CHAPTER-3

Under Fiscal Policy the Govt. uses its expenditure programmes to produce desirable effects and avoid undesirable effects on the national income, production and employment.

-Arthur Smith.

METHODOLOGY

Myriad generalized external economy and diseconomy situations where private pecuniary interest can be expected to deviate from social interest, provide obvious needs for govt. activity.

-Paul Samuelson.

3.1 INTRODUCTION

This chapter is intended to provide the conceptual clarification and methodological orientation to this study on elasticity and buoyancy of the taxation system in Orissa and of individual taxes of the State. The review of literatures in the previous chapter has been imensely beneficial to develop the methodololgy appropriate to the present study.

3.2 BUOYANCY AND ELASTICITY : CONCEPTS

On the state level, the growth in tax revenue comes about through `automatic' response of the tax yields to changes in Net State Domestic Product (NSDP) and/or, through the imposition of new taxes, revision of the rate structure of existing taxes, expansion of the tax base, making tax compliance harder by law and other administrative measures backed by legal action.

Changes in tax yield resulting from modifying tax parameters (i.e. rate, base, etc.) are called `discretionary changes'. They are the result of legislative action. With tax parameters held constant (i.e. discretionary) changes being eliminated), automatic changes in tax yield resulting from variations in NSDP measures the elasticity of a tax system. However changes in the tax yield flowing from the combined effect of `automatic' changes and `discretionary' changes are the measures of the `buoyancy' of a tax or a tax system.

An analysis of such buoyancy and elasticity is important for many reasons. First, to the extent that the buoyancy is low, it would suggest a need for devising a tax structure which would overcome the deficiencies. Secondly, on the basis of such study, a state Government can estimate the probable tax revenue with unchanged base and rate of tax consequent upon mere increase in the NSDP. Thirdly, it would be helpful in indicating the extent of additional tax effort needed to increase the revenue of the Government.

3.3 HISTORICAL APPROACH TO THE MEASURE OF ELASTICITY AND BUOYANCY

In the case of understanding the tax responsiveness in the frame-work of methodology, there is a distinct dichotomy, one is referred to as tax buoyancy and the other is tax elasticity (as noted earlier). Eventhough, the total tax receipts are influenced by both National/State income and tax base, yet, the synergic effect of each of the influencing variable remains to be seen in isolation. The composite nature of behaviour of the tax format sometimes poses problems for tax analysts since base and income are correlated phenomena. Rao (1978) has remarked that, "the coefficient obtainable by relating the changes in the net tax yields to those in National income is termed as built-in-flexibility or elasticity measure of the tax system".[1] Whereas, "the coefficient obtainable by relating the changes in the historical tax receipts to changes in National income is tax buoyancy". Thus, one relates to the partial account of tax responsiveness to changes in National income (in our study, we will refer it as state income) and, the other is related to total responsiveness. If, this theory holds true, then the problem is to be viewed, how the total responsiveness would in isolation, in changes in state income or vice-versa would react to the total tax yields. The marginal tax rate, while defined as the ratio of absolute changes in tax revenue to the absolute changes in the National/State income, which, when considered as a ratio of percentage change in National/State income gives as income elasticity. It is statistically established that,

$$T = f(B) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$\text{and,} \quad T = f(B,Y) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where, T = Tax revenue

B = Base

and, Y = National or state income.

Given, these two equations, it can be shown that,

$$E_{TB} = \frac{(\Delta T/T)}{(\Delta B/B)} \quad \ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$E_{YB} = \frac{(\Delta B/B)}{(\Delta Y/Y)} \quad \ldots\ldots\ldots\ldots\ldots \quad (4)$$

Where, equation (3) refers to Rate response, i.e.; the response of the tax to its base (E_{TB}) and, equation (4) refers to base response, i.e.; the response of the tax base to state income (E_{YB}). From equation (3) and (4), it may be derived that,

$$E_{TY} = \frac{(\Delta T/T)}{\Delta B/B} \quad , \quad \frac{(\Delta B/B)}{\Delta Y/Y}$$

$$= \frac{(\Delta T/T)}{(\Delta Y/Y)} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

Where, E_{TY} = Elasticity of tax with respect to state income.

The above equation states that the response of a tax is a product of its response to base and the response of that base to the state income. With these definitions in mind, it was attempted to show that, the overall response of a tax system may be calculated as the weighted sum of individual tax's income elasticities, the weights being the proportions of individual taxes in total tax revenue. But soon we would realize that the equation (4) can be directly obtained as a single regression coefficient, if, we adopt a multiplicative type of model, i.e.

$$\text{Log } T = a_0 + a_1 \text{ Log } B + a_2 \text{ Log } Y + U \quad \ldots\ldots\ldots \quad (6)$$

where, B = Tax Base

Y = State income

a_i = Parameters of the variables (i = 0,1,2)

and, U = Disturbance term.

The ordinary least square estimation of the parameters a_i will not be valid unless the following assumptions are fulfilled regarding the disturbance term. As for example,

$$\epsilon\ (U) = 0 \qquad \text{..........} \quad (i)$$

$$\epsilon\ (Ui^2) = \sigma^2, \text{ a constant} \qquad \text{..........} \quad (ii)$$

$$\epsilon\ (U_iU_j) = 0, \text{ for } i \neq j \qquad \text{..........} \quad (iii)$$

According to assumption (iii) that, there is no autocorrelation in the disturbance term. But, often it is found in practice (Bez, 1990), that in the time series analysis, there is always autocorrelation present.[2] This is due to the upheavals in the economy. As a result, errors are not always the same. Sometimes, they increase and sometimes, they decrease.

In equation (6), $a_2 = E_{TY}$, since, logarithmic equation yields coefficients, which are themselves elasticities of the respective concomitant variables. It can be shown mathematically as follows :

$$T = a_0B^{a1}Y^{a2} \qquad \text{.............} \quad (a)$$

$$\frac{\partial T}{\partial B} = a_0 a_1 B^{a1-1} Y^{a2} \quad \ldots\ldots\ldots\ldots\ldots \text{(b)}$$

$$\frac{\partial T}{\partial Y} = a_0 a_2 B^{a1} Y^{a2-1} \quad \ldots\ldots\ldots\ldots\ldots \text{(c)}$$

$$E_{TB} = \frac{\Delta T/T}{\Delta B/B} = \frac{\Delta T}{\Delta B} \cdot \frac{B}{T} = \frac{a_0 a_1 B^{a1-1} Y^{a2} \cdot B}{a_0 B^{a1} Y^{a2}} \quad \ldots\ldots \text{(d)}$$

Where = a_1, which is constant ..... (e)

T = Total tax realized

B = Base

Y = State income

a_i = the coefficient of the equation

and, E_{TB} = elasticity

It is a different matter, whether we would like to have constant elasticity or variable elasticity. If, we go for variable elasticity, i.e.; time point elasticity, then the equation (5) will be of use. What actually we need to investigate into, is the effect of base in isolation of state income to total tax receipts. It is found in practice that, Base could be eliminated from the system of equation. Instead of taking base as an independent variable, we thought it practicable, to introduce another variable which may be termed as discretionary effort of tax realisation and, will act as a substitute for this variable, i.e.; Base. We must note it here that discretionary measures not only include legislated change in the tax base but also, (a) changes in tax rates, (b) the multiplication of levies, (c) the extension of taxation to areas hither to not covered by the tax, (d) the conversion of specific taxes into advalorem taxes, (e) the substitution of a single-point tax by a double or multi-point one, (f) the withdrawal of or reduction in exemptions, rebates or tax holidays, and so on. Further, it must be noted here that, all these discretionary changes noted above relates directly to the tax base. Almost, it is an established fact that if, from the total tax, that part of tax realization accounted for discretionary efforts is substracted, then the net tax yields will have a direct linear or loglinear functional relationship with state income in order to find the elasticities later on. If, we examine thoroughly, the two statistical variables as two distinct variables as base and the discretionary effort, then, what we must find that, their covariance is so strong that, it will yield pearson coefficient (r) almost equal to one. only, in such a situation, base could be a substitute for discretionary effort, which can be shown mathematically as follows :

$$Cov\ (B,\ D) \neq 0$$

$$\text{and,}\quad r = \frac{Cov\ (B,\ D)}{\sqrt{V(B)\ V(D)}} = 1$$

Where, B = Base, and

D = Discretionary measures.

Only then, in a regression equation, both B and D, if included as independent variables, the problem of multicollinearity would arise and the estimates of regression coefficient become in-estimable. If, the above proposition holds true, then, why could we not take another version of, T = f(D,Y), where, both D and Y are related to T, because we may also take tax as a function of state income alone, thus,

$$\text{Log } T = a_0 + a_1 \log Y + U \qquad \ldots\ldots\ldots \quad (7)$$

Where, T = Tax realized

Y = State income

U = Disturbance term, which is assumed to be normally distributed with zero mean and unit variance and,

a_i = parameters of the variables

(i = 0, 1)

The above equation would also give us E_{TY}. From this equation, neither we need to consider the individual taxes separately within the total tax receipts, because such a task will lead to statistical complicacy, nor, we can find logic in adopting a seemingly uncompromising methodology to assess E_{TY} as a product of marginal tax and income elasticity of individual tax, defined as (Rao, 1978)[3],

$$E_{TY} = \Sigma\ t/T \ .\ Ety \quad \ldots\ldots\ldots\ldots\ldots \quad (8)$$

where, E_{TY} = Income response of individual tax,

T = Aggregate Tax Revenue

t = Revenue from a particular tax

and, Y = National/State income.

Since, both base and income effects total tax revenue and with dominant periodic effect, therefore, to study the tax system over a longer period, the appropriate methodology would be to adopt a model, which is statistically viable.

It is difficult to ascertain, which model will be statistically satisfactory, when there involved probable multiple interpretation of tax theory. We present here some of the models that have been used (Rao, 1979)[4].

$$\text{Log } T = \log a_1 + b_1 \log B \quad \text{.........} \quad (9)$$

$$\text{Log } B = \log a_2 + b_2 \log Y \quad \text{.........} \quad (10)$$

Where, T = Total tax revenue

B = Tax base

Y = National/state income.

a_1 and a_2 = constant terms and,

b_1 and b_2 = regression coefficient of B and Y respectively.

There appears some other econometric impropities, the equation (9) as such possess no problem and also it is in accordance with the theory of taxation. But, the equation (10) would certainly be superfluous and if not statistically violative. Since, equation (9) and (10) implied that Base is functionally related to income, which in turn is related to tax. Inspite of probable multicollinearity, why can't we use tax as a function of both Base and income. Because, the method that, Rao has suggested would not yield estimate of the parameters for a simple reason that the number of equations is less than the number of parameters to be estimated. Therefore, we are having a safe way to define tax yield as,

$$T = f(Y, B) \quad \ldots\ldots\ldots\ldots\ldots \quad (11)$$

In the above equation, the exogeneous variables Y and B are assumed to be independent. If, they are correlated, that is functionally represented as,

$$B = f(Y) \quad \ldots\ldots\ldots\ldots\ldots \quad (12)$$

then, the resulting variance-covariance matrix produced by equation (10) would have serious multicollinearity problem, which we would like to avoid. However, Rao has treated both (9) and (10) as a set of simultaneous equations. In that case, the problem of identification arises. As, we see, the transplantation of equation (10) into equation (9) does not yield anything because it remains under identified, since the number of parameters to be estimated from,

$$\text{Log } T = \log a_1 + b_1 \log a_2 + b_1 b_2 \log Y \quad \ldots\ldots \quad (13)$$

is more than the number of parameters estimated from equation (13). Hence, it is a futile exercise.

Yet, there is another model (Wilford, 1965)[5].

$$\text{Log } T = \log a + b \log Y + c \log r \quad \ldots\ldots\ldots \quad (14)$$

which, also leads us to statistical problem. If, r happens to be the tax rate defined interms of total tax revenue over the units of time, then, logically, we donot find anything new as regards to estimate the tax responsiveness to changes in income. This view is also supported by Wilford. The equation (14) is remodelled as,

$$\text{Log } T = \log a + b \log Y + c \log r + d \log B \quad \ldots\ldots \quad (15)$$

where, all the variables are defined earlier (Ray, 1966)[6]. In order to relate r with T, or, for estimating T, we can use a very simple model,

$$T = T_0 \, e^{r} \quad \ldots\ldots\ldots\ldots \quad (16)$$

where, T_0 = Tax revenue at the base period

and r = Rate of the tax.

But, our problem is to find buoyancy and elasticity and if, possible to isolate them. Some other authors even go a step further to modify equation (14) and equation (15) as (Legler et al, 1968)[7],

$$\text{Log } T = \log a + b \log \hat{Y} + C \log N + d \log r_1 + e \log r_2 + f \log P \quad \ldots\ldots\ldots\ldots \quad (17)$$

where, $\hat{Y}$ = percapita income

N = population

r_1 = income tax rate

r_2 = sales tax rate

and, P = relative price of taxed versus untaxed goods.

First, it is a composite equation for determining all taxes, whether it is ethical to do so or not is another matter for examination. Still, there is another statistical irregularities which the author seems to ignore. The exogeneous variable N and $\hat{Y}$ are correlated, i.e. covariance $(N, \hat{Y}) \neq 0$, since, while estimating the percapita income the N variable is utilized, hence the same variable cannot appear another time in disguise. The authors only lament for its infeasibility for application, since tax system is not that uniform.

The alternative method is suggested with the model,

$$\text{Log } AT = \log a + b \log Y \quad \ldots\ldots\ldots \quad (18)$$

Where, AT = adjusted tax revenue

Finally, the empirical analysis, was vested with,

$$\text{Log } AT = \log a_1 + b_1 \log Y + U \quad \ldots\ldots\ldots \quad (19)$$

$$\text{Log } T = \log a_2 + b_2 \log Y + V \quad \ldots\ldots\ldots \quad (20)$$

Where, T = historical tax yields.

to estimate the built-in-flexibility and buoyancy for the specified tax groups and individual taxes.

All these theoretical models, are product of tax logistics. Every model is mathematically true. But, empirically, they might not be sound enough. Since, we know, that, tax could be considered as a product of r and B, where r is the rate of tax and, B is the base. While, we are utilising B as an independent variable in estimating tax, then r should automatically appear as another independent variable with only one restriction that such model be always multiplicative. So, why do not we try a model of this nature which is not indifferent to the existing tax theories. If, we define;

$$T = f\ (Br) \qquad \ldots\ldots\ldots\ldots \qquad (21)$$

where, T = Total tax

B = Tax base

and, r = Tax rate

In which case, the model will be :

$$T = \alpha_0 B^{\alpha 1} r^{\alpha 2} \qquad \ldots\ldots\ldots \qquad (22)$$

where, α_1 and α_2 = coefficient of B and r.
with the restriction that, $\alpha_1 + \alpha_2 \leq 1$.

Also, we may suggest another model, i.e., a simple variation of the above,

$$r = f\left(\frac{T}{B}\right)$$

$$= \alpha_0\ T^{\alpha 1}\ B^{-\alpha 2} \qquad \ldots\ldots\ldots \qquad (23)$$

Where , r = tax rate.

These two simple models utilize both base and rate of tax as independent variables.

Looking at these models, we found that, tax yield may not be a function of just one variable, i.e. state income, but, number of other independent variables. Therefore, we decide to use tax yield as,

$$T = f\ (D,\ Y) \quad \ldots\ldots\ldots\ldots \quad (24)$$

where, D = Discretionary effects and,

Y = state income

There are advantages and disadvantages in two variable model. Definitely, in a multivariate model, the coefficient of Determination (R^2) is higher, whereas, in a two variable model, R^2 is often smaller. Because, the effects of other variables are ignored. On the other hand, in the estimate of the parameters of regression equations in a multivariate model, their empirical values are distributed in such a way, that the estimate relating to the principal variable becomes smaller. Therefore, equation (17), we considered to be a weak equation.

3.4 THE PRESENT APPROACH TO MEASURE ELASTICITY AND BUOYANCY

Keeping in view the infeasibilities of the existing models to the heterogeneous tax structure, we have made an humble attempt in this chapter, to develop our own model. We have adopted two alternative methods for analysing the tax elasticity and buoyancy. The first method, we call it as Econometric Approach and, the second approach, we termed it as Probabilistic approach.

3.4.1. ECONOMETRIC APPROACH

To measure elasticity, we have to separate the effects of changes in tax revenue with respect to "Base". When, T is related to "Income" as well as "Base", the multiple regression model suggested by the empirical analysis in the literature,

$$\text{Log } T = a_1 + a_2 \log Y + a_3 \log B + U \quad \ldots\ldots \quad (25)$$

where, T = Total tax yield,

Y = state income

B = Tax Base, U = disturbance term and,

a_i = estimates of the parameters (i = 0,1,2) does give the account of tax estimation, where the other variables like tax rate and its growth etc. are not incorporated into the model. On this ground, we thought it imperative to substitute the variable D (as defined earlier) for B, where D includes all sorts of discretionary changes. If, we will have to believe that estimate of tax be separable as automatic response (elasticity) and discretionary response, then, the combination of these two responses, will give us the buoyancy of a tax or that of the tax system as a whole. Then,

$$T = T_D + T_Y \quad \ldots\ldots\ldots\ldots \quad (26)$$

where, T_D = Response of the tax to discretionary changes (B)

T_Y = Automatic response of the tax to changes in income (Y)

and, T = Total unadjusted tax yields from theses two effects.

So, from the total response of the tax (T), we will have to separate the effects' of income and the effects of discretionary changes (base). But, this is not an easy task unless, we know the marginal probability distribution of tax with respect to both automatic as well as discretionary changes.

Since, in the equation (25), the discretionary response and automatic response of the tax are given by the estimates of a_3 and a_2 (being a log-linear model) and these are constant throughout the period under study, it would be mathematically possible to estimate that part of tax revenue which will be accounted only by automatic response (Income) or discretionary response (Base), e.g., the empirical equation :

$$\text{Log } \hat{T} = \hat{a}_1 + \hat{a}_2 \log Y + \hat{a}_3 \log D \quad .... \quad (27)$$

from which, after taking anti-log, we can get the adjusted tax revenue series as

$$T - \theta_1 T \propto T_a \quad .... \quad (28)$$

where, $\theta_1 T = \hat{a}_3 \log D$ (i.e. the response of the tax to the discretionary measures).

Then, we can re-estimate,

$$Ta = a_4 + a_5 \log Y \quad .... \quad (29)$$

The above equation (29) will give us the elasticity. In this process, we eliminated the effect of discretionary changes from the original multiple regression. The same procedures could be used also for eliminating the effect of income from the tax by subtracting from,

$$T - \theta_2 T \approx T_D \qquad \ldots\ldots\ldots\ldots \qquad (30)$$

where, T_D = Response of the tax due to discretionary measures.

The theoretical considerations though appear to be sound, but due to the presence of constant (intercept), when both Discretionary and income variables act as independent variables then, this constant term of the empirical equation may be partly influenced by income and partly by the discretionary variable in an indirect way, or, it may be free from their effect. According to empiricists, tax could only be a function of both Y and D, or, Y and D separately. That means, the contribution of Y and D, both separately and as well as jointly can be seen from the model structure. But, then the constant term α_0-how could we explain! Therefore, we may suggest a regression equation, which is going through the mean value of the variables, then, we can avoid the problem of α_0. For example,

$$\text{Log } (T - \bar{T}) = \hat{\alpha}_1 \log (Y - \bar{Y}) + \hat{\alpha}_2 \text{ Log } (D - \bar{D}) \text{ ..... } (30)$$

Where, $\bar{T}$, $\bar{Y}$, $\bar{D}$ are the mean value of T, Y, D respectively. We may also think that $\hat{\alpha}_0$ is free from the effect of both Y and D. This contribution to the tax given by the value of $\hat{\alpha}_0$ are those functions such as additional tax efforts, new means adopted for resource mobilisation etc., which are always inherent in the tax structure. That is why, when we are estimating T relating to Y or, T relating to D alone we used,

$$T = \theta_1 T - (D) \text{ .... } (31)$$

$$T = \theta_2 T - (Y) \text{ .... } (32)$$

Where, $\theta_1 = \hat{a}_3 \log D$, and, $\theta_2 = \hat{a}_4 \log Y$.

Therefore, we have to make an alternative way of removing the effect of either the discretionary factor or the income factor. For example, we take,

$$\text{Log } T = a_6 + a_7 \log Y + U \text{ .... } (33)$$

Here, the assumption is that the total tax is explained by income alone. The empirical equation,

$$\text{Log } \hat{T} = \hat{a}_6 + \hat{a}_7 \log Y \qquad \text{........} \qquad (34)$$

gives the estimate of tax as a function of income. Here, the intercept term gives the account of that element of tax which is beyond the ambit of the model, say, extraneous causes, but certainly not by income variable. We estimate,

$$T_d = T - T_y \qquad \text{............} \qquad (35)$$

Now, $$Ty \equiv \theta_3 \simeq a_6 \log Y \qquad \text{...........} \qquad (36)$$

if, our assumptions are correct then, we re-estimate,

$$T_d = \hat{a}_8 + \hat{a}_9 \log D \qquad \text{............} \qquad (37)$$

Though, $\hat{a}_8$ still present in the model, this is bound to be smaller than $\hat{a}_{10}$ of,

$$\text{Log } \hat{T} = \hat{a}_{10} + \hat{a}_{11} \log D \qquad \text{............} \qquad (38)$$

This is not only probability, but, the empirical evidence will support the view.

We have to consider one fact that in the previous chapters, we have been discussing the variations of tax realizations in different years, which have to be also supported by empirical evidence within the model. For this reason, we may suggest a linear equation as against the loglinear equation. In a multiplicative type of the model, the total effects of any change does not conform to the theory of additivity. For example,

$$Y = a + bx \qquad \text{...........} \qquad (39)$$

and, $$\text{Log } Y = \log a + b \log x \qquad \text{.......} \qquad (40)$$

where, Y denotes tax revenue

x denotes Net State Domestic Product

and, b denotes regression coefficient.

Here, a + b of the equation (39) = 1. But, in the loglinear equation, represented by equation (40), $a + b \neq 1$. For the simple reason, to explain the variation of tax for every single year, we would prefer a linear equation, which supports the additivity property of the parameters estimates.

Next, we have to consider another theoretical constraint. The authorities investigating the buoyancy and elasticity of tax revenue have adopted with solid grounding that,

$$\left.\begin{array}{l} T = f_1 \ (Y) \\ T = f_2 \ (D) \\ D = f_3 \ (Y) \end{array}\right\} \quad \ldots\ldots\ldots\ldots \quad (41)$$

This would lead us to the problem of multicollinearity. In that case, the model will be,

$$\text{Log } T = a + b \log Y + c \log B + U \quad \ldots\ldots \quad (42)$$

Which is inconsistent and untenable econometrically. Therefore, we have to make a compromise by adopting only the 2-variables model suggested by these functions.

Further, we know that we rely on the independent variables to such an extent that atleast 50 percent of the total variabilities could be explained. The coefficient of determination (R^2) will tell us this. But, often from practice, we find that any addition of independent variables will contribute to R^2 but at the cost of reliability of the estimates of the parameters. Also, in time series type of analysis, the disturbance term `U' does not behave in the way we expect, as often, there is serial correlation of the disturbance term. If, we consider the 1st order auto-regression function of the disturbance term, then, we can express,

$$U_t = P\, U_{t-1} + V_t \quad \text{...........} \quad (43)$$

and, the estimate of P can be obtained by :

$$P = \frac{\Sigma\, U_t \;.\; U_{t-1}}{\Sigma\, U_{t-1}^2} \quad \text{...........} \quad (44)$$

Keeping this in mind, that P is also affecting the reliability of the estimate, we re-introduce the earlier model as such,

$$\text{Log } T_t = a_{1t} + a_{2t} \log Y_t + a_{3t} \log D_t + U_t \text{ ....} \quad (45)$$

and, with one period log,

$$\text{Log } T_{t-1} = a_{1t-1} + a_{2t-1} \log Y_{t-1} + a_{3t-1} \log D_{t-1} + U_{t-1} \quad \text{........} \quad (46)$$

Multiplying the lagged equation by P throughout and subtracting from the 1st, we obtain,

$$\text{Log } (T_t - PT_t) = (a_{1t} - Pa_{1t-1}) + (a_{2t} - Pa_{2t-1})$$
$$\log (Y_t - PY_{t-1}) + (a_{3t} - Pa_{3t-1})$$
$$\log (B_t - PD_{t-1}) + (U_t - PU_{t-1}) \quad \ldots \quad (47)$$

if, we express the above equation (47) as,

$$\text{Log } T_t^* = a_{1t}^* + a_{2t}^* \log Y_t^* + a_{3t}^* \log D_t^* + U_t^* \quad \ldots (48)$$

Then, this U_t^* will have to hold the same properties as the U_t.

If, we now follow the same procedure in isolating "income" or "discretionary" effect, then we can estimate the automatic response and the discretionary response that constitute the total tax revenue.

In conclusion, for our analysis, we may adopt the following models.

$$T = a_0 + a_1Y + U_1 \quad \ldots\ldots\ldots\ldots \quad (49)$$
$$TA = a_2 + a_3Y + U_2 \quad \ldots\ldots\ldots\ldots \quad (50)$$
$$T = a_4 + a_5Y + a_6D + U_3 \quad \ldots\ldots\ldots \quad (51)$$

where, T = Actual tax revenue realized

TA = Adjusted tax revenue after taking out discretionary effects.

D = Discretionary effort of tax realization.

U_i = Stochastic disturbance term.

and, Y = state income.

Equation (49) measures the buoyancy of tax revenue, whereas equation(50) measures the elasticity of tax revenue we may also adopt log linear version of the above models. Equation (51) measures the total responsiveness of the tax or the tax system, which is decomposed into two effects namely income response and discretionary response.

In empirical analysis, we shall use the methods mentioned here to separate the effects of discretionary effects to measure the elasticity.

3.4.2. PROBABILISTIC APPROACH

The alternative method that we suggest runs interms of probabilistic procedure as mentioned earlier.

This is based on the theory of probability and the model is derived by Bez (1990)[8], known as Bez Reaction function. Before, proceeding with the mathematical exposition of the pre-conditions laid down in support of this model.

(i) The model may be treated as the sophisticated type of probability distribution-marginal.

(ii) It is assumed that, when there are two things say object and agent then, the resultant reaction is no more as regards to the effects produced by them and there is no room for externalities.

(iii) It has wide range of application due to the adhoc nature of the model. The model has been applied so for (a) to isolate the effect of use of fertilizers and Man hours employed to produce yields of certain crops (b) to find, whether the production variation of agricultural output in the seven states of North-East India is to be accredited to spatial or time factors.

(iv) The main stem of analysis is graphical because assuming that the respective objects or agents would behave rather in a rational way.

The model is conceived as, the details of which can be found elsewhere (Bez, 1990)[9].

Let us consider the observed matrix Tij.

Dj

Yi	D_1	D_2	D_3 ...	... D_n
Y_1	T_{11}	T_{12}	T_{13}	T_{1n}
Y_2	T_{21}	T_{22}	T_{23}	T_{2n}
	((Tji))			
Y_n	T_{n1}	T_{n2}	....	T_{nm}

We are using the symbols familiar to our own type of analysis. The reaction function is giving as,

$$Tij = Fij\ (Yi,\ Dj) \quad \text{..........} \quad (52)$$

From this, we can derive the probability distribution function as,

$$\begin{aligned} P(Tij/Yi,\ Dj) = {} & P(T_{11}/Y_1,\ D_1) + P(T_{12}/Y_1,\ D_2) + \ldots + \\ & P(T_{1n}/Y_1,\ D_n) + \ldots + P(T_{n1}/Y_n,\ D_1) + \\ & P(T_{n2}/Y_n,\ D_2) + \ldots + P(T_{nn}/Y_n,\ D_n) \quad ..(53) \end{aligned}$$

Finally, summing up all the probable functions n, we get the composite function which we can write,

$$P\ (Tij/YiDj) = f\ (Yi,Dj) \quad \ldots\ldots\ldots\ldots \quad (54)$$

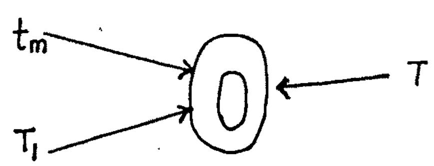
In any sub-set of tax revenues, we may have, say 2 types of responses,

$$P\ (t^{m}/T_{1}),\ \text{and},\ P\ (t^{q}/T_{1}) \quad \ldots\ldots\ldots \quad (55)$$

These can be expressed independently,

$$P\ (t^{m}/T_{1},\ Dj) = \frac{P\ (t^{m}/T_{1})}{P\ (T_{1}/T)} \quad \ldots\ldots\ldots \quad (56)$$

$$P\ (t^{q}/T_{1},\ Dj) = \frac{P\ (t^{q}/T_{1})}{P\ (T_{1}/T)} \quad \ldots\ldots\ldots \quad (57)$$



(Conceptual illustration)

or, we may possibly get a probability function of the following type.

$$P\ (t^{m}/T_{1}) + P\ (t^{q}/T_{1}) \quad \ldots\ldots\ldots\ldots \quad (58)$$

and, $$P(t^{m+q}/T_{1}) = P(T_{1}/T) \quad \ldots\ldots\ldots\ldots \quad (59)$$

Similarly, for each sub-set, we can imagine the same type of distribution function.

Finally, the model is made operational, by taking the logistic function of the type,

$$\text{Log } Yj = a + b \log Yj + U_1 \quad \ldots\ldots\ldots \quad (60)$$

$$\text{and, Log } Di. = \alpha + \beta \log di. + U_2 \quad \ldots\ldots\ldots \quad (61)$$

i.e., for each income variant and the discretionary variant, there will yield as many regression lines as there are number of incomes and discretionary measures. Hence, the time series type of analysis, we can say that the same tax revenue series will have a line with the tangents supposed to be all proportionally equal if the income as well as discretionary variable behave rationally. However, with this type of analysis, unlike the econometric analysis, we cannot see straight way, the quantum of tax revenue as income responsive or discretionary measure responsive, since probability function deals even with minute variations. Since, data are not available according to the choice of this probabilistic model, we rather confine ourselves to econometric type of analysis. lm26

3.5 NOTES AND REFERENCES

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