METHODS FOR GENERATION OF A REGIONAL INPUT OUTPUT TABLE FOR THE STATE OF MAHARASHTRA: *A Comparative Analysis*

A.M.Swaminathan

Abstract

Construction of regional input output table is not new in India. However, generation of regional input output table using non-survey methods is not as prevalent. Of late, globally there has been a number of non-survey methods used for generating a regional input output table. This paper uses five of these methods which are widely used and tries to generate a regional input output table for the state of Maharashtra under each of these methods. These results are then compared.

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Introduction

The study on regional input output in India has its beginning in the early sixties. There have been number of works dealing with the construction of regional input output in India. Of these studies [1,2,3,4,5 &6] some have discussed the methodology involving estimation using available data, some others have constructed the regional input output tables on the basis of estimation through available data relating to the region/ state /sector. According to Prasad [7], these tables formed by these studies is said to be highly diversified in respect of year for which it is constructed, the time lag and therefore the cost involved in completion, the sectoral classification, the data base for sectors not covered under the Annual Survey of Industries, the methodology used to derive coefficients of non-manufacturing sectors etc. However, two studies [8,9] deal with the construction of regional input output tables.

In the recent past, globally, there are number of studies on the generation of regional input output tables through the use of non-survey methods. Some of these works [10,11,12,13& 14], have analyzed the regional problems by generating regional input output tables. But, in India the generation of regional input output tables using non-survey methods is rare. Therefore there is urgent need of working on such topics. Besides, the spatial factors help in testing the reliability of the generated regional input output table. It also helps in identifying the best of the methods used in the generation of the regional input output table. As such the paper aims at analyzing the spatial influence in the generation of the regional input output tables using five methods initially for the state of Maharashtra.

Section 2 deals with the methodology, where as, 3 deals with database and adjustments, analysis and conclusions are dealt with in sections 4 & 5 respectively.

Methodology

Though, the non-survey method could be put into three groups – the quotients approach, the commodity balance approach and the use of iterative procedure, this study attempts to generate regional input-output table for the state of Maharashtra by following the quotient approach. All these methods make use of the national input output table to arrive at the regional table. By quotients approach is meant the use of location quotients – LQs. The basic assumption in all these models is that the national technical relationships hold good at the regional level. The regional trade coefficients are different from the national technical coefficient to the extent to which goods and services are imported from other regions. This implies that the national technical coefficients $\mathbf{a}_{ij}^{N}$ is equal to regional input coefficient $\mathbf{a}_{ij}^{R}$ plus regional import coefficient $\mathbf{m}_{ij}^{R}$. Thus, the regional trade flows are estimated by assuming that $\mathbf{a}_{ij}^{R} = \mathbf{LQ}_i\ \mathbf{a}_{ij}^{N}$ subject to $\mathbf{LQ}_i$ is less than or equal to unity. The $\mathbf{LQ}_i$ gives a measure, which, reflects the relative importance of regional industry in comparison to its national counter part and it is calculated as the ratio of regional output to the national output share of each industry/sector.

The process involves two main stages a) the stage of generating the regional coefficients and the regional inter-sector flow matrix and b) the generation of the final demand vector with the break-up of personal consumption expenditures, investments, state and local government, as well as exports both abroad and to the rest of the country. Thus, the methodology section is divided into two sub sections.

Generation of regional coefficients and the regional inter-sector flow matrix

The first method refers to the simple location quotient. Denoted as SLQ, it has been formulated thus:

$$SLQ_i = \frac{RO_i / TRO}{NO_i / TNO} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad \text{I}$$

Here the subscript i represents the sectors in the economy e.g. agriculture, industry etc., ROi refers to regional output of sector ‘i’, TRO is the total regional output, NOi refers to the national output of sector ‘i’ and TNO is the total national output. If $\mathbf{SLQ}_i > 1$, it means that the regional sectors output is greater than the national average.

Thus, the regional sector is more specialized than its national counter part and therefore self-sufficient. On the other side, if $\mathbf{SLQ}_i < 1$, it implies that the regional industry has less output than its national average. Therefore less than self-sufficient and thus needs to import from other regions to meet the demand requirements of the region. In practice when $\mathbf{SLQ}_i \geq 1$ then it is considered as 1. That is assuming that regional sector will be able to meet all the local demands implying that regional coefficient is equal to national coefficient. But, if $\mathbf{SLQ}_i < 1$ it is considered as it is. Thus, when $\mathbf{SLQ}_i \geq 1$ the regional input coefficient $\mathbf{a}_{ij}^R$ is estimated as $\mathbf{a}_{ij}^R = 1\ \mathbf{a}_{ij}^N$. i.e $\mathbf{a}_{ij}^R = \mathbf{a}_{ij}^N$. But, when $\mathbf{SLQ}_i < 1$, $\mathbf{a}_{ij}^R = \mathbf{SLQ}_i\ \mathbf{a}_{ij}^N$ .Here $\mathbf{a}_{ij}^N$ is the national technical coefficient. Thus,

$$\mathbf{a}_{ij}^R = \mathbf{SLQ}_i\ \mathbf{a}_{ij}^N \qquad \ldots\ldots\ldots\ldots\ldots \qquad \text{II}$$

This approach is such that only the size of the selling industry is considered in determining the extent of regional imports. However, researchers felt that since the relative size of the purchasing industry could also be crucial in determining the extent of regional imports, $\mathbf{SLQ}_j$, be used as the location quotient. But, the impact of this method on the results was only marginal. This followed the Cross Industry Quotient. This Location Quotient compares the share of ith selling industry's output of the region to the national with that of the jth purchasing industry in the region to the national. Denoted as **CILQij** it is formulated as

$$CILQ_{ij} = {SLQ_i}\big/{SLQ_J} = \frac{RO_I / NO_i}{RO_j / NO_j} \qquad \ldots\ldots\ldots\ldots\ldots \qquad \text{III}$$

Where

$$SLQ_j = \frac{RO_j / TRO}{NO_j / TNO} = \frac{RO_j / NO_j}{TNO / TRO}$$

Here also the ijth cell of the national technical matrix is adjusted in the same manner as done in $\mathbf{SLQ}_i$ i.e. where $\mathbf{CILQ}_{ij} \geq 1$ it is considered as 1 and where $\mathbf{CILQ}_{ij} < 1$ the coefficient is taken as it is. Thus,

$$\mathbf{a}_{ij}^R = \mathbf{CILQ}_{ij}\ \mathbf{a}_{ij}^N . \qquad \ldots\ldots\ldots\ldots \qquad \text{IV}$$

But, this technique though, takes the selling and purchasing industry; it does not take into account the size of the region or the nation.

Over coming this drawback, Round [14] came up with a location quotient which is said to consider the selling and purchasing industry as in the case of cross industry location quotient, but, also adds the relative sizes of the region and nation. Thus, Round's location quotient is denoted as

$$RLQ_{ij} = \frac{SLQ_i}{Log_2(1+SLQ_J)} \qquad \ldots\ldots\ldots\ldots\ldots \qquad V$$

$$= \frac{\{(RO_i/NO_i)(TNO/TRO)\}}{\{Log_2(1+(RO_j/NO_j)(TNO/TRO))\}}$$

Thus, $\mathbf{a}_{ij}^{R} = \mathbf{RLQ}_{ij}\, \mathbf{a}_{ij}^{N}$ …………….. VI

Here the subscript i represents the sectors in the economy e.g. agriculture, industry etc., ROi refers to regional output of sector 'i', TRO is the total regional output, NOi refers to the national output of sector 'i' and TNO is the total national output. Here too the trade coefficients are scaled down such that when **LQs** ≥ 1 the regional input coefficient $\mathbf{a}_{ij}^{R}$ is estimated as $\mathbf{a}_{ij}^{R} = 1\ \mathbf{a}_{ij}^{N}$. i.e $\mathbf{a}_{ij}^{R} = \mathbf{a}_{ij}^{N}$. But, when **LQs** < 1, $\mathbf{a}_{ij}^{R} =$ **LQs** $\mathbf{a}_{ij}^{N}$.

Round [14], suggests that the size of any trading coefficients, t_{ij} ($0 \leq t_{ij} \leq 1$) is likely to be a function of i)the relative size of the supplying sector which is measured as RO_i/NO_i, ii)the relative size of the purchasing sector which is measured as RO_j/NO_j, iii) the relative size of a region which is measured as TRO/TNO and iv) some other additional unspecified factors. Though the SLQ in equation I incorporates the first and the third factors and the CILQ in equation III makes use of the first and the second factors, it is only the RLQ in equation V that satisfies all the three requirements mentioned above.

Morrison and Smith [13] brought about changes in $\mathbf{CILQ}_{ij}$ by adjusting the principal diagonal elements of $\mathbf{CILQ}_{ij}$. This is because, according to them as $\mathbf{CILQ}_{ij}$ is equal to unity for all i, implies that every industry/sector can meet all its demand of output from its own industry/sector locally, whatever be the size of the sector. This they felt was a misleading assumption that one could make, specifically if the industry/sector is very small. Thus, they modified the $\mathbf{CILQ}_{ij}$ such that $\mathbf{SLQ}_i$ is applied all along the principal diagonal of the matrix.

Thus we have the Adjusted Cross Industry Location Quotient formulated as

$$ACILQ_{ij} = CILQ_{ij} x S\hat{L}Q_i \left(or S\hat{L}Q_j \right) \qquad \text{.............} \qquad \text{VII}$$

Therefore,

$$\mathbf{a}_{ij}^{R} = [\ \mathbf{CILQ}_{ij}\ \mathbf{x}\ \mathbf{S\acute{L}Q}_i]\ \mathbf{a}_{ij}^{N}. \qquad \text{................} \qquad \text{VIII}$$

Flegg et.al.[10] came out with a method, which was seen to be a modified version of Round. This was further modified to overcome certain shortcomings that were criticized. Thus Flegg et.al [11] brought out their further modified version of the formula. Flegg's method denoted as $\mathbf{FLQ_{ij}}$ is formulated as

$$FLQ_{ij} = \frac{RO_i / RO_j}{NO_i / NO_j} x\lambda^{*} \qquad \text{..................} \qquad \text{IX}$$

$$\lambda^{*} = \left[Log_2 \left(1 + TRO/TNO \right) \right]^{\delta}$$

Therefore,

$$\mathbf{a}_{ij}^{R} = \mathbf{FLQ}_{ij}\ \mathbf{x}\ \mathbf{a}_{ij}^{N}. \qquad \text{.................} \qquad \text{X}$$

$\mathbf{FLQ_{ij}}$, incorporates the properties of the $\mathbf{CILQ}_{ij}$ and $\mathbf{SLQ}_i$. If **FLQ** has to be used then one should estimate δ. A bigger δ it is said, results in regional imports adjustments being greater. Studies (including that of Flegg's testing) on this, have found that δ being equal to 0.3 helps in deriving multipliers close to those calculated through survey based regional input output tables. δ is said to be a parameter used for comparison of such tables with survey based regional input output tables. But, in

India, as we do not have survey based regional input output tables, δ has been taken as 1 and 0.3. Besides, though the $\mathbf{FLQ_{ij}}$ the formula uses only $\mathbf{CILQ}_{ij}$ this study uses $\mathbf{CILQ}_{ij}$ **x** $\mathbf{S\acute{L}Q}_{i}$ i.e $\mathbf{ACILQ}_{ij}$. However, the results found to better than just using $\mathbf{CILQ}_{ij}$.

Now for the rest of the rows, let us first deal with the value added coefficients. The value added coefficients are assumed to be the same as the national value added coefficients. The residual of these coefficients is the import coefficient i.e. one minus input coefficients plus value added coefficients is equal to import coefficients. These are then converted into the flow matrix by using the sector wise GDP of Maharashtra. Thus, we form the inter sector flow table for 25 sectors, the value added row and the row of imports.

Generation of the Final Demand

The estimates of regional industry output obtained through these SLQ coefficients may exceed actual output for some industries. As such there could be complications. To overcome such complications or see that these sector outputs do not over estimate regional output, we need to balance the equations [15]. For example let us calculate the estimated sector i's output by using the actual regional industry outputs (the available data) and the SLQ estimated regional input coefficients (and regional final demand purchase coefficients). i.e. for sector 'i' this is

$$\bar{X}_i = \sum_j a_{ij}^R X_j + \sum_f c_{if}^R y_f \qquad \ldots\ldots\ldots\ldots\ldots \qquad \text{XI}$$

Where, X_i = estimated regional output of sector *'i'* y_f = total regional final demand of final demand sector *f*, and c^R_{if} = estimated regional final demand purchase coefficients of regional final demand sector f from industry *i*. The c^R_{if} elements, show purchases of regionally produced output *i* by regional final demand sector *f*. It is known, that the regional final demand sectors relate to personal consumption expenditures, investments, state and local government, as well as exports both abroad and to the rest of the country.

The estimates of c^{R}_{if} are calculated almost in the same manner as the regional inter-sector coefficients $\boldsymbol{a}_{ij}^{R}$ i.e. by using the national data and the regional specific location quotients.

$c_{ij}^{R} = c_{if}^{N}\left(SLQ_{i}\right)$ if $\mathbf{SLQ}_{i} < \mathbf{1}$ ………. XII

$c_{ij}^{R} = c_{if}^{N}$ if $\mathbf{SLQ}_{i} \geq \mathbf{1}$ ………… XIII

Here, $c_{if}^{N} = \dfrac{Y_{if}}{Y_{f}}$ and Y_{if} = national sales of industry i to final demand sector *f*, and Y_{f} = total national purchases of final demand sector *f*. Thus, when $\mathbf{SLQ}_{i} \geq \mathbf{1}$, it is assumed that national proportion of purchases of good *i* by final demand sector *f* to the total sector *f's* purchases remain the same for the region also.

Now, after framing the whole input output matrix, next follows the balancing procedure. This is done by calculating the ratio of estimated regional output $\overline{X}_{i}$, to actual regional output X_{i}. This is shown as $Z_{i} = \dfrac{\overline{X}_{i}}{X_{i}}$. Each row of the estimated regional input coefficients, for which, $Z_{i} > 1$, is adjusted downwards. In other words in order to estimate an adjusted (balanced) set of regional input coefficients we use inverse of Zi i.e. that row for which Zi > 1, we calculate $\mathbf{a}_{ij}^{R}$ (1/Zi). In the case of those rows where Zi ≤ 1, $\mathbf{a}_{ij}^{R}$, is retained as it is. Lastly the regional commodity balance for industry i, is calculated as

$b_{i} = X_{i}^{R} - \overline{X}_{i}^{R}$ ……………… XIV

If this balance is positive or zero then it is said that the national coefficients as estimates of regional coefficients does not generate an over estimate of regional production and $a_{ij}^{R} = a_{ij}^{N}$ and $c_{if}^{R} = c_{if}^{N}$ .But, if the balance is negative it implies that national coefficients are too large that they generate unrealistically high regional outputs by sector. Therefore, the national coefficients are reduced by the amount necessary to make the regional balance for that sector exactly zero.

Data Base and Adjustments

As already mentioned, the regional input output matrix for Maharashtra is to be constructed with the help of the national coefficient table, the output statistics of the different sectors of the nation (India) as well as the state of Maharashtra. As such initially the latest national input output table i.e. for the year 1998-99 is considered. This 115 sector is aggregated to form a 26 sector input output table for the nation. These 25 sectors are 1)Agriculture & allied activities; 2)Forestry & Logging; 3)Fishing; 4)Mining & Quarrying; 5)Food Products; 6)Beverages; 7)Textiles; 8)Textile Products; 9)Wood & Wood Products; 10)Paper & paper products; 11)Leather & leather products; 12)Rubber plastic glass & petroleum products; 13)Basic Chemical & chemical products; 14)Non-metallic mineral products; 15)Basic metal & alloys; 16)Metal products & parts (except machinery & equipment); 17)Machinery & equipment other than transport equipment; 18)Transport equipment; 19)Other manufacturing industries; 20)Construction; 21)Electricity gas and water supply; 22)Transport, Communication, Storage & warehousing; 23)Trade Hotels & restaurants; 24)Banking & Insurance and 25)Public Administration Defense and other services. This flow table is converted into a coefficient table by dividing the columns pertaining to the sectors by the output of the respective sector. The so formed coefficient table is used for constructing the regional input output table for Maharashtra.

To calculate the output Location Quotient for the state of Maharashtra, the state's sectoral output is divided by the state's total output. This ratio is calculated by using the Gross State Domestic Product at Factor cost at current prices. This is taken from, the State Domestic Product (State Series) data, under the CSO Reports and Publications available in the net. Here, the sectors under Manufacturing, is broken into 15 sectors, by using the share of these sectors in the ASI data for Maharashtra. The National sectoral ratios are calculated by dividing the national sector wise data by the National Output, using the Gross Domestic Product by Economic Activity at current prices brought out by the National Accounts Statistics under the CSO Reports and Publications. Here also, the sectors under Manufacturing, is broken into 15 sectors, by using the share of these sectors in the ASI data for All India.

The private final consumption expenditure of the final demand, are calculated by using the rural urban population census 2001 and the monthly per capita consumption expenditure given by the NSS 55^{th} round. This is allocated sector wise at the national rate of sectoral allocation. Similarly, government final consumption expenditure is collected from 'State Finances' published by the RBI and allocated sector wise at the national rate of sectoral allocation. The gross fixed capital and changes in stock is collected from the ASI and adjusted to the respective industries.

Results

The generation of regional input output tables using the five different methods have shown that the Flegg's method gives the least over estimation both in number of sectors as well as value in each of them. It is seen in the Table I below that under the SLQ, CILQ and ACILQ there are 4 sectors, showing over estimation, but, under RLQ there are five sectors showing over estimation. However, in the Flegg's method (FLQ) there are only two sectors showing over estimation. The rate of change in adjustments, indicate the extent to which these are over estimated. This again shows that Flegg's method has the least percentage of change in adjustments. Here also this rate of change depends on the value of δ. The smaller the value of δ, lower is the adjustment required. Flegg's criticism of Round's method as 'counter-intuitive' is obvious in the analysis. In RLQ, the SLQ in the numerator and denominator maintain a high figure of 1 in many sectors as such the nation level is maintained for these sectors. However, in FLQ, the multiple of a scalar which is less than 1 through out helps in downsizing the regional coefficients from the national. Table II shows the import values calculated under the five different methods. This Table II shows that it is only under the Flegg's method the import values are consistently greater than import values derived by all the other methods. This is a step further from the Smith & Morisons' result indicating that the SLQ is the best of the methods.

Conclusion

The generation of input output tables using all the five methods have shown that Flegg's method of estimating the regional input output matrix gives the least level of over estimation. It also provides a consistently high import values. Therefore, it is regarded as the best.

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Table 1 - Over Estimation in Sectoral Coefficients under the different methods and their adjustments

Sectors/ Methods	SLQij	CILQij	ACILQij	RLQij	FLQij
Sector 4 at 1/Zi				0.5439612	
4 after adjustment				0.5439582 (0.0001%)	
9 at 1/Zi	0.0638918	0.0638918	0.0638918	0.0638918	0.0865349
9 after Adjustment	0.0615766 (3.62%)	0.0615766 (3.62%)	0.0615766 (3.62%)	0.0615766 (3.62%)	0.0834719 (3.54%)
10 at 1/Zi	0.9216198	0.9216198	0.9216198	0.9216198	
10 after Adjustment	0.9210129 (0.066%)	0.9210129 (0.066%)	0.9210129 (0.066%)	0.9210129 (0.066%)	
14 at 1/Zi	0.8865121	0.8224466	0.8320960	0.4494606	
14 after Adjustment	0.8857133 (0.09%)	0.8212893 (0.14%)	0.8309875 (0.13%)	0.4475036 (0.44%)	
15 at 1/Zi	0.6079668	0.5818358	0.5944476	0.5265052	0.8057014
15 after Adjustment	0.6077944 (0.028%)	0.5816597 (0.030%)	0.5942733 (0.029%)	0.5263248 (0.034%)	0.8055881 (0.014%)

NB Figures in bracket show the rate of change.

Table 2 – Sector wise estimates of imports under the different methods before final adjustment in Rs.Lakhs

Methods/ Sectors	SLQi	CILQij	ACILQij	RLQij	FLQij
1	196773	26542	188145	75535	349434
2	18492	17785	17898	17985	22132
3	1874	876	1676	1168	4505
4	82849	81812	82442	82585	87220
5	191681	191742	191721	91735	303180
6	8189	6149	6451	4334	16554
7	32760	32788	32776	17056	82449
8	19023	19050	19038	14367	48097
9	667	669	668	541	1152
10	36016	36046	36034	34799	48244
11	2688	567	2224	1203	3498
12	236214	236299	236260	220719	294341
13	215348	215575	215487	198260	344483
14	11721	6413	6901	10966	12596
15	106784	98122	103660	103984	126512
16	45732	47288	46540	44105	61753
17	314301	317233	315836	310861	374057
18	60050	61504	60809	57224	99103
19	107342	108899	108150	105633	120057
20	188411	180072	179179	172154	273644
21	42126	42128	42127	34778	126917
22	123025	123201	123127	104227	335115
23	111041	88211	92258	63526	247929
24	46498	46498	46498	31192	187752
25	234765	198457	217939	198202	438059
Total	2434372	2183925	2373846	1997139	4008775