Demography India
Vol. 19, No. 2 (1990), pp. 205-216

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Criteria for Model Choice in the Context of India's Inter-Regional Migration: An Applied Econometric Study

Introduction

IN the recent past, the economic theory of local public goods is being used to derive an empirical framework for testing the role of fiscal (federal inter-regional transfers and regional taxes) and non-fiscal (wage rates, labour market conditions, moving costs etc.) variables in the inter-regional migration of workers in India (Narayana 1990, 1991). In particular, these studies provide positive empirical evidence for resource (labour) allocative effects of federal transfers and for Tiebout (1956) hypothesis (whether or not the differences among regional governments in the mix and amount of local public goods provided would, other things being equal, influence human migration). However, the use of a single equation model in these studies with *a priori* functional form .has eliminated the opportunity of model choice and thereby testing for the robustness of estimation results in the context of alternative specification of migration equations in terms of explanatory variables and functional forms. The main purpose of this paper is to fill in this empirical gap and to obtain additional insights. This will be done in a proposed disaggregate economic model for India's inter-regional (or, inter-state) migration, and estimating it by standard econometric techniques with alternative specifications of the independent/explanatory variables and functional forms.

The most important result of our empirical study shows that the log-linear functional form is empirically (statistically) more appropriate than the linear functional form. Further, the estimation results which follow from log-linear functional form are in conformity with

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The author is grateful to Professors Yoshitsugu Kanemoto (University of Tokyo, Japan) and Noboru Sakashita (University of Tsukuba, Japan) for research guidance, and to Professors N. S. Iyengar and P. R. Brahmananda (Indian Statistical Institute, Banglore) for encouragements.

1. It may be mentioned that Greenwood's (1971) study on India's inter-state migration did consider alternative estimation models with two dependent variables and varying number of explanatory variables. The implicit model choice in his paper was based on qualitative differences in terms of the magnitude of estimated coefficients, coefficient of determination etc. However, our econometric model, and the criteria for model choice in it, is completely different from Greenwood's approach.

theoretical predictions for fiscal and non-fiscal variables, and are consistent with earlier studies on the subject as well. Consequently, the policy scope of fiscal variables is enlarged in effecting population redistribution in space in general rather than in effecting spatial reallocation of workers in particular. These new results unambiguously imply that any *a priori* specification of a linear functional form for India's inter-regional migration may lead to misleading results.

The rest of the paper is organised as follows. In Section 2, a disaggregate economic model of migration is constructed, and its estimation results are summarised. Section 3 details the criteria for model choice in the context of the disaggregate economic model of migration in Section 2. In the light of the appropriate model chosen, a brief economic interpretation of estimation results are given. Section 4 concludes the paper.

2. A Proposed Disaggregate Economic Model of Migration

For the purpose of analysing the problems of model choice, we consider a simple diaggregation of total inter-regional migrants into worker and non-worker migrants, and assume that their mobility from region *i* to region; is influenced by the following economic variables: per capita income *[Yi, Yj*]; per capita regional government taxes [G;, G/l, per capita federal inter-regional transfers [Si, *Sj],* labour stock *[Pi, Pj]* and distance [£></]. Thus, our purpose is limited to estimate the differential propensity of worker and non-worker migrant groups to a common set of economic variables. In a statistical sense, this implies the replication of a dependent variable for fixed values of independent variables. However, we are aware that in reality worker and non-worker migrants may be influenced by different set of variables.

In formal terms, our disaggregate model can be expressed as follows:

$$TISWMij = f[Yi.Yj.Gi.Gj.Si,Sj.Pi,Pj,Dij;\mu_1], \qquad (1)$$

$$TISNWMij = g\,[Yi, Yj, Gi, Gj, Si, Sj, Pi, Pj, Dij, \mu_2], \qquad (2)$$

where *TISWMij (TISNWMij)* is the total inter-regional worker (non-worker) migration from region *i* toy, and all other notations are the same as defined earlier.

For the purpose of statistical estimation, we consider a specification of (1) and (2), where all the independent variables, except labour stock and distance, are expressed as the ratio of the origin to destination variables and estimate the following two models.

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2. Note that our disaggregalion is based on aggregate data which may not capture the true behavioural structure of inter-regional migration at the individual level. For a review of disaggregate models of inter-regional migration based on individual behaviour, see Est (1981).

3. See Narayana (1991) for the theoretical justifications of these variables, in a macro migration equation, based on the quantitative economic theory of local public goods.

4. One important non-economic factor which may influence migration decision in India is marriage. In a recent micro study, Rosenzweig and Stark (1989) have explained the pattern of marriage migration among rural women in India in terms of marital arrangements.

Model1

$$TISWM_{ij} = h\,[Y_i/Y_j, G_i/G_j, S_i/S_j, P_i, P_j, D_{ij}; \mu_1^*], \tag{3}$$

$$TISNWM_{ij} = k\,[Y_i/Y_j, G_i/G_j, S_i/S_j, P_i, P_j, D_{ij}; \mu_2^*], \tag{4}$$

where μ_1 (μ_2) is the random error term for worker (non-worker) migration. In this model, total number of parameters to be estimated, in each equation, is 7 including the intercept term. We mainly predict the following signs for the coefficients in order to offer plausible economic interpretation of estimation results:

$$[\delta h/\delta\,(Y_i/Y_j)] < 0\,;\; [\delta h/\delta\,(G_i/G_j)] > 0;\; [\delta h/\delta\,(S_i/S_j)] < 0;\; [\delta h/\delta\,(D_{ij})] < 0; \text{and,}$$

$$[\delta k/(Y_i/Y_j)] < 0\,;\; [\delta k/(G_i/G_j)] > 0;\; [\delta k/\delta\,(S_i/S_j)] < 0;\; [\delta k/\delta\,(D_{ij})] < 0.$$

Model 2

$$TISWM_{ij} = m\,[Z_i/Z_j, S_i/S_j, P_i, P_j, D_{ij}; \mu_1^{**}], \tag{5}$$

$$TISNWM_{ij} = n\,[Z_i/Z_j, S_i/S_j, P_i, P_j, D_{ij}; \mu_1^{**}], \tag{6}$$

where $Zi = (Y_i - G_i)$ and $Z_j = (Y_j - G_j)$ are the disposable income in region i and j. In this model, the total number of parameters to be estimated, in each equation is 6 including the intercept term. We predict the following signs for coefficients of disposable income in (5) and (6): $[(\delta m/\delta\;(Z_i/Z_j)] < 0$ and $[(\delta n/\delta\,(Z_i/Z_j)] < 0$. Other predictions are the same as given above for model 1.

In general, variables expressed in ratio form assume that the 'push' of unfavourable conditions in the origin region and the 'pull' of favourable economic conditions in the destination region are equally strong. Further, these ratio variables also[1] tell that migrants respond to relative differences in those variables between origin an destination regions rather than absolute changes occuring in origin and destination regions separately. On the other hand, labour stock variables allow for origin and destination conditions to have differential effects from one another.

Next, in order to derive the technique of estimation, we consider that within each group of migrants in both me models, the standard assumptions of a linear regression model hold. Further, we assume that between worker and non-worker migrant groups, the random errors have zero correlation (or worker and non-worker migrant decisions are independent). Hence, each equation in model 1 and model 2 can be estimated by the technique of Ordinary Least Squares (OLS) in the framework of a multiple-equations model.

In order to avoid ambiguities associated with *a priori* specification of a functional form, we estimate all equations in both the models by fitting linear and log-linear functional forms.

5. In recent past, a general functional form of migration relations which provide more flexibility with regard to the choice of a functional form is employed. See, for instance, Goss and Chang (1983). For a sophisticated approach to the study of model choice criteria, in general, see Chapter 9 in Chow (1983).

Next, the main source of data is the census of India (1977) which is latest available source of comprehensive migration data needed for our estimations. In order to base our estimations on direct moves, we use the migration data on place of last residence rather than on the place of birth. The sample employed consists of 21 states: (1) Andhra Pradesh; (2) Assam; (3) Bihar; (4) Gujarat (5) Haryana; (6) Himachal Pradesh; (7) Jammu and Kashmir; (8) Karnataka; (9) Kerala; (10) Madhya Pradesh; (11) Maharashtra; (12) Manipur; (13) Meghalaya; (14) Nagaland; (15) Orissa; (16) Punjab, (17) Rajasthan; (18) Tripura; (19) Tamil Nadu; (20) Uttar Pradesh, and (21) West Bengal. Each of these 21 states is chosen as a destination and gross migration from each of the other 20 states to each of these states is included in the data base. Hence, the total number of observations is 420. The data sources and descriptions for all explanatory variables of our study are the same as used in a recent study by Narayana (199*1)*. Hence, a summary of them is given in Appendix I.

Tables 1 and Table 2 report the OLS results of model 1 and model 2 respectively. The economic interpretation of these estimation results will be given in the following section with the appropriate model chosen.

TABLE 1 : PATTERNS OF INTERSTATE MIGRATION IN INDIA: 1971 LINEAR AND LOG-LINEAR REGRESSION COEFFICIENTS (6) AND f-RATIOSfO FOR MODEL 1

Total Interstate Non-Workers Migration			*Total Interstate Workers Migration*	
	Linear Form	*Log-Linear*	*Linear Form*	*Log -Linear*
c	*b:* 40628.5 t: (3.756)*	31.494 (47.272)*	36570.8 (3.529)*	28.278 (40.172)*
Yi/Yj	-9965.82 (1.405)	-0.576 (2.545)*	-17059.3 (2.504)*	-0.547 (2.286)*
Gi/Gj	284.66 (0.660)	0.202 (2.807)*	301.80 (0.729)	0.240 (3.157)*
Si/Sj	-668.53 (0.834)	-0.334 (2.925)*	-720.41 (0.936)	-0.419 (3.472)*
Pi	327817.9 (4.858)*	0.875 (11.773)*	280211.4 (4.323)*	0.691 (8.806)*
Pj	351574.4 (5.372)*	1.180 (15.897)*	280273.6 (4.458)*	1.058 (13.485)*
Dij	-23.16 (8.017)*	-2.293 (26.654)*	-16.02 (5.775)*	-2.001 (22.020)*
R^2	0.267	0.830	0.193	0.767
F	25.149	337.772	J6.551	226.860
S.E.	50069.8	1.180	48091.8	1.247

' Indicates that the coefficient is significant at 5% level or better ($t \geq 1.645$ for one tail-test; $t \geq 1.960$ for two-tail test).

3. Criteria for Model Choice

In the context of our estimations above, there are two explicit problems concerning the choice of model specification. The first problem is what criterion we may use to test whether model 1 and model 2 is statistically significant. The major difference between these models lies in the nature of independent variables used. That is, relative per capita income and per capita regional taxes appear as separate explanatory variables in model 1 whereas in model 2 they appear jointly in the form of disposable income. The second problem is by what criterion we may decide the appropriate functional form of migration estimation in question.

With regard to the first problem, we follow Rao and Miller (1971:109), and test whether the difference between the residual sum of squares is different when an equation is estimated in the model 1 and model 2 using the same functional form. The null and alternative hypotheses of this test, say for worker migration *(TISWM),* are given as follows:

Ho:RSS(TISWM) =RSS**(TISWM)* H_1*:*

RSS(T1SWM) = RSS**(TISWM),*

where *RSS** () is the residual sum of squares of the total worker migration equation in model 1, and *RSS**()* is the residual sum of squares of the total worker migration equation in Model 2.

TABLE 2 : PATTERNS OF INTERSTATE MIGRATION IN INDIA: 1971 LINEAR AND LOG-LINEAR REGRESSION COEFFICIENTS *(b)* AND *t*- RATIOS(0 FOR MODEL 2

Total Interstate Nun-Workers Migration			*Total Interstate Workers Migration*	
	Linear Form	*Log-Linear*	*Linear Form*	*Log-Linear*
c	b: 40313.7 t: (3.684)*	31.494 (46.894)*	36703.9 (3.492)*	28.278 (39.746)*
ZiZj	-8956.93 (1,275)	-0.195 (1.069)	-16462.7 (2.440)*	-0.082 (0.425)
Si/Sj	-680.37 (0.853)	—0.335 (2.914)*	-727.78 (0.950)	-0.419 (3.442)*
Pi	329201.0 (4.878)*	0.950 (13.622)*	327817.1 (4.324)*	0.782 10.586)*
Pj	340347.5 (5.454)*	1.105 (15.857)*	351574.3 (4.506)*	0.967 (13.101)*
Dij	-22.86 8.033)*	-2.293 (26.439)*	-15.73 (5.753)*	-2.001 (21.785)*
R^2	0.266	.0.827	0.193	0.761
F	30.146	397.369	19.824	264.553
S.E	50032.8	1.190	48053.8	1.126

Indicates that the coefficient is significant at 5% level or better ((> 1.645 for one tail-test; (> 1.960 for two-tail test).

Then, the test statistic, *d,* suggested by Rao and Miller is given as follows:

$$d = N/2\ |[\log [RSS^{*}(TISWM)IRSS^{**}(TISWM)\}$$

The d-statistic follows a Chi-square distribution with one degree of freedom. When the ^-statistic exceeds the chosen critical value, we may reject the null hypothesis that the two models are empirically equivalent.

We summarise the results of the test in Table 3. It is clear from the table that the computed statistic exceeds the critical value for all the cases in the log-linear case, but does not exceed the critical value for the all the cases in the linear case. Hence, when we estimate the equations in Models 1 and 2 using log-linear functional form, we can reject the null hypothesis that Models 1 and Model 2 are empirically equivalent with 95 percent confidence. On the other hand, when we estimate the equations in models 1 and 2 using linear functional form, we can accept the null hypothesis that model 1 and model 2 are empirically equivalent with 95 percent confidence.

T ABLE 3 : d-STATTSTIC FOR MODEL SELECTION

Dependent Variable	*Value of the d-Statistic*	
	Linear Case	*Log-Linear Case*
TISWM	0.175	4.981
TISNWM	0.197	3.873

The critical value of Chi-square distribution with one degree of freedom at the critical value of 95 percent level of confidence is 3.841.

With regard to the second problem (choice of the functional form), we adhere to the minimum variance criterion. But a direct comparison of residual sums of squares between linear and log-linear equations is meaningless because the dependent variables are expressed in different units. Hence, before the comparison, we need to standardise the variables in such a way its variance does not change with units of measurement. In this regard, we follow the procedure of standardisation suggested by Maddala (1976: 317). The procedure says that if we have, say *TfSWM,* in linear and log-linear forms, we divide each observation *ofTISWM* by the geometric mean of it, and then estimate the two equations and choose the one with the smaller residual variance.

Note that in the above estimation we only need the residual sums of squares, but not the estimates of coefficients. Hence, the criterion for the choice of the functional form, say for the case of *TISWM,* can be written as follows:

$$S = [RSS\ (L)/g^{2} - RSS\ (LL)\},$$

where

$RSS(L)$ = residual sums of squares from the linear equation of *TISWM*; g^{2}-$RSS(LL)$: g = geometric mean of the dependent variable, *andRSS(LL)* is residual sums of squares from log-linear estimation of *TISWM.*

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6. The following S-criterion is also called Sargan's method by Godfrey and Wickens (1981).

The criterion provides a simple rule for clear-cut decision between linear and log-linear functional form. If 5 is less than one, then the data can be said to favour linear form, or if *S* is greater than one, then the log-linear model is to be preferred.

In Table 4, we have summarised the value of *S* for *TISWM* and *TISNWM* in model 1 and model 2. But in computing this *S,* we have used the arithmetic mean rather than the geometric mean. This is because of the fact that the size of the observations in our dependent variables is quite big, and hence the computation of the geometric mean is difficult. However, this does not affect the above decision rule because geometric mean is always less than or equal to arithmetic mean.

TABLE 4 : S-CRITERION FOR MODEL SELECTION

Dependent Variable	*Approximate Value of the S-Criterion*	
	Model	*Model 2*
TISWM	5.312	5.197
TISNWM	3.784	3.719

The result shows that the log-linear functional form possesses smaller residual sums of squares. Hence, log-linear function appears empirically (statistically) more appropriate than the linear functional form for Indian inter-state migration estimation.

It should be emphasised that the appropriateness of log-linear model for India's interstate migration from the above testings is consistent even if we had based our model choice criterion exclusively on 'qualitative-differences, (i.e., sign conditions or significance level of individual coefficients) between linear and log-linear estimations. However, the main advantage of our approach lies in its systematic and unambiguous results especially when the model choice problem become intricate due to 'qualitative-equivalence' (e.g. sign of the estimated coefficients is the same for all variables in all equations of model 1 and model 2 as shown in Table 1 and Table 2 respectively) between linear and log-linear forms.

Here we might add that upto now, we have dealt with two explicit problems of model choice in our estimations. However, there is an implicit problem concerning model choice as well, viz., whether or not the equality of coefficients between *TISWM* and *TISNWM* is statistically significant. If significant, no separate model is required for worker and non-worker migrations. In order to test this, we use theF-test for parameter equality, popularised by Chow, as given below:

$F[K. N_1+N_2-{}_2K] = [(RRSS - URRSS)/K]/[URRSS(N_1 +N_2- 2K)]$ where *RRSS*

= restricted residual sum of squares obtained from pooling the data;

URRSS = unrestricted residual sum of squares obtained by adding residual sum of squares for *TISWM* and *TISNWM* after estimating each of th^{f} m separately;

N_1 (N_2) = number of observations in estimating *TISWM (TISNWM),* and K = number of parameters estimated.

In Table 5, we have summarised the results of the above Chow test for model 1 and model 2. In the table, under the first hypothesis we test that all parameters are the same between *TISWM and TISNWM.* The results of our testing show that for log-linear model, the F-statistic is greater than the critical value of the F-distribution at the 1 per cent level, and therefore we reject the null hypothesis. On the other hand, for the linear model, the F-statistic is less than the critical value of the F at the 1 (or 5) per cent level, and therefore we accept the null hypothesis. The acceptance of null hypothesis for linear model implies (the opposite is true for rejecting it in the log-linear case) that the parameter equality restrictions will not affect the explanatory power of the models, and *RRSS* will not be much larger than *UNRSS.* In other words, the rejection of the alternative hypothesis implies that two separate regressions must not be estimated.

TABLE 5 : TEST FOR THE EQUALITY OF REGRESSION COEFFICIENTS BETWEEN *TISWM* AND *TISNWM*

Nature of the Hypothesis Functional Form	Model 1 (K = 7)			Model 2 (K = 6)		
	RRSS	URRSS	f*	RRSS	URRSS	F**
(I) All Parameters are the Same Between						
TISWMandTISNWM						
Linear	20,09,580	19,90,587	1.13	20,11,400	19,92,355	1.32
Log-Linear	1248.89	1218.322	2.96	1274.403	1244.403	3.38
(2) *Only the Slope*						
Parameters are the Same Between TISWM And TISNWM						
Linear	20,04,160	19,90,587	0.80	20,05,970	19,92,355	0.94
Log -Linear	1248.38	1218.322	2.91	1274.35	1244.403	3.32
(3) *Only the Intercept*						
Term is the Same Between TISWN and TISNWM						
Linear	19,90,780	19,90,587	0.01	19,92,510	19,92,355	0.01
Log-Linear	1219.09	1218.322	0.07	1245.24	1244.403	0.09

* The critical value of the *F* distribution at 1 per cent level is 2.64, and at 5 per cent level is 2.01.

* * The critical value of the *F* distribution at 1 per cent level is 2.80, and at 5 per cent level is 2.10.

The number of observations for *URSS* = 420, and *for RRSS* = 84P

Note that the Chow test that we conducted above has accepted (rejected) the hypothesis of equality (inequality) but did not let us know which particular coefficients were equal (unequal). Since the dummy-variable method gives us this information, we use dummy-variable method in order to test the equality of subset of coefficients within the framework of the Chow test. The results of this testing are summarised in Table 5 under the hypotheses (2) and (3). It is interesting to note from these results that log-linear model consistently rejects the null hypothesis under hypothesis (2) but rejects it under hypothesis (3). This implies that the parameter inequality accepted under the Chow test by the log-linear model is attributable for unequal slope parameters between worker and non-worker migration. Hence, the aggregation of worker and non-worker migration is rejected by log-linear model.

Economic Interpretation of Estimation Results

The following interpretations are based on the estimation results in Table 1 and Table 2 for the log-linear functional form.

In general, the results show that all the estimated coefficients have signs which are consistent with our predictions. The explanatory power of the model 1 is considerably high as shown by the R-square of about .83 for non-worker migration and .76 for worker migration.

More specifically, first of all, the positive sign for the migration elasticity of regional taxes for both worker and non-worker migration in model 1 shows that, other things being equal, people in India move from high tax regions to low tax regions, and thereby offer yet another evidence for familiar Tiebout hypothesis in the context of a developing country. This result is also confirmed by looking at the negative migration elasticity of disposable income for worker and non-worker migration in model 2 since with a lower tax burden their disposable income for purchasing private-sector commodities are greater and hence their utility levels. However, as compared to the elasticity of per capita income in model 1, the elasticity of disposable income in model 2 is considerably smaller. This may indicate that migrants in India suffer from "money illusion". Secondly, the elasticity of federal transfers shows that migrants, irrespective of their type, move from low transfer regions to high transfer regions. This empirical finding provides evidence for the human resource allocative effects of federal inter-regional fiscal transfers in India. Hence, federal transfers can, as a policy tool, influence population redistribution in space. Thirdly, the distance elasticity for worker and non-worker migration is considerably different and is the biggest in magnitude as compared to other elasticities. Thus, distance (moving costs) account for one of the most important factors in the inter-regional population allocation in India. In this connection, Greenwood's (1971) study found that the distance elasticity for gross male inter-state migrants was -2.416. This estimate is higher than our estimates for both worker (-2.001) and non-worker (-2.293) migration in model 1 as well as in model 2, or higher than the estimate for total inter-state male worker migrants (-1.953) in Narayana (1991). This finding suggests that population in India is becoming more mobile than before, say, as the result of improvements in transportation and communication. Fourthly, the estimated coefficient is negative for wage rates. This implies, other things being equal, people move in India from low wage regions to high wage regions, and hence accentuation of wage rate differentials should encourage inter-regional migration. Fifthly, the positive sign for coefficients of origin and destination population size in both models

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7. For empirical evidence of Tieboul hypothesis in the context of developed countries, see, for instance, Cebula (1978).

imply that, *Ceteris paribus,* bigger the size of region /', the greater the number of persons who are likely to migrate from *i,* and bigger the size of the region;', the greater the number of people who are likely to migrate to;'.

4. Conclusion

In a simple disaggregate economic model of migration, this paper has confirmed that, as compared to linear functional form, the log-linear functional form is more appropriate for India's inter-regional migration. This result rigorously supports the use of log-linear functional form, in earlier studies on India's inter-state migration, on empirical grounds. Secondly, the estimation results which follow from log-linear functional form provide additional evidence for human resource allocative effects of federal inter-regional transfers and for familiar Tiebout hypothesis. Moreover, the rejection of aggregation of worker and non-worker migration tells that any results obtained under such aggregation may not be valid empirically. These results are new in the context of fiscally induced disaggregate migration in a developing country.

Our empirical results demonstrate that the propensity of economic factors of interregional migration between workers and non-workers is different. This suggests the need for a cautious step in evaluating the impact of a common policy, e. g. federal transfers policy, on population redistribution in space.

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APPENDIX-I

The purpose of this appendix is to provide data sources and description of the independent variables employed in the estimation.

(1) *Per Capita income (per capita net domestic product at factor cost) in Rupees,* 1970-71: This variable is used as a proxy for wage rate in different states. *Source:* Planning Commission (1982 :488).

(2) *Per Capita regional taxes (in Rs.), 1971-72:* The regional taxes revenue include state taxes on land and income, property, commodities and services. *Source:* Tripathy [1983: 131].

(3) *Per capita federal transfers (in Rs.), 1971-72:* Federal transfers include share in central taxes, grants-in-aid and other federal contributions to states. *Source:* Tripathy [1983 : 131].

(4) *Population size of the states, 1971:* This variable refers to the total population of a state according to the 1971 Population Census of India, and is expressed in '000 persons. *Source:* Government of Karnataka (1983: 533).

(5) *Distance:* This variable refers to the railway distance (in '000 kilometers) between state capitals/representative cities. Since Meghalaya state is not connected by railways to other parts of India, an approximate road distance of 100 km is used between Shillong (state capital of Meghalaya) and Gauhati (state capital of Assam). Here we might add the fact that Gauhati is well connected by railways to all parts of the nation, and is considered nearest to the state capital of Meghalaya. *Source:* Computed by the author based on the information contained in: *A Guide for Railway and Air Travellers,* No. 1445, Newman and Co., New Delhi, July 1986.