
|---|---|
| **Stage I.** | **Estimation of regional technical coefficients** |
| **Phase 1.** | **Derivation of national technical coefficients** |
| Step 1. | Preparation of national input-output tables |
| Step 2. | Calculation of national technical coefficients |
| Step 3. | Updating for price and technological change |
| **Phase 2.** | **Adjustment for regional technology** |
| Step 4. | Adjustment for regional technology differences |
| Step 5. | Separation of non-competitive imports coefficients |
| Step 6. | Insertion of superior data |
| **Stage II.** | **Estimation of regional input coefficients** |
| **Phase 3.** | **Estimation of intra-regional input coefficients** |
| Step 7. | Estimation of domestic trade flows |
| Step 8. | Calculation of total competitive imports |
| Step 9. | Calculation of total competitive import ratio |
| Step 10. | Estimation of regional competitive import coefficients |
| Step 11. | Derivation of intra-regional input coefficients |
| **Phase 4.** | **Estimation of inter-regional input coefficients** |
| Step 12. | Calculation of total domestic imports |
| Step 13. | Estimation of inter-regional flows |
| Step 14. | Calculation of inter-regional import ratio |
| Step 15. | Derivation of inter-regional input coefficients |
| Step 16. | Insertion of superior data |
| **Stage III.** | **Derivation of transaction tables** |
| **Phase 5.** | **Derivation of initial transaction tables** |
| Step 17. | Preparation of a complete coefficient table |
| Step 18. | Derivation of initial transaction table |
| Step 19. | Insertion of superior data and adjustments |
| Step 20. | Calculation of inverses and multipliers for the initial table |
| **Phase 6.** | **Sectoral aggregation** |
| Step 21. | Aggregation of sectors |
| Step 22. | Insertion of aggregated superior data and balancing |
| **Phase 7.** | **Derivation of final transaction tables** |
| Step 23. | Final superior data insertions and other adjustments |
| Step 24. | Consistency check and sensitivity analysis |

To calculate the total regional intermediate input ratio, the column adjustment technique of Round (1978; 1983) is more applicable for the initial estimation of regional technical coefficients. The initial regional technical coefficients, ($^{r*}a_{ij}$) are estimated by adjusting the national technical coefficients ($^{n}a_{ij}$) so that :

$$^{r*}a_{ij}=[(\Sigma^{r}a_j)/(\Sigma^{n}a_{ij})](^{n}a_{ij}) \text{ for } i,j=1,2,\ldots n \quad (2)$$

where :

$^{r*}a_{ij}$ = initial regional technical coefficients

$(\Sigma^{r}a_j)$ = total regional intermediate input coefficient sector $j$, calculated as :

$(\Sigma\,^{r}a_j) = (^{r}X_j - {}^{r}V_j)/(^{r}X_j)$

$(\Sigma^{n}a_{ij})$ = total national intermediate input sector $j$

$^{n}a_{ij}$ = national technical coefficients

$^{r}X_j$ = total regional input sector $j$

$^{r}V_j$ = regional value-added sector $j$

The above initial regional technical coefficients still contain import components made up of competitive and non-competitive imports.

Step 5 separates the non-competitive imports from the initial regional technical coefficients, resulting in $^{r**}a_{ij}$; the regional technical coefficients in which the non-competitive imports have been separated out. The regional non-competitive imports are identified by checking whether the sectors or industries exist in the region:

$$^{r}X_i \begin{cases} > 0 \text{ then } {}^{r**}a_{ij} = {}^{r*}a_{ij} \text{ for } i,j = 1,2,\ldots n \\ =0 \text{ then } {}^{r**}a_{ij} = 0 \text{ for } i,j = 1,2,\ldots n \end{cases} \quad (3)$$

If a sector exists in the region, $^{r}X_i > 0$ then set $^{r**}a_{ij}$ equals $^{r*}a_{ij}$ for all $j$. If a sector does not exist in the region, $^{r}X_i = 0$, set $^{r**}a_{ij} = 0$ for all $j$. This means that the value of regional technical coefficients for the $i$th row are zero.

Total regional non-competitive import coefficients for sector $j$ ($\Sigma^{r}nm_j$) are calculated as:

$$\Sigma\,^{r}nm_j = \Sigma\,^{r*}a_{ij} - \Sigma\,^{r**}a_{ij}, \text{ for } i,j = 1,2,\ldots n \quad (4)$$

This procedure should also be employed to separate non-competitive imports of final demand, especially those of household consumption and other final demand.

Step 6 provides for the insertion of more reliable, superior data on commodity or sectoral cost structures of production, if they are available for the region. Attempts to insert more reliable data of regional technical coefficients should focus on the sectors that are generally resource-based, namely those sectors whose technology varies considerably by region. Lahr (1993) identified the three sectors where the technology varies considerably by location: agriculture; extractive industry; and miscellaneous industries. For every province in Indonesia, the cost structure data for some agricultural commodities, mining and quarrying, and for almost all manufacturing sectors are usually available.

Up to this phase, which compares with Phase 1 of GRIT II, the GIRIOT procedure provides a more accurate initial estimation since the difference between national and regional technology is adjusted. GRIT assumes that regional technology is the same as its national counterpart so that national technical coefficients can be used as substitutes for regional technical coefficients. This assumption might be more appropriate for a more developed country's mainland economy like Australia where spatial variations in technical structure are not significant. For Indonesia, it is evident that regional variations in technical structure exist.

### 3.2.2. Estimation of Regional Input Coefficients

After the national technical coefficients are regionally adjusted to derive more accurate regional technical coefficients, Stage 2 provides a procedure for the estimation of regional input coefficients. Phase 3 estimates the intra-regional input coefficients, namely locally supplied regional inputs. Phase 4 estimates the inter-regional input coefficients, that is, those inputs that come from other regions within the country.

**Phase 3 : Estimation of Intra-regional Input Coefficients**. The intra-regional input coefficients are the coefficients of regional inputs in which the regional import components have been separated from the regional technical coefficients. In other words, the intra-regional input coefficients are the coefficients of locally supplied regional inputs.

The objective of Phase 3 is to derive the intra-regional input coefficients ($^{rr}a_{ij}$) by separating the regional competitive imports ($^{r}cm_{ij}$) from the regional technical coefficients ($^{r}a_{ij}$). Since the regional technical coefficients have been estimated previously, the main task in this phase is to estimate the regional competitive import coefficients ($^{r}cm_{ij}$) :

$$^{r}cm_{ij} = (^{r}CM_{ij})/(^{r}X_j) \text{ for } i,j = 1,2,\ldots n \quad (5)$$

Unfortunately, data on $^{r}CM_{ij}$ are usually not available. This requires, therefore, an estimation of the regional competitive import coefficients from data on total regional competitive imports ($^{r}CM_i$).

Two approaches are commonly employed for estimating import matrices. The most popular is the row-only approach which employ techniques such as location quotients (LQ), supply-demand pool (SDP), regional purchase coefficients (RPC), and regional supply percentage (RSP). The analogy to the row-only approach is the approach that is applied to columns-only where a matrix of imports ($^{r}cm_{ij}$) can be created by multiplying the diagonal import proportion ($^{r}cm_j$) by the corresponding columns of the regional technology matrix ($^{r}a_{ij}$). This column approach input coefficient matrix is referred to as the regional input proportion (RIP) technique.

Since the first approach is row average and the second one is column average, neither approach is likely to generate a partitively accurate matrix of regional imports. Two different regional input matrices will then be obtained. This GIRIOT procedure proposes reconciling the results of the two approaches using the RAS procedure.

The two sources of total regional competitive imports ($^{r}CM_i$) are international (foreign) imports ($^{fr}CM_i$), which provide regional (provincial) data; and inter-regional (domestic) imports ($^{dr}CM_i$), which provide data from other regions within the country. Since international import data are available, the main task of this phase is to estimate the domestic competitive imports first by estimating domestic trade flows.

Based on the structure of the input-output table in which imports are indirectly allocated, the estimation of domestic competitive imports are as follows:

$$\sum {}^{r}a_{ij}\, {}^{r}X_j + {}^{r}F_i - {}^{r}M_i = {}^{r}X_i \qquad (6)$$
$${}^{r}F_i = {}^{r}H_i + {}^{r}O_i + {}^{r}E_i \qquad (7)$$
$${}^{r}E_i = {}^{fr}E_i + {}^{dr}E_i \qquad (8)$$
$${}^{r}M_i = {}^{rf}M_i + {}^{rd}M_i \qquad (9)$$

where :

$^{r}a_{ij}$ = regional technical coefficients
$^{r}X_j$ = regional input
$^{r}X_i$ = regional output
$^{r}F_i$ = final demand, that consists of :
$^{r}H_i$ = household consumption, and
$^{r}O_i$ = other final demand
$^{r}E_i$ = regional exports, that consist of
$^{fr}E_i$ = regional exports to foreign country and
$^{dr}E_i$ = regional exports to other regions within the country
$^{r}M_i$ = regional competitive imports, that consist of
$^{rf}M_i$ = regional competitive imports from f foreign country
$^{rd}M_i$ = regional competitive imports from other regions in the country

Substituting (7), (8) and (9) into (6) results in:

$$\sum {}^{r}a_{ij}\, {}^{r}X_j + {}^{r}H_i + {}^{r}O_i + {}^{fr}E_i + {}^{dr}E_i - ({}^{rf}M_i + {}^{rd}M_i) = {}^{r}X_i \qquad (10)$$

Rearranging the above equation, the regional net domestic flows are calculated as:

$$({}^{dr}E_i - {}^{rd}M_i) = [{}^{r}X_i - (\sum {}^{r}a_{ij}\, {}^{r}X_j + {}^{r}H_i + {}^{r}O_i + {}^{fr}E_i) + {}^{rf}M_i] \qquad (11)$$

If ($^{dr}E_i$ - $^{rd}M_i$) is positive, it means that domestic competitive exports are larger than regional competitive imports. In net terms, the region is assumed to export goods and services to other regions within the country. Otherwise, if ($^{dr}E_i$ - $^{rd}M_i$) is negative, the region is assumed to import goods and services from other regions within the country.

Domestic competitive imports are then formulated as :

$$ {}^{dr}CM_i = \begin{cases} 0 & \text{for } ({}^{dr}E_i - {}^{rd}M_i) > 0 \\ ({}^{dr}E_i - {}^{rd}M_i) & \text{for } ({}^{dr}E_i - {}^{rd}M_i) < 0 \end{cases} \qquad (12)$$

Step 8 calculates total competitive imports ($^{r}CM_i$) as the sum of foreign competitive imports ($^{fr}CM_i$) and domestic competitive imports ($^{dr}CM_i$) so that:

$${}^{r}CM_i = {}^{fr}CM_i + {}^{dr}CM_i \qquad (13)$$

Step 9 calculates the ratio of total competitive imports. This step employs the generalised RSP technique introduced by Lahr (1992) for row-only estimation and the generalised RIP technique for column-only estimation. Assuming that exports comprise local and imported goods and services in certain proportions, these techniques can easily handle a situation where regional exports and/or imports are larger than regional output, a situation that is likely in port cities. The simplest variant of the technique employed in this procedure assumes that local and imported exports are in the same proportion and calculated as :

$${}^{r}cm_i = ({}^{r}CM_i) / ({}^{r}X_i + {}^{r}CM_i) \qquad (14)$$

where :

$^{r}CM_i$ = Total competitive imports of region *r* for sector *i*.
$^{r}X_i$ = Total input region *r* for sector *i*.

This formulation is the analog for the column-only approach by replacing *i* (row) with *j* (column).

This step also derives a diagonal matrix of RSP and RIP that can be employed to in derive the intra-regional input coefficients in Step 11. The elements of the diagonal RSP matrix can be calculated as :

$${}^{r}s_i = ({}^{r}X_i)/({}^{r}X_i + {}^{r}CM_i) \qquad (15)$$

which equals (1 - $^{r}cm_i$). The elements of the diagonal RIP matrix are calculated as :

$${}^{r}i_j = ({}^{r}X_i)/({}^{r}X_i + {}^{r}CM_i) \qquad (16)$$

Step 10 estimates the regional competitive import coefficient matrix (with elements of $^{r}cm_{ij}$) by multiplying the diagonal matrix of the total import ratio (with diagonal elements of $^{r}cm_i$), calculated in Step 9, by the regional technical coefficient matrix ($^{r}a_{ij}$) of Step 6, by row and column-only.

for row-only allocation :

$${}^{r}cm_{ij} = \sum ({}^{r}cm_i)({}^{r}a_{ij}) \text{ ; for } i, j = 1,2,\ldots n. \qquad (17)$$

for column only allocation :

$${}^{r}cm_{ij} = \sum ({}^{r}a_{ij})({}^{r}cm_j)\text{; for } i, j = 1,2,\ldots n. \qquad (18)$$

Using the RAS procedure (where the coefficients matrix is first transformed into transactions by multiplying it with the vector of the total regional input), the above import matrices could be reconciled.

Step 11 calculates the intra-regional input coefficients ($^{rr}a_{ij}$) in one of the following ways. The first method separates the competitive import coefficients ($^{r}cm_{ij}$) from the regional technical coefficients ($^{r}a_{ij}$) so that :

$$^{rr}a_{ij} = {}^{r}a_{ij} - {}^{r}cm_{ij} \text{ for } i, j = 1,2,\ldots n. \quad (19)$$

An alternative method can also be used to cross-check the results of the first method. This method involves multiplication of the diagonal matrix of RPC by the matrix of regional technology for row-only estimation, or by multiplying the regional technology matrix with the diagonal matrix of RIP for column-only estimation.

In row-only estimation, the intra-regional input coefficients are calculated as:

$$^{rr}a_{ij} = \sum ({}^{r}s_{i}) ({}^{r}a_{ij}) \text{ for } i, j = 1,2,\ldots n. \quad (20)$$

In column-only estimation, the intra-regional input coefficients are calculated:

$$^{rr}a_{ij} = \sum ({}^{r}a_{ij}) ({}^{r}i_{j}) \text{ for } i, j = 1,2,\ldots n. \quad (21)$$

Using RAS these two matrices of regional input coefficients are reconciled. Total intra-regional input coefficients, ($\sum^{rr}a_{ij}$) should be equal to the difference between the total regional technical coefficients ($\sum^{r}a_{ij}$) and the total competitive import coefficients:

$$(\sum{}^{rr}a_{ij}) = (\sum{}^{r}a_{ij}) - (\sum{}^{r}cm_{ij}) \quad \text{for } i, j = 1,2,\ldots n. \quad (22)$$

where: $(\sum {}^{r}cm_{ij}) = {}^{r}cm_{j}$. The total regional competitive imports are then inserted in the import competitive row of the table.

The results of this phase are the coefficients of intra-regional inputs ($^{rr}a_{ij}$) where the competitive import components were separated from regional technical coefficients.

This step also derives the intra-regional household consumption and other final demand by separating out their component of competitive imports. This results in intra-regional household consumption and intra-regional other final demand.

Generating a single-region table requires continuing to Stage III, starting from Step 17 to derive the initial transaction tables. To construct an inter-regional table, repeat Step 1 to Step 11 to estimate the intra-regional input coefficients of each region in the nation or the system of regions, then continue to Phase 4.

**Phase 4: Estimation of Inter-regional Input Coefficients.** Phase estimates the inter-regional input coefficients. Ideally, if trade flow data are available in the form of region and sector of origin to region and sector of destinations, as in the pure, ideal approach of Isard (1951), they can be used directly for the estimation of inter-regional input coefficients. However, these data are not available, not only for Indonesia, but also for many other countries in the world. The main task in this phase, therefore, is to decompose total inter-regional imports ($^{dr}M_{j}$) into sector and region of origin and destination.

Step 12 calculates the total inter-regional imports ($^{dr}M_{j}$). Since data on foreign imports are more reliable because they are well-documented, the non-competitive imports calculated in Step 5 are assumed to come from domestic sources only, not from foreign sources. The total inter-regional imports will then consist of the non-competitive imports ($^{r}NM_{j}$) and the domestic competitive imports ($^{dr}CM_{j}$) so that :

$$^{dr}M_{j} = {}^{r}NM_{j} + {}^{dr}CM_{j} \quad \text{for } j = 1,2,\ldots n. \quad (23)$$

where :

$^{dr}M_{j}$ = total inter-regional imports

$^{r}NM_{j}$ = regional non-competitive imports

$^{dr}CM_{j}$ = domestic competitive imports

Step 13 estimates the inter-regional import flows, that is, imports by region of origin and destinations for every sector ($^{sr}X_{j}$). This occurs by disaggregating the total of the inter-regional imports calculated in Step 12, so that :

$$\sum {}^{sr}X_{j} = {}^{dr}M_{j} \quad \text{for } j = 1,2,\ldots n. \quad (24)$$

The transport pattern will be used first to estimate the inter-regional imports of region *r* that come from region *s* for commodity/sector *j* ($^{sr}X_{j}$). Furthermore, for those who have no transport pattern data available, the estimation process focuses on the non-zero total inter-regional imports. Many modelling techniques are available depending on the types of regional trade data available. In Indonesia, those sectors are expected to be service sectors in which population distribution plays an important role in determining the flows of the services. The total inter-regional imports are then allocated into the region of origin and destination. The allocation is based on the pattern of population distribution since this approach seems more appropriate for an island economy.

Step 14 provides a calculation of inter-regional import ratios ($^{sr}a_{j}$). The ratios are defined as a proportion of the inter-regional imports ($^{sr}X_{j}$), estimated in Step 13 to total regional inputs ($^{r}X_{j}$) so that :

$$^{sr}a_{j} = ({}^{sr}X_{j}) / ({}^{r}X_{j}) \quad (25)$$

where :

$^{sr}a_{j}$ = inter-regional import ratio of sector *j*

$^{sr}X_{j}$ = inter-regional imports of sector *j* that come from region *s*

$^{r}X_{j}$ = total regional input of sector *j*

Step 15 derives the inter-regional input coefficients ($^{sr}a_{ij}$) by allocating the inter-regional import ratio ($^{sr}a_{j}$) into the inter-regional inter-industry cells following the pattern of regional imports. As in Step 10, two approaches of allocation can be performed at this stage: by row-only; and by column-only estimation. In row-only estimations, the inter-regional input coefficients are estimated as :

$^{sr}a_{ij} = \sum(^{sr}a_j)(^{rr}a_{ij})$ for $i, j = 1,2, \ldots, n$ and $r, s = 1,2, \ldots m$ (26)

and in column-only estimation, the inter-regional input coefficients are calculated as:

$^{sr}a_{ij} = \sum(^{rr}a_{ij})(^{sr}a_j)$ for $i, j = 1,2, \ldots, n$ and $r, s = 1,2, \ldots m$. (27)

Since zero domestic trade balance is only required at the national level, it is not necessary for the total domestic imports to equal total domestic exports at the regional level. Row and column reconciliation is therefore required at this step.

This technique of estimation is different to that used by Riefler and Tiebout (1970). The Riefler-Tiebout procedure follows the imports pattern of the region but ignores the existence of regional non-competitive imports. This proposed technique is believed to provide more accurate estimation because it takes into account the existence of regional non-competitive imports.

Furthermore, Step 16 provides the opportunity to insert more reliable data, especially when Isard's type data are available.

### 3.3.3. Derivation of Transaction Tables

The third stage of the procedure consists of three phases: derivation of initial transaction tables (Phase 5); sectoral aggregation (Phase 6); and derivation of final transaction tables (Phase 7). During this stage, either the single-region tables or the inter-regional tables can be generated.

**Phase 5 : Derivation of Initial Transaction Tables.** Phase 5 provides for the derivation of initial transaction tables. Step 17 prepares a complete coefficient table by putting together all the coefficients in one table. To generate a single-region table, only the coefficients of the region concerned are arranged. To generate an inter-regional table, however, all single-region coefficients that consist of the intra-regional input coefficients as well as the inter-regional input coefficients are arranged.

Step 18 derives an initial transaction table. Coefficients in each column are multiplied by the total regional input ($^rX_j$) to obtain first estimates of transactions. In this step, the value of final demand quadrants are also put together into the table to complete the prototype table. Conventionally, the components of final demand are household consumption, government expenditure, capital formulation, change in stock, and exports. Only two components of final demand are used frequently in regional analysis, namely, household consumption and exports, therefore, they are shown separately while the others are aggregated as other final demand.

Many studies show that the household sector has a very important role in regional economy (Stevens & Trainers, 1980; Park, Mohtadi & Kurubusi, 1981; Cochrane, 1990; Lahr, 1993). This sector is also one of the sources of error in regional multipliers. The household column, therefore, should be based on the most reliable data available. In Indonesia every province publishes data on household expenditure surveys. The estimation of regional exports also relies on the use of superior data. Where the Central Bureau of Statistics publishes national statistics of imports and exports annually these data are broken down by commodity and by province.

In Step 19, more reliable data are inserted should they be available, and other final demand and other value-added are adjusted so that the total output equals the total input. The RAS technique is employed for balancing and reconciling the table.

Step 20 calculates multipliers of the initial table. The inter-regional multipliers are compared to the single-region multipliers. Sectoral multipliers of a region are also compared to those of other regions. Inter-regional feed-back effects are calculated.

**Phase 6: Sectoral Aggregation.** In Phase 6, sectors are aggregated in Step 21. Since all the sectors are in transaction form no aggregation problems arise in this step. Ideally, if a table is constructed for general purposes, the level of aggregation is better kept as disaggregate as possible. However, increasing the accuracy of the table by inserting more reliable data will depend on the level of aggregation of the superior data available. If superior data are available at the same level of disaggregation, no aggregation is required. If superior data are only available at a more aggregate level, however, the table should be aggregated so that the table and the data are in the same level of aggregation. Insertion of aggregated superior data and balancing is provided for in Step 22.

**Phase 7: Derivation of Final Transaction Tables.** Finally, final transaction tables are derived in Phase 7. However, Step 23 still provides some opportunities for the insertion of superior data to improve the accuracy of the table. In Step 24, the last step, final transaction tables are generated by ensuring that regional trade is balanced. As well, the table consistency is checked, and a complete sensitivity analysis is conducted. Inverses and multipliers are calculated.

## 4. EMPIRICAL APPLICATION TO THE INDONESIAN DATA

### 4.1. Regional Definitions

At least three definitions of regions have been adopted in the literature: homogenous regions; nodal regions; and planning or administrative regions (Blair, 1991; Richardson, 1969).

The concept of a homogenous region is based on the view that spatial units might be linked together as a single region when they have uniform characteristics. These characteristics might be economic (e.g. similarities in production structure or consumption patterns); geographical (e.g. similarities in topography or climate); social or political (e.g. similarities in regional identity or traditional party allegiances). The task of defining regional boundaries is more difficult when regions are uniform in some respects but dissimilar in others.

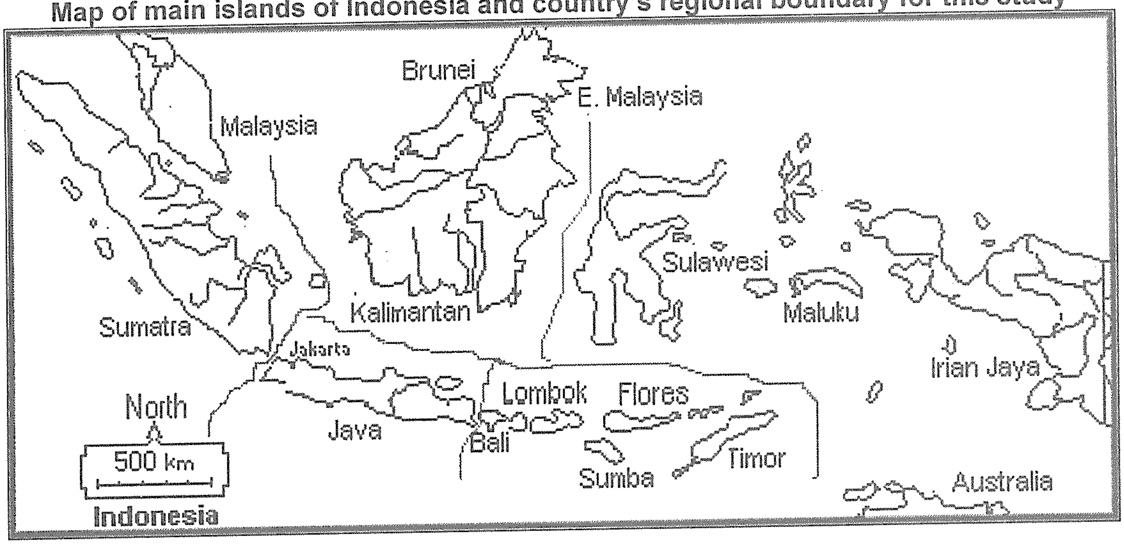
It is evident that differences in economic phenomena exist between regions. Most regions comprise urban and rural areas. Moreover, large areas are likely to exhibit an uneven distribution of population with greater numbers in urban centres and fewer people in some rural areas. Acceptance of the lack of uniformity in the space economy leads to the second concept of regions: nodal regions. These regions are composed of closely and functionally interrelated heterogenous units both internal and external. Internally, the functional linkages occur through trade and service connections within the region. Externally, production links, trade links, transportation networks, communication networks, migration networks and the flow of raw materials and manufactured goods connect a particular region to other regions as well as the rest of the world.

The third classification for regions requires dividing a nation into planning or administrative regions. These division are important questions arise concerning regional policy and planning. Since implementing regional policy presupposes power to act then these regions need to be defined as administrative areas with political jurisdiction of various sizes and levels.

In research, the choice of an ideal region depends mainly on the purpose of the study of the regions, the overall structure of the regions, and the degree of integration of the regional system as a whole. It is easier to divide a nation into regions if a number of areas have clearly defined economic structures. However, the choice of regional boundaries becomes more difficult and arbitrary where clearly marked geographic areas of economic specialisation are not evident.

Ideally, the regions defined for an input-output analysis should demonstrate reasonably stable intra-regional as well as inter-regional trade coefficients. They should also conform to production areas that exhibit local economic structure (West, Morison & Jensen, 1982; West et al., 1989).

Figure 1.
**Map of main islands of Indonesia and country's regional boundary for this study**



In a developing ccuntry in general, and in Indonesia in particular, governments tend to intervene directly or indirectly in economic activity through policy formulation and planning. Direct intervention is usually implemented through the government's administrative hierarchy, from the highest level (e.g. central and provincial governments) to the lowest level (e.g rural and sub-district governments). For the construction of inter-regional input-output tables for Indonesia, the nation was divided into regions based on the country's administrative units because statistical data are available on every stage of administrative level.

Administratively, Indonesia comprises 24 provinces and 3 special territories. For the purpose of modelling the spatial structure of the island economy of Indonesia, the division of the nation into regions was based on the five main island groups. Based on data so far available, the national economy was disaggregated into five regions: (1) Sumatra (SUM), consisting of all provinces in Sumatra as well the special territory of Aceh; (2) Java (JAV), including all three provinces of the island plus its two special territories, (3) Kalimantan (KAL), comprising of four provinces; (4) Nusa Tenggara (NUS), which includes Bali, West Nusa Tenggara, East Nusa Tenggara and East Timor; and (5) Other eastern islands (OTH), which consists of all provinces in Sulawesi, Maluku and Irian Jaya.

Figure 1 shows the main islands of Indonesia and the country's regional boundaries for the purpose of this study. Table 4 provides a list of the names of the regions, including the provinces comprising the regions.

Table 4.
**Regional definitions for generating of inter-regional input-output tables (GIRIOT) for Indonesia**

| No. | Region/island | Province |
|---|---|---|
| 1. | Sumatra (SUM) | 1. Special Territory of Aceh<br>2. North Sumatra<br>3. West Sumatra<br>4. Riau<br>5. Jambi<br>6. South Sumatra<br>7. Bengkulu<br>8. Lampung |
| 2. | Java (JAV) | 9. Special Territory of Greater Jakarta<br>10. West Java<br>11. Central Java<br>12. Special Territory of Yogyakarta<br>13. East Java |
| 3. | Kalimantan (KAL) | 14. West Kalimantan<br>15. Central Kalimantan<br>16. South Kalimantan<br>17. East Kalimantan |
| 4. | Nusa Tenggara (NUS) | 18. Bali<br>19. West Nusa Tenggara<br>20. East Nusa Tenggara<br>21. East Timor |
| 5. | Other islands (OTH) | 22. North Sulawesi<br>23. Central Sulawesi<br>24. South Sulawesi<br>25. South-East Sulawesi<br>26. Maluku<br>27. Irian Jaya |

## 4.2. Sectoral Classification

In an input-output model, the number of intermediate sectors and the formal classification of those sectors are determined mainly by the aim of the model's construction. The number of sectors varies from highly-disaggregated tables to highly-aggregated tables.

A high level of disaggregation (i.e. tables with a large number of sectors) has the advantage of providing more detailed specification of an economy. They also identify give significant features of the table with more accuracy. The disadvantage of a high level of disaggregation, however, is a concomitant high cost for constructing the table. For an inter-regional table, a high level of disaggregation can magnify the size of the table, so that the table becomes difficult to visualise.

More aggregated tables (i.e. tables with few sectors) have the advantage of visual simplicity. However, they have two important disadvantages. First, as the aggregation proceeds from establishment into groups of establishments or into broad sectors, it will include more groups of establishments which are less homogenous in term of products as well as in terms of input structure. An aggregate table would be sufficient for a simple exercise. For analytical research, however, a table of this type could not only blur important relationships, but also be quite misleading. The second weakness of the highly-aggregated table is that it makes it impossible for the analyst to identify any economic activity other than that of major economic aggregates. The fewer the sectors in a table, the more restricted its use for specific the purposes of studying economic interdependence.

Table 5.
**Sectoral classification for generating inter-regional input-output tables (GIRIOT) for Indonesia**

| No. | 9-Sector Classification | No. | 28-Sector Classification |
|---|---|---|---|
| 1. | Agriculture, livestock, forestry and fishery | 01. | Food crops |
| | | 02. | Estate crops |
| | | 03. | Livestock |
| | | 04. | Forestry |
| | | 05. | Fishery |
| 2. | Mining and quarrying | 06. | Oil and gas mining |
| | | 07. | Non-oil and gas mining |
| 3. | Manufacturing | 08. | Food, beverages and cigarettes |
| | | 09. | Textiles |
| | | 10. | Wood processing |
| | | 11. | Paper and printing |
| | | 12. | Chemical and rubber products. |
| | | 17. | Machines and electrical machines |
| | | 18. | Transport equipment |
| | | 13. | Non-metallic mineral products |
| | | 14. | Iron and steel |
| | | 15. | Non-ferrous basic metal products |
| | | 16. | Fabricated metal products |
| | | 19. | Other manufactured products |
| 4. | Electricity, water and gas | 20. | Electricity, water and gas |
| 5. | Construction | 21. | Construction |
| 6. | Trade, hotels and restaurants | 22. | Trade |
| | | 23. | Hotels and restaurants |
| 7. | Transportation and communication | 24. | Transportation and communication |
| 8. | Banking and other finance | 25. | Banking and other finance |
| 9. | Other services | 26. | Public administration and defence |
| | | 27. | Other services |
| | | 28. | Unspecified |

The decision regarding the number of sectors in input-output tables will also be constrained by data availability and the resources available for data collection. Even though the national input-output table of Indonesia provides a 66-sector classification, sectoral disaggregation at provincial level is still very limited to about a half of the national level. So far, the most common sectoral classifications use 9, 11, 15, 19 or 22 sectors. The National Development Planning Agency (NDPA), disaggregated the regional economy into 25 sectors using the Statistics of Regional Income. Recently, the Indonesian Central Bureau of Statistics (CBS) provided an estimation of regional gross-output, value added, and employment, as well as foreign exports and imports data, for a 28-sector classification.

After an intensive consultation of key persons at CBS and NDPA, this spatial structure study uses the 28-sector classification of CBS since this is the only classification available at the most consistent disaggregation level. For general purposes it is advisable to keep the table as disaggregate as possible. However, since some superior data are only available at higher aggregate levels, this study used a 9-sector classification which is presented in Table 5.

### 4.3. Data and Their Source

The availability of data largely determines the estimation procedure and its accuracy in regard to the construction of inter-regional input-output tables. This section describes the data used in applying the GIRIOT procedure and their sources. The following publications from CBS were the main data sources of the GIRIOT:

- Biro Pusat Statistik, Badan Perencanaan Pembangunan Nasional and Japan International Cooperation Agency, 1995, **Tabel input-output intra-regional Indonesia menurut 5 pulau/kepulauan 1990** *(Indonesia's intra-regional input- output tables by islands 1990)*, Kerjasama Biro Pusat Statistik, Badan Perencanaan Pembangunan Nasional dan Japan International Cooperation Agency *(Joint Project: Central Bureau of Statistics, National Development Planning Agency and the Japan International Cooperation Agency)*, Jakarta.
- Biro Pusat Statistik, 1994a, **Tabel input-output Indonesia 1990** (*Indonesian input-output table 1990*), Jilid 1 dan Jilid 2 (*Volume 1* and *Volume 2*), Biro Pusat Statistik (*Central Bureau of Statistics*), Jakarta.
- Biro Pusat Statistik, 1994b, **Produk domestik regional bruto propinsi-propinsi di Indonesia menurut lapangan usaha 1987-1991** (*Gross regional domestic product of provinces in Indonesia by industrial origin 1987-1991*), Biro Pusat Statistik (*Central Bureau of Statistics*), Jakarta.
- Biro Pusat Statistik, 1994c, **Produk domestik regional bruto propinsi-propinsi di Indonesia menurut penggunaan 1987-1991** (*Gross regional domestic product of provinces in Indonesia by expenditure 1987-1991*), Biro Pusat *Statistik (Central Bureau of Statistics)*, Jakarta.
- Biro Pusat Statistik, 1991a, **Statistik perdagangan luar negeri Indonesia, Import 1990** (*Indonesia foreign statistics, Imports 1990*), Jilid 1 (*Volume 1*), Biro Pusat Statistik (*Central Bureau of Statistics*), Jakarta.
- Biro Pusat Statistik, 1991b, **Statistik perdagangan luar negeri Indonesia, Ekspor 1990** (*Indonesia foreign statistics, Exports 1990*), Jilid 2 (*Volume 2*), Biro Pusat Statistik (*Central Bureau of Statistics*), Jakarta.
- Departemen Perhubungan and Biro Pusat Statistik, 1992, **Statistik angkutan laut 1990** (*Sea transport statistics 1990*), Departemen Perhubungan dan Biro Pusat Statistik (*Department of Transport and Central Bureau of Statistics*), Jakarta
- Biro Pusat Statistik, 1992a, **Statistik bongkar muat barang di pelabuhan Indonesia 1990** (*Cargo loading and unloading at ports of Indonesia 1990*), Biro Pusat Statistik (*Central Bureau of Statistics*), Jakarta
- Biro Pusat Statistik, 1992b, **Survey sosial ekonomi nasional, Buku 3: Pengeluaran untuk konsumsi penduduk Indonesia per propinsi 1990** (*National survey for socio-economy, Book 3: Expenditure for consumption of Indonesia by province 1990*), Biro Pusat Statistik (*Central Bureau of Statistics*), Jakarta.

The two most important data sources were the national input-output table (NIOT) for 1990 from CBS, for 1990 which is available for 66 economic sectors (Biro Pusat Statistik, 1994a) and the intra-regional input-output tables for the five main islands, which provide information for 28 economic sectors (Biro Pusat Statistik, Badan Perencanaan Pembangunan Nasional & Japan International Cooperation Agency, 1995). The NIOT is aggregated into 28 sectors. This aggregation forms the basic framework of the GIRIOT procedure.

Those publications above provided estimates of the 28-sector classification in the following areas: (1) gross-output by region; (2) value-added by region; (3) wages and salaries by region; (4) employment by region; (5) household consumption by region; (6) other final demand by region including government expenditure, capital formation and stock estimation; (7) foreign exports by region; and (8) foreign imports by region. These data became available when CBS, together with NDPA and JICA, prepared five island intra-regional input-output tables for 1990. The methods of estimation were also discussed in these publications.

Other important data for GIRIOT are international and domestic cargo loading and unloading data and domestic transportation data by port of origins and destinations. Converting the data into 28-sector classification allows the pattern of inter-regional trade for primary and secondary sectors to emerge. These data are used to estimate the inter-regional flow of non-zero inter-regional imports from the primary and secondary sectors. Since transport pattern data are not available for service sectors, the estimation of inter-regional flows for these sectors is based on other estimation techniques.

Data on the cost structure for several sectors are also available. For almost all agricultural commodities the cost structure data are published yearly (Biro Pusat Statistik, 1993). For all manufacturing sectors, the cost structure data are also available since every province publishes the industrial statistics yearly and, more generally, every province publishes yearly provincial general statistics. At the national level, the following CBS publications are useful :

- Biro Pusat Statistik, 1991c, **Survey tahunan perusahaan industri besar dan sedang 1990** (*Industrial statistics, Survey of manufacturing industries, Large and medium scale 1990*), Biro Pusat Statistik (*Central Bureau of Statistics*), Jakarta.
- Biro Pusat Statistik, 1991d, **Statistik industri kecil 1990** (*Small scale manufacturing industry statistics 1990*), Biro Pusat Statistik (*Central Bureau of Statistics*), Jakarta.
- Biro Pusat Statistik, 1991e, **Statistik industri kerajian/rumah tangga 1990** (*Household/cottage industry statistics 1990*), Biro Pusat Statistik (*Central Bureau of Statistics*), Jakarta.

For other sectors such as oil and gas mining as well as electricity, water and gas data on the cost structure are also available (Biro Pusat Statistik, 1992c). These data are treated as superior data and inserted when applicable.

### 4.4. Model Validation

It is difficult to validate the inter-regional input-output model produced by GIRIOT procedure as no reliable inter-regional input-output table has been produced for Indonesia. However, in the evaluation of any method of economic model compilation, Jensen (1987) provided important guidance by identifying two fundamental questions that should be answered: Does the method produce a model which is representative of reality within professionally acceptable limits? Do the results of the model have a professionally acceptable level of integrity in the real world ?

To evaluate the procedure designed to generate an inter-regional input-output table for studying the spatial structure of the Indonesian economy, these question can be rephrased thus: (1) Does the procedure produce inter-regional input-output tables that reflect the spatial characteristics of the Indonesian economy ? (2) Do the results, in the form of multipliers, represent reality within acceptable professional norms ?

The first question might be answered by inspecting the structure of inter-regional input-output tables in the most aggregate form. More specifically, it will be answered by inspecting the proportion of regional imports and the pattern of inter-regional trade flows.

Two versions of very similar tables resulted when the procedure was applied to Indonesian data. One version originated from a column-only estimation and the other resulted from a row-only estimation. These two tables were aggregated into a 5-region-1-sector model. The question arises at to which table is more likely to represent the spatial structure of the island economy of Indonesia.

The two tables differ the value of the cells in the intermediate sector, even though the total intermediate input and total intermediate demand were made equal. Inspection therefore, should focus on the intermediate quadrant of the two tables.

Tables 6 and 7 show that the intra-regional coefficients of the table that originated from the column-only estimation are larger than those of the table derived from row-only estimation. Consequently, given that each table received the same amount of total intermediate input, the inter-regional import proportions of the first table are smaller (Table 8). In comparison, the intra-regional coefficients for Sumatra (0.3358), Java (0.3731), Kalimantan (0.2539), Nusa Tenggara (0.2277) and Other Islands (0.2812) of Table 6 are all higher than those of Table 7, the proportion of imports in the column-only table for Sumatra (total : 7.9 %, inter-regional: 0.9%), Java (total: 21.3%, inter-regional:4.7%), Kalimantan (total 12.7%, inter-regional: 6.5%), Nusa Tenggara (total: 12.0%, inter-regional: 10.7%) and Other Islands (total: 10.4%, inter-regional : 7.1%) are all smaller than those of the row-only table.

For an island economy where every island tends to be self-sufficient because of difficulties associated with inter-regional trade, it seems reasonable to expect that the intra-regional input coefficients (the coefficients of input that are supplied locally) would be higher. The same reason could explain why the proportions of inter-regional imports are smaller. As the size of the region and the stage of economic development determines the size of regional imports, Table 8 shows that Nusa Tenggara, the less-developed region in the country, with an area just 4.6 per cent of the nation total areas, has the largest import proportion. Other islands, at about the same stage of economic progress as Nusa Tenggara but with a larger area (35.7 % of the national total), is the second-highest region in regard to inter-regional imports. The proportion of domestic imports for Java is higher than Sumatra, mainly because the area of Java is only one-fifth that of Sumatra. The inter-regional input-output table whose initial estimations were based on the column average could reflect the spatial structure of an island economy more properly. To evaluate whether the constructed inter-regional input-output tables reflect the spatial structure of an island economy, the pattern of inter-regional trade flows could be analysed by applying the feed-back loop approach (Sonis & Hewings, 1991; Sonis, Oosterhaven & Hewings, 1993; Sonis, Hewings & Gazel, 1995). Intermediate transaction flows of two 5-region-1-sector models are presented in the two tables following: Table 9 was initially constructed by applying column-only allocations; and Table 10 was initially constructed by applying row-only estimations.

Table 6.
**Direct coefficients: 5-region-1-sector model (Column estimation)**

| SECTOR | SUM | JAV | KAL | NUS | OTH | TOT | H-SUM | H-JAV | H-KAL | H-NUS | H-OTH | OFD | EXPRT | TOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUM | 0.3358 | 0.0216 | 0.0205 | 0.0131 | 0.0152 | 0.4061 | 0.8308 | 0.0340 | 0.0142 | 0.0840 | 0.0683 | 0.1461 | 0.3533 | 1.9367 |
| JAV | 0.0047 | 0.3731 | 0.0206 | 0.0323 | 0.0099 | 0.4406 | 0.1089 | 0.8319 | 0.2053 | 0.0872 | 0.1358 | 0.7218 | 0.4164 | 2.9473 |
| KAL | 0.0015 | 0.0150 | 0.2539 | 0.0273 | 0.0419 | 0.3396 | 0.0095 | 0.0155 | 0.6394 | 0.0434 | 0.0560 | 0.0211 | 0.1614 | 1.2860 |
| NUS | 0.0007 | 0.0013 | 0.0034 | 0.2240 | 0.0027 | 0.2320 | 0.0038 | 0.0134 | 0.0198 | 0.7793 | 0.0635 | 0.0443 | 0.0041 | 1.1610 |
| OTH | 0.0022 | 0.0097 | 0.0194 | 0.0343 | 0.2812 | 0.3468 | 0.0043 | 0.0194 | 0.0846 | 0.0032 | 0.6046 | 0.0418 | 0.0648 | 1.1694 |
| TOTAL | 0.3449 | 0.4207 | 0.3177 | 0.3309 | 0.3509 | 1.7651 | 0.9572 | 0.9141 | 0.9633 | 0.9972 | 0.9283 | 0.9751 | 1.0000 | 8.5004 |
| HH-SUM | 0.1515 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.1515 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.1515 |
| HH-JAV | 0.0000 | 0.1789 | 0.0000 | 0.0000 | 0.0000 | 0.1789 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.1789 |
| HH-KAL | 0.0000 | 0.0000 | 0.1977 | 0.0000 | 0.0000 | 0.1977 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.1977 |
| HH-NUS | 0.0000 | 0.0000 | 0.0000 | 0.2184 | 0.0000 | 0.2184 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2184 |
| HH-OTH | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2264 | 0.2264 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2264 |
| OVA | 0.4336 | 0.2344 | 0.4215 | 0.4335 | 0.3881 | 1.9111 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1.9111 |
| IMPORT | 0.0700 | 0.1659 | 0.0623 | 0.0134 | 0.0334 | 0.3450 | 0.0428 | 0.0859 | 0.0367 | 0.0028 | 0.0717 | 0.0249 | 0.0000 | 0.6098 |
| TOTAL | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 5.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 12.0000 |
| EMPLOY | 0.1752 | 0.1967 | 0.1444 | 0.5220 | 0.2544 | 1.2927 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1.2927 |

Table 7.
**Direct coefficients: 5-region-1-sector model (Row estimation)**

| SECTOR | SUM | JAV | KAL | NUS | OTH | TOT | H-SUM | H-JAV | H-KAL | H-NUS | H-OTH | OFD | EXPRT | TOT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SUM | 0.3098 | 0.0330 | 0.0130 | 0.0106 | 0.0029 | 0.3693 | 0.8308 | 0.0340 | 0.0142 | 0.0840 | 0.0683 | 0.1461 | 0.3533 | 1.8999 |
| JAV | 0.0223 | 0.3578 | 0.0404 | 0.0710 | 0.0599 | 0.5513 | 0.1089 | 0.8319 | 0.2053 | 0.0872 | 0.1358 | 0.7218 | 0.4164 | 3.0579 |
| KAL | 0.0044 | 0.0170 | 0.2389 | 0.0141 | 0.0367 | 0.3111 | 0.0095 | 0.0155 | 0.6394 | 0.0434 | 0.0560 | 0.0211 | 0.1614 | 1.2574 |
| NUS | 0.0015 | 0.0017 | 0.0032 | 0.2145 | 0.0004 | 0.2213 | 0.0038 | 0.0134 | 0.0198 | 0.7793 | 0.0635 | 0.0443 | 0.0041 | 1.1504 |
| OTH | 0.0069 | 0.0113 | 0.0222 | 0.0207 | 0.2510 | 0.3121 | 0.0043 | 0.0194 | 0.0846 | 0.0032 | 0.6046 | 0.0418 | 0.0648 | 1.1347 |
| TOTAL | 0.3449 | 0.4207 | 0.3177 | 0.3309 | 0.3509 | 1.7651 | 0.9572 | 0.9141 | 0.9633 | 0.9972 | 0.9283 | 0.9751 | 1.0000 | 8.5004 |
| HH-SUM | 0.1515 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.1515 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.1515 |
| HH-JAV | 0.0000 | 0.1789 | 0.0000 | 0.0000 | 0.0000 | 0.1789 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.1789 |
| HH-KAL | 0.0000 | 0.0000 | 0.1977 | 0.0000 | 0.0000 | 0.1977 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.1977 |
| HH-NUS | 0.0000 | 0.0000 | 0.0000 | 0.2184 | 0.0000 | 0.2184 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2184 |
| HH-OTH | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2264 | 0.2264 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2264 |
| OVA | 0.4336 | 0.2344 | 0.4215 | 0.4335 | 0.3881 | 1.9111 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1.9111 |
| IMPORT | 0.0700 | 0.1659 | 0.0623 | 0.0134 | 0.0334 | 0.3450 | 0.0428 | 0.0859 | 0.0367 | 0.0028 | 0.0717 | 0.0249 | 0.0000 | 0.6098 |
| TOTAL | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 5.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 12.0000 |
| EMPLOY | 0.1752 | 0.1967 | 0.1444 | 0.5220 | 0.2544 | 1.2927 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1.2927 |

Table 8.
**Regional import proportion by island (% of total input)**

| Column Estimation | SUM | JAV | KAL | NUS | OTH |
|---|---|---|---|---|---|
| Total Import | 7.9 | 21.3 | 12.7 | 12.0 | 10.4 |
| Inter-regional | 0.9 | 4.7 | 6.5 | 10.7 | 7.1 |
| Foreign | 7.0 | 16.6 | 6.2 | 1.3 | 3.3 |
| **Row Estimation** | **SUM** | **JAV** | **KAL** | **NUS** | **OTH** |
| Total Import | 10.5 | 22.8 | 14.2 | 13.3 | 13.4 |
| Inter-regional | 3.5 | 6.3 | 8.0 | 12.0 | 10.1 |
| Foreign | 7.0 | 16.6 | 6.2 | 1.3 | 3.3 |

Table 9.
**Intermediate transaction flows (column-only estimation), in billion rupiahs**

| REGION | SUM | JAV | KAL | NUS | OTH | TOT |
|---|---|---|---|---|---|---|
| SUM | 27,011 | 4,903 | 558 | 148 | 334 | 32,954 |
| JAV | 377 | 84,839 | 562 | 365 | 217 | 86,359 |
| KAL | 123 | 3,417 | 6,919 | 308 | 921 | 11,688 |
| NUS | 53 | 302 | 92 | 2,530 | 58 | 3,036 |
| OTH | 177 | 2,200 | 528 | 387 | 6,176 | 9,469 |
| TOTAL | 27,741 | 95,661 | 8,660 | 3,739 | 7,706 | 143,507 |

Table 9 shows that the total intermediate transactions in 1990 equalled Rp.143,507 billions. This was only about 39 per cent of the total national gross-output. As expected, intra-regional transactions dominated the flow patterns where total intra-regional transactions equalled Rp. 127,475 billions and accounted for 89 per cent of the Rp. 143,507 billions total intermediate transactions. The remaining percentage of the total intermediate transaction, 11 per cent (Rp. 16,032 billions ), were the inter-regional flows.

Table 10 shows that intra-regional transactions in 1990 equalled Rp. 120,713 billion or 84 per cent of the total intermediate transactions. The remaining 16 per cent were the inter-regional flows. In the USA, an example of a developed economy of a mainland country, Hewings and Gazel (1993) reported that inter-regional transactions accounted for 13 per cent of the total intermediate transactions. It seems more appropriate, therefore, to accept the inter-regional table initially estimated by the column-only approach to represent the spatial structure of the island economy of Indonesia. It shows that 11 per cent of the total intermediate transactions are inter-regional flows whereas the other table's inter-regional flow proportion is higher (16 % of intermediate transaction) than the developed economy of a mainland country (i.e. the USA: 13% of intermediate transaction).

To inspect the structure of inter-regional trade flows more closely, Table 11 and Table 12 provide bi-region and inter-regional trade flows among the islands. As expected, Java, Sumatra and Kalimantan dominate the inter-regional transactions in Indonesia's economy. The trade flow between Java and the rest of Indonesia accounts for 77 per cent of the nation's inter-regional trade flows. The highest percentage trade flow occurred between Java and Sumatra (33 %), followed by Java and Kalimantan (25 %), Java and Other Islands ( 15 %), and Java and Nusa Tenggara (4 %).

Table 10.
**Intermediate transaction flows (row-only estimation), in billion Rupiahs**

| REGION | SUM | JAV | KAL | NUS | OTH | TOTAL |
|---|---|---|---|---|---|---|
| SUM | 24,919 | 7,496 | 355 | 120 | 64 | 32,954 |
| JAV | 1,795 | 81,348 | 1,100 | 803 | 1,315 | 86,359 |
| KAL | 351 | 3,860 | 6,511 | 159 | 807 | 11,688 |
| NUS | 118 | 398 | 88 | 2,423 | 8 | 3,036 |
| OTH | 558 | 2,560 | 605 | 234 | 5,512 | 9,469 |
| TOTAL | 27,741 | 95,661 | 8,660 | 3,739 | 7,706 | 143,507 |

Table 11.
**Bi-region transaction flows, Indonesia 1990**

| Two-region flows | Rp. billion | Percent | Two-region flows | Rp.. billion | Percent |
|---|---|---|---|---|---|
| S-J, J-S | 5,280 | 32.83 | J-S,S-J | 5,280 | 32.83 |
| J-K,K-J | 3,979 | 24.74 | K-J,J-K | 3,979 | 24.74 |
| J-O,O-J | 2,417 | 15.02 | O-J,J-O | 2,417 | 15.02 |
| K-O,O-K | 1,450 | 9.01 | O-K,K-O | 1,450 | 9.01 |
| S-K,K-S | 681 | 4.23 | K-S,S-K | 681 | 4.23 |
| J-N,N-J | 674 | 4.19 | N-J,J-N | 674 | 4.19 |
| S-O,O-S | 511 | 3.18 | O-S,S-O | 511 | 3.18 |
| N-O,O-N | 470 | 2.92 | O-N,N-O | 470 | 2.92 |
| K-N.N-K | 421 | 2.62 | N-K,K-N | 421 | 2.62 |
| S-N,N-S | 201 | 1.25 | N-S,S-N | 201 | 1.25 |
| Total | 16,085 | 100.00 | Total | 16,085 | 100.00 |

Source: Calculated from Table 9.

Table 12.
**Inter-region transactions between island and the rest of Indonesia**

| Inter-regional flows | Rp. billion | Percent | Dominant two-region trade flows |
|---|---|---|---|
| J-the rest of Indonesia | 12,351 | 76.78 | (J-S,S-J; J-K,K-J;J-O,O-J:J-N,N-J) |
| S-the rest of Indonesia | 6,673 | 41.49 | (S-J,J-S; S-K,K-S;S-O,O-S;S-N,N-S) |
| K-the rest of Indonesia | 6,531 | 40.60 | (K-J,J-K;K-O,O-K;K-S,S-K;K-N,N-K) |
| O-the rest of Indonesia | 4,848 | 30.14 | (O-J,J-O; O-K,K-O: O-N,N-O,;O-S,S-O) |
| N-the rest of Indonesia | 1,767 | 10.99 | (N-J,J-N :N-O,O-N;N-K,K-N :N-S,S-N;) |

Source: Calculated from Table 9.

The trade flow between Sumatra and the rest of Indonesia accounted for more than 42 per cent of the total inter-regional trade whereas the trade flow between Sumatra and Java accounted for 33 per cent, and trade flows between Sumatra and Kalimantan, Nusa Tenggara and Other Islands was less than 10 per cent of total inter-regional transactions

The trade flow between Kalimantan and the rest of Indonesia accounted for 40 per cent, with the general trade flow dominated by Java (25%). The rest of Kalimantan's trade was with Sumatra (4%), Nusa Tenggara (3%) and Other Islands (9%). The trade flow between the Other Islands and the rest of Indonesia accounted for 30 per cent of the total inter-regional trade while the trade flows with Java accounted for 15 per cent of the total, with Nusa Tenggara 3 per cent; Kalimantan 9 per cent; and Sumatra 3 per cent. Finally, the trade flow between Nusa Tenggara and the rest of Indonesia amounted 11 per cent of the total inter-regional trade: 4 per cent of the trade flow between Nusa Tenggara and Java; 3 per cent trade between Nusa Tenggara and Other Islands; 3 per cent trade between Nusa Tenggara and Kalimantan; and 1 per cent trade between Nusa Tenggara and Sumatra.

To answer the second question (Do the results, in the form of multipliers, represent reality within acceptable professional norm ?), the stability of the multipliers could be examined by inspecting the indicative parameters of the total multipliers as well as by conducting sensitivity analysis to determine the cells and sectors that are critical to the accuracy of the model.

Table 13 provides the indicative parameters of total output, income and employment multipliers at a 95 per cent confidence interval. The highest standard error for the total output multipliers is for Java (0.221) while the lowest is for Kalimantan (0.123). For total income multipliers, the highest standard error is Java (0.040) and the lowest is for Sumatra (0.022). For the total employment multipliers, Nusa Tenggara has the highest standard error (0.056) while Kalimantan has the lowest (0.021). All observed values total multipliers for output, income and employment lie between the lower and upper bound of the 95 per cent confidence interval, indicating that the total multipliers of the model are stable.

Finally, to identify which coefficients are critical to the accuracy of the model, sensitivity analysis was performed. Using GRIMP Input-Output software of West (1993), a shock of 10 per cent changes was applied to all direct coefficients. The changes of the total multipliers are ranked. For the inter-regional model with 5 regions and 9 sectors, the closed inverse of the Leontief matrix consisted of 2500 cells. The sensitivity analysis ranked. 361 cells in total output, 362 cells in total income, and 334 cells in total employment. Those were the cells that experienced changes of more than 0.01 per cent in multipliers due to 10 per cent changes in direct coefficients. When this value was used as the criterion for critical cells generating multipliers, only 14.4, 14.4 and 13.4 per cent of the cells of direct coefficients are important for creating total output, income, and employment multipliers respectively. The rest of the cells are not important and can be ignored.

The results of the tests were summarised in a matrix, called Boolean or Adjacency matrix. This is a matrix that contains unity and zero cells (Cochrane, 1990). A zero cell denotes an element of direct coefficients considered not critical in the sense that 10 per cent change in direct coefficients generates less than 0.01 per cent changes in multipliers. A cell with a value of 1 denotes a critical cell.

Rather than specifying coefficients as critical, it would be equally useful to determine which sectors are critical for accuracy of the table. This information is very important for designing surveys for updating table where data for all inputs are gathered, not just a few types of inputs.

The sums of rows plus the sums of columns of the Boolean matrix are calculated to indicate which sectors contain the greatest number of critical cells. If a sector comprises 15 or more critical cells it is considered a critical sector. Table 14 presents the most critical sectors for creating output, income and employment multipliers.

Table 13.
**Indicative parameters of total multipliers**

Total output multipliers

| Region | Observed Value | Expected Value | Standard Error | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | Lower | Region |
| SUM | 1.979 | 1.99 | 0.145 | 1.734 | SUM |
| JAV | 2.363 | 2.384 | 0.221 | 2.006 | JAV |
| KAL | 2.082 | 2.091 | 0.123 | 1.873 | KAL |
| NUS | 2.224 | 2.235 | 0.138 | 1.991 | NUS |
| OTH | 2.253 | 2.265 | 0.152 | 1.997 | OTH |

Total income multipliers

| Region | Observed Value | Expected Value | Standard Error | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| SUM | 0.304 | 0.306 | 0.022 | 0.266 | 0.355 |
| JAV | 0.424 | 0.428 | 0.040 | 0.360 | 0.518 |
| KAL | 0.407 | 0.409 | 0.024 | 0.366 | 0.461 |
| NUS | 0.468 | 0.470 | 0.028 | 0.420 | 0.533 |
| OTH | 0.488 | 0.490 | 0.032 | 0.433 | 0.561 |

Total employment multipliers

| Region | Observed Value | Expected Value | Standard Error | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| SUM | 0.351 | 0.353 | 0.026 | 0.307 | 0.410 |
| JAV | 0.467 | 0.471 | 0.044 | 0.396 | 0.571 |
| KAL | 0.337 | 0.339 | 0.021 | 0.301 | 0.386 |
| NUS | 0.978 | 0.981 | 0.056 | 0.880 | 1.104 |
| OTH | 0.551 | 0.553 | 0.037 | 0.488 | 0.634 |

Table 14.
**The most critical sectors in generating multipliers**

| Rank | Output | Income | Employment |
|---|---|---|---|
| 1 | HH-SUM | HH-SUM | HH-SUM |
| 2 | JAV-3 | JAV-3 | JAV-3 |
| 3 | HH-NUS | HH-NUS | HH-NUS |
| 4 | KAL-3 | SUM-3 | HH-KAL |
| 5 | SUM-3 | JAV-7 | KAL-3 |
| 6 | JAV-7 | NUS-3 | NUS-3 |
| 7 | HH-KAL | HH-JAV | SUM-3 |
| 8 | NUS-3 | KAL-3 | OTH-3 |
| 9 | HH-JAV | HH-KAL | HH-JAV |
| 10 | OTH-3 | SUM-6 | JAV-1 |
| 11 | SUM-6 | OTH-3 | NUS-6 |
| 12 | KAL-7 | JAV-6 | SUM-6 |
| 13 | JAV-6 | KAL-7 | JAV-6 |
| 14 | NUS-6 | OTH-6 | JAV-7 |
| 15 | SUM-7 | SUM-7 | KAL-1 |
| 16 | SUM-8 | SUM-8 | KAL-7 |
| 17 | OTH-6 | JAV-8 | NUS-7 |
| 18 | KAL-1 | KAL-1 | OTH-6 |
| 19 | JAV-8 | NUS-6 | |
| 20 | OTH-8 | OTH-8 | |
| 21 | | SUM-9 | |
| 22 | | OTH-7 | |

Table 14 highlights three significant results. First, the number of sectors that are crucial in generating multipliers varies: 20 sectors for output multipliers; 22 sectors for income multipliers; and 18 sectors for employment multipliers. Second, except in Other Islands, the household sectors are consistently critical. This confirms the suggestion that household sectors might be the most important feature of at region's economy. Third, the manufacturing sectors in all regions are the next significant critical sectors for generating output, income and employment multipliers. Transport and communication sectors are crucial for Sumatra, Java and Kalimantan. Trade sectors in Sumatra, Java, Nusa Tenggara and Other Islands are also critical for generating output, income and employment multipliers. Financial sectors are critical only in Sumatra and Java. Except in Kalimantan, no agricultural sectors are identified as critical sectors.

To summarise, while it is not easy to test the validity of the inter-regional input-output model produced by GIRIOT, an attempt has been performed to evaluate the validity of the model by answering the two fundamental questions suggested by Jensen (1987). These questions were answered by examining the proportion of inter-regional imports, the pattern of inter-regional flows and the stability of multipliers.

Inspecting the structure of constructed inter-regional input-output tables in the most aggregate form (5 region-1 sector), it can be expected for an island economy that the proportion of inter-regional import would be small because of difficulties associated with inter-regional trade. Applying the feed-back loop analysis introduced by Sonis and Hewings (1991), Sonis, Oosterhaven and Hewings (1993), Sonis, Hewings and Gazel (1995) it was showed that inter-regional flows in the Indonesian economy was only 11 per cent. This was smaller than that of mainland economy of the USA reported by Hewing and Gazel (1993) but higher than that of small island economies in the South Pacific reported by Fairbairn (1985). Inspecting bi-regional transaction flows, the constructed model, as expected, showed that Java dominated the inter-island transactions in the Indonesia's economy in which the trade flow between Java and the rest of Indonesia accounted for 77 per cent of the nation's inter-regional trade flows.

The stability of multipliers resulted by the model was tested by inspecting the indicative parameters of the total multipliers. It was showed that all observed values of total multipliers lie between the lower and upper bound of the 95 per cent confidence interval, indicating that the total multipliers of the model are stable. To identify which sectors are critical to the accuracy of the model, sensitivity analysis was also performed.

In conclusion, although it is difficult to validate constructed inter-regional input-output model for Indonesia, it can be justified that the GIRIOT procedure would produce inter-regional input-output tables that reflect the spatial characteristics of the Indonesian economy and the results, in the form of multipliers, represent reality within acceptable professional norms.

## 5. CLOSING REMARKS

Although hybrid procedures have been widely accepted in the practice of constructing regional and inter-regional input output tables, there are still some general considerations that should be kept in mind when formulating these tables. As in many modelling techniques, one of the most important considerations when applying the GIRIOT procedure is the question of table accuracy. The problem of accuracy is related to several interrelated factors, such as the purpose of the table construction, the primary use of the model, level of disaggregation of available data, and the availability of necessary and desirable quantities and types of primary data.

The purpose of the table construction and the primary use of the model can be crucial to the construction process and methodology (West, 1990). For instance, if the purpose of the model construction is for an impact study of a certain industry, the process can be directed into the sector of economy under study, with less emphasis on other sectors.

Drake (1976) and Conway (1977) show that the critical cells of a particular industry are located in industries with strong inter-sectoral linkages to it. Therefore, the sector under study should be isolated and detailed as much as possible. Ready-made models might be better for this kind of impact study. However, if the model is constructed for general purposes decisions regarding the level of disaggregation and data sources become more critical. In this case it might be necessary to move closer the full survey so that partitively accurate tables can be constructed. Alternatively, if the model is designed for general purpose impact studies, more scope for compromise is available. In the latter case, the activity under study can be isolated from the remainder of the table and additional detailed survey data for that activity can be collected and inserted as part of the impact analysis. This latter procedure produces a table with holistic accuracy.

The early GRIT hybrid studies (Jensen, Mandeville & Karunaratne, 1979) aimed to produce regional input-output tables that were accurate in all substantial respects, but not for cells by cells accuracy. This was described as whole table accuracy in terms of "freedom from significant error". Further, Jensen (1980) defined holistic accuracy as "a mathematical portrait" of an economy with which the table represents the main features of the economy in a descriptive sense. At the same time, the table preserves the importance of these features in an analytical sense. Jensen's holistic approach is based on two facts. First, the critical cells in the table, with respect to analytical accuracy, are the larger and more interconnected cells. These cells must exhibit a high degree of accuracy. Second, the smaller and less interrelated cells have little analytical significance, therefore, it is relatively unproductive in an empirical sense to devote time to the less significant elements. The concept of holistic accuracy in an operational sense was explicitly incorporated in the later GRIT studies (West, Wilkinson & Jensen, 1979; Jensen, 1980) by the identification of those cells in the table that were more significant in multipliers formation and by ensuring the accuracy of these cells.

The inter-regional input-output table constructed for studying the spatial structure of the Indonesian economy was a massive empirical exercise. Cell entries were required for five 28-sectors regional tables (3,920 cells), 20 trade matrices (15,680 cells), the sum of 19,600 intermediate cells and 1,960 cells for primary input and final demand sectors. This made a total of 21,560 cells that required attention.

With severe limitations on data and with resources constraints, it was not possible to ensure the achievement of partitive accuracy. Inspection of the finished table shows a large number of zero entries, so that cells by cells exactness is not necessary for the achievement of a holistic accuracy table.

As well, the GIRIOT procedure employed for constructing the inter-regional input-output table for the island economy of Indonesia could not guarantee that the resulting table was partitively accurate. However, the table as a whole is believed to be an acceptable representation of the regional and inter-regional structure of the island economy of Indonesia. Its accuracy can be improved whenever more superior data are available.

Although the standard of accuracy reached was satisfactory, detailed attention should be given to data collection and processing since data collection and data processing have very important roles in determining the accuracy of the table. The data problem is one of the most restrictive constraints on the quality of economic models. For the inter-regional input-output model, the problem of quality and quantity data is the main reason for a noticeable dearth of the models.

The approach to solving the problem will be determined by the general approach to table compilation. In a hybrid approach, where non-survey data are combined with more-reliable data, the data problem becomes less serious because a great deal of crucial data required for the completion of acceptable quality input-output tables is available more readily and cheaply than suggested in the literature on input-output compilation. At a minimum level, data are required to provide a series of controls since the framework for the inter-regional table is provided by the control totals, representing the total gross outputs of the row and column. Once these data are available, the task of allocating these totals across sectors in the intra and inter-regional matrices can be undertaken easily.

These data should include regional and sectoral estimates of employment, gross output, net output (net of primary inputs), wages and salaries and other items of value added, household consumption, other final demand, and inter-regional trade patterns. For Indonesia, data on regional foreign exports and imports are also available in more disaggregate forms. Almost all of these data can be obtained from the Indonesian Central Bureau of Statistics (CBS), the National Development Planning Agency (NDPA), other government reports, and indirect estimation methods. Some of the data are readily available in publications; some are in unpublished forms for restricted readers.

Although a great deal of data directly relevant to the GIRIOT procedure exist in various sources and are readily available, the magnitude of the task of preparing a set of data for the construction of the inter-regional input-output table for Indonesia cannot be underestimated. Several technical problems relating to data processing could still be encountered. Different types of data and sources have different classifications. For instance, data on regional foreign exports and imports as well as data on inter-regional trade patterns, are classified differently to those with input-output classification. Fortunately, these data are classified in highly disaggregated so that, although it takes time, they can be transformed into input-output classification easily.

Problems of attempting to estimate unrecorded data occurred as anticipated. When it was not possible to obtain estimates from official sources, judgments were made based on previous studies of related or similar situation. For example, when data on inter-regional transport pattern of service sectors as estimates of inter-regional trade pattern was not available then data on population distribution was employed to estimate the inter-regional trade flows for these sectors.

In the process of constructing the model, survey and non-survey estimates were integrated into the table. This integration created problems for reconciling the table. In many stages of the table construction, the more reliable or superior data were inserted. The reconciliation procedures applied for a full survey model were employed and the balancing procedures were monitored carefully to avoid introducing distortions.

Data problems could still be encountered when applying the empirical GIRIOT procedure, but the prospects of this procedure are promising. This procedure cannot only produce an inter-regional table of many regions but it will also generate accompanying single-region tables. As the usefulness of an inter-regional model for an island economy like Indonesia is more recognised, the importance of the inter-regional input-output model as the basis of a more powerful data-hungry inter-regional model such as the inter-regional SAM (Social Accounting Matrix) and inter-regional CGE (Computable General Equilibrium) models must also be realised. More inter-regional data are now being collected. More computing facilities are now available at more affordable prices. Since government institutions have now more political will to produce inter-regional models, more resources could be expected to be made available.

The NDPA employed very mechanistic procedures with little or no region-specific data to construct a multi-region input-output table. The resulting table would not be acceptable to most professional input-output analysts. The CBS, in its function as data provider, is now planning to conduct a full survey for constructing an inter-island input-output table. Their plans which will involve the expenditure of significant national resources. This GIRIOT procedure provides more scope for compromise.

## References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**Riwayat Penulis**

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# ANALISIS DAN PROYEKSI KEBUTUHAN AIR DI DKI JAKARTA



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**Abstract**
*Recently, high population growth and increasing economic activities in Jakarta make the use of water is also increasing. Declining capacity of available sources of raw water due to mismanagement of environment would cause problem in supplying water.*
*One way to know how much water needed by Jakarta now and to estimation of the water use until 2010, logaritmic curve method is employed. The result of the study is expected to be used as input in policy or strategy in developing water potency and water source management.*

**Kata kunci :** analisis dan proyeksi kebutuhan air, jumlah penduduk, kurva logaritma

## I. PENDAHULUAN

### 1.1 Latar Belakang

Meskipun saat ini krisis moneter yang menimpa Indonesia masih terus berlangsung, tetapi pembangunan Kota Metropolitan Jakarta terlihat terus berjalan serta pertumbuhan penduduk setiap tahunnya tetap semakin bertambah. Hal tersebut mengakibatkan daerah Jakarta yang luasnya hanya sekitar 661 $km^2$ telah dipenuhi penduduk sekitar 8,26 juta juta jiwa pada tahun 1990 ( ..... ......), yang diperkirakan akan menimbulkan permasalahan dalam penyediaan sarana kebutuhan air bersih, sebab saat ini baru 60 % dari total penduduk yang dapat terlayani oleh sistem penyediaan air bersih dari PAM DKI Jakarta [(1)]. Apabila dilihat masih terdapatnya kebocoran dari sistem pelayanan tersebut maka praktis sekitar 50 % saja yang dapat dimanfaatkan oleh penduduk Jakarta. Sedangkan penduduk yang belum mendapat pelayanan air bersih masih harus mengandalkan penyediaan air bersih dari sumber air tanah. Ini terlihat dari jumlah debit pengambilan air tanah pada tahun 1983 sekitar 0,82 liter per detik meningkat menjadi 1 liter per detik pada tahun 1985 [(2)].

Laju pertumbuhan penduduk Jakarta rata-rata meningkat 3,3 % pertahun, pertumbuhan ini tidak dapat terkejar oleh program pelayanan air bersih PAM DKI, sehingga penduduk tetap bergantung kepada pengambilan air tanah dangkal maupun air tanah dalam. Pemakaian air tanah yang terus menerus serta jumlahnya yang semakin besar dapat mengakibatkan berkurangnya cadangan air tanah, menurunnya muka air tanah dan berkurangnya kualitas air tanah karena instrusi air laut.

Berdasarkan hal-hal tersebut di atas serta melihat penggunaan air tanah yang akan semakin besar di masa mendatang, maka perlu dipikirkan bersama pemecahan yang terpadu untuk menangani masalah kebutuhan air bagi penduduk DKI Jakarta. Dalam studi ini akan diidentifikasi tentang kondisi kebutuhan air domestik dan fasilitas-fasilitas lainnya serta proyeksi kebutuhan air untuk tahun-tahun mendatang di DKI Jakarta.

### 1.2 Tujuan

Tujuan dari studi ini adalah untuk mengatasi permasalahan penyediaan air bersih bagi penduduk kota Metropolitan Jakarta dengan melakukan kajian terhadap kebutuhan air domestik dan fasilitas-fasilitas lainnya di seluruh wilayah DKI Jakarta. Sasaran yang akan diperoleh adalah kebutuhan air domestik DKI Jakarta baik saat ini maupun proyeksi yang akan datang bagi.

## 2. METODOLOGI

Untuk mencapai tujuan dari kegiatan ini dilakukan identifikasi permasalahan kebutuhan air bersih saat ini khususnya di Ibukota DKI Jakarta dengan melakukan survai, pengumpulan data, dan diskusi dengan beberapa instansi pemerintah seperti PAM DKI, Direktorat Geologi dan Tata Lingkungan.

Inventarisasi fasiltas-fasilitas pemerintah dan umum, fasilitas komersial serta jumlah industri yang ada di wilayah DKI Jakarta, ini