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CENTRE STATE RESOURCE ALLOCATION IN INDIA : A SUGGESTIVE MATHEMATICAL APPROACH

BY

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Introduction

As far as the division of resources are concerned, the Indian Constitution has given the Central Government large amount of resources than it requires and an elastic source of revenue. But, it was well realised by the Constitution Assembly that the states would not be able to balance their budgets by using their individual taxing power [1]. As such, the issue of Centre State financial distribution has always been a topic of discussion in India. Though this did not have so much of importance during the first two decades of independence, lately with the upcoming of larger regional parties, ruling individual states, the topic has gained more weightage. Currently some of these ruling regional parties in the states have been working rigorously on the development of their respective states by introducing reforms favourable for investment and growth. At such a juncture, their expectations from the centre are a high reward or a fair deal for their performances. However, even the latest financial allocation by the centre to these reformists states have disappointed them and are made to feel that they are being punished for doing better on development indices, where as other states are being rewarded for their poor performance. A solution to this issue of rewarding the reformists states for their efficient fiscal management, at the same time maintaining a balanced distribution that is favourable to all states as well as the centre is the need of the hour.

Right from the beginning of planning era in India, it is seen that, the Finance Commission with its recommendations, the Planning Commission with its formulas/ methodologies and the various ministries, decide about the financial distribution of central resources to the states. Though, there have been changes after changes in the recommendations of the Finance Commissions and methodologies used by the Planning Commission, till date there continues to be complains/blames by States on this issue of resource allocation by the Centre to the States.

Critiques point out that after the Eighth Finance Commission, the Commissions in their recommendations do not take into account the commitments as well as the resources at the command of the Centre, while dealing with other considerations. It is also said hat there is no evidence in the Commissions response to State's demand, attempting to estimate a reasonably fair proportion of the Centre's resources to the States [2]. It is also commented that "the assessment of the Finance Commission has been however that, taken as a whole, the States have not lagged behind the Centre with regard to tax effort, though there are noticeable differences between States in their tax effort". Further, G. Thimmaiah, in his study [3], says, "that the Finance Commission's transfers have been unequally distributed mainly because of the outmoded methodology used by the Finance Commissions to determine fiscal need of the state"[3]. The study[1], further shows that financial resources through various channels have not gone to help the less developed states as much as the more developed states [3].

It is felt that given the position of clear financial imbalance in which the States have been placed under the Constitution, the question of a reasonable fair sharing by the Centre[2] of its vastly large resources at the command of both the Centre and the States and sharing thereof should be decided upon taking into account their respective responsibilities under the Constitution regardless of the committed expenditures or liabilities of the Centre [3]. Further, the States are also being made responsible for the disparities in financial resources allocated to them. Because it is said that the states provide under estimated figures of their resources to the Finance Commission, which fill the revenue gap through statutory grants, and over estimated figures of their resources to the Planning Commission, which grant on their potential to raise finance [4].

Looking into these problems, Ashok Mitra [5] suggested an alternative framework where in he says that the primary responsibility for economic management should be transferred to the states and their financial and monetary powers should be strengthened. Then the Centre should act as a mediator between the states and as builder of the country's economic infrastructure, though, defence, external affairs, some important

industries, major networks of transport and communication and economic co-ordination would continue to be with the Centre. Thus, with the Centre not being responsible for economic management and growth and this prerogative being transferred to the States, the responsibility for failure would lie with the states. The states will no longer be able to run to the Centre for filling the resource gap or for saddling it with the blame for lack of development. Thus the states will have to work for managing their economic affairs.

Raja Chelliah puts up a suggestion, in almost the same direction, in one of his article [6] on Centre State relations. Here, he says, "In the new setting, there seems to be no point in going through the same old motions of plan discussions with the states. The states should be left to formulate their own plans within the broad guidelines laid down by the National Developmental Council and the Planning Commission itself. There is no need to call the Chief Ministers to Delhi"[6]. However, he has insisted on continuos interaction between the two i.e. "There should of course be constant interaction between States and the Planning Commission through official discussion, meetings and conferences" [6]. He has further suggested that "the Planning Commission could also evaluate the plan performance of each State concerned and then be submitted to the National Developmental Council for discussions"[6]. Talking about a system of federal transfers he says, "in designing a system of transfers too, equity and efficiency considerations will have to be kept in view" [6].

Besides, in a new development, the Eleventh Finance Commission (EFC) has been called upon to suggest [7] ways of having joint efforts of both centre and states to restore budgetary balance and maintain macro economic stability. In this process, the EFC has been asked to assess revenue requirements of States in the context of expenditure needs of both 'Plan' and 'Non-Plan' account. Thus, the EFC, has been asked to base its recommendations by considering the resources of both centre and states, ensuring reasonable returns on investments and maintaining state's capital assets to improve socially and economically backward areas of the state. These indicate that the EFC has

been asked to look into the optimum utilisation of resources of both centre and states in the process of development of states in particular and the nation in general.

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Working in a similar direction, it could be suggested, that while the states are being asked to manage their economic management, they could be asked to prepare their detailed plans of expenditure for the different developmental and non-developmental projects and equate it with their resources or the resources available at their hands. Then for the deficit or for additional developmental programmes they could approach the centre for resources by linking their planning with the central planning which also has the responsibility of supplying resources to all the states, which are in need, as well as to carry out the central developmental schemes. These planning exercises of the centre and states could be linked with a dialogue at every stage till they arrive at a figure which would be optimal, at the same time satisfactory both to the giver (centre) and the taker (states). This whole exercise could be carried out by using the 'decomposition principle[3]' and the problems of discontent among the states, or blames of favouritism by the Centre, especially at a time when the ruling party at the Centre and the States are different, could be avoided.

In continuation with the same objective, this paper has framed a practically closer problem and analysed the economic and policy implications of the use of the mathematical technique the 'decomposition principle', in arriving at a co-operative solutions related to allocation of resources from the centre to states. **Here it should be stated that the most ideal problem to be considered under centre state financial allocations, would be to see that all states maximise value added, subject to the resources available. At the same time it is to be seen that efficient states are rewarded for their better performance and their effort to bring about development, whereas, both the poor states and hilly region states are not neglected due to their poor performance, because of social hitches and geographical locations respectively.**

Added to this, the planning exercises of the centre and the states are linked with a dialogue at every stage till they arrive at a figure which would be optimal, at the same time satisfactory both to the giver (centre) and the taker (states).

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Framing a problem involving each state, demands details on resources available under each broad sector e.g. agriculture, manufacturing, forestry, fishing etc. This also asks for input, output and value added figures in each of these sectors under every state. However, to the best of my knowledge, though output data on sector wise break-up for each state is available in the National Accounts Statistics published by the EPW Foundation[4]. Moreover, framing such a problem for each state is on one side laborious for it involves going through each state budget and not available in it, contacting the concerned state administrative departments to supply them. On the other side, considering around 30 states would mean dividing the decomposition problem into 30 divisions. Again, the technical feasibility of such a problem is still to be found.

Therefore, as an initial step to study the feasibility of the technique, to centre state financial relations in India, the like states could be combined together to frame a problem. As the state wise finance data relating to revenue and expenditure are published in the RBI Bulletin and it is the only accessible source for such detailed state wise data, a possible model using the available data, is framed in the decomposition framework. This whole exercise is to see how does the technique work and what are the policy implications of the results. If found suitable then the work could be tried with data available with the Planning Commission.

In order to suit the technical feasibility of the method the model is so framed that the state wise data has been clubbed to form groups of three -a) special category states b) non- special category states c) and I non-special category states II. These non-special category states being larger in number i.e.15 and as, an exercise using the same, has not given better results, the category is divided into two on the basis of their revenue

coefficients. The solution is found to be optimal, satisfactory to both the giver (Centre) and the taker (States) for it has been arrived at through dialogues or iterations involving changes in information at every stage of the whole process. This whole exercise helps in solving the problems of discontent among the States, or blames of favouritism by the Centre, especially at a time when the ruling party at the Centre and the States are different.

Approach to the Study

This study frames a model and tests it empirically to find out, as to how far are central resources {that has already been arrived at for distribution[5] among the different states} optimally allocated to the states. The study uses the `Decomposition Principle' - a variant of the linear programming as a tool to solve the problem of integrated planning of Centre and the States in the framework of decentralised planning. The 'Principle' having the quality of iterative procedure, helps in solving the problem of getting an optimal solution, acceptable, both to the Centre and the States with the use of dialogues between the two.

There are number of variants[6] [8-13] of this 'Decomposition Principle', but here the study makes use of the indirect method developed by Dantzig & Wolfe [11-13]. In this method the divisions initially supply information about, requirement of central resources to the Centre by solving their specific divisional plan exercise. Using this signal, the Centre works out, as to, at what price (cost or requirements they have to fulfill) would they be available to the divisions. When these prices or costs are supplied to the divisions, the divisions again calculate the required quantity of central resources at the new price. The process continues and after a finite numbers of such iterations the optimum is reached, which is agreeable to the two i.e. the Centre and the States with in the division.

The Model

Now, having settled, the financial resources[7] (for details see note 4) that are to be allocated by the Centre to the States, we face a problem where there are two central

constraints. These are one deciding the share of the total taxes or tax revenue to be allotted to each State and the second, the allocation of non-tax revenue to the different States. An overall objective function is such that the objective is common to all States. The overall objective function is the sum total of the objective functions of the different States. The question here is, how will the States arrive at a common objective, for, the different States are at different stages of development i.e. while some are more developed, others are less. Not only that, with the existing scenario these different States, have different social/ economic objectives like providing basic education to all, providing basic housing facilities, developing under-developed or backward regions or areas etc., which they have to fulfill. It is assumed that states by themselves solve these different objectives through goal programming[8] so as to arrive at one common objective for all states in the sense of maximising revenue from the different regions/districts of the states. The states in order to fulfill the above objectives with the inadequate financial resources approach the Centre for financial assistance. Here comes the question of optimum allocation of the central resources.

The decomposition principle helps in allocating the financial resources like shares from taxes or tax revenue and non-tax revenue at the hands of the Centre, to the States. As mentioned earlier, it is also assumed that all the divisions arrive at a common objective i.e. over all development of the States in the sense of maximising revenue from all states of the three divisions. Thus, the objective function for the whole economy, which is a sum of the objective functions of all the States or the three divisions, is given by equation 1 i.e. overall development of all the States of maximising revenue from all the States. Equations 2 and 3 are the constraints comprising of central resources i.e. shares from tax revenue and non-tax revenue to be supplied to all the States under each of the divisions. Set of equations 4, 5 and 6 refer to specific resources of each set of States or divisions. These specific resources[9] are like resources for social services (SS), resources for economic services (ES), resources for fiscal services (FS), resources for interest payment and servicing of debt (IP&SD), resources for administrative services (AS) and resources

for other miscellaneous purposes (OTH). Thus, the mathematical model would take the form as

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Maximise

$$R^1_1X^1_1 +..+ R^7_1X^7_1 + R^1_2X^1_2 +..+ R^8_2X^8_2 + R^1_3X^1_3 +..+ R^{10}_3X^{10}_3 \qquad ..(1)$$

subject to

$$a^1_{1,1}X^1_1+..+a^7_{1,1}X^7_1+a^1_{1,2}X^1_2+..+ a^8_{1,2}X^8_2 +a^1_{1,3}X^1_3+..+ a^{10}_{1,3}X^{10}_3 \leq TR \quad ..(2)$$

$$a^1_{2,1}X^1_1+..+a^7_{2,1}X^7_1+a^1_{2,2}X^1_2+..+a^8_{2,2}X^8_2 +a^1_{2,3}X^1_3+..+a^{10}_{2,3}X^{10}_3 \leq NTR \quad ..(3)$$

$$a^1_{3,1}X^1_1 +..+ a^7_{3,1}X^7_1 \quad \leq SS_1 \qquad |$$

$$a^1_{4,1}X^1_1 +..+ a^7_{4,1}X^7_1 \quad \leq ES_1 \qquad |$$
$$\qquad\qquad\qquad\qquad\qquad\qquad\qquad | \qquad ..(4)$$
$$a^1_{5,1}X^1_1 +..+ a^7_{5,1}X^7_1 \quad \leq FS_1 \qquad |$$

$$a^1_{6,1}X^1_1 +..+ a^7_{6,1}X^7_1 \quad \leq IP\&SD_1 \qquad |$$

$$a^1_{7,1}X^1_1 +..+ a^7_{7,1}X^7_1 \quad \leq AS_1$$

$$a^1_{8,1}X^1_1 +..+ a^7_{8,1}X^7_1 \quad \leq OTH_1 \qquad |$$

$$a^1_{9,2}X^1_2 +..+ a^8_{9,2}X^8_2 \quad \leq SS_2 \qquad |$$
$$\qquad\qquad .. \qquad\qquad\qquad | \qquad ..(5)$$
$$a^1_{14,2}X^1_2 +..+ a^8_{14,2}X^8_2 \quad \leq OTH_2 \qquad |$$

$$a^1_{15,3}X^1_3 +..+ a^{10}_{15,3}X^{10}_3 \quad \leq SS_3 \qquad |$$
$$\qquad\qquad .. \qquad\qquad\qquad | \qquad ..(6)$$
$$a^1_{20,3}X^1_3 +..+ a^{10}_{20,3}X^{10}_3 \quad \leq OTH_3 \qquad |$$

$$X^1_1 \;..\; X^8_1, \; X^1_2 \;..\; X^7_2, X^1_3 \;..\; X^{10}_3 \geq 0$$

Here, while $R^1_1..$ R^{10}_3 refer to the revenue coefficients $X^1_1..$ X^{10}_3, refer to the expenditures of the different states of the three divisions. In both the cases while the subscript refers to the division, the superscript refers to the state of that particular division. $a^1_{1,1} .. a^{10}_{3,3}$ refer to the resource coefficient. The first subscript refers to the resources, while the second refer to the division. The superscript refers to the states in the respective division. While, TR refers to total taxes or tax revenue that have to be shared, NTR refers to non-tax revenue. SS_1, ES_1, FS_1, $IP\&SD_1$, AS_1 and OTH_1 represent the specific resources respectively of the first division. Similarly, SS_2, ES_2, FS_2, $IP\&SD_2$,

AS_2 and OTH_2 and SS_3, ES_3, FS_3, $IP\&SD_3$, AS_3 and OTH_3 refer to the corresponding specific resources of divisions two and three respectively.

When the decomposition procedure begins, initially (i.e. at the second stage, since at the first stage initial basic solution is zero[10]) we start with the divisions solving their individual problems. That is, when the overall objective function 1 is split into 3 disaggregated objective functions of the respective division, on the basis of its own specific set of constraints 4, 5 and 6 respectively. The division's problems are solved to find out the components of share of taxes and non-tax revenue required from the Centre as enumerated in equation 2 & 3.

If the first and second proposals given by the divisions 1, 2 and 3 respectively are:

$$(x^1_{11}, \ .. \ x^7_{11}), (x^1_{12}, \ .. \ x^7_{12}) \quad |$$
$$(x^1_{21}, \ .. \ x^8_{21}), (x^1_{22}, \ .. \ x^8_{22}) \quad | \qquad ..(7)$$
$$(x^1_{31}, \ .. \ x^{10}_{31}), (x^1_{32}, \ .. \ x^{10}_{32}) \quad |$$

Here, the first subscript refers to the division, the second to the number of the proposal. The superscript refers to the State. Now, when this requirement is supplied to the Centre, it then uses this information to form a master programme (see equations 8, 9, 10, 11, 12 and 13 below)

Maximise

$$(R^1_1 x^1_{1,1} +..+ R^7_1 x^7_{1,1}) \ \alpha_1 + (R^1_1 x^1_{1,2} +..+ R^7_1 x^7_{1,2}) \ \alpha_2 + (R^1_2 x^1_{2,1} +..+ R^8_2 x^8_{2,1}) \ \beta_1 + (R^1_2 x^1_{2,2} +..+ R^8_2 x^8_{2,2}) \ \beta_2$$

$$+ (R^1_3 x^1_{3,1} +..+ R^{10}_3 x^{10}_{3,1}) \ \theta_1 + (R^1_3 x^1_{3,2} +..+ R^{10}_3 x^{10}_{3,2}) \ \theta_2 \qquad ..(8)$$

Subject to

$$(a^1_{1,1} x^1_{1,1} +..+ a^7_{1,1} x^7_{1,1}) \ \alpha_1 + (a^1_{1,1} x^1_{1,2} +..+ a^7_{1,1} x^7_{1,2}) \ \alpha_2 + (a^1_{1,2} x^1_{2,1} +..+ a^8_{1,2} x^8_{2,1}) \ \beta_1 +$$

$$(a^1_{1,2} x^1_{2,2} +..+ a^8_{1,2} x^8_{2,2}) \ \beta_2 + (a^1_{1,3} x^1_{3,1} +..+ a^{10}_{1,3} x^{10}_{3,1}) \ \theta_1 + (a^1_{1,3} x^1_{3,2} +..+ a^{10}_{1,3} x^{10}_{3,2}) \ \theta_2 \le TR \ --(9)$$

$$(a^1_{2,1} x^1_{1,1} +..+ a^7_{2,1} x^7_{1,1}) \ \alpha_1 + (a^1_{2,1} x^1_{1,2} +..+ a^7_{2,1} x^7_{1,2}) \ \alpha_2 + (a^1_{2,2} x^1_{2,1} +..+ a^8_{2,2} x^8_{2,1}) \ \beta_1 +$$

$$(a^1_{2,2} x^1_{2,2} +..+ a^8_{2,2} x^8_{2,2}) \ \beta_2 + (a^1_{2,3} x^1_{3,1} +..+ a^{10}_{2,3} x^{10}_{3,1}) \ \theta_1 + (a^1_{2,3} x^1_{3,2} +..+ a^{10}_{2,3} x^{10}_{3,2}) \ \theta_2 \le NTR \ -(10)$$

$$\alpha_1 + \alpha_2 \qquad\qquad = 1 \quad ..(11)$$

$$\beta_1 + \beta_2 \qquad\qquad = 1 \quad ..(12)$$

$$\theta_1 + \theta_2 \qquad = 1 \quad ..(13)$$

$$\alpha_1, \alpha_2, \beta_1, \beta_2, \theta_1, \theta_2 \geq 0$$

In this master programme, (at the initial stage i.e. stage II) such proposals of the divisional requirements of shares from tax revenue and non-tax revenue (equation 9 & 10) are calculated as weighted averages of the two (i.e. initial basic and second[11]) proposals. Thus weights pertaining to the two proposals i.e. α_1 and α_2 of the first division, β_1 and β_2 of the second division and θ_1 and θ_2 of the third division are the unknowns in the reformulated primal of the master programme. This master programme which is calculated as the weighted average of the two proposals tries to maximise the revenue of all the divisions made up of States (see equation 8). These weights increase in number (though, its sum total for each State always remain equal to1 (see equation 11 to 13)) with each proposal of the divisions. Since these weights are unknown variables they form the non-negative constraints. The duals[12] of the master programmes, that tries to minimise the cost incurred or expenditure involved in making up that revenue, gives the dual prices of the central financial resources (share from tax and non-tax revenue). It also provides the revenue figures[13] given by the current proposal of the divisions. Such dual prices and the figures of revenue are supplied to the States. Then they enter the third stage. The divisions make use of the dual prices and subtract the cost of these common resources from their respective objective functions. With such modified objective functions, the division's problems are solved to find another set of quantities of the central resources required in the third stage alongwith their optimal value (i.e. maximising revenue from expenditure of the different States under each division. The revenue figures so derived are compared with the revenue figures of the previous proposal i.e. given by the dual value for each division pertaining to the value of the different weights corresponding to its various proposals). It is known as the optimality test[14] i.e. the objective value of each of the division's problem at the third stage are compared with the dual value of different weights corresponding to its various proposals at the second stage. If the new revenue figures are equal to the revenue figures given by

the previous problem, for each of the division, the process ends. But, if the new revenue figures of even one of the division is greater than its previous revenue figures, then, the process continues with the new and all other proposals of that division, not passing the optimality test. In the case of other division which have passed the optimality test, those proposals which have been given weights by the master programme at the stage when the optimality is passed, are considered. The process continues till the new revenue figures given by the new proposal are equal to the revenue figures given by the previous proposal in the case of the concerned division. Then only the process ends i.e. optimality test is satisfied and optimal solution is reached. At such a situation, the weighted average of the proposals of the division, give the allocation of the central resources i.e. share from the tax and non-tax revenue to the divisions and the States with in them.

Data Base and Adjustments

Data related to finances of States are collected from the RBI Bulletin, Feb 1999. The Appendix I of 'Finances of State Governments 1998-99' presented in the above volume, give statewise total revenue, which has a detailed break-up of share in central taxes and grants from the centre. The two - share in central taxes and grants from centre are considered as tax revenue and non-tax revenue respectively for the different states and used as central constraints. Expenditure figures are collected from Appendix II of the same article. This provides statewise total expenditure with a break-up of expenditure on 1) social services 2) economic services 3) fiscal services 4) interest payments and servicing of debt 5) administrative services 6) organs of states 7) pensions 8) miscellaneous general services 9) grants-in-aid and contributions 10) compensation and assignments to local bodies and Panchayati Raj institutions and 11) reserve with finance department. Though, the first five break-ups are considered as individual constraints, the rest of them are clubbed to form others, because, the figures in them are too meager to calculate resource coefficients.

As the objective is to maximise revenue subject to the expenditure incurred, the revenue coefficients are found by dividing statewise revenue by their respective total expenditure. Similarly the resource coefficient under each sector as well as for the two central

constraints are calculated by considering the respective sectoral resource/ expenditure of the respective state and divided by the respective states total expenditure. The coefficients are arranged to suit the model with three divisions i.e. the states are divided broadly into two groups - special category states and non-special category states as presented in the RBI Bulletin. The non-special category states are further divided into two groups on the basis of their revenue coefficients i.e. those above 0.9 are separated from those below 0.9. A case of only two divisions i.e. special category states and non-special category states was also tried, however, since the results of this alternative was not as good as that with three divisions, the results pertaining to the use of three divisions only are presented. Thus, the first division or set of states has seven states in them, followed by eight states in the second division and ten states in the third division of special category states.

Empirical Results and Analysis

As in reality, one cannot imagine a state, functioning without any expenditure the technique is processed by considering a minimum[15]figure of 7082 unlike the regular process involving non-negative condition. The overall optimal results as seen from table 1 show positive expenditure values and corresponding revenue values for the states of first second and third division. In Table 1, while Bihar, Gujarat, Karnatak and Tamil Nadu of the first division show differing values, in the case of division II and III they are Andhra Pradesh, Haryana, Madhya Pradesh, Punjab & Rajasthan and Arunachal Pradesh, Assam, Jammu & Kashmir, Meghalaya & Sikkim respectively. All the other states show the minimum value considered.

This implies that on the basis of the resource constraints in order to maximise revenue, the states of Bihar, Gujarat, Karnatak and Tamil Nadu of the first division should be spending Rs.15688, Rs.16778, Rs.24325 and Rs.13266 crores respectively. Similarly, states Andhra Pradesh, Haryana, Madhya Pradesh, Punjab and Rajasthan of the second division should be spending Rs.1727, Rs.8234, Rs.11077, Rs.18890 and Rs.42367 crores respectively. In the case of division III Arunachal Pradesh, Assam, Jammu & Kashmir Meghalaya and Sikkim should be spending Rs.2678, Rs.5306, Rs.1839, Rs.2467 and

Rs.1253 crores respectively. However, it could be implied that those states having minimum expenditure are either wasting resources or spending much more than required or the expenditure does not earn reasonable revenue.

On the basis of the optimum solution, the optimum allocation of common resources calculated (see Table 2) shows that, while there is a balance of 3.07 % of tax revenue, after allocation, the entire non-tax revenue is allotted.

Looking at the overall procedure from Table 1, it can be seen that the convergence of the problem is with in seven iterations. While the first and second divisions have passed the optimality test at the sixth stage, the third division passed it at the seventh stage.

Comparing the stage wise results for each division, it is seen, that, in the case of division I, while in the second stage there are four states having differing values, in the third stage there are five states having differing values. Though, this could be analysed as a case of balanced development, the process did not continue in the other stages for there were throughout four states having differing values. Not only that, the optimal results are the sum of the weighted average of different proposals. In the first division, as the optimal results showed a weight of 1, to only the fifth proposal, therefore only the fifth proposal, stand as the optimal proposal.

In the case of the second division too, these sorts of change in number of states showing the differing values appear. Here also while the second, fifth and sixth stages showed five states having differing values the third and fourth showed only four states. Further the fifth proposal to have weight 1 & all others zero while passing the optimality test. Thus, only the fifth proposal is considered.

The picture in the third division is different. This is because, while in the second stage, five states have shown differing values, in the third, it was only two states, in the fourth it was four, in the fifth, sixth and seventh it was five states. The optimal solution showed a weight of 0.535048 & 0.464952 to the fifth and sixth proposals respectively. Thus, the

optimal solution was calculated using the two weights and the proposals they corresponded to.

Comparing the part I & part II B of Table 1, it could be seen that so long as the cost of common resources incorporated reduced, the revenue figure of the division's problem increased. Apart from these costs of common resources, the original revenue coefficients of the divisions play a role in determining the total revenue figures of each division at different stages. This is because, there is a constant increase in the objective functions, till optimality is reached, whether there is any change in the expenditure figures for individual state figures or not. But in the case of third division, though, the process continued similarly till the first two divisions passed the optimality test, later, its objective value marginally decreased and then rose while passing the optimality test. The final objective value at the seventh stage was less than its own optimal value at the sixth stage. This is because the cost of common resources increased at the sixth stage, showing its influences on the objective function at the seventh stage. It could be interpreted as higher costs being paid for additional benefits received as special category states. But with a minimum amount of expenditure being fixed, there seems to be a trade-off and the special category states seem to be paying marginally less than the non-special category states. Thus, preference could be retained even with the use of a scientific approach.

A comparison of objective values (revenue figures) at each stage, with that of the dual prices $\bar{\pi}_1$, $\bar{\pi}_2$ & $\bar{\pi}_3$ of the previous stage, in part I & II Table 1, shows that, for the first division the objective value (revenue) Q_{12}, Q_{13}, Q_{14} & Q_{15} i.e. 6646576, 5661454, 6115767 & 6281971 were greater than the respective dual values of the first, second, third and fourth stages i.e. $\bar{\pi}_{11}$, $\bar{\pi}_{12}$, $\bar{\pi}_{13}$ & $\bar{\pi}_{14}$ i.e. 0, 5627349, 6115751 & 6281974. In the sixth stage $Q_{16} = 6289340$ is almost equal to $\bar{\pi}_{15} = 6289344$ implying the passing of the optimality test. Similar situations exist in the second and third division. Only difference being, that while the first and second division passed the optimality at the sixth stage, the third division, passed the optimality test at the seventh stage. Thus, the whole problem passed it only in the seventh stage.

Once this optimality test for the whole problem is reached, the optimal expenditure values are calculated as weighted average of all the proposals, which is seen, in Table 1. This weighted average is calculated only with the first five proposals of the first and second divisions and sixth proposal of the third division. This is because, the sixth proposal of division I & II and seventh proposal of division III only help in passing the optimality test. Thus, it could be said that the fifth stage of the division I & II and the sixth stage of division III is optimal stage so far as the optimal solution is concerned.

These results are not only optimal because its final solution is arrived at with the use of the programming technique, but is also satisfactory to both the states with in the divisions and the central government. This is because; the results have been attained through dialogue at each stage between the central government and the states through the divisions. This can be seen from Table 2, which shows that the states of the different divisions at every stage put up their demand for central financial resources i.e. Tax revenue and non-tax-revenue and the government in return allocates the financial resources.

It can be seen that for the first division the demand resources of tax revenue and non-tax revenue were allocated as demanded for, in the second, third, fourth and fifth stage. As the optimal allocation depended on the weight given at the time of optimality test, the fifth stage demand, determined it. This is because the optimal weight 1 was for the fifth proposal. In the case of the second division, the demands for tax revenue and non-tax revenue were allocated as demanded for, at each stage, for, the respective proposals were given weight 1, at each stage.

However, in the case of the third division, the allocations never tallied with the demand at any of the stage. This is because; the weights were divided between two proposals at every stage. That is, between first and second in the second stage, between the second and third in the third stage, between second and fourth at the fourth stage, between second and fifth at the fifth stage and between fifth and sixth at the sixth stage. With the

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allocations being done on two proposals it could be said that in order to follow the decentralised pattern the financial resources for one state is reduced so that another state/ states enter the group and shares the central resources for developing its own region. Thus, there is a trade- off between one another.

A comparison of the derived financial resource allocation with that of the actual, using deviation ratio in Table 3, shows that, except for Gujarat, Karnatak & Tamil Nadu of division I, Haryana, Punjab & Rajasthan of division II and Arunachal Pradesh, Assam, Meghalaya & Sikkim of division III seem to have been allotted more than they ought to have been allotted.

Policy Implications

The model has shown us, how to arrive at an optimum solution with reference to revenue figures and allocation of scarce financial resources as well as the specific resources of the states. In other words the centre is able to allocate the best possible money package to the states on the basis of their performances. This tallies with the demand of the current reformists states who feel that their efforts on development of the state is not rewarded.

Further, the solution is favourable to the divisions (sets of states), because the division's problems also experience an increase in the revenue figures stage after stage, after the incorporation of costs of common resources, till the overall optimality is reached. That is, the objective function (maximising revenue) of the set of states improves at every stage of the dialogue between the centre and the states.

Similarly, the optimum solution is also favourable to the centre, which is allocating the central financial resources, because the master program experiences a higher and higher revenue figure stage after stage till it reaches the highest revenue figure where the optimality test of all the divisions are passed. In otherwords the centre finds its revenue (reward) increasing for sharing its resources with the states, after every stage of its dialogue with the states. To explain, it takes into consideration the expenditure pattern of

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the different states and the revenue they earn from such expenditure. Thus, the methodology fully supports the states doing well. In other words the returns from the reforms introduced by the states is well considered.

At the same time, the methodology also sees that the centre is not put at a loss by seeing that it gets the best return for its allocation. Besides, the preference of lesser price to special category states in this exercise of a real situation implies concessions to backward states though, the reformists states manage to get their due for their performance.

Added to all these, the optimum solutions on allocation of financial resources are had, through dialogues, in which the process initiates at the state level. In other words, it is a case of decentralised planning. Not only that, the dialogues (involved in this method) are held several times in the form of different proposals which are also calculated on the basis of an optimization procedure. And with every change in proposal the solutions go on improving at each stage, both for the divisions and the centre which could be implied as constructive dialogues even if the planning is from below. The model accommodates decentralisation, for there is a trade-off between one state and another, and during this, the divisions as a whole have only to gain and nothing to loose, for, at each stage the divisions objective values go on improving.

Thus, the model talks about a meaningful approach to decentralised planning involving dialogues between centre and states. Further, in a country like India where there are vast area which need development and this in return need financial resources, the surplus available with tax revenue could be diverted to the states shown to be in need of, so that it is effectively utilized. Even, if, balanced development is to be considered and a real situation should be observed as in the second case, then, the non-negativity constraints in the Linear programming problem should be changed to follow some minimum amount as done in this exercise. Though, a trail to this effect has been attempted, research on this point still continues for the optimal minimum in a practical situation is yet to be ascertained.

Conclusion

The study empirically tests the model and the broad results show that out of 14 out of 25 states seem to have excess allocation of tax and non-tax revenue from the centre. The other states have been allotted less than what they ought to get. Thus, the use of the technique could be a useful tool in solving, centre state financial problems and overcome excess allocation to certain states and short fall to others at the same time be relieved of states blaming the centre for misallocation.

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Notes

1.   Thimmaiah has used rank correlation between the following: -
i)Finance Commission's financial transfers and level of development as reflected by indicators of backwardness;
ii)Planning Commiossion's transfers and per capita SDP   and   percentage of population below the poverty line;
iii) institutional funding and indicators   of backwardness and
iv) investment by Central government in public sector undertakings and indicators of backwardness.

2.   Here the sharing means sharing under two situations: -
 i) between centre and total states and
ii) between the centre and different states individually.
The first case of sharing between the centre and total states is a research study by itself and the same is not dealt with here, for that too involves conflicting multi-criteria. However, it could be suggested, that such a situation could be handled by game theory if necessary. Here, it is assumed that the total quantity of financial resources that has to be shared between the different states is already arrived at and then the whole work of optimal allocation among the different states begins.

3.   This principle is a technique developed by Dantzig & Wolfe to efficiently solve large problems in linear programming. It helps in breaking a large problem into sub- problems whose iterated solutions solve the large problem through a generalisation of simplex method for linear programming.

4.   It is one of the two known published sources on detailed state wise data.

5.   Here the sharing means sharing under two situations: i) between centre and total states and ii) between the centre and different states individually.
The first case of sharing between the centre and total states is a research study by itself and the same is not dealt with here, for that too involves conflicting multi-criteria. However, it could be suggested, that such a situation could be handled by game theory if necessary. Here, it is assumed that the total quantity of financial resources that has to be shared between the different states is already

arrived at and then the whole work of optimal allocation among the different states begins.

6.   Interested persons could contact the author for details.

7.   Here, financial resources tax revenue and non-tax revenue refer to taxes like estate duty and union excise duties and non-tax revenue refers to grants from the centre for state plan schemes, centrally sponsored schemes and non-plan grants like statutory grants, grants for relief on account of Natural calamities and others. Thus all the financial resources combined, taken, as a constraint would give the total of the share from taxes grants-in-aid, etc., that have to be allotted to each State under the different divisions. Now, it should be mentioned that each tax or grants- in-aid separately also can be taken as a constraint to get the share of each tax or grant to be allotted but, the problem is initially tried in a simple form by combining the financial resources and forming only two financial resource constraint - the tax revenue and non-tax revenue.

8.   In accordance with this approach, when each problem has a number of objectives, initially one objective is taken in the objective function, the others are taken as constraints in the problem with less than or greater than equal to sign depending upon the maximisation or minimisation problem. Once the optimal solution to this problem is attained, the objective function of this problem becomes the constraint of another problem where the next objective becomes the objective function. The new constraint is added in the other problem i.e. the objective function of the previous problem now has strict equality sign for, its optimal solution had already been attained.

9.   It is not necessary that all the States should have the same number of specific resource constraints. Here, it is considered same, just for simplicity purpose. Further, the RBI Bulletin publish State wise tax and non-tax revenue data symmetric for all States under the broad heading social services (SS), resources for economic services (ES), resources for fiscal services (FS), resources for interest payment and servicing of debt (IP&SD), resources for administrative services (AS) and resources for other miscellaneous purposes (OTH) (for further details see section on Data base)

10.   It is assumed that at the first stage the States submit zero as the first proposal, which is the initial basic feasible solution. This solution when supplied to the Centre, do not   help the Centre in providing any information about prices of the common resources.

11.   See equation 7 for these proposals.

12.   In order to reduce the mathematical component of the paper the dual of the master programme is not presented. This could be provided to interested readers on request.

13.   The dual variables represent the measure of revenue offered by the respective State's then (second) proposed solution i.e. with the states' problem solved at the second stage, the states, provide the second proposal. If this is to be considered, then the weights of the earlier proposal (first) should decrease, so as to accommodate this proposal and maintain the sum of weights equal to 1. This results in a marginal addition in revenue i.e. the dual variable is interpreted as the marginal additions in revenue because of letting the weights to be accommodated.

14.   The values of the objective function of the states are compared with the respective measure of revenue of the previously proposed solutions to have the optimality test. For if they are equal, then the optimum is reached. But, if the new objective value of the states are greater than each of their respective revenue value at the previous stage or at least one is greater than but none less than, the process continues, for the new proposed solutions (third) would help in improving the revenue figures of the states and also the centre.

15.   The minimum considered here is a random figure of the expenditure of states. It is still to be seen whether this is the optimal minimum which could give better allocation under a real situation. This practical approach could be further revised by considering different minimum for different states or maintaining further consistency between the growth/ developmental factors and expenditures incurred.

Table 1. (Part I)

Optimal figures for the three divisions at different stages of the decomposition process

Division	2nd stage	3rd stage	4th stage	5th stage	6th stage	7th stage	Optimal
I							
Bihar	1091028	1559848	1568828	1568828	1568828		1568828
Goa	1113365	7082	7082	7082	7082		7082
Gujarat	2999277	1543174	1677818	1677818	1677818		1677818
Karnatak	7082	2336118	2432511	2432511	2432511		2432511
Kerala	7082	7082	7082	7082	7082		7082
Maharashtra	7082	263190.90	7082	7082	7082		7082
Tamil Nadu	1741444	1313996	1326642	1326642	1326642		1326642
Obj. Value	6646576	5661459	6115767	6281971	6289340		
II							
Andhra Prad.	172763.30	7082	7082	172763.30	172763.30		172763.30
Haryana	823448.90	823628.10	823628.10	823448.90	823448.90		823448.90
MadhyaPrad.	1107735	1260398	1260398	1107735	1107735		1107735
Orissa	7082	7082	7082	7082	7082		7082
Punjab	1889013	1966767	1966767	1889013	1889013		1889013
Rajasthan	4236696	4152443	4152443	4236696	4236696		4236696
UttarPradesh	7082	7082	7082	7082	7082		7082
West Bengal	7082	7082	7082	7082	7082		7082
Obj. Value	7175767	5433616	6241327	6536362	6549591		
III							
ArunachalPrad.	329791.90	7082	227903	213280.10	330480.70	330480.70	267772.75
Assam	547987.20	1014204	527597.60	510853.10	552108.70	552108.70	530034.97
HimachalPrad.	7082	7082	7082	7082	7082	7082	7082
Jammu&Kash.	344706.10	7082	7082	46635.07	341855.80	341855.80	183898.54
Manipur	18279.87	7082	7082	7082	7082	7082	7082
Maghalaya	7082	7082	451233.70	447148.20	15938.13	15938.13	246656.22
Mizoram	7082	7082	7082	7082	7082	7082	7082
Nagaland	7082	7082	7082	7082	7082	7082	7082
Sikkim	125907.80	121007.70	124304.60	124424.60	126342.50	126342.50	125316.33
Tripura	7082	7082	7082	7082	7082	7082	7082
Obj. Value	1662383	329534.50	810522.80	1058426	1070847	1058994	

Table 1. (Part II - A)

Weights	2nd Stage	3rd stage	4th stage	5th stage	6th stage
α_1	0	0	0	0	-
α_2	1	0	0	0	-
α_3	-	1	0	0	-
α_4	-	-	1	0	-
α_5	-	-	-	1	1
β_1	0	0	0	0	-
β_2	1	0	0	0	-
β_3	-	1	1	0	-
β_4	-	-	0	0	-
β_5	-	-	-	1	1
θ_1	0.082257	0	0	0	0
θ_2	0.917743	0.885272	0.604021	0.455181	0
θ_3	-	0.114728	0	0	0
θ_4	-	-	0.395979	0	0
θ_5	-	-	-	0.544819	0.535048
θ_6	-	-	-	-	0.464952
Obj.Value	15329610	15423020	15437320	15438520	15439160

Table 1. (Part II - B)

Dual Weights	2nd Stage	3rd stage	4th stage	5th stage	6th stage
π_1	0	0	0	0	0
π_2	1.852814	0.989639	0.674775	0.660815	0.674058
$\underline{\pi}_1$	5627349	6115751	6281974	6289344	6282353
$\underline{\pi}_2$	5412130	6241332	6535964	6549597	6537048
$\underline{\pi}_3$	0	774458.70	1056961	1069486	1058995

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Table 2 (A)
Demand and allocation of Tax Revenue

Division	Demand 2nd stage	Allocation 2nd stage	Demand 3rd stage	Allocation 3rd stage
I				
Bihar	539072.57	539072.57	770714.66	770714.66
Goa	127794.26	127794.26	812.89	812.89
Gujarat	343354.23	343354.23	176661.02	176661.02
Karnatak	1200.89	1200.89	396135.53	396135.53
Kerala	1296.45	1296.45	1296.45	1296.45
Maharashtra	772.87	772.87	28722.29	28722.29
Tamil Nadu	288642.60	288642.60	217793.52	217793.52
II				
Andhra Prad.	35275.67	35275.67	1446.04	1446.04
Haryana	52554.16	52554.16	52565.59	52565.59
MadhyaPrad.	254713.69	254713.69	289817.18	289817.18
Orissa	2167.23	2167.23	2167.23	2167.23
Punjab	144109.02	144109.02	150040.72	150040.72
Rajasthan	887990.30	887990.30	870331.29	870331.29
UttarPradesh	2238.92	2238.92	2238.92	2238.92
West Bengal	1654.02	1654.02	1654.02	1654.02
III				
ArunachalPrad.	98050.43	89985.10	2105.55	87042.87
Assam	180379.85	165542.35	333843.50	197986.43
HimachalPrad.	1452.21	1332.75	1452.21	1452.21
Jammu&Kash.	97690.40	89654.68	2007.05	86712.84
Manipur	5984.70	5492.42	2318.60	5564.10
Maghalaya	2497.45	2292.02	2497.45	2497.45
Mizoram	2074.28	1903.66	2074.28	2074.28
Nagaland	2248.88	2063.90	2248.88	2248.88
Sikkim	9176.92	8422.05	8819.77	9135.94
Tripura	2488.64	2283.93	2488.64	2488.64

Table 2. (A)
Demand and allocation of Tax Revenue

Division	Demand 4th stage	Allocation 4th stage	Demand 5th stage	Allocation 5th stage	Demand 6th stage	Allocation 6th stage
I						
Bihar	775151.64	775151.64	775151.64	775151.64		
Goa	812.89	812.89	812.89	812.89		
Gujarat	192074.93	192074.93	192074.93	192074.93		
Karnatak	412480.89	412480.89	412480.89	412480.89		
Kerala	1296.45	1296.45	1296.45	1296.45		
Maharashtra	772.87	772.87	772.87	772.87		
Tamil Nadu	219889.58	219889.58	219889.58	219889.58		
II						
Andhra Prad.	1446.04	1446.04	35275.67	35275.67		
Haryana	52565.59	52565.59	52554.16	52554.16		
MadhyaPrad.	289817.18	289817.18	254713.69	254713.69		
Orissa	2167.23	2167.23	2167.23	2167.23		
Punjab	150040.72	150040.72	144109.02	144109.02		
Rajasthan	870331.29	870331.29	887990.30	887990.30		
UttarPradesh	2238.92	2238.92	2238.92	2238.92		
West Bengal	1654.02	1654.02	1654.02	1654.02		
III						
ArunachalPrad.	67757.84	86055.20	63410.31	79177.83	98255.22	79611.52
Assam	173668.25	177722.20	168156.49	173720.33	181736.52	174470.55
HimachalPrad.	1452.21	1452.21	1452.21	1452.21	1452.21	1452.21
Jammu&Kash.	2007.05	59801.80	13216.47	51667.40	96882.62	52117.21
Manipur	2318.60	4533.00	2318.60	3987.34	2318.60	2318.60
Maghalaya	159126.66	64519.33	157685.92	87047.08	5620.55	86982.82
Mizoram	2074.28	2074.28	2074.28	2074.28	2074.28	2074.28
Nagaland	2248.88	2248.88	2248.88	2248.88	2248.88	2248.88
Sikkim	9060.07	9130.65	9068.81	9118.02	9208.60	9133.81
Tripura	2488.64	2488.64	2488.64	2488.64	2488.64	2488.64

Table 2. (B)
Demand and allocation of Non-Tax Revenue

Division	Demand 2nd stage	Allocation 2nd stage	Demand 3rd stage	Allocation 3rd stage
I				
Bihar	73548.38	73548.38	105152.47	105152.47
Goa	98509.42	98509.42	626.61	626.61
Gujarat	249908.76	249908.76	128581.89	128581.89
Karnatak	543.05	543.05	179135.86	179135.86
Kerala	511.35	511.35	511.35	511.35
Maharashtra	513.15	513.15	19070.29	19070.29
Tamil Nadu	123545.00	123545.00	93220.13	93220.13
II				
Andhra Prad.	20983.14	20983.14	860.15	860.15
Haryana	41451.59	41451.59	41460.61	41460.61
MadhyaPrad.	125654.81	125654.81	142971.99	142971.99
Orissa	1241.34	1241.34	1241.34	1241.34
Punjab	98410.02	98410.02	102460.69	102460.69
Rajasthan	658204.62	658204.62	645115.24	645115.24
UttarPradesh	859.72	859.72	859.72	859.72
West Bengal	772.70	772.70	772.70	772.70
III				
ArunachalPrad.	304700.01	279636.30	6543.17	270493.08
Assam	244159.53	224075.70	451885.69	267991.54
HimachalPrad.	3275.06	3005.67	3275.06	3275.06
Jammu&Kash.	288325.63	264608.82	5923.66	255926.21
Manipur	12981.78	11913.94	5029.41	12069.42
Maghalaya	4454.37	4087.97	4454.37	4454.37
Mizoram	4937.53	4531.38	4937.53	4937.53
Nagaland	4312.29	3957.57	4312.29	4312.29
Sikkim	25319.68	23236.96	24334.29	25206.63
Tripura	4754.17	4363.10	4754.17	4754.17

Table 2. (B)
Demand and allocation of Non-Tax Revenue

Division	Demand 4th stage	Allocation 4th stage	Demand 5th stage	Allocation 5th stage	Demand 6th stage	Allocation 6th stage
I						
Bihar	105757.83	105757.83	105757.83	105757.83		
Goa	626.61	626.61	626.61	626.61		
Gujarat	139800.83	139800.83	139800.83	139800.83		
Karnatak	186527.38	186527.38	186527.38	186527.38		
Kerala	511.35	511.35	511.35	511.35		
Maharashtra	513.15	513.15	513.15	513.15		
Tamil Nadu	94117.29	94117.29	94117.29	94117.29		
II						
Andhra Prad.	860.15	860.15	20983.14	20983.14		
Haryana	41460.61	41460.61	41451.59	41451.59		
MadhyaPrad.	142971.99	142971.99	125654.81	125654.81		
Orissa	1241.34	1241.34	1241.34	1241.34		
Punjab	102460.69	102460.69	98410.02	98410.02		
Rajasthan	645115.24	645115.24	658204.62	658204.62		
UttarPradesh	859.72	859.72	859.72	859.72		
West Bengal	772.70	772.70	772.70	772.70		
III						
ArunachalPrad.	210563.23	267423.82	197052.90	246051.82	305336.41	247399.53
Assam	235074.80	240562.17	227614.17	235145.31	245995.90	236160.79
HimachalPrad.	3275.06	3275.06	3275.06	3275.06	3275.06	3275.06
Jammu&Kash.	5923.66	176500.38	39007.39	152492.31	285941.52	153819.91
Manipur	5029.41	9832.81	5029.41	8649.18	5029.41	5029.41
Maghalaya	283812.91	115074.89	281243.25	155254.21	10024.62	155139.61
Mizoram	4937.53	4937.53	4937.53	4937.53	4937.53	4937.53
Nagaland	4312.29	4312.29	4312.29	4312.29	4312.29	4312.29
Sikkim	24997.28	25192.02	25021.41	25157.18	25407.10	25200.74
Tripura	4754.17	4754.17	4754.17	4754.17	4754.17	4754.17

Table 3.
State-wise deviation ratio of Tax Revenue (TR) and Non-Tax Revenue(NTR)

Division	Actual TR	Optimal TR	A-O/A	Actual NTR	Optimal NTR	A-O/A
I						
Bihar	407820.00	775151.64	-90.07	55641.00	105757.83	-90.07
Goa	9055.00	812.89	91.02	6980.00	626.61	91.02
Gujarat	117450.00	192074.93	-63.54	85485.00	139800.83	-63.54
Karnatak	172980.00	412480.89	-138.46	78223.00	186527.38	-138.46
Kerala	124265.00	1296.45	98.96	49013.00	511.35	98.96
Maharashtra	227493.00	772.87	99.66	151046.00	513.15	99.66
Tamil Nadu	216550.00	219889.58	-1.54	92688.00	94117.29	-1.54
II						
Andhra Prad.	293871.00	35275.07	88.00	174805.00	20983.14	88.00
Haryana	43189.00	52554.16	-21.68	34065.00	41451.59	-21.68
MadhyaPrad.	263560.00	254713.69	3.36	130019.00	125654.81	3.36
Orissa	156598.00	2167.23	98.62	89696.00	1241.34	98.62
Punjab	52835.00	144109.02	-172.75	36080.00	98410.02	-172.75
Rajasthan	176598.00	887990.30	-402.83	130900.00	658204.62	-402.83
UttarPradesh	607238.00	2238.92	99.63	233173.00	859.72	99.63
West Bengal	242015.00	1654.02	99.32	113061.00	772.70	99.32
III						
ArunachalPrad.	17905.00	79611.52	-344.63	55641.00	247399.53	-344.63
Assam	117556.00	174470.55	-48.41	159122.00	236160.79	-48.41
HimachalPrad.	44023.00	1452.21	96.70	99282.00	3275.06	96.70
Jammu&Kash.	82146.00	52117.21	36.56	242447.00	153819.91	36.56
Manipur	23185.00	2318.60	90.00	50292.00	5029.41	90.00
Maghalaya	21757.00	86982.82	-299.79	38805.00	155139.61	-299.79
Mizoram	18178.00	2074.28	88.59	43270.00	4937.53	88.59
Nagaland	27475.00	2248.88	91.81	52684.00	4312.29	91.81
Sikkim	8155.00	9133.81	-12.00	22500.00	25200.74	-12.00
Tripura	31878.00	2488.64	92.19	60898.00	4754.17	92.19