CDE

Centre for Development Economics

WORKING PAPER SERIES

Optimal Taxation and Resource Transfers In a Federal Nation

M.N. Murty
Institute of Economic Growth

Ranjan Ray
Delhi School of Economics

Working Paper No: 2

Centre for Development Economics
Delhi School of Economics
Delhi 110 007 INDIA

OPTIMAL TAXATION AND RESOURCE TRANSFERS IN A FEDERAL NATION

BY

M.N. Murty
Institute of Economic Growth,
University Enclave,
Delhi-110007.

and

Ranjan Ray
Delhi School of Economics
Delhi University,
Delhi-110007.

Written: July, 1990.
Last revised: October, 1993.

* This paper is complete re-write and a major extension of an earlier version which was circulated in 1990 as a Delhi School of Economics Working Paper No.90/01. We are grateful to K. Lal for programming assistance and two anonymous referees for helpful remarks on the earlier version. We have, also, benefitted from seminar presentations at the University of Western Australia in Perth, New South Wales in Sydney and Alberta in Edmonton, Canada. The disclaimer applies.

Abstract

This paper analyses optimal commodity taxes in a federal nation under alternative models of fiscal federalism, namely, fully coordinated and non co-operative fiscal behaviour of the federal and provincial authorities. Illustrative calculations for India confirm sensitivity of optimal commodity taxes to federal specification. The paper, then, extends the non co-operative model to allow resource transfer from the Centre to the provinces. The paper also proposes computational procedures to estimate the federal and provincial components of optimal commodity tax. Illustrative empirical evidence suggests considerable potential for these procedures in future numerical applications.

1. Introduction

In the optimal tax literature, formulae for commodity taxes are derived on the assumption that there is an unitary form of government with an exclusive right to design and levy taxes [see Diamond and Mirrlees (1971), Atkinson and Stiglitz (1980, ch. 12)]. There have been very few attempts[1] to extend or modify the traditional approach to meet the peculiar characteristics of a Federal nation. These include: (i) many levels of government[2] each with a constitutional right to levy taxes, partly on the same base, (ii) statutory definition of some commodity taxes (namely, 'excise tax' in the Indian context) as Federal i.e. 'Central' instruments, while others (namely, 'sales tax') belong to the provinces, and (iii) resource transfers from the Centre to the provinces linked to revenue collection.

There are many major countries in the world with federal forms of government (U.S.A., Australia, West Germany, Canada and India).[3] In these countries commodity taxes are levied on the same base by the federal as well as provincial government. The main virtue of fiscal federalism is the freedom of the provincial government to take economic decisions, keeping in mind local needs and resource constraints. In contrast, the 'Centre' designs commodity taxes given national economic objectives. The tax on commodity i, paid by an individual

---

[1] See for example, Arnott and Grieson (1981), Gordon (1983). The motivation of these studies is quite different, however, from that of the present exercise.

[2] These will be referred to as the 'Centre' and the 'provinces' or 'states'.

[3] See Gulati and George (1988) for a recent description of federal financial relations in India.

living in province s, is the sum of two components: the excise tax θ_i that accrues to the Centre, and the sales tax $t^s{}_i$ that accrues to the province and varies across the provinces. Tax calculations for Federal countries, which do not distinguish between Federal and provincial taxes[4] are, thus, very difficult to interpret, and, potentially, misleading if used in policy formulation.

This paper presents alternative approaches to the study of optimal taxation in a federal set-up based on centralised and decentralised (i.e. non cooperative) models of fiscal federalism. In the former, the federal and provincial tax and spending behaviour are fully co-ordinated so that the centralised model captures the external effects of changes in federal, provincial taxes on the resource of the other. In contrast, in the decentralised procedure, each decision making unit acts independently, in the light of its own objectives, taking as given the fiscal decisions made by the others. The chief motivation of this paper is to investigate whether the quantitative and the qualitative conclusions about the structure of optimal taxes vary quite significanly between the alternative federal models.

The plan of this paper is as follows. Section II introduces the centralised federal tax model. Section III presents the non-cooperative federal model and compares with the centralised case. Section IV describes the computational procedures, and presents illustrative optimal tax estimates under the alternative approaches. Section V extends the non

---

4 See, for example, Ahmad and Stern (1984), Ray (1986), Heady and Mitra (1987).

cooperative model to allow for resource transfer between the 'Centre' and the constituent provinces, and presents numerical evidence on the impact of the resource transfer parameter on the optimal tax magnitudes. The paper ends on the concluding note of Section VI.

II. The Centralised Model of Fiscal Federalism

To keep the notation and exposition simple, we initially consider, without loss of generality, a federal structure with two provinces and a Centre. In this study, expenditure and labour supply decisions are assumed separable. Let u^s_h (x^s_h), v^s_h (p^s, M^s_h) denote the direct and indirect utility, respectively, of individual h (1,..., H) residing in province s (= 1,2). x^s_h, p^s denote his vector of commodity demand, consumer prices, respectively, and $M^s_h = p^{s\prime} x^s_h$ his aggregate expenditure. The social welfare Ψ of the federation is defined over the social welfare W^s of the individual provinces which, in turn, are defined over the individuals' indirect utilities.

$$\psi(p, M) = \psi[W^1\{v^1_1(p^1, M^1_1), \quad , v^1_H(p^1, M^1_H)\}$$
$$W^2\{v^2_1(p^2, M^2_1), \quad , v^2_H(p^2, M^2_H)\}] \tag{1}$$

where the sub vectors p^1, p^2 constitute the (2nx1) aggregate price vector p, and M is the (2Hx1) vector of aggregate expenditures. Note that, for notational simplicity, we are assuming identical number of individuals in each province. Assuming full shifting of taxes, as is traditional in the literature, the consumer price has three elements.

$$p^1_i = \bar{p}_i + \theta_i + t^1_i \tag{2a}$$

$$p^2_i = \bar{p}_i + \theta_i + t^2_i \qquad (2b)$$

where θ_i is the excise tax, t^s_i is the province specific sales tax on commodity i and, without loss of generality, the producer price $\bar{p}_i$ is assumed to be constant across provinces. Direct taxes and lump sum transfers to individuals are ruled out in this paper. Assuming what Gordon (1983, p.573) calls 'fully co-ordinated decision making behaviour', the optimal tax problem requires constrained maximisation of SWF, Ψ, (defined in (1)) with respect to excise tax θ_i and sales tax t^s_i subject to the following federal and provincial revenue constraints.

$$R^o \leq \sum_{h=1}^{H} \sum_{i=1}^{n} \theta_i (x^1_{ih} + x^2_{ih}) \qquad (3a)$$

$$R^s \leq \sum_{h=1}^{H} \sum_{i=1}^{n} t^s_i \, x^s_{ih} \qquad (3b)$$

$$s=1,2$$

where R^o, R^s are, respectively, the net revenue requirements of the Centre and the constituent provinces. The exercise implies the following Lagrangean

$$L = \psi(p, M) + \lambda [\sum_{i=1}^{n} \theta_i (\sum_{h=1}^{H} (x^1_{ih} + x^2_{ih})) - R^o]$$
$$+ \mu^1 [\sum_{i=1}^{n} \sum_{h=1}^{H} t^1_i \, x^1_{ih} - R^1] + \mu^2 [\sum_{i=1}^{n} \sum_{h=1}^{H} t^2_i \, x^2_{ih} - R^2] \qquad (4)$$

where the Lagrangean multipliers λ, μ^1, μ^2 can be interpreted as the marginal 'social' cost of raising an extra unit of revenue by the Centre and provinces.

Assuming that all the demand and welfare functions are well behaved and that the regularity conditions are satisfied, using Roy's identity, optimal federal or central taxes imply

$$O = \frac{\delta L}{\delta\theta_k} = -\sum_{h=1}^{H} \frac{\delta\psi}{\delta W^1} \frac{\delta W^1}{\delta v_h^1} \alpha_h^1 x_{kh}^1 - \sum_{h=1}^{H} \frac{\delta\psi}{\delta W^2} \frac{\delta W^2}{\delta v_h^2} \alpha_h^2 x_{kh}^2$$

$$+ \lambda [\sum_h x_{kh}^1 + \sum_h x_{kh}^2 + \sum_i \theta_i \sum_h (\frac{\delta x_{ih}^1}{\delta\theta_k} + \frac{\delta x_{ih}^2}{\delta\theta_k})]$$

$$+ \mu^1 [\sum_{i=1}^{n} t_i^1 \sum_{h=1}^{H} \frac{\delta x_{ih}^1}{\delta\theta_k}] + \mu^2 [\sum_{i=1}^{n} t_i^2 \sum_{h=1}^{H} \frac{\delta x_{ih}^2}{\delta\theta_k}]$$

$$k = 1,..,n \qquad (5)$$

where α^1_h, α^2_h denote the 'private' marginal utility of income to individual h in the 2 provinces. Since, by the assumption of full shifting, change in taxes and prices are formally equivalent and their effects identical, using the Slutsky decomposition, equation (5) yields after some re-arrangement

$$\sum_i (\theta_i + \frac{\mu^1}{\lambda} t_i^1) \sum_h S_{ikh}^1 + \sum_i (\theta_i + \frac{\mu^2}{\lambda} t_i^2) \sum_h S_{ikh}^2$$

$$= -H(\bar{x}_k^1 + \bar{x}_k^2) + \sum_h b_h^1 x_{kh}^1 + \sum_h b_h^2 x_{kh}^2 \qquad (6)$$

where

$$b_h^1 = \frac{\beta_h^1}{\lambda} \frac{\delta\psi}{\delta W^1} + \sum_i (\theta_i + \frac{\mu^1}{\lambda} t_i^1) \frac{\delta x_{ih}^1}{\delta M_h^1} \qquad (7a)$$

$$b_h^2 = \frac{\beta_h^2}{\lambda} \frac{\delta\psi}{\delta W^2} + \sum_i (\theta_i + \frac{\mu^2}{\lambda} t_i^2) \frac{\delta x_{ih}^2}{\delta M_h^2} \qquad (7b)$$

$\bar{x}^1_k$, $\bar{x}^2_k$ are the mean consumption of k, S^1_{ikh}, S^2_{ikh} the Slutsky i.e. compensated price responses for individual h in the 2 provinces, and $\beta_h^s = \frac{\delta\psi}{\delta v_h^s} \alpha_h^s$ denotes the 'social' marginal utility of income of individual h in province s. Equation system (6) can be re-written as

$$\sum_i t_i^{*1} \sum_h S_{ikh}^1 + \sum_i t_i^{*2} \sum_h S_{ikh}^2$$

$$= - H(\bar{x}_k^1 + \bar{x}_k^2) + \sum_h b_h^1 x_{kh}^1 + \sum_h b_h^2 x_{kh}^2 \qquad (8) \quad .$$

$t_i^{*s} = \theta_i + \frac{\mu^s}{\lambda} t_i^s$ is the 'effective' tax paid on commodity i in province s.

'Optimal' provincial taxes imply

$$O = \frac{\delta L}{\delta t_k^s} = -\sum_{h=1}^{H} \frac{\delta \psi}{\delta W^s} \beta_h^s x_{kh}^s + \lambda [\sum_i \sum_h \theta_i \frac{\delta x_{ih}^s}{\delta t_k^s}]$$

$$+ \mu^s [\sum_h x_{kh}^s + \sum_i \sum_h t_i^s \frac{\delta x_{ih}^s}{\delta t_k^s}] \qquad s=1,2 \qquad (9)$$

Using the Slutsky relationship in (9) we obtain after some re-arrangement

$$\sum_i t_i^{*s} \sum_h S_{ikh}^s = -\frac{\mu^s}{\lambda} H\bar{x}_k^s + \sum_h b_h^s x_{kh}^s \qquad (10)$$

$$s = 1,2$$

Substituting (10) in equation (8), we obtain after re-arrangement the following relationship between the mean consumption levels in the 2 provinces

$$(1 - \frac{\mu^1}{\lambda}) \bar{x}_k^1 + (1 - \frac{\mu^2}{\lambda}) \bar{x}_k^2 = O \qquad k=1,..,n \qquad (11)$$

Since $\bar{x}^1{}_k$, $\bar{x}^2{}_k$ have the same sign, (11) implies that λ must lie between μ^1, μ^2 i.e. $\mu^1 < \lambda < \mu^2$ or, $\mu^1 > \lambda > \mu^2$.

Equation (11) can be easily generalised to the case of $S(\geq 2)$ provinces.

$$\sum_{s=1}^{S}(1-\frac{\mu^{s}}{\lambda})\bar{x}_j^s = 0 \qquad (12)$$

Since the $\bar{x}^s{}_j$ are all non-negative, (12) implies that λ must lie between μ (min.) and μ (max.). We have, thus etablished the following proposition.

Proposition I

In the centralised federal State, if federal and provincial commodity taxes are set optimally, then relationship (12) between the mean quantities demanded in the provinces must be satisfied, and the marginal social benefit of federal revenue must lie between the minimum and maximum values of the marginal social benefit of tax revenue in the provinces.

III. Optimal Taxation in Decentralised Federal Model: The Non-Cooperative Outcome

To examine the consequences of allowing provincial autonomy on the optimal taxes, we present a decentralised federal model where each tax authority acts independently taking as given the fiscal decisions made by the others. We consider the general case of S(≥ 2) provinces. We now, allow a provincial poll tax, denoted by 1^s, that is uniform within a province but varies between provinces. We, also, allow the federal authorities to levy a national lump sum tax, $\tilde{1}$, that is invariant between and within provinces. The federal and provincial resource constraints now become, respectively,

$$R^{o} \leq HS\tilde{1} + \sum_{s=1}^{S}\sum_{i=1}^{n}\sum_{h=1}^{H}\theta_{i}\, x_{ih}^{s} \qquad (13)$$

$$R^{s} \leq H1^{s} + \sum_{i}\sum_{h} t_i^s\, x_{ih}^{s} \qquad (14)$$

where all the notations are as explained before.

The federal government maximises the nation's SWF, given by equation (1) extended to the case of S provinces, with respect to its own policy instruments (θ_i, $\tilde{l}$) subject to its resource constrant, taking as given, at existing values, the provinces policy parameters {$t^s{}_i$, l^s}. Similarly, each province s maximises its residents SWF, W^s, with respect to its own instruments {$t^s{}_i$, l^s}, subject to its resource constraint, taking as given others instruments at their observed levels. In Lagrangean terms, therefore, the decentralised procedure involves separate maximisation of L_1, $L^s{}_2$ with respect to {θ_i, $\tilde{l}$} and {$t^s{}_i$, l^s}, respectively, where

$$L_1 = \psi(W^1, \ \ldots, \ W^S) + \lambda\{HS\tilde{l} + \sum_s \sum_i \sum_h \theta_i \, x^s_{ih} - -R^o\} \qquad s = 1,..,S \qquad (15)$$

$$L_2^s = W^s(p,M) + \mu^s\{Hl^s + \sum_i \sum_h t^s_i \, x^s_{ih} - R^s\} \qquad s = 1,..,S \qquad (16)$$

Differentiating L_1, $L^s{}_2$ with respect to θ_i, $t^s{}_i$, respectively using Roy's identity, the Slutsky decomposition and following the same procedure as in the centralised framework, the first order consitions yield after some re-arrangement the following equations for optimal commodity taxes in the decentralised federal economy.

$$\sum_s \sum_h \{\frac{\delta\psi}{\delta W^s} \, \frac{\beta^s_h}{\lambda} + \sum_i \theta_i \frac{\delta x^s_{ih}}{\delta M^s_h}\} x^s_{kh} = \sum_s \sum_h x^s_{kh} + \sum_s \sum_h \sum_i \theta_i \, S^s_{ikh} \qquad (17)$$

$$\sum_h \{\frac{\beta^s_h}{\mu^s} + \sum_i t^s_i \frac{\delta x^s_{ih}}{\delta M^s_h}\} x^s_{kh} = \sum_h x^s_{kh} + \sum_i \sum_h t^s_i \, S^s_{ikh} \qquad s=1,\ldots,S \qquad (18)$$

Let us define

$$\tilde{b}_{1h}^{s} = \frac{\delta\psi}{\delta W^{s}} \frac{\beta_{h}^{s}}{\lambda} + \sum_{i} \theta_{i} \frac{\delta x_{ih}^{s}}{\delta M_{h}^{s}} \qquad (19)$$

$$\tilde{b}_{2h}^{s} = \frac{\beta_{h}^{s}}{\mu^{s}} + \sum_{i} t_{i}^{s} \frac{\delta x_{ih}^{s}}{\delta M_{h}^{s}} \qquad (20)$$

Note $\tilde{b}^{s}_{1h}$, $\tilde{b}^{s}_{2h}$ can be interpreted as the social marginal valuation of income, net of federal and provincial commodity taxes, respectively, and expressed in terms of the corresponding Lagrangean multipliers $\{\lambda, \mu^{s}\}$ as numeraire.

Equations (17, 18) can thus be re-written as

$$\sum_{s}\sum_{h} \tilde{b}_{1h}^{s} x_{kh}^{s} = \sum_{s}\sum_{h}(x_{kh}^{s} + \sum_{i} \theta_{i} S_{ikh}^{s}) \qquad (21)$$

$$\sum_{h} \tilde{b}_{2h}^{s} x_{kh}^{s} = \sum_{h}(x_{kh}^{s} + \sum_{i} t_{i}^{s} S_{ikh}^{s}) \qquad s=1,\ldots S \qquad (22)$$

(21, 22) together imply the following relationship between federal and provincial commodity taxes.

$$\sum_{s}\sum_{h} (\tilde{b}_{1h}^{s} - \tilde{b}_{2h}^{s}) x_{kh}^{s} = \sum_{s}\sum_{i}\sum_{h}(\theta_{i} - t_{i}^{s}) S_{ikh}^{s} \qquad (23)$$

(23) implies that equality between the two net social marginal utilities (i.e. $\tilde{b}^{s}_{1h} = \tilde{b}^{s}_{2h}$) is consistent with equality between federal and provincial taxes (i.e. $\theta_{i} = t^{s}_{i}$)

Using the definition of $\tilde{b}^{s}_{1h}$, $\tilde{b}^{s}_{2h}$, the conditions for optimal lump sum taxes become

$$\sum_{s}\sum_{h} \tilde{b}^{s}_{1h} = S$$

$$\text{i.e. } \bar{\tilde{b}}_{1} = 1 \qquad (24)$$

$$\text{and } \tilde{b}^{s}_{2} = 1 \text{ for all } s \qquad (25)$$

Lump sum taxes in the decentralised federal model, by equating to unity the mean values of $\tilde{b}_1$ (over all individuals and provinces) and $\tilde{b}_2^s$ (in each province s), thus, perform a role similar to that in the unitary State model. Assuming that federal and provincial tax authorities have no income distributional preferences, i.e. $\tilde{b}^s_{1h}$, $\tilde{b}^s_{2h}$ are invariant to h, then using the same argument as advanced in the traditional case, it follows from (21, 22) that the availability of individualised lump sum taxes by the federal and provincial authorities implies that $\theta_i = t^s_i = 0$, i.e. no commodity taxes need to be employed. The reader can verify that the presence of lump sum taxes $\{\tilde{l}, l^s\}$ in the centralised federal framework of Section II implies that effective tax $\tilde{t}^s_i = \theta_i + (\mu^s/\lambda)\ t^s_i$ is zero. This does not necessarily imply that $\theta_i = t^s_i = 0$, merely that federal and provincial taxes are proportional across commodities. The traditional unitary State model is, thus, closer to the decentralised federal model rather than to the centralised version where individually tailored lump sum taxes do not necessarily imply the absence of commodity taxes. Unlike in the centralised federal State, the federal resource constraint multiplier, λ need not lie between the minimum and maximum values of the provincial resource constraint multiplier μ^s.

IV. Optimal Commodity Tax Estimates Under Alternative Models of Fiscal Federalism

We now show how the theory outlined above can be made operational and the analytical result of Proposition I checked from actual tax data. This section proposes and applies a computational algorithm to calculate optimal commodity taxes under the alternative models of fiscal federalism considered above. We extend the optimal tax algorithm proposed in Murty and Ray (1989) in the context of a unitary State. The computational procedures are based on a federal extension of the analysis of marginal tax reform provided in Ahmad and Stern (1984).

The central concept behind the proposed procedure is the 'social marginal cost' of public funds generated via increase in the ith commodity tax. If we denote the social marginal cost for federal and provincial government funds by λ_i and $\mu^s{}_i$, respectively, then in the centralised federal case these are given by

$$\lambda_i = - \frac{\delta\psi}{\delta\theta_i} / \frac{\delta R^o}{\delta\theta_i} \qquad (26a)$$

$$\mu_i^s = - \frac{\delta\psi}{\delta t_i^s} / \frac{\delta R^s}{\delta t_i^s} \qquad (26b)$$

$$s = 1,\ldots,S$$

where Ψ has been defined in (1). We can interpret λ_i as the marginal social cost of raising an extra unit of federal revenue from increasing the federal tax on good i; the numerator in (26a) represents the welfare cost of a unit change, and the inverse of $\delta R^o/\delta\theta_i$ tells us the magnitude of the change in θ_i required to raise one extra unit of federal revenue. If $\lambda_i < \lambda_j$, then we increase welfare at constant revenue by increasing θ_i and decreasing θ_j, and the reverse if $\lambda_i > \lambda_j$. A similar interpretation holds for $\mu^s{}_i$, and we have a corresponding analysis of marginal provincial tax reform based on a comparison of $\mu^s{}_i$, $\mu^s{}_j$. Optimality requires that λ_i and $\mu^s{}_i$ are independent of i.

The computational procedure is based on the simple rule that items with an above average marginal social cost of raising revenue have their taxes lowered, and increased otherwise. The principle is adhered to in successive iterations which recalculate the simulated demand levels and elasticities at post iteration prices. Optimal commodity taxes are obtained on convergence i.e. when the marginal social cost of all items are equal. As shown in Murty and Ray (1989, p.661-62), the optimal taxes are revenue neutral with respect to the set of initial taxes.

The computational algorithm is given by

$$\begin{bmatrix} \Delta\theta_i \\ \Delta t^1_i \\ \text{--------} \\ \Delta t^S_i \end{bmatrix} = \begin{bmatrix} k & 0 & & 0 \\ 0 & k & & 0 \\ \text{----} & \text{----} & \text{----} & \text{----} \\ 0 & & & k \end{bmatrix} \begin{bmatrix} \bar{\lambda} - \lambda_i \\ \bar{\mu}^1 - \mu^1_i \\ \text{--------} \\ \bar{\mu}^S - \mu^S_i \end{bmatrix}$$

$i = 1, \ldots n$ (27)

where the Δ operator denotes tax changes between successive iterations. $\bar{\lambda}$, $\bar{\mu}^s$ denote means over items in each iteration and k (> 0) denotes step length fixed exogenously for a particular set of calculations.

In the centralised federal case, the expressions for λ_i, μ^s_i, expressed in terms of social welfare weights and price elasticities, are given by

$$\lambda_i = \frac{\sum_s \sum_h w^s \beta^s_h x^s_{ih} - \sum_s \sum_h \sum_j \mu^s_j t^s_j e^s_{ji} \left(\frac{X^s_j}{p^s_i}\right)}{\tilde{X}_i + \sum_s \sum_j \theta_j e^s_{ji} \left(\frac{X^s_j}{p^s_i}\right)} \qquad (28a)$$

$$\mu_i^s = \frac{w^s \sum_h \beta_h^s p_i^s x_{ih}^s - \lambda^s \sum_j \theta_j e_{ji}^s X_j^s}{p_i^s X_i^s + \sum_j t_j^s e_{ji}^s X_j^s} \qquad (28b)$$

where h denotes individual, $\tilde{\beta}^s{}_h$ is 'social marginal utility' of income of h in province s as evaluated by that provincial authority, w^s is province s's welfare weight to the federal authority, and $e^s{}_{ji}$ is the aggregate price elasticity in province s. $X^s{}_i$ is aggregate demand for i in province s, and $\tilde{X}_i = \sum_s X^s{}_i$ is the total demand for item i in the nation as a whole. Note that $\beta^s{}_h = w^s \tilde{\beta}^s{}_h$ is the social marginal utility of income of h in province s as evaluated by the federal authority. The welfare weight depends not only on the planner's "inequality aversion" to income disparities between individuals within the province but, also, on economic disparities between provinces.

The corresponding expressions for the social marginal cost parameters in the decentralised case are given by

$$\lambda_i = \frac{\sum_s \sum_h w^s \beta_h^s x_{ih}^s}{\tilde{X}_i + \sum_s \sum_j \theta_j e_{ji}^s \frac{(X_j^s)}{p_i^s}} \qquad (29a)$$

$$\mu_i^s = \frac{\sum_h \beta_h^s p_i^s x_{ih}^s}{p_i^s X_i^s + \sum_j t_j^s e_{ji}^s X_j^s} \qquad (29b)$$

$$s=1,\ldots,S$$

Given initial values of taxes, estimates of demand parameters, data on expenditure distribution, a priori chosen value of the 'inequality aversion' parameter ϵ, equation system (27), used in conjunction with (28 a, b) or (29a, b) yields on convergence the full set of optimal federal and provincial taxes that are revenue neutral with respect to the set of initial taxes. We ensured that the illustrative optimal tax estimates for India reported below are truly optimal by checking their invariance to alternative sets of revenue neutral taxes as starting values, and to the step length k.

The data base for this study is the table of urban consumer expenditure in the 38th round of the National Sample Survey (1983-84) available in Government of India (1986). The fifteen major provinces, arranged alphabetically and the corresponding actual provincial commodity tax rate on the assumption of uniformity, and the federal tax rate are presented in Table 1. These are used as starting values in the optimal tax calculations. Table 2 presents the estimates for the provinces of Bihar and Andhra Pradesh - see Murty and Ray (1990) for estimates for all the provinces. The results establish sensitivity of optimal taxes to federal specification. They also confirm that, unlike in the centralised case, under decentralised fiscal federalism, the shadow price of federal revenue need not lie between the minimum and maximum values of the shadow price of revenue of the constituent provinces of the federal Union.

V. Optimal Commodity Taxes Under Resource Transfer in Decentralised Federal Model

A significant federal characteristic is resource transfer from the Centre to the constituent provinces.[5] In India, the Centre-State financial relations are characterised by a significant share of Central tax revenue that is returned to the States on the recommendation of the Finance Commission [see

[5] See Murty and Nayak (1989) for a discussion of the criteria for Centre - province resource transfers in developing countries.

Gulati and George (1988, Ch.2) for details]. Criteria such as population, reciprocal per capita income, tax effort etc. are used to distribute the aggregate resource transfer among the individual States. During 1979-89, 40 to 45% of Central tax revenue was to be distributed among the States.

In the following discussion, we extend the non co-operative model to admit resource transfer from the Centre to the provinces. Let ϕ^s denote provinces' share of federal taxes, so that $\phi = \sum_{s=1}^{S} \phi^s$ denotes the provinces total share of federal tax revenue. The federal and provincial resource constraints now become

$$R^o \leq HS\bar{I} + (1-\phi) \sum_{h=1}^{H} \sum_{i=1}^{n} \sum_{s=1}^{S} \theta_i x_{ih}^s \qquad (30a)$$

$$R^s \leq Hl^s + \sum_i \sum_h t_i^s x_{ih}^s + \phi^s \sum_h \sum_i \sum_s \theta_i x_{ih}^s \qquad s=1,\ldots S \qquad (30b)$$

In Lagrangean terms, therefore, the decentralised procedure involves separate maximisation of L_1, L^s_2 with respect to $(\theta_i, \bar{l})$ and (t^s_i, l^s), respectively, where

$$L_1 = \psi(W^1,\ldots,W^S) + \lambda\{HS\bar{I} + (1-\phi)\sum_s \sum_i \sum_h \theta_i x_{ih}^s - R^o\} \qquad (31a)$$

$$L_2^s = W^s(p,M) + \mu^s\{Hl^s + \sum_i \sum_h t_i^s x_{ih}^s + \phi^s \sum_h \sum_i \sum_s \theta_i x_{ih}^s - R^s\} \qquad (31b)$$

The expressions for 'social marginal cost' of public funds now become

$$\lambda_i = \frac{1}{1-\phi} \frac{\sum_s \sum_h w^s \beta_h^s x_{jh}^s}{\bar{X}_i + \sum_s \sum_j \theta_j e_{ji}^s \left(\frac{X_j^s}{p_i^s}\right)} \qquad (32a)$$

$$\mu_i^s = \frac{\sum_h \beta_h^s p_i^s x_{ih}^s}{p_i^s X_i^s + \sum_j (t_j^s + \phi^s \theta_j) e_{ji}^s X_j^s}$$

$$s=1,\ldots,S \qquad (32b)$$

Assigning a priori value to the resource transfer parameter, ϕ, and assuming the provinces share of federal commodity tax revenue to be distributed in the given proportions, optimal federal and provincial commodity taxes are computed for the non co-operative model. Tables 3, 4 present comparative tax estimates for all the fifteen provinces without ($\phi = 0$) and with resource transfer. The tables reveal remarkable insensitivity of the tax magnitudes to resource transfer. Of related interest is the ranking of the provinces on the basis of their marginal social cost of tax revenue (μ^s). These rankings are also, robust to resource transfer.

VI. Summary and Conclusion

In designing tax rules within the framework of a unitary State, the traditional optimal commodity tax literature overlooks the possibility of fiscal federalism. As there are several major countries in the world with a federal structure and, with the forthcoming economic integration of the member States of EEC, interest in designing commodity taxes and tax reform in the federal context has taken on a special policy significance. The chief motivation of this paper is to extend the traditional unitary State framework in calculating optimal commodity taxes to meet the peculiar characteristics of a federal nation. Alternative models of fiscal federalism, based on centralised or fully coordinated decisions between federal and provincial authorities, and decentralised or non-cooperative behaviour are introduced, and their analytical implications for optimal taxes examined. As the empirical evidence for India shows, the structure of federal and provincial taxes are sensitive to federal specification. The paper develops the non cooperative model to incorporate resource transfer from the Centre to the constituent provinces. Illustative empirical evidence shows, however, that the optimal tax magnitudes are quite robust to the resource transfer parameter.

A secondary contribution of this paper is to propose and apply simple iterative procedures for the calculation of optimal commodity taxes in the federal model. Illustrative calculations on Indian budget data demonstrate success of the procedures in disaggregating the federal and provincial components of optimal commodity tax.

Table 1

List of States and the Initial Taxes[a]

Number (s)	State	t^s	
1.	Andhra Pradesh	0.18	
2.	Assam	0.09	
3.	Bihar	0.08	
4.	Gujarat	0.24	
5.	Jammu & Kashmir	0.18	
6.	Karnataka	0.32	$\theta = .08$
7.	Kerala	0.22	
8.	Madhya Pradesh	0.19	
9.	Maharashtra	0.24	
10.	Orissa	0.12	
11.	Punjab	0.22	
12.	Rajasthan	0.10	
13.	Tamil Nadu	0.26	
14.	Uttar Pradesh	0.10	
15.	West Bengal	0.15	

a. As reported in the text the initial taxes are assumed to be uniform i.e. $t^s_i = t^s$, $\theta_i = \theta$ for all i.

Table 2

Optimal Commodity Taxes Under Alternative Federal Models[(a)]

(ϵ = 2.0)

Commodities	Fully Co-ordinated			Non Co-operative		
	θ_i	t^1_i	t^2_i	θ_i	t^1_i	t^2_i
1. Cereals	-.027	-.003	.050	-.119	-.066	-.012
2. Milk and Milk Products	.110	.133	.217	.137	.135	.237
3. Edible oils	.073	.087	.171	.047	.070	.155
4. Meat, Fish and Eggs	.094	.100	.192	.088	.101	.193
5. Sugar	.071	.095	.174	.045	.069	.154
6. Other food	.086	.102	.182	.071	.088	.178
7. Clothing	.133	.142	.246	.179	.163	.272
8. Fuel and light	.047	.070	.138	-.006	.029	.104
9. Other non-food	.121	.138	.224	.158	.149	.254
	λ	μ(min.)	μ(max.)	λ	μ(min.)	μ(max.)
λ	.168	.143	.206	.141	.146	.198

(a) Province 1 is Bihar, Province 2 is Andhra Pradesh.