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Construction of Regional Input-Output Table by the Use of GRIT Methodology: A Case Study in the Province of Isfahan in Iran

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Abstract

Provision of regional input-output tables by the use of information obtained through census methods, in addition to imposing excessive costs on planning apparatus, imposes time constraints on the realization of regional development plan objectives in due time. Moreover, the use of sample surveys at the regional level, may lead to high inaccuracy due to limited number of observations.

One of the more common approaches in obtaining regional input-output tables with much less expenses and time, is the GRIT[1] methodology, which uses the national input-output table as the base and then make necessary adjustments for: 1) the change in prices with respect to time and location and 2) the differences between the pattern of a country's foreign trade and the regional trade within the country's territory. These adjustments lead primarily to a mechanically-produced table of regional interindustry transactions. In further steps, recent "superior data" is to be used to adjust the technical coefficients in that table, based on their degree of importance.

It is evident that construction of such regional tables, as appropriate planning tools, is important and as such, construction of this table for the province of Isfahan in Iran was undertaken. The aim of this article is mainly an attempt to summarize and briefly present the GRIT methodology of obtaining regional input-output tables, describe its strengths and weaknesses and discuss the summary results of its application to the region of Isfahan in Iran.

Keywords: Regional Input-output Table, GRIT Methodology, Province of Isfahan.

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1. Generation of Regional Input-Output Table

I. Introduction

Since the regional development objectives in many developing countries have gradually gained importance in overall national development strategy, and because of accessibility of regional quantitative information in these countries in recent years, regional planning has become a main part of any national development effort. Regional planning takes different forms. Wayne Street (1987) has surveyed and evaluated a range of analytical planning techniques, with the objective of presenting practical recommendations for exploiting economic opportunities at local and regional level. These analytical techniques are wide spread, from a broad and general form, like recognition and performance evaluation of economic sectors at the regional level, to specific forms, like feasibility of the establishment of an individual firm in a region. In this wide array of techniques, input-output analysis is one of the general techniques that demonstrates the structure of economic relations within a region.

In regional economics literature, determination of the geographical domain of regions is based on the type of application and the purpose of studying the domain. There are three general approaches to determine the domain of regions, namely: i) homogeneous region; ii) development pole and iii) regional planning region. Each of these regions could be the base foe determining the region in accordance with the problems and objectives of the research.

Within the geographical domain of regions, regional accounts measure the general economic phenomena. The regional accounts of any geographical unit could be constructed either through survey, non-survey or combination of the two. In survey approach, information about the economic phenomena is obtained either by the census method, sample survey method or the existing information in statistical references of regional public and private institutions and organizations. In this approach, although more precise methods are used in collecting information and usually the size of selected sample is large, but it has some limitations, including the following:

- A long period of time is required to obtain information. Usually, five years or more is required till exact results of statistical investigations at national level become available for publication.
- Large budgets are needed both in census and survey methods and in wide range of applications.
- The need for budget allocations from national government organizations to the regional government entities, may lead to instability and discontinuity of these sources.

- There is a possibility that practitioners and people in the local planning offices, specially, in poor regions of developing world, are unfamiliar with statistical problems and procedures of evaluating or measuring regional accounts.

Input-output analysis is potentially an excellent descriptive device and a powerful analytical technique. But as mentioned, the time and expense required to complete survey-based tables has restricted the application of the technique to 'research' rather than operational applications. Certainly, input-output techniques appear to have played no significant part in regional planning decisions, due to at least partly to the inability of analysts to produce input-output tables by conventional means within the time span in which most decisions must be made.

In non-survey methods, and in their early stages, reference variables, at the national level, were being used for the estimation of regional statistics. For example, in order to estimate the crop production of a region, information at the region and national level for a base year, usually the nearest year to the current year under study, and information at the national level for the current year can be used. Also, regional and national technical coefficients, i.e. wheat production per hectare, can be assumed identical, and accordingly, regional production (wheat) can be estimated, based on regional information.

However, it is evident that, these kinds of estimations in the non-survey methods, could lead to significant errors in regional accounts, because production functions and productivity of resources can be quite different, when the nation and its constituent regions are compared, due to technological differences and differences in climatic and labor force characteristics. But, the advantage of non-survey methods is that they do not include limitations and problems of the survey methods, mentioned above. In other words, application of these methods can be made by spending shorter time period and a much smaller budget appropriations.

In the literature on input-output, during the last three decades, there is a lot of attempts to produce input-output tables by non-survey, or largely mechanical means. These methods have the advantage of relative speed and low cost, but have attracted criticisms for an apparently low degree of reliability. The current 'state-of-the-art' appeared to offer a choice between the more expensive and professionally-respected survey-based tables and the cheaper, less-respected non-survey tables.

II. The Early Attempts to Generate Regional I-O Tables

Quantitative analysis of regional economies within the framework of general equilibrium models was first presented by Leontief for one region (W. Leontief ,1953), by Walter Izard for two regions(W. Izard, 1951) and by Polenske for more than two regions (Polenske, 1995). Izard in his book, "The Economics of Location and Space"' has argued that the reason for studying regional and spatial economies is the ignorance of such studies in classical and neoclassical analysis:

'***Classical and neoclassical economics have established the firm in an ideal land as if there is no problem of location and transportation costs. They do not consider the accessibility to sales markets.***'

The attempts by Izard were to compensate the deficiency in classical and neoclassical analysis, by resort to regional input-output tables. In any case, the early attempts by Leontief and Izard and alternative regional economics view points in the decade of 1960, provided the ground for generalization of regional planning knowledge.

In recent years, regional input-output tables have been used for different aspects of regional policy issues, like the impact of productive activities on employment, income and growth of regions through the multiplier analysis for one or more regions and also for the analysis of regional feedback effects and environmental impacts of regional economic activities. In this regard, one of the important benefits of regional input-output table analysis is the exploration of the impacts of change in the components of final demand (household consumption, government expenditure, physical investment, changes in inventories and net exports) in one region upon the economic sectors of that region or other regions. For example, with the use of input-output accounts, the impact of an increase in the government infrastructural investment in construction and development of transportation routes in one region upon production of building materials can be investigated. Or, the regional impacts of petrochemical and steel exports can be analyzed by the application of such regional models.

In brief, the technique of input-output is considered a strong planning tool at different regional levels of a country. Today, many countries in the world, including Australia, Canada, Spain and China, are producing regional input-output tables, and with its application, they analyze the effects of changes in economic activities undertaken upon local and regional economies.

III. Regional I-O Tables and Regional Accounts

What is the relation between regional accounts and regional input-output tables? On one hand, system of regional accounts can provide many of the statistical bases needed for the regional input-output tables, such as value of production and intermediate consumptive uses in various sectors of the region in question. In spite of the fact that the system of regional accounts, like the system of national accounts, usually do not make any effort to identify interindustry relations quantitatively, but the type of data they provide, is still considered important for the construction of regional input-output tables.

On the other hand, the application of the GRIT system can lead to the compilation of regional data to such an extent that even information relevant for the construction of regional social accounting matrix (RSAM) could be obtained. Psaltopoulos and his colleagues (2000) obtained the social accounts of a region in Greece from the information they collected for the application of the GRIT system.

IV. The GRIT System

At present, due to limitations and advantages of both approaches (survey and non-survey methods), the only further alternative is the so-called 'hybrid' approach, which has gained considerable attention in recent years. An attempt has been made by West and his associates (West, Wilkinson and Jensen, 1980) to move input-output analysis from the category of 'research' technique to one of operational application for regional planning and analysis. A system was developed, termed the Generation of Regional Input-Output Tables (GRIT) which produced variable-interference non-survey based tables, essentially hybrid in nature. GRIT relied on a series of mechanical steps to produce regional coefficients, but at the same time provided the opportunity for the insertion of 'superior data' at three stages of its implementation. This approach supplements mechanically produced elements of the table with the insertions of survey-based data to improve the acceptability of the resulting table.

The term 'superior data' refers specifically to data considered by the analyst to be 'more reliable' than that produced by the mechanical process. Such data could originate from local surveys, primary or secondary regional data sources at various public and private regional departments, or simply from "well-informed' sources.

The system is ' *variable-interference* ' to the extent that the analyst is flexible in his or her interferes by inserting the superior data at his or her disposal at various stages of table development. Accordingly, the judgment of the analyst is incorporated into the table-building process. It seems that such a system incorporates the advantages of both survey-based and non-survey methods, while it avoids the cost extravagances of the former. The construction of input-output table by the use of GRIT system provides such a degree of accuracy that has been claimed by West and his collaborates (West, et. al., 1980) as *'free from significant error*, rather than overall accuracy or accuracy in detail. Therefore, they conclude that such a table as a whole is substantially representative of the regional economy in question.

One of the interesting implications of the application of GRIT methodology is the fact that relatively speaking, it disregards the importance of any specific method of calculation for the small coefficients in an input-output table, since the smaller coefficients have little effect on the analytical uses of the tables. However, the more significant coefficients in such tables warrant more attention, and if necessary, must be corrected by the insertion of the superior data. So, as far as reliability of table coefficients are concerned, GRIT methodology strives to get close to survey-based methods.

However, the question remains as to what extent the interference in the mechanical process of table construction should be made. At first, it appears that the interference should be maximized without bound. But, this maximization is subject to resource availability constraint and the time limit set for the results of the table construction to be published. There is also another approach, and that is to be ensured that the characteristics of major or dominant industries are faithfully represented, and to warrant the search of the prototype table for any anomalies apparent to those familiar with the economic structure of the representative region.

The flexibility and manipulability of the GRIT system is incorporated into its characteristics which are shown in the following:

- Construction of input-output tables and their corresponding multipliers for any geographical domain and its sub-regions (local area, district, county, state or grand region) for which certain minimum levels of data are accessible.
- The consistency between a table for the national economy and the tables of its constituent regions. Likewise, the consistency between the table of a region and the tables of its sub-regions.
- The insertion of data at local, regional or state level, where deemed necessary and at the discretion of the analyst.
- Capability of updating the table with minimum efforts, when the new sources of information and data become available.
- Internal consistency and comparability of the multipliers of a region and its sub-regions within the system.

- Empirical application of the system with minimum time and expense with the reasonable degree of accuracy in the results.
- Ease in the application of the system that encourages adoption by analysts without a high level of expertise.
- The design of the system as a series of modular components, modification of each is possible at the discretion of the analyst.

According to a number of regional economists' view point (West, 1990; Vander, 1992; Lahr, 1993), the hybrid approach is the most practical method for the construction of regional input-output tables. In this approach, attention is paid to an appropriate combination of 'reliability' and 'time and budget constraint', so that a reliable decision making and policy formulation can be reached within a relevant time period under consideration.

V. The GRIT Methodological Sequence*

The basic component of GRIT is a multi-stage mechanical sequence for adjusting the national input coefficients, calculating regional imports and aggregating sectors. Important modifications to this mechanical procedure, if deemed necessary, could be incorporated into the table to improve the creditability, reliability and its level of accuracy through the insertion of superior data. The GRIT methodological system is basically a combination and adaptation of non-survey methods in the literature, reinforced by new approaches formulated by West and his associates in the early 1980s and refined by other scholars in subsequent years, into an overall framework for application to individual regions. The objective was to convert the national input coefficients in any column vector into the regional input structure.

The conversion is necessary because the national sector differs from the regional counterpart due to the following main factors:

- Differences in the degree of openness, implying a larger relative import in the regional, compared to national, economies.
- Industrial mix, indicating the absence of one or more industries and more relative significance of other industries in the region, compared to the nation.
- Differences in production functions, due to differences in scale of production, natural endowments and entrepreneurship.
- The difference in sectoral relative prices within a region, as compared to the national relative prices.

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* This section heavily draws on the work by West, Wilkinson and Jensen (1980)

The GRIT methodology takes into account these differences and in a sequence of actions, takes fifteen steps within five phases for its implementation. A brief description of this methodological sequence is presented below.

Phase I: Adjustment to the National Table
In this phase, a national input-output table is selected as a starting point, and then necessary adjustments are made to this table to develop the most appropriate form for the subsequent steps in generating regional tables:

Step 1: *Identification and selection of a national I-O table.* On the basis of such table, the GRIT methodology will be undertaken. Generally, the closest table to the year for which the regional table is under construction is selected.

Step 2: *Updating and adjusting for relative price changes.* Since price changes do not occur in different sectors comprising the I-O table, in such a manner that the initial relative prices are preserved, separate adjustments should be made in each row vector of the table. Procedures for these adjustments could be incorporated at the discretion of the analyst. However, this step may require sizable data on prices and weighing factors and resources.

Step 3: *Adjusting for international trade.* Adjustments to the national table should be made, due to differences in the relative importance of national trade and trade patterns as compared with its constituent regions. These differences arise because a nation and its constituent regions differ in their extent of trade with the *'rest of the world'*. Adjustments in this step provide a table that looks as if the nation has a closed economy, i.e. the imports originally shown in the national table were assumed to be domestically produced. This procedure can be achieved by allocating the imports of each sector over the intermediate entries in the corresponding column of the national table.

Phase II: Adjustments for Regional Imports
The steps undertaken in phase one, included the selection of an appropriate national I-O table and making necessary adjustments for price changes and differences in the pattern of regional and national trade, in order to provide the basic input for the GRIT system. From this reference base thus far

provided, the construction of any number of tables for regions within the nation could be initiated, which are mechanical in nature. Phase II and the subsequent phases are undertaken with respect to each regional table. In phase II, the task is to convert the national trade coefficients to the *first approximation* of regional trade coefficients. A matrix of regional coefficients is produced by applying two adjustment procedures in this phase which are as follows:

Step 4: *Adjustment for the regional absence of national sector(s)*. Whenev there are evidences (from firm, employment or production data) that ar nationally defined sector (or sectors) is (are) absent in the region, an adjustme in the matrix of national coefficient is warranted. The procedure for th adjustment is similar to that suggested by Smith and Morrison (1974) ar applied by West (1980) to the State and Regions of the Northern Territory Australia. In this procedure, the (a_{ij}) coefficients in the column vector of tl national table, corresponding to the 'absentee' sector(s) are summed and the dealt with as that region sector's import in the so called 'regional' table.

Step 5: *Decomposition of adjusted national coefficients*. Some of the national coefficients provided in phase I, are decomposed into regional input coefficients (r_{ij}) and regional import coefficient (m_{ij}). The decomposition is usually based on the assumption that national and regional technical coefficients are identical and the decomposition will provide estimates of regional input-output coefficients [West, 1980]. However, to the extent that the coefficients in the national table are trade coefficients rather than technical ones in any real sense, then regionalization of national coefficients should be seen as adjusting national trade coefficients to coefficients which are regional flows in nature.

In this step, some of the remaining coefficients in the national matrix, after taking step 4, are downwardly adjusted. This adjustment is due to the fact that not all the purchases by some regional sectors are regional (domestic) purchases, but rather imports from 'outside of the world', as compared with sectoral purchases at the national, 'closed' economy level, where all the purchases were assumed domestic and that there were no imports. Thus, a portion of purchases ascribed to some sectors in the national table, are removed to the import row in the regional table.

Various techniques of decomposition have been suggested and applied in the literature. It seems, as will be shown below, that the selection of such techniques has received more attention in the literature than other aspects of non-survey methods, particularly in the GRIT system. The selection could have different impacts on the ultimate accuracy of resulting regional tables. A most commonly used technique is the simple location quotient (SLQ).

It is a measure of relative intensity of a sector's activity within a region, compared to the nation as a whole. A simple location quotient (SLQ) that was first suggested by Morrison, *et .al.*(1974) and Czamanski, *et. al.*(1969), takes the following form:

$$SLQ_i = (X_{ir}/X_r)/(X_{in}/X_n) \qquad (1)$$

where X_{ir} is employment in the i^{th} sector in the r^{th} region; X_r is the summation of X_{ir} over all sectors($i=1,2,...n$) in that region; X_{in} is the corresponding employment data in the i^{th} sector in the reference region (i.e. nation) and X_n is the corresponding variable for all the sectors in the reference region.

The application of location quotient in the decomposition process in the GRIT system takes the following steps:

(1) Calculation of LQ for different sectors in the national table, usually based on employment, the data for which is commonly available in many regions.

(2) Isolation of those sectors for which LQ<1. These sectors are considered not to have regional comparative advantage or not to be locally specialized, and therefore, relied on imports for the satisfaction of their regional demand.

(3) Application of the LQ across each row vector of appropriate sectors designated in (2), in order to decompose the national trade coefficients into regional trade and import coefficients. Operationally, the regional trade coefficients for row i, are estimated by multiplying the national coefficients in that row by LQ_i and apportioning the difference to imports:

$$r_{ij} = a_{ij} . LQ_i \qquad \text{where } LQ_i < 1 \qquad (2)$$

The differences (a_{ij} - r_{ij}) are summed across each column vector and moved to the import row for each relevant sector. This means that sector i in the region produces less than its share of national output and imports, are therefore, required. On the other hand, if $LQ_i > 1$, then the sector produces more than its fair share and the balance is exported.

Phase III: Insertion of Superior Data and Definition of Regional Sectors

After regional coefficients are produced by mechanical operation, 'superior data' can be made ready for the insertion into the table at step 6 of this later phase of operation. Moreover, an aggregation procedure is taken to form smaller tables in step 7and 8.

Step 6: *Insertion of superior data.* If the analyst considers some available regional disaggregated coefficient estimates superior to those produced by the mechanical process in phase I and II, the analyst will substitute these coefficients for the mechanically-produced counterparts.

Step 7: *Aggregation of regional sectors.* In general, regions have different economic structures with different degree of economic dependencies and inter-industry relations, compared to the national economy. Likewise, the economic functioning of localities and sub-regions (county, district,...) show different pattern, compared with the region to which they belong. Whereas the economic functioning of some sub-regions consists of simple agricultural and trade service activities, industrial productive activities with advanced technical know-how, features the complex economic structure of other sub-regions. The implication is that the level of disaggregation of the national I-O tables are not only unnecessary for sub-regions with simple economic structure, but an appropriate aggregation of some of the sectors in that table and presentation of a more general framework of local economic structure is more useful. Thus, in step 7, sectors are aggregated to form smaller tables which are more commensurate with the simpler economic structure of sub-regions.

The regional I-O tables are usually produced at two different levels of industry mix or aggregation. One set of regional tables are produced at different levels of aggregation to accommodate the variety in regional economic complexity, and one set at a uniform level of aggregation to allow direct comparisons between regions and between regions and the nation, for all sectors.

Step 8: *Insertion of aggregated superior data.* Now, is the time to insert superior data which are available only in a more aggregated form and which are more consistent with the sector definitions adopted in the sector aggregation process. Steps 6 and 8 facilitate maximum potential use of various types of superior data, some of which are available on a detailed basis, and some others are available at more aggregated level of industry classification.

Phase IV: Derivation of Primary Transactions Table

At this phase, the regional matrix of input coefficients is converted to prototype transactions table for the each region studied. This phase is to fulfill four objectives: one is to expand the input matrix into conventional transactions table, the second is mainly to complete the final demand quadrant of the regional table, the third is to aggregate sectors further to provide uniform tables, and the fourth is to derive regional multipliers from such table provided.

Step 9: *Generation of regional transactions table.* To derive the regional transactions table from input coefficients matrix, the elements of each column of that matrix is simply multiplied by the values of gross output for respective sector, in order to convert those coefficients into estimates of transactions. This table is *initial* transactions table which at a later stage, is subject to a detailed scrutiny of the analyst and covers only intermediate and primary input quadrants. The values of gross output are either estimated by indirect methods of calculation, or taken from official regional accounts report, if available.

Step 10: *Completing the transactions table.* This step is taken to give a complete picture of regional I-O table, by providing detail information for the elements of final demand quadrant. The components of final demand usually include household consumption, exports, local government current expenditure and housing investment, private inventory accumulation and capital formation. Unfortunately, these are aspects of economic activity for which there are almost a complete lack of data in many countries around the world. At this stage, three questions are of main concern in dealing with the final demand quadrant, all are interrelated: 1) What are the ultimate uses of a regional table?; 2) What level of aggregation of the final demand sectors should be considered? and 3) What kind of technique should be used for the estimation of final demand sectors?

In any regional growth study, information regarding two sub-sectors of final demand quadrant, namely regional household consumption and exports are usually of prime concern and necessary for the estimation of regional multipliers. However, other components of final demand may become necessary, depending upon the objectives of regional study undertaken. In estimating regional final demand, it seems that there are only two approaches: one is to provide independent estimates of final demand components, and second is to deal with aggregate final demand as a residual.

In the first approach, estimating each final demand components separately, it will almost certainly produce inconsistent table, since there is no basis for the column and row totals of each intermediate sector to be equal. If this approach is followed, then it becomes necessary to enforce consistency by using an appropriate mathematical technique, similar to the RAS method. The second approach though has the advantage of no estimation burden, but it deprives the analyst from having detail regional multipliers in regional impact studies.

The choice between these two approaches depends on the objectives of regional I-O table construction and the availability and reliability of regional final demand data. In most cases, there are no reliable or non existent regional data on final demand components, leaving the estimates of aggregate final demand as a residual, the only alternative in completing the I-O table.

Step 11: *More aggregation of sectors.* If the analyst is to compare the economic structure of regions and that of regions with the nation, then uniform regional tables must be constructed. Uniformity of tables may require more aggregation of sectors at this stage.

Step 12: *Estimation of regional multipliers.* In most economic impact studies and even in studies related to regional growth issues, regional multipliers play an important role. The conventional technique for multiplier calculation is used at this stage of GRIT sequence.

Phase V: Derivation of Final Transactions Table

At this last phase of the GRIT sequence, the analyst examines in detail, all uniform and non-uniform regional tables for any anomalies and implements the final superior data insertions and other adjustments, as new and updated information becomes available. Generally, it is expected that those sectors which do not differ substantially in structure between regions, the estimates generated in phase I-IV are reasonably free of any substantial error. Identification of such sectors requires a professional judgment by the analyst or other experts in any region. On the other hand, the burden of investigating and detecting for any inappropriate entries in the table is imposed on the analyst, who can not escape from his ultimate responsibility, as there should be no refuge to mechanically produced tables.

The GRIT research team should always draw on the extensive knowledge of other input-output experts and professionals, government officials well-knowledged in economic interpretation of the various facets of the regional economies, and other regional and or national sources of opinion. Moreover, the coefficients of those sectors which show unique regional characteristics or which have been 'submerged' by dominant national sectors outside the region through their effect on the national coefficients, should be given outmost attention for inspection and any major adjustment, if necessary. Another way of evaluating the reliability and relative accuracy of the results obtained by the GRIT system is to compare the derived multipliers with those from other studies in highlighting potential areas of 'disturbance'.

Step 14: *Finishing touches and derivation of the final transactions table.*

Step 15: *Final estimation of regional multipliers, based on the derived tables.*

VI. The GRIT Critique

Although, downloading regional I-O table from its national counterpart by the use of location quotient has been relatively accepted by many academics and regional analysts, questions have been raised that have persuaded many to criticizes its uses. Actually, the problems associated with the use of location quotient can be classified into three categories. One is associated with the assumptions of the location quotient method, another is related to international trade, and the third is in regard to aggregation issues.

Problems associated with the assumptions:

- Application of the location quotient assumes uniformity of production and consumption demand patterns across regions.
- Labor productivity in each industry or sector is assumed to be the same across regions (if employment data are used).

Problems with international trade issues:

- National employment share used in calculation of LQ, proxies employment needed to meet local demand.
- 'Closing' the economy by 'internalizing' imports, assumes that the nation is the net exporter of goods produced by all sectors in the I-O table.

- A sector with a lower than average employment share (LQ<1) in a region, could still be an exporting sector in that region.

Problems with aggregation issues:

- Data usually more aggregated than desired.
- Some parts of a broadly defined industry may be exporting, where other parts may not or may be importing.
- Overestimation of intraregional interdependence and the existence of cross-hauling problem in some of the sectors in the region. While some products produced by sector are exported, some other products are imported at the same time.

The empirical results of studies, whose aim were to evaluate the capability and creditability of non-survey approaches, including location quotient method, have pointed to inefficiency of location quotient technique in estimating regional I-O coefficients from their national counterparts, when the regional economy is faced with cross-hauling problem (Robinson, *et. al.*, 1988). Moreover, aside from error estimates, comparing regional coefficients provided by various computation techniques, offered by the location quotient approach, makes the selection from those estimates difficult (Harrigan, *et. al.* 1980 a, b). In addition, theoretical investigations by Mc Cann (1995) and Dewhurst (1990), regarding region size, industry location and I-O input coefficients based on location quotient approach, have shown, in contrast to Flegg claims, that no theoretical relation between the size of regions and the magnitude of I-O coefficients exist. They have emphasized the nature and structure of industries in each region, in the construction of single region I-O table from a national table.

VII. The GRIT Modification

In order to remedy many of the deficiencies and problems associated with the use of LQ in the GRIT sequence, attempts have been made by many authors to improve the calculation and application of this quotient in the GRIT methodology. Since the first introduction of SLQ, a varying degree of LQ has been introduced, applied and been commented in the literature.

It has been argued that more unique a regional sector is in terms of different production function and demand/supply characteristics, the less appropriate is the simple SLQ. Although identification of these sectors is the responsibility of the GRIT research team, but the GRIT methodology is flexible enough to allow the addition of superior transactions data into the table to discount the problem. Some other main criticisms regarding the application of LQ, were surrounding the problems associated with the use of employment data in its calculation. Using employment data assumes that labor productivity is the same in each sector throughout the nation. This problem can be remedied either by simply using value added figures for each sector instead of employment data, or labor productivity in every sector. The use of value added or labor productivity ratios takes care of disuniformity in labor productivity across regions. The use of productivity indices is in the following form:

$$SLQ_i^a = SLQ_i * (\theta/\theta_i) \qquad (3)$$

Where θ is labor productivity ratio for all sectors, comparing region (r) with the nation (n):

$$\theta = (Qn/En)/(Qr/Er) \qquad (4)$$

where E refers to employment and Q refers to output. Likewise, the labor productivity ratio for corresponding industry i is:

$$\theta_i = (Qin/Ein)/(Qir/Eir) \qquad (5)$$

Another justification into the use of LQ is related to disuniformity in demand and consumption patterns across regions. If personal consumption figures can be obtained for each sector at the national and region level, then the modification takes the following form:

$$SLQ_i^a = SLQ_i * (C/C_i) \qquad (6)$$

Where C is, per capita consumption level, for all commodities produced by all sectors in the nation relative to the region:

$$C = (Cr/Cn) \quad , \quad C_i = (Cir/Cin) \qquad (7)$$

C_i refers to per capita consumption levels of significant commodities or groups of commodities produced by sector i.

Another modification into the use of LQ is related to some of international trade problems mentioned above. If national production levels of sector i include a significant export component, then employment figure in that industry at the national level overestimates employment in that industry for domestic consumption and thus becomes an inappropriate base for the estimation of that industry's LQ in the region. LQ can be adjusted in the following form:

$$SLQ_i^a = SLQ_i *(Q_i^a) \qquad (8)$$

where Q_i^a is adjusted Q_i for exports:

$$Q_i^a = Q_i /(Q_i - X_i) \qquad (9)$$

where X_i is sector i's exports. The overall modified LQ thus becomes:

$$SLQ_i^a = SLQ_i *(\theta/\theta_i) *(C/C_i)*(Q_i^a) \qquad (10)$$

An alternative modification to the SLQ is to take into account cross-industry LQs., which is called cross industry location quotient (CILQ). This version of LQ assumes that the production input demand of the i^{th} sector for the products of the j^{th} sector, is not only dependent upon the relative intensity of the i^{th} activity in the region, but it also depends on the relative intensity of the j^{th} activity in that region. Thus, what seems to be relevant, is the calculation of the following quotient:

$$CILQ_{irj} = (LQir/LQjr) \qquad (11)$$

The application of LQirj for decomposition process, is the same as has been mentioned above. But since LQir = LQjr for i=j, then LQirj becomes unity, and this suggests that the diagonal coefficients in the regional I-O table are the same as those in the national I-O table. This 'generalization' is one of the limitations of the use of this type of location quotient.

Another version of LQ was suggested by Round (1985). This alternative formulation of LQ, makes some adjustment in CILQ in the following form:

$$RLQ_{irj} = (LQir)/(\log 2(1+Q_{jri})) \qquad (12)$$

A different adjustment to the LQ was suggested by Elliott (1995). According to Elliott formulation:

$$ELQ_{irj} = \left[\log 2\left(1+SLQ_i\right)\right]/SLQ \qquad (13)$$

Flegg, and his colleagues (Flegg, *et. al.* 1995) have offered another approach for adjusting national I-O coefficients to obtain regional coefficients. Their model was based on the work of Round (1978) and Richardson (1986), and is indeed an expanded version of the location quotient. They obtained an explicit negative relationship between the size of the region and region's import propensity. The formula presented by Flegg. *et. al. is*:

$$FLQ_{ij} = CILQ_{ij} * \lambda_p^{\beta} \qquad (14)$$

Where:

$$\lambda_p = (Er/En)/(\log2(1+Er/En) \;\; ; \;\; 1<\lambda<2.693 \;\; \& \;\; \beta \geq 1 \qquad (15)$$

But the question remains, as to which of these alternative formulations of the location quotient should be used in phase5 of the GRIT system, in obtaining a regional I-O table. The criteria for the selection of appropriate LQ, is based upon the study region's economic structure and on the assumptions underlying its uses. However, whatever the relative merits of alternative LQ, its selection and application in the GRIT sequence, remains at the discretion of the analyst.

VIII. The History of Regional Accounts in Iran

The first regional accounts in Iran, was provided by Bettel Consultant Engineers for 11 regions of the country for the years 1972 and 1977. The main statistical data in these accounts were comprised of regional production, intermediate and final consumption. These data were estimated by the use of non-survey method.

Stanford Research Institute also used the non-survey method for provision of a comprehensive energy project in Iran and attempted to estimate the agriculture, industry and services gross output in 1977, by the application of the ratio method and the use of national data. In estimating the value added in agriculture, the Institute was faced with two different sources of data, one from Statistical Center of Iran (SCI) and the other, the Central Bank of Iran

(CBI), with significant difference between the two. Based on the SCI data, the Institute calculated production and distribution ratios in different provinces. Based on the association between the degree of urbanization and industrial activity on the one hand and the growth of national service sector on the other hand, the Institute was able to obtain a series of coefficients and with the help of information related to industry value added distribution figures and the degree of urbanization, value added in the service sector for different regions of the country were estimated.

The SCI made an attempt to obtain a 7 sector input-output table for the city of Isfahan in 1975, with the use of aggregate ratios at the national level, applying a non-survey method. In this attempt, the Center made some adjusted in the estimated coefficients, by the help of existing information at the Center, in relation to the city of Isfahan.

The first attempt to obtain survey-based regional accounts was made by the Plan and Budget Organization branch office in Chahar-Mahal-Bakhtiari province in 1983 under a research project, titled "Chahar-Mahal-Bakhtiari Comprehensive Development Plan". The 7th volume of this research project describes the methodology of collecting information and data analysis. This study has analyzed different aspects of population of the region, specially, employed workforce, its distribution among different economic sectors and the changing trend in sectoral employment.

This research has also estimated production and value added in agriculture, industry and service sub-sectors in the region. The regional input-output table has been constructed with 19 sectors, for the year 1983. In this table, consumption, investment, change in inventories, export and import figures were also estimated. It should be mentioned that in all of these research reports, the statistical methods of collecting information have not been clearly stated, and therefore, no clear judgment about the preciseness and the reliability of data collected could be made. Moreover, the approach taken to transform activity sectors under ISIC[1] classification to 19 regional economic sectors has not been described.

In another research, undertaken at the Plan and Budget Organization branch office in the Fars province, regional accounts of this province for the period of 1974-84 was provided and its documentary report under the title "The Regional Accounts of the Fars Province" was published in 1989. In this research, 'Stone Method' was used to reach at the regional input-output table for the Fars province. Three main approaches were used to adjust the results and to convert the current values to real values. These approaches were those

1. International Standard Industrial Classification

that have been cited in the system of national accounts (SNA) and they are namely: i) simple-adjustment method; ii) double-adjustment method and iii) quantity index method.

Moreover, based on the logic that the provincial economic accounts should be obtained such that, they become consistent with the attainment of national accounts, an attempt was made to take this consistency into account. In providing value figures for the regional variables, the value added approach was preferred to expenditure approach in the evaluation of production. The reason was that commodities in the household budget expenditure are not decomposed into regional and ultra-regional production. Also, an interesting and convincing argument was presented regarding the method of obtaining information. It seems that this research, compared to the previous one, has taken clearer steps from data compilation stand point. But, since the objective has been only to help assemble the regional accounts in line with national accounts, the result can not be totally convincing and useful for intraregional analysis. On the other hand, the national accounts are generally prepared for short-run analysis, whereas in intermediate and long-run inter-sectoral, intraregional analysis, more detail information is needed.

Another table of regional inter-industry relations with 21 sectors was prepared for the province of Kerman for the year 1995 at the Plan and Budget Organization branch office in that province. The combination of five types of data was used for the preparation of this table. These were: i) registered data at various state government departments; ii) the SCI and CBI census and sample-survey results. iii) data that was collected from government offices by the use of specially designed questionnaire for this purpose; iv) data from questionnaire for large industrial sites and v) data from sample-survey of certain activities.

IX. The Application of the GRIT Methodology to The Province of Isfahan

In constructing Isfahan region I-O table, the national I-O table for the year 1991 was selected for two main reasons: first, it was the most recent and comprehensive national table which has been published; second, intermediate import transactions matrix was included in the table, which facilitated greatly the procedure of 'internalizing' imports.

Before proceeding, it should be reemphasized that there are different kinds of adjustments which should be made in the original national I-O coefficients to make them appropriate for use in constructing the regional I-O tables:

- One of the main assumptions in constructing I-O coefficients is that relative price of sectors are not changed and remain the same as data are collected for the original table. In many developing countries, most often these ratios are changing and thus, based upon recent prices ratios, adjustments should be made in intermediate trade flows of the national table.
- Furthermore, if the relative prices of sectors in any region are different from their national counterparts, then there is a further need for adjustment in the trade coefficients.
- The structure of regions' economies, are more open, as compared with that of the nation, and so, there is need to make adjustment for the ratio of imports to the total output in this regard.

In order to update the transaction table of 1991 and make it usable for I-O table in the year 1997, the data on the total intermediate input consumption and total gross output were being used as the key elements. These data have been published in Iran's National Account for 72 economic sectors. However, the number of sectors in 1991 national I-O table, were 78 which did not match with the number of sectors in the national account data. Furthermore, definition of some sectors did not match closely and thus, some aggregation on both sides, were necessary before any adjustment was made for updating. Attempts to reconcile sectors as to keep uniformity between the number and the type of sectors and the data at hand, eventually resulted in 46 sectors, on the basis of which, the regional I-O table was to be constructed.

The updating procedure took the following sequence of actions: 1) Intermediate imports were added to intermediate inputs for respective entries in the national table. 2) Direct input coefficients were calculated. 3) These coefficients in each column entry were multiplied by that column sector value of output for 1997 in order to convert transactions data to 1997 values. 4) The new entries in each column were added to give a rough approximation of each sector's intermediate input consumption in 1997.

Since there is no a periori reason for these intermediate input figures to be identical with the similar figures in national account, the new estimates of intermediate purchases (in step3) were adjusted by the ratios of intermediate inputs in 1997 national account, relative to that obtained by the summation. It should be born in mind that when this procedure is followed, the sum of row entries and column entries need not be identical. In order to make reconciliation between the sum of row entries and column entries, now the row entries must be adjusted. This needs information on the components of final demand for each sector. Unfortunately, such data was not available and so we stopped the updating procedure at this point and let the final demand, as a whole, to take up the difference between the estimated output and output reported in the national accounts.

In the next step, the regional accounts for the Province of Isfahan, published by SCI, was looked upon to search for those national sectors that were absent in the economy of this region. Two sectors were found, namely, crude petroleum and natural gas and tobacco manufacturing. Their respective row coefficients were transferred to the import row of inter-industry table. Then, the location quotients were calculated to derive the regional coefficients from the national counterparts. For this calculation, a simple location quotient formula was used and regional and national 1997 value added data from official statistics were applied. From 44 regional sectors, 15 were shown to have $LQ \geq 1$. Thus, the coefficients for these sectors remained unchanged and the remaining coefficients were adjusted by the methods discussed above, in the GRIT methodology.

The 1997 output vector for each region's sector, was applied to the new matrix of trade coefficients, obtained by the above procedure, in order to estimate the intermediate transaction flows of the region's input-output table. Similarly, intermediate import figures for 44 sectors were estimated, by multiplying output by the corresponding import coefficients.

Unfortunately, there are no information regarding the region's components of final demand and in order to complete the regional table, one has to resort to calculating total final demand as a residual. Though, the difference between what we have obtained from this methodology for GRP and what has been published in regional accounts for the year1997 is nil, only 1.2 per cent difference[1], still we acknowledge that we have not been able to implement the GRIT methodology with its full potentials. First, we did not have sectoral price ratios for the base and terminal year, and so the necessary price adjustment could not directly be undertaken. Second, we did not have final demand components for the year 1997 to use them as a base for making reconciliation between row and column vectors, similar to the RAS technique. Third, this technique involves the usage of 'superior' data for the trade coefficients. And so, we have not paid the cost for enhancing the accuracy of the table.

X. Conclusion

In this article, we enlisted steps in the GRIT technique needed to make a regional input-output table, with much lower cost than the survey approaches. This technique was used to make an input-output table for the Province of Isfahan. Though, we could not apply this methodology with its full capabilities, but it led to the results about GRP which was close to published statistics. Finally, it should be emphasized that this technique is superior to competing statistical apparatus, such as RAS, which does not capitalize on a periori information available to analysts, about the import components of input transactions, relative price changes and the like.

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1. The GRP reported in regional accounts publication for the year 1997 for Isfahan Province,is 21988.1 billion rials, whereas our estimation through the construction of regional I-O table is 21723.4 billion rials.

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